Manor Top Feasibility Study

Report for Sheffield City Council

December 2006

mvaconsultancy

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Document Control

Project Title:	Manor Top Feasibility Study
MVA Project Number:	C34881
Document Type:	Report
Directory & File Name:	M:\Tp\C34881 Manor Top Supermarket\Word\Finalreport\Main Report.Doc

Document Approval

Primary Author:	Tony Barker
Reviewer(s):	John Allan
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Formatted by:	Tony Barker

Distribution

Issue	Date	Distribution	Comments
1	04/12/2006	Sheffield City Council	Initial Draft
2	11/12/2006	Sheffield City Council	Final Draft
3	15/12/2006	Sheffield City Council	Final Version

Summary

In 2006 EDAW, in association with King Sturge and Faber Maunsell produced a report, entitled "Transforming Manor Top into a 'Beacon' District Centre for South Sheffield". The report seeks to provide a solution to reverse the predicted cycle of decline at Manor Top and regenerate the area. The main recommendation is to attract a major food retailer to develop a supermarket on the current Territorial Army Site, establishing Manor Top as a 'Beacon' District Centre.

At Manor Top Sheffield Supertram intersects a key radial route serving Sheffield (City Road) and a major relief road (the Outer Ring Road). The junction suffers from heavy congestion in the peak periods, leading to a concern that any development in the area would lead to increased journey times through the area and possible rerouting onto other less suitable roads.

This study was commissioned by Sheffield City Council to gain an understanding of the effect such a development would have on the surrounding road network. We have used the 2006 Sheffield District highway model, adjusted to include appropriate trips to and from the development. We have then looked at key statistics which provide an indication of both the effects the development have on the network and the relative merits of the options modelled. These indicators include the increased journey times through the junction on the main routes along with the traffic levels on those routes. We have also considered both the local and network-wide rerouting that occurs as people seek to find a quicker route between their origin and destination.

In observing the effects on the network, we have modelled various options that attempt to reduce the impact of the proposed development on the road network. The changes that can be made to the road network surrounding the development are limited due to the presence of the Supertram and the available space that exists. The existing gyratory layout is considered efficient at providing close to the maximum capacity given the demand and space available. The options largely deal with signal timing changes as well as attempts to provide improved crossing opportunities for pedestrians.

We have estimated the effect of the modelled options on pedestrians by looking at the delays experienced when crossing the various stages of the junction. It is important to stress however that this analysis, as with the other local indicators, provides only an indication of the likely effects as the impact will change as a result of the detailed design of any alterations which is outside the scope of this study.

We conclude that a major development situated so close to the intersection of a key strategic route for Sheffield and a well-used main road will have a major impact on traffic conditions. Large volumes of existing traffic will reroute (both widely onto other strategic routes and locally onto residential streets) whilst the remaining traffic and the new development traffic will encounter larger queues and delays at the junction.

The modelling indicates that without any measures to mitigate the impact of the development, an extra 300 person-hours will be spent travelling during each weekday evening between 5pm and 6pm. This equates to around £600,000 of disbenefits per year in the evening peak alone. Around 4,000 extra vehicle kilometres will be travelled as a result of rerouting, equating to an extra £60,000 spent in fuel alone. An extra 600kg of Carbon Dioxide will be produced by vehicles each weekday evening between 5 and 6pm.

Measures can be taken to mitigate the impact of the development in the area, both by reducing the number of trips to the development and managing the extra demand in the area. However,

our modelling suggests that irrespective of the measures that are introduced, such a development will have a significant negative impact on the traffic conditions in the area.

The impact of the development on pedestrians will be governed by the detailed design of any alterations in the area. However our modelling indicates that it is likely that the effect on pedestrian journey times will be minimal given thoughtful design.

This report has been a feasibility assessment and whilst the analysis is based on a calibrated and validated strategic model, further detailed analysis of both Manor Top and the key junctions which receive the rerouted trips on Sheffield and Mosborough Parkway is needed. This will also provide the evidence to demonstrate that the internal operation of the gyratory is viable and does not become gridlocked at peak times.

1 Background

1.1 The Current Situation at Manor Top

1.1.1 The South Sheffield Area Development Framework (ADF) Service Centres Report considered Manor Top to be at risk of a cycle of decline due to the following factors:

- limited retail offer compared to nearby centres such as Crystal Peaks;
- substantial leakage of spend to other areas;
- severance caused by the outer ring road and the tram lines;
- limited car parking spaces; and
- the size of current retail outlets.

1.2 Transforming Manor Top

1.2.1 In 2006 EDAW, in association with King Sturge and Faber Maunsell, produced the report entitled "Transforming Manor Top into a 'Beacon' District Centre for South Sheffield". The report seeks an outline masterplan for Manor Top which will address the current issues and provide a solution which will:

- change people's current perception of Manor Top as an out-of-date centre;
- increase spend retention within the South Sheffield ADF;
- attract spend from a wider catchment;
- provide training and employment opportunities for local people;
- improve choice of goods and facilities in the area; and
- make the area attractive as a location of choice for middle and higher income households.

1.2.2 Using the Seacroft Development in Leeds as a case study, the report recommends the attraction of a major food store operator as an anchor facility for the expansion of Manor Top as a District Centre and the wider regeneration of South Sheffield. It is proposed that the development includes improved pedestrian links to prevent severance and an improved public transport interchange.

1.2.3 Several locations have been considered by the Sheffield City Council Regeneration Team, however the current Territorial Army Site at Manor Top is considered the most suitable.

1.3 The Potential Problems

1.3.1 Sheffield City Council commissioned MVA Consultancy to evaluate the effects that a major supermarket development at Manor Top may have on the surrounding road network. The area is currently considered congested during peak periods and there is a concern that a development of such a size may lead to increased delays for vehicles at Manor Top or significant rerouting of vehicles which may cause congestion on other parts of the road network.

1.3.2 This report presents our analysis performed using the 2006 Sheffield District SATURN model that has been tailored for the local area surrounding Manor Top. It shows the effects the trips attracted to the development is expected to have on both the local junctions and the wider network. We have considered and modelled several network enhancements in an attempt to mitigate the effects of the development.

It is important to note that this is an initial feasibility study. Many of the effects we have assessed both quantitatively and qualitatively are indicative only. In particular, the detailed effects on local junctions will need to be assessed further during the detailed design stage using dedicated traffic engineering design tools.

1.4 Site Specification

1.4.1 The development has been specified as having 90,000 sq-ft of gross floor area. This was revised from the study brief which stated 80,000 sq-ft of retail floor area with 400 parking spaces, attracting around 10,000 vehicle trips per day. We have therefore adjusted the required capacity of the car park and estimated vehicle trips per day accordingly.

1.5 Site Location

1.5.1 The red dot in Figure 1.1 shows the location of the proposed development site in relation to the City of Sheffield. The site is currently a Territorial Army (TA) base and is located at Manor Top, close to the very busy Outer Ring Road/City Road junction. Figure 1.2 shows a more detailed location of the site. It is bound by Mansfield Road, Hurlfield Road, Ridgeway Road and Newlands Road.

1.5.2 The yellow shaded area in Figure 1.2 is the current TA site which may be large enough to contain the entire new development. However, if more land is required, there is the possibility of relocating the Day Care Centre which is adjacent to the TA site (shaded green in Figure 1.2).

Figure 1.1 The Location of the Proposed Development

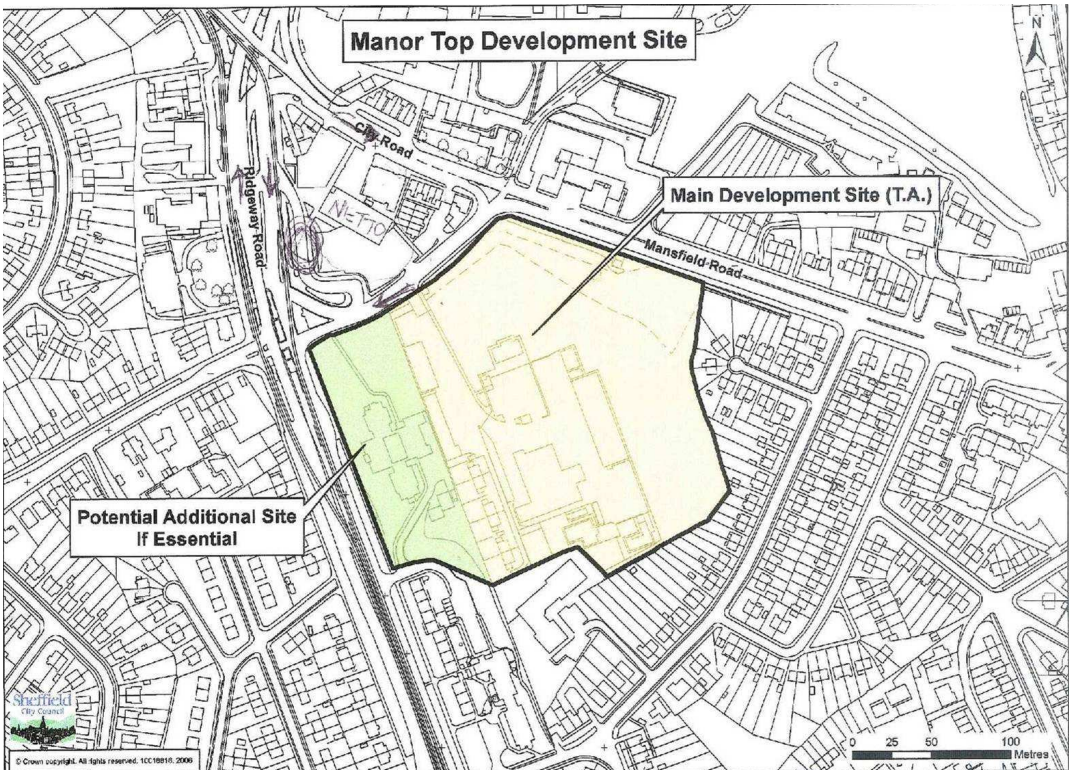


Figure 1.2 The Plan of the Proposed Development

2 The Base Model

2.1 Introduction

2.1.1 We used the 2006 Sheffield District SATURN Model to assess the effect of the development. SATURN is well suited to assessing the effect of developments and network changes on the wider network.

2.1.2 We have examined the worst case traffic conditions on the surrounding network, which is when the supermarket's busiest time coincides with the busiest time on the road network. This is during the peak hour on a Friday evening. Whilst Saturdays may attract more trips to the development, the level of congestion on the surrounding road network is expected to be lower due to the lower background flows on the network.

2.2 Network Refinement

2.2.1 We needed to add detail in the network around Manor Top for two key reasons:

- the District model does not contain very many minor roads which can be used as rat-runs which will affect local routing; and
- several turning movements at each junction in the area are represented by a single node in the District model which, whilst providing acceptable modelling at a district wide level, lacks some of the subtleties of lane choice and distances that affect the model on a local level.

2.2.2 The network refinement resulted in over one hundred new nodes being added to the network. More details can be found in Appendix A.

2.3 Zone Refinement

2.3.1 As well as refining the network to enable us to model the local rerouting effects, we refined the zone system in the area. This was done for the following reasons:

- to represent the new development;
- to match the level of detail provided by the network added to represent minor roads; and
- to provide zones which wholly include sites that are ear-marked for future development.

2.3.2 The zone refinement resulted in an extra ten zones being added to the model. More details can be found in Appendix A.

2.4 Mansfield Road Bus Lane

2.4.1 There is a bus lane on Mansfield Road in the westbound direction. In order to calibrate the model correctly, we removed the bus lane and modelled the link as two lanes for all traffic. This was because the bus lane is not currently enforced and is poorly observed by cars.

Sheffield City Council intend to strictly enforce bus lanes in the area as part of any future highway works. Therefore we included the bus lane in the testing options.

2.5 Data Collection

2.5.1 We needed to collect further data in the area in order to provide as accurate a representation of the current conditions as possible. We collected the following sets of data:

- ten manual traffic counts to compare with the flows in the model;
- five automated traffic counts to monitor the variance in traffic levels throughout the week;
- pedestrian crossing counts at the main City Road/Ring Road junction; and
- outputs of traffic signal timings to put into the model to help mirror the signal stages and timings during the evening peak on a typical Friday.

2.6 Local Model Calibration

2.6.1 Calibration involves comparing the assigned traffic and conditions in the model to those in reality and adjusting both the network and demand matrices so the two match as closely as possible. This is necessary to ensure that both the network and demand matrices represent reality accurately so that changes made to the model result in realistic changes in traffic conditions on the network.

2.6.2 We calibrated the model locally for two reasons:

- the base model was calibrated for Sheffield as a whole and in doing so, it may be that the validation around Manor Top is not as tight as it could be; and
- in adding detail to the network the network is effectively changed and therefore the validation can deteriorate.

2.6.3 More details on the local calibration of the model can be found in Appendix B.

3 Trip Distribution and Car Park Occupancy

3.1 Introduction

3.1.1 In order to assess the effect the development will have on the road network, it is necessary to estimate the number of trips that the development will attract and also where they will come from.

3.1.2 We estimated the number of trips the development will attract by using the planned gross floor area along with trip rates actually observed at similar developments that already exist. We considered the trips that will be generated specifically on a Friday between 5pm and 6pm (in line with the modelled hour) as well as for each hour during a typical Friday and Saturday (to provide the car park occupancy profile).

3.1.3 We estimated the distribution of the trips by considering the trips to be made up of pass-by trips (people which currently pass by the supermarket and will call in to shop) and round trips (people who make a special trip to shop). These types of trips have different characteristics to each other and are dealt with in different ways.

3.2 Trips Attracted by the Development

3.2.1 The supermarket is now expected to have 90,000sq-ft (8,361m^2) of gross floor area. This was updated from the 80,000sq-ft of retail floor area stated in the brief.

3.2.2 The TRICS database contains details of actual arrivals and departures observed by surveys at a range of differing sites (in terms of both land usage *and* size) across the country. Since trip rates per 100m^2 tail off as floor space increases, we limited our search in the database to supermarkets with gross floor area of between 6,000 m^2 and 10,000 m^2. Table 3.1 shows the trip rates obtained from the database, while Table 3.2 shows this translated into actual trips expected for the development.

Table 3.1 Trip Rates Obtained from TRICS for Fridays (per 100m^2 GFA)

Time Period	Arrivals	Departures
5-6pm	6.42	6.65
24 hours	82.62	83.14

Table 3.2 Expected Trips Attracted by Development on a typical Friday

Time Period	Arrivals	Departures
5-6pm	537	556
24 hours	6,907	6,952

3.3 Distribution of Trips

3.3.1 We separated the trips that are likely to be attracted by the development into two categories:

- pass-by trips – people who currently pass by the site and will in future do their shopping and then continue on their original journey; and
- round trips – people who make a special trip from home to the supermarket and return home immediately afterwards.

We considered both types of trips separately as they have different characteristics.

3.3.2 We used the 2005 and 2006 survey data for Rotherham and Sheffield to obtain data regarding the likely origin and destination purposes of shoppers in the evening peak. The proportions of purposes are shown in Table 3.3 and Table 3.4.

Table 3.3 Origins of People arriving to Shop

Origin	Proportion
Home	65%
Work	18%
Other	17%

Table 3.4 Destinations of People after Shopping

Destination	Proportion
Home	83%
Work	1%
Other	16%

Pass-By Trips

3.3.3 Table 3.3 shows that 18% of shopping trips in the evening peak are people originating from work, most likely breaking up a work-to-home (commute) trip. Therefore, we expect around 98 trips (18% of the shopping trips expected) trips to be pass-by commute trips.

3.3.4 Our approach was to look at the origins and destinations of the trips that currently pass nearby the site and factor them to the appropriate number of pass-by trips we expect (98). We then split the trips into two – a work-to-shop trip and a shop-to-home trip. The technique we used to analyse the trips which pass nearby the site is called Select Link Analysis. We performed this on both Mansfield Road and Ridgeway Road, analysing commute trips only.

Round Trips

3.3.5 The number of round trips we expect to be attracted to the development is the total number of trips, less the 98 pass-by trips. We estimated how many of these trips come from each zone in the model by using a gravity model. A gravity model produces its estimate from two key attributes of each zone: the number of people who live in the zone and its distance from the supermarket. More residents implies more trips, whereas a larger distance implies fewer trips. We calibrated the gravity model by using the trip length distribution for shopping trips observed in the Roadside Interview Surveys (RISs) from which we built the SATURN model. Figure 3.1 shows the this trip length distribution.

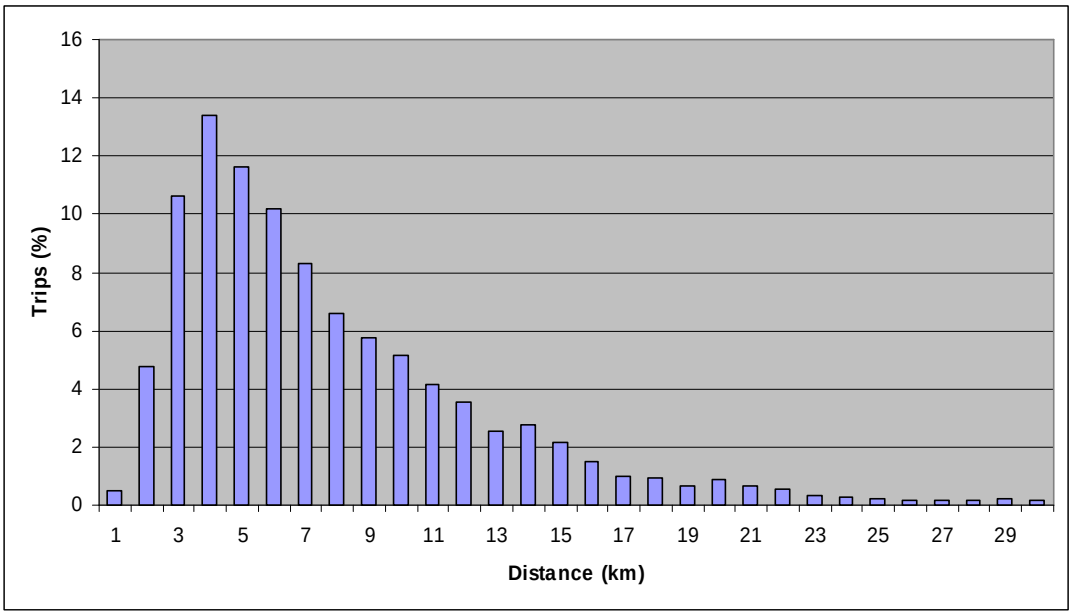


Figure 3.1 Trip Length Distribution for Shopping Trips obtained from RISs

3.3.6 The trips to the supermarket are unlikely to be brand new trips; they are more likely to be trips that have changed destination from a competing shop because building a new supermarket does not increase people's need to eat. We therefore constrained the matrix to maintain the overall number of trips that people make. What did change was their destination. The commute trips that we dealt with in the previous section were excluded from this process as they were already treated in the most appropriate manner.

Combining the Trips

3.3.7 We added the trips created from the old pass-by commute trips to the "Shop" matrix. The only increase in the number of trips in the matrix was a result of splitting the work and home trips into two separate trips. Whilst these trips will double in number, the change itself will have negligible effect on the total vehicle-kms in the model.

3.4 Car Park Occupancy

3.4.1 In order to provide an estimated car park occupancy profile we used the TRICS database to estimate the hourly arrivals and departures that the development will attract. Over the 24

hour period of the surveys in the database, the arrivals and departures do not exactly match. We factored the departures each hour so that the car park occupancy at the end of the 24 hour period matched that at the beginning. We used an approximation that at 3am there are a nominal amount of spaces occupied: we assumed 20.

3.4.2 As we expect the capacity of the car park to be critical on Fridays and Saturdays, we estimated the occupancy on both these days. Tables C1 and C2 in Appendix C show the expected arrivals and departures along with approximate car park occupancy on Fridays and Saturdays respectively. The grey shaded line indicates the figures for the modelled hour on a Friday whilst the violet shaded lines highlight the maximum occupancy on both days. The tables show that the peak occupancy is around 500 and is expected to occur between 11am and 12pm on a Saturday.

3.4.3 It is important to note that this is the expected occupancy for an *average* Saturday. Demand is likely to exceed this during, for example, the weeks leading up to Christmas. If the demand for parking spaces exceeds the car park capacity, then cars will queue out of the car park and onto the highway, blocking back junctions and causing major congestion for other vehicles in the area.

4 Site Size and Access

4.1 Site Size

4.1.1 A gross floor area of 90,000 sq-ft relates to approximately 8,400m^2.

4.1.2 We have established that the peak car park occupancy is around 500 spaces on a Saturday. As previously discussed, this is the occupancy for an average Saturday so we should be cautious and estimate for around 600 spaces. On average each car park space requires around 25m^2 of land. For 600 spaces this totals 15,000m^2.

4.1.3 In total, the actual supermarket and car park will therefore require around 23,400m^2 of land. which is over 10,000 m^2 less than the main development site area of 34,000 m^2. However the area of land required does not take into account the area required for landscaping, access roads (for both cars and goods vehicles) and areas of land that cannot be developed. Whilst without detailed design work we cannot estimate the land required for these works, it is not out of the question that the entire development will fit on the site without the need to relocate the Day Care Centre.

4.2 Site Access

4.2.1 The Territorial Army Training Centre currently has one access from Hurlfield Road (marked 1 in Figure 4.1), directly opposite the access to Netto. We have considered the following other potential access options:

- multiple entry and exit accesses for cars;
- car access from Mansfield Road (marked 2 in Figure 4.1);
- car access from Newlands Road (3); and
- car access from Ridgeway Road (4).

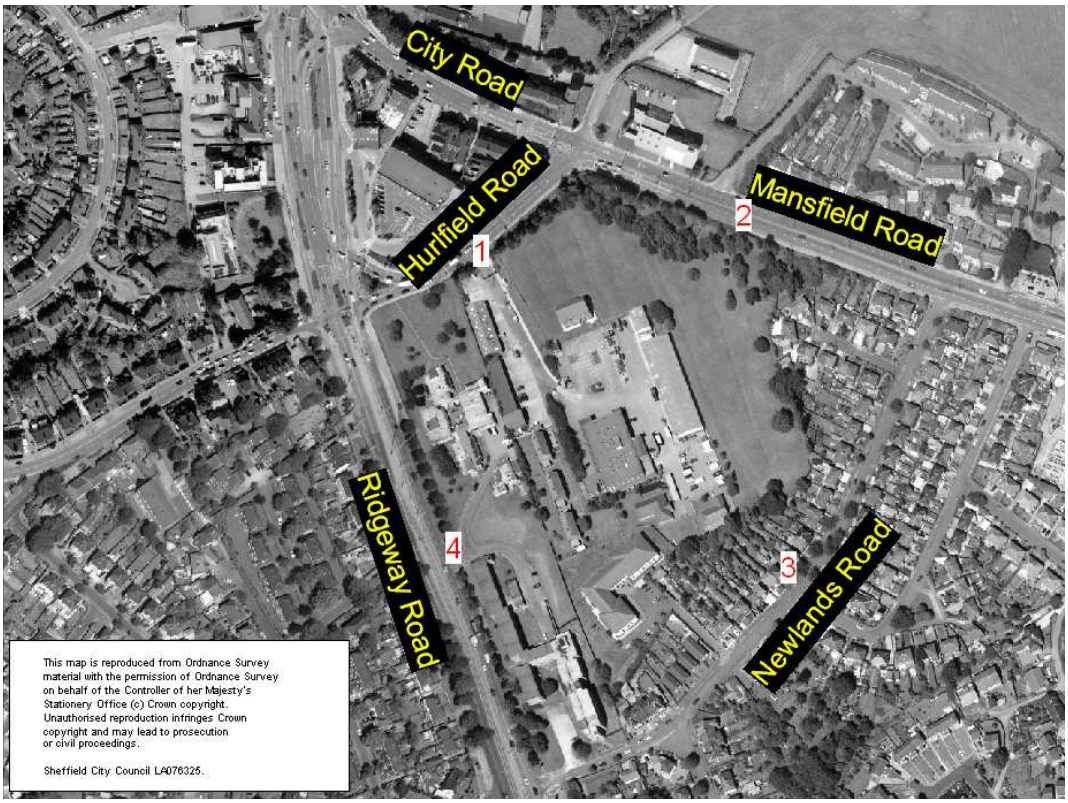


Figure 4.1 Existing and Potential Access Points to the Development Site

4.2.2 It is likely that an operator interested in a supermarket of this size will desire a petrol filling station to be part of the plans. The operator would prefer customers to drive past the petrol station on their entry and exit therefore maximising their opportunity to buy petrol. We decided that this would most likely lead to a single entry/exit access for cars.

4.2.3 We considered a car access from Mansfield Road infeasible due to its close proximity to other major road junctions. There would be limited storage capacity for cars waiting to turn into the development without queues blocking back across the adjacent junctions. Also the access is in a location in relation to the gyratory which would cause inconvenience in the routing of cars at this end of their journey. Eastbound traffic on Mansfield Road turning into the development would be opposed by westbound traffic and cause further delays to traffic outbound from Sheffield.

4.2.4 Car access from Newlands Roads is not feasible. Not only do houses lie inbetween Newlands Road and the development but this street is a residential street and attracting large volumes of traffic would be undesirable

4.2.5 The Supertram would cause conflict with a car access from Ridgeway Road. Traffic would be hindered getting across the road and also the Supertram gains partial priority at the traffic signals.

4.2.6 Having considered the other potential access points from the surrounding roads, we conclude that the most suitable form of access would be a single access for cars (customers and staff) somewhere on Hurlfield Road (most likely but not limited to being near to the current TA Site

access). A separate access for goods vehicles would be desirable and would be most suitably located on Mansfield Road.

5 Highway Improvements

5.1 Introduction

5.1.1 We expect the effect of the development will be to attract traffic to the area, causing mainly rerouting of traffic away from the area (as the junction is currently operating near capacity in the evening peak) along with a little increased queuing. We have considered several improvements to the road network that could help mitigate the effect of the extra trips in the area, many of which were recommended in the EDAW Report.

5.1.2 As with the improvement of an *existing* highway network, there are many restrictions on what can be practically implemented on the ground. We have detailed the main restrictions on improvements at Manor Top in Appendix D and have described several suggested improvements that we deemed not feasible from the outset. The remaining options which we have modelled in detail are as follows:

- the base scenario;
- the do minimum option;
- full pedestrian crossing green time;
- a full pedestrian crossing facility on Ridgeway Road;
- allowing eastbound traffic on Hurlfield Road; and
- several different signal timings options.

5.2 Base Scenario

5.2.1 We locally calibrated the 2006 SATURN model in the Manor Top area. More details of this process can be found in Appendix B. We assigned the demand matrix to the network which represents the current traffic conditions on the road network. This base scenario can be used as part of a "before and after" comparison.

5.3 Do Minimum Option

5.3.1 This option represents the conditions that will occur if the development takes place and no further highway improvements are made. We added expected demand for the supermarket but also removed existing demand which will help account for the shopping trips being redistributed from elsewhere: we do not expect people to shop more because a new store has opened, rather they will change the location of their shopping. More details on the trip generation and distribution can be found in Section 3.

5.3.2 The only changes we made to the network were to reintroduce the westbound bus lane on Mansfield Road and model a signalled junction at the entrance to the development. We assumed that for any development, there would have to be a suitable entry and exit junction to cope with the arrivals and departures expected, without causing congestion on the road network. We assumed that two lanes both for entry and exit would provide enough capacity for the arrivals and departures at the development.

5.4 Full Pedestrian Green Time

5.4.1 This option was suggested in the EDAW report and covers the possibility of providing exclusive pedestrian movement around the main junctions. We estimated that the maximum distance this would involve for a single pedestrian movement would be around 30 metres, being the Mansfield Road arm by the junction with City Road. Other arms range from 15 to 25 metres wide. **It must be noted that current guidelines advise against single pedestrian movements being over 15m long without making the movement staggered and containing a central refuge.**

5.4.2 Sheffield City Council's UTC team estimated that a 30 metre crossing would require approximately 45 seconds of clearance time (the time between the green man extinguishing and green time being given to vehicles). A best case option (for traffic) would be to give pedestrians 5 seconds of green man time, therefore making a total pedestrian stage of 50 seconds. Clearly 50 seconds is far too high a proportion of a 70 second cycle, and after discussions, we decided that the most likely option would be to model a 120 second cycle, with the existing 70 seconds given to vehicles and the extra 50 seconds being reserved for the exclusive pedestrian time. This is against our belief that the cycle time should remain at 70 seconds, however as it is a key recommendation in the EDAW report we felt it warranted being tested.

5.5 Full Pedestrian Crossing Facility on Ridgeway Road

5.5.1 The EDAW Report proposes another option for improved pedestrian facilities in the area. This is to provide a full pedestrian crossing across Ridgeway Road. It is hoped this would make using the public transport interchange more attractive and also provide a more direct crossing route for pedestrians.

5.5.2 Similar clearance timings would be required as for the Full Pedestrian Green Time option therefore we modelled a pedestrian crossing with a cycle time of 120 seconds (again against our belief in an optimum cycle time of 70 seconds), 70 to vehicles and 50 to pedestrians. It is likely during the evening peak that the pedestrian crossing will be called once per cycle. **Again it must be noted that current guidelines advise against single pedestrian movements being over 15m long without making the movement staggered and containing a central refuge.**

5.6 Allowing Eastbound Traffic on Hurlfield Road

5.6.1 This option allows traffic leaving the development to turn right onto Hurlfield Road and then right onto Mansfield Road. This means that traffic heading to a destination north east of the development will not have to either circulate the gyratory to gain access to Mansfield Road or perhaps even use Newlands Road as a rat run to avoid the congested gyratory.

5.6.2 We believe that this is the most viable of alterations that can be made to the junction as land from the development site can be used to expand the existing Highway.

5.7 Different Signal Timing Options at City Road/Ring Road Junction

5.7.1 We have modelled different options of signal timings at the City Road/Ring Road junction. This is the key junction for which delays affect the rerouting of traffic. As the cycle time and inter-green times are to remain constant, the total green time allowed to traffic must remain constant. However, we looked at a new demand and route-choice and therefore different signal timings may prove more optimal.

5.7.2 The definition of the three stages will not change: it is not possible to reduce the number of stages as all the turning movements could not be accommodated without conflict, whilst increasing the number of stages will add extra inter-green time and thus reduce the total green time given to traffic, clearly reducing capacity.

5.8 Development Traffic Reduced by 10%

5.8.1 We expected the development to have a significant impact on the surrounding network. We decided to model a scenario where the trips generated by the development were reduced by 10%. This should provide an indication of the effect of, say, reducing the floor size of the supermarket in order to reduce the impact on the surrounding network.

5.9 Combination of Options

5.9.1 Having modelled various options in isolation, we modelled a combination of favourable options to see their sum effect. The options combined to make this test were chosen after they had been modelled in isolation.

6 Public Transport

6.1 Introduction

6.1.1 Manor Top is currently well served by public transport. The Supertram links the area with Sheffield City Centre and continues to the south east along Ridgeway Road. Buses are frequent along both Ridgeway Road and Mansfield Road and a small public transport interchange on Ridgeway Road allows for easy changing of modes. However, the interchanges between buses and trams can be inconvenient as passengers may have to cross busy roads.

6.1.2 It is part of the proposal to improve public transport provision as Manor Top strives to be a leading district centre. Suggestions include providing an expanded interchange and introducing a contra-flow bus lane down the one-way section of City Road, between the Ring Road and Hurlfield Road. The provision of a Park and Ride scheme to reduce congestion in the area has also been proposed.

6.2 Contra-Flow Bus Lane on City Road

6.2.1 Figure 6.1 shows the current route for buses inbound to Sheffield along Mansfield Road. Delays are experienced by buses largely as a result of their path on Hurlfield Road. This is due to the disruption to the signal cycle caused by the Supertram on Mansfield Road. As the signals on Mansfield Road (marked "1") do not take into account the changing cycle at Hurlfield Road (marked "2"), congestion can build up on Hurlfield Road causing extra delays. It is envisaged that if a contra-flow bus lane were introduced, as shown in Figure 6.2, then these delays could be avoided, thus improving bus journey times to Sheffield.

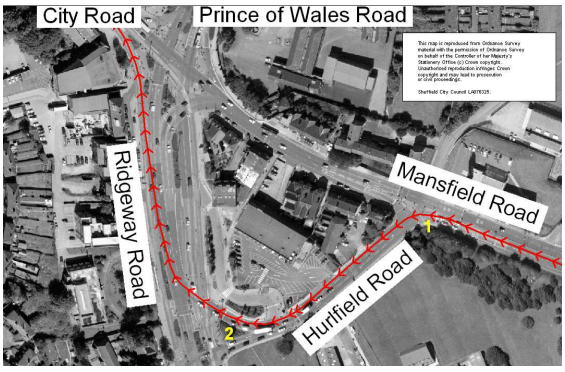


Figure 6.1 Current Bus Route

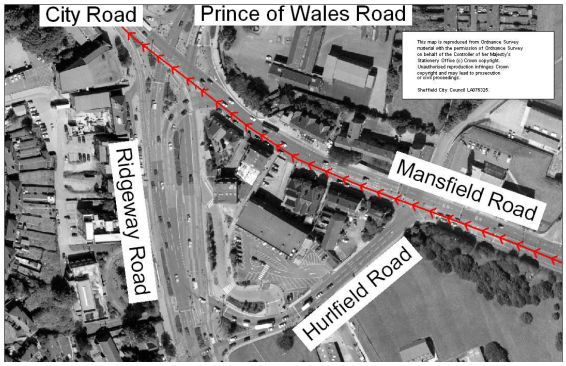


Figure 6.2 Suggested Contra-Flow Bus Route

6.2.2 The main issue that would influence the success of such an adjustment would be the physical space available on City Road. There are currently three lanes allocated to traffic eastbound. It may be possible to retain all three lanes whilst including the bus lane, however at this stage it would seem very narrow and a detailed engineering study would have to be done to confirm the feasibility of this proposal.

6.2.3 There is, however, a tighter constraint than the width of City Road at the main City Road/Ring Road junction. The contra-flow bus movement would have to use some of the highway space currently allocated to the right turners from Ridgeway Road. This could have the effect of reducing the number of lanes allocated to the right turners from two to one. At present, the capacity for this movement does not cause excessive queuing however this alteration would certainly reduce the capacity and possibly cause congestion problems.

6.2.4 The contra-flow movement would also require an extra stage in the signal sequence at the City Road/Ring Road junction which would require almost all other movements to be at red. This would reduce capacity at the junction, increasing delays even without considering the extra demand caused by the new development.

6.2.5 Introducing the contra-flow bus lane would also mean that the bus would no longer directly pass the Supertram stop. Any passengers wishing to switch from the bus to the Supertram would have further to walk, thus reducing the effectiveness of the public transport interchange.

6.2.6 The Traffic Signal Control Team at Sheffield City Council are currently working towards implementing the SPRUCE system at the gyratory. It is envisaged that the system will coordinate the traffic signals at each end of the Hurlfield Road section thus helping to reduce the blocking back that currently hinders buses' progress round the gyratory. This will decrease delays experienced by buses without having the detrimental effects caused by the contra-flow bus lane, as described above.

6.3 Improved Public Transport Interchange

6.3.1 There are currently two bus stands serving the Public Transport Interchange at Manor Top. Desire has been expressed to increase this and improve facilities at the interchange to make it more attractive to potential users.

6.3.2 The key issue with expanding the interchange in its current location is space. The current bus stands back onto the Netto car park, and therefore any expansion would require the acquisition of land from Netto. This could be both problematic and costly and so is not considered viable at this time.

6.3.3 An alternative would be to provide a brand new interchange as part of the development. Space would be less of an issue, however any benefits of the increased size of the interchange would be offset by the increased separation from the Supertram stops. Not only would the distance be increased significantly, but the walk would also involve at least one road crossing which would detract from the effectiveness of the interchange.

7 Analysis of Pedestrians

7.1 Introduction

7.1.1 The purpose of the proposed development at Manor Top is to act as a catalyst for regeneration in the area by establishing Manor Top as a 'Beacon' District Centre. In order to achieve this it is a key requirement that, in altering conditions to increase vehicular capacity, crossing times for pedestrians do not increase which would promote unwanted segregation.

7.1.2 Many design factors contribute to pedestrian segregation at junctions. The two factors which could change the impact on segregation in this study are:

- the physical layout of the junction; and
- the signal timings and phase interaction of the stages.

7.1.3 We have worked closely with Brent Collier and Emma Jones of the Traffic Control Team to establish a feasible estimate of pedestrian crossing times in order to provide an indication of the effects of junction design changes on pedestrian crossing times.

7.2 Physical Layout of Junctions

7.2.1 As discussed in Appendix D there seems little scope for altering the actual physical layout of the junctions at Manor Top. There is very little space to increase the number of lanes for turning movements and the current gyratory system means that banning selected turning movements to give greater capacity to others is not practical. Therefore, as there will be little change in physical layout, the impact of this course of action on pedestrian crossing times will be minimal.

7.3 Signal Timings

7.3.1 The main effect on pedestrian crossing times will therefore be due to adjustments to the signal timings at the junctions.

Whilst we have estimated the crossing times for pedestrians by considering their arrival at a crossing at each second of the cycle, it is important to note that the signal timings represent an average of the timings over the modelled hour. Subtle changes in stage lengths caused by, for example, the Supertram arriving and extending a stage length cannot be modelled. Also the signal timings are very likely to change when the junctions are modelled in AIMSUN as part of the detailed design stage. Therefore whilst our pedestrian calculations provide an *indication* of what the effect on pedestrian crossing times might be, they by no means provide a certain answer to what is a detailed traffic engineering problem.

7.3.2 In our calculations we have assumed that it is equally likely that a pedestrian will arrive at the crossing at any time during the 70 second cycle of the signals. We have also assumed that a pedestrian will only cross whilst a green man is showing, and will walk at an average speed of 1.2 m/s. We have considered both the time to cross the road and the time taken to walk between crossings. We have also taken into account that when the pedestrian has crossed part of the road, they may meet a red light at an island and so encounter a further

delay. Figure 7.1 shows a typical crossing time profile of a pedestrian crossing City Road to the west of the Ring Road in the current situation. There is a step in the crossing time as the pedestrian reaches a certain crossing stage just before or after the green man has extinguished.

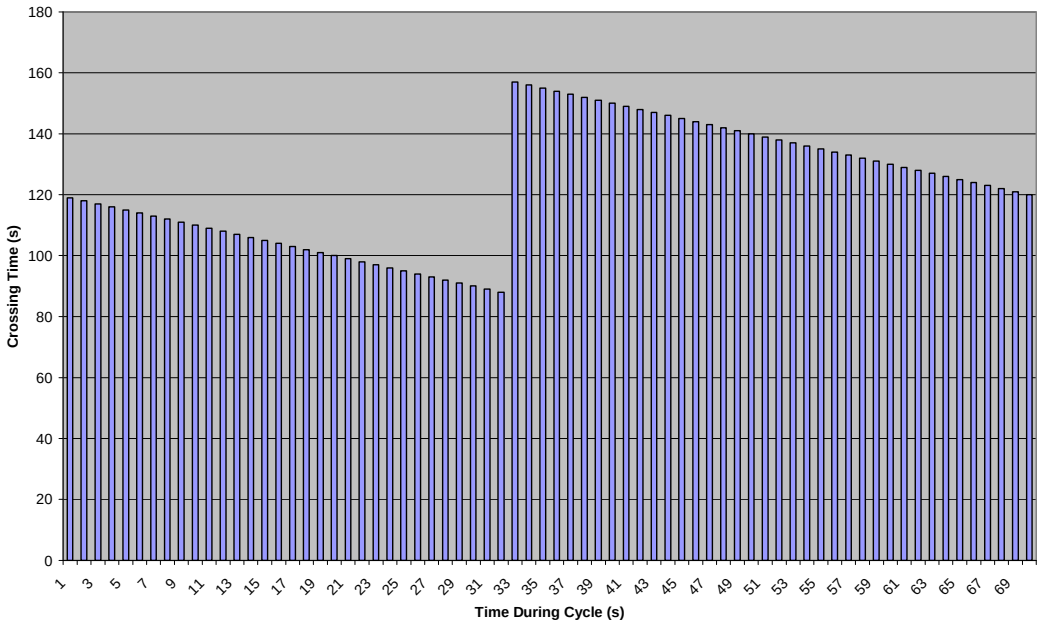


Figure 7.1 Crossing Time Profile

7.4 Effect on Pedestrians in other time periods

7.4.1 We have only modelled the effects on traffic during the evening peak time period. During other times of the day, when the area is less congested, it is likely that traffic flows will increase. Brent Collier has suggested that this may lead to the Traffic Control Team increasing the cycle time from the current 50 seconds to 70 seconds during these times in the day. This could lead to the average crossing time for pedestrians increasing, however we cannot say this with certainty as we have not conducted any formal analysis.

8 Model Results

8.1 Introduction

8.1.1 This section contains the results of the modelling work undertaken, the options being as described in Section 5.

8.1.2 We have provided a qualitative assessment as well as quantifying several reasonable indicators that we have calculated using results from the model. We must stress again that the quantitative indicators should not be considered with greater weight than the qualitative ones. The indicators have been selected as being meaningful however **provide only an indication** of the relative merits of the different options. Whilst any calculations we have provided are meaningful, the actual figures are likely to change as the scheme does with detailed design.

8.2 The Indicators

8.2.1 We have performed calculations for the following indicators:

Total PCU Hours in the Model : This is the total number of hours that all the trips in the model take to get from their origins to their destinations. This provides a measure as to the increase in journey times across the model. A PCU (Person Carrying Unit) is a similar measure to the number of vehicles in the model.

Total PCU kms in the Model : This is the total number of kilometres that all trips in the model must travel to get from their origins to their destinations. This indicates the increased distances that people travel due to rerouting around areas that become congested.

Flows on the Main Roads : We have indicated the expected flows on the main routes inbound and outbound of the main junction.

Pedestrian Times Across Junctions : This is an estimate of the average crossing times that a pedestrian would face taking into account the distances across the junction (which are constant) and the delays they face due to signal timings (which may change as different signal timings are investigated).

Changes in Queue Lengths : We have indicated the likely changes in queue lengths at the main City Road/Ring Road junction.

Vehicle Times through the Main Junction : We have indicated the likely travel time of vehicles travelling through the City Road/Ring Road junction. We have considered vehicles travelling along the Ring Road and along City Road/Mansfield Road, in both directions.

8.2.2 Table 8.1 shows the PCU-hours and PCU-kms for each of the options tested. The absolute values for the entire model are shown along with the change from the Base scenario. The total person delay is shown based on an average of 1.2 occupants per car in the evening peak.

Table 8.1 Summary of Model Results

Option	PCU-hours	Change (hours)	Person-delay (hours)	PCU-kms	Change (kms)
Base	83,558	-	-	3,855,350	-
Do Minimum	83,820	262	314	3,859,373	4,023
Full Green Pedestrian	84,203	645	774	3,862,353	7,003
Primary Pedestrian	83,834	276	331	3,859,520	4,170
Two-way Hurlfield Road	83,815	257	308	3,859,461	4,111
Lights Option 1	83,855	297	356	3,859,624	4,274
Lights Option 2	83,811	253	304	3,859,123	3,773
Lights Option 3	83,861	303	364	3,859,553	4,203
Lights Option 4	83,942	384	461	3,860,293	4,943
Lights Option 5	83,856	298	358	3,859,719	4,369
Lights Option 6	83,807	249	299	3,859,421	4,071
Lights Option 7	83,818	260	312	3,859,530	4,180
Lights Option 8	83,806	248	298	3,859,360	4,010
Traffic Calming	84,009	451	541	3,859,932	4,582

8.3 Base Scenario versus Do Minimum

8.3.1 This compares the situation as it is now (Base scenario) with the situation if the development were to proceed with no highway improvements apart from the supermarket entrance being signalised (Do Minimum option).

8.3.2 The development results in over 300 extra person-hours of travelling and over 4,000 extra kilometres driven during *each* evening peak hour (5-6pm on a weekday) of the year. Annualised for the evening peak (4-7pm) at a value of time of £5 per hour, the time delays result in around £600,000 worth of additional delays just in the evening peak. The distance increase results in around £60,000 worth of extra fuel consumed each year. It is estimated that this results in 600kg of extra Carbon Dioxide created in each evening peak modelled *hour*.

8.3.3 The total PCU-hours and PCU-kms in the model show an increase of 0.3% and 0.1% respectively. As the PCU-hours increase by a larger proportion than the PCU-kms, this

demonstrates an **overall slowing of the traffic on the network**. It should be noted that this is as a result of the *changing of origin and/or destination* of less than 1,200 trips (rather than 1,200 *new* trips). The model as a whole contains over 130,000 trips in total and therefore it demonstrates a dramatic effect on the wider network.

8.3.4 The full page insert shows a difference plot of traffic flows on the roads. The green lines represent an increase in traffic and the blue lines represent a decrease in traffic. The width of the green/blue line represents the magnitude of the change. The major changes in flows are labelled with the numeric difference between the scenarios.

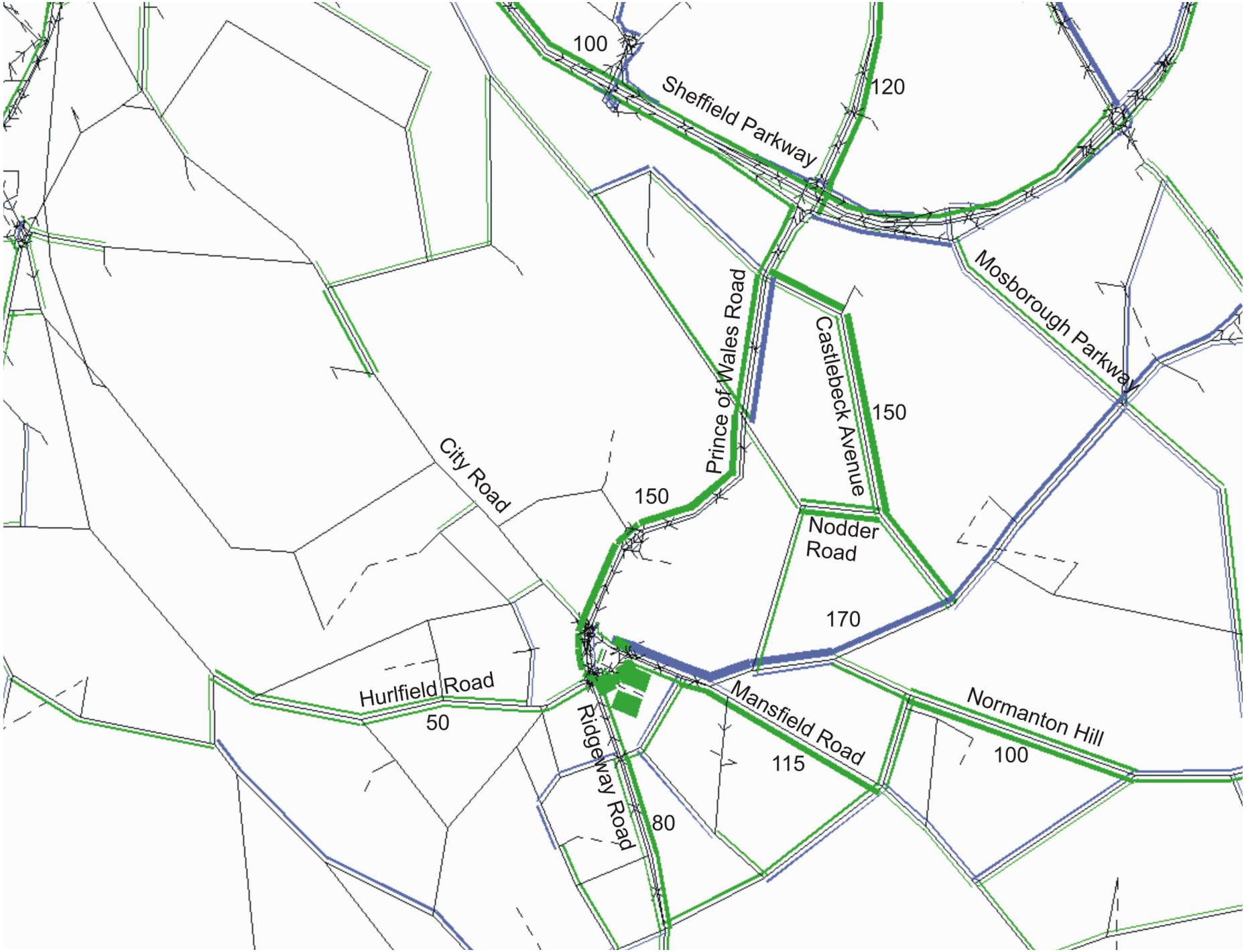
8.3.5 The plot shows significant changes in traffic flows both at Manor Top and further afield. As expected, there is significant growth on radial routes from the development. The decrease in traffic heading to the north east may be unexpected but this can be explained by route choice. Traffic heading to the development from Sheffield will generally come along City Road. Any traffic which previously used this route to then head north east of Manor Top will most likely reroute, as can be seen from the increase in traffic on Sheffield Parkway, Mosborough Parkway and even Handsworth Road.

8.3.6 We have inspected queue length changes at Manor Top, and there appears to be little change (less than ten vehicles). There are two effects at work here. Firstly, there is a limitation in the way that SATURN models queues. There is a measure known as "V/C" which is volume of traffic at a junction divided by the capacity of the junction. SATURN shows queues only when V/C exceeds 1.00, that is, when there are more vehicles trying to get through a junction than is possible. However, due to the nature of the way people drive, in reality queuing begins to occur when V/C reaches around 0.85. Therefore the changes in queue length are underestimated. Secondly, the Manor Top junction is currently almost at capacity during the evening peak. Therefore as more traffic is attracted to the area, it is more likely that the dominant effect will be that of the rerouting of any traffic which does not specifically need to use the roads around Manor Top (ie. if their origin and destination are far removed).

8.3.7 Both City Road and the Outer Ring Road are key routes. If, as the modelling shows, congestion does not severely increase at the Manor Top junction, as feared, but traffic is simply rerouted onto other roads, we face the situation that key routes which we wish to keep traffic on, rather than using minor roads, are becoming unattractive.

8.3.8 Undesired increases in flows on local roads have occurred on Castlebeck Avenue (approximately 150 vehicles per hour) and to a lesser extent Nodder Road (approximately 100 vehicles per hour). Small increases are shown on Gleadless Common. Hollinsend Road shows an increase in traffic which whilst not a residential street, it is hoped to introduce improved pedestrian facilities at the junction with Ridgeway Road which would reduce capacity thus eliminating the rerouting (ie. traffic returning to the main junction) or pushing traffic further away from the junction.

8.3.9 Whilst the model shows very local rerouting onto residential streets, this is not always what happens. Local people *will* use short cuts through estates as their local knowledge allows this. However, people who travel through Manor Top in the middle of a longer journey (as is likely on such a key radial route) will simply see the area as a bottleneck in their journey. They are likely to have little local knowledge and if excessive congestion makes their route


100
Sheffield Parkway
120
Mosborough Parkway
Prince of Wales Road
Castlebeck Avenue
150
City Road
150
Nodder
Road
170
Hurlfield Road
50
Ridgeway Road
80
Mansfield Road
115
Normanton Hill
100

unattractive, they are more likely to take the decision to reroute onto other major roads, such as the Sheffield Parkway route described above.

8.3.10 The numeric indicators show that journey times through Manor Top on City Road increase whilst journey times on the Ring Road remain the same. This is because we have adjusted the signal timings slightly to account for the large increase in Ring Road traffic in order to reduce overall congestion. Whilst City Road traffic is disbenefited, there is more traffic on the Ring Road that is benefited by the change in signal timings.

8.3.11 All flows on the key routes serving Manor Top see little change or an increase with the exception of Mansfield Road eastbound. This has already been explained in terms of wider network rerouting.

8.3.12 Our calculations show that it is likely, subject to further detailed design, that pedestrians are not likely to be significantly affected.

8.4 Full Pedestrian Green Time

8.4.1 As expected, the numeric indicators show some significant increases in journey times through the junction. Also apparent is the decrease in traffic flows on the main routes serving Manor Top. This is due to further rerouting of traffic as is demonstrated by the increase in PCU-hours and PCU-kms from the Do Minimum option. It is interesting to note that pedestrians are on balance disbenefited by this scheme, as they generally will have to wait a further cycle to complete their two-legged journey across the diagonal of the junction.

8.5 Primary Pedestrian Crossing Facility on Ridgeway Road

8.5.1 It is interesting to note that this scheme does not reduce the traffic flows through the junction. It appears that the major effect is simply on the journey time for vehicles through the junction, which is what we would logically expect. Whilst the pedestrian times across the main junction are unaffected, we would clearly expect benefit for pedestrians crossing Ridgeway Road, especially as it aids people using the public transport interchange.

8.5.2 It is important to note, however, that this pedestrian crossing would be located very close to both the main City Road/Mansfield Road junction and the Hurlfield Road/Mansfield Road junction. There maybe safety issues that arise during the detailed design of such a scheme. Also it may be that as the signal phase timings change during detailed design that the vehicle green time is not in line to allow steady progression through the junction and further delays are caused by the pedestrian crossing. Any increased cycle time will negatively impact on the efficiency of the gyratory

8.6 Allowing Eastbound Traffic on Hurlfield Road

8.6.1 This option is particularly significant in terms of traffic flows as it effectively provides a new route choice for traffic. Figure 8.1 shows a difference plot for the traffic flows, comparing it to the Do Minimum option (therefore both options have the same trips).

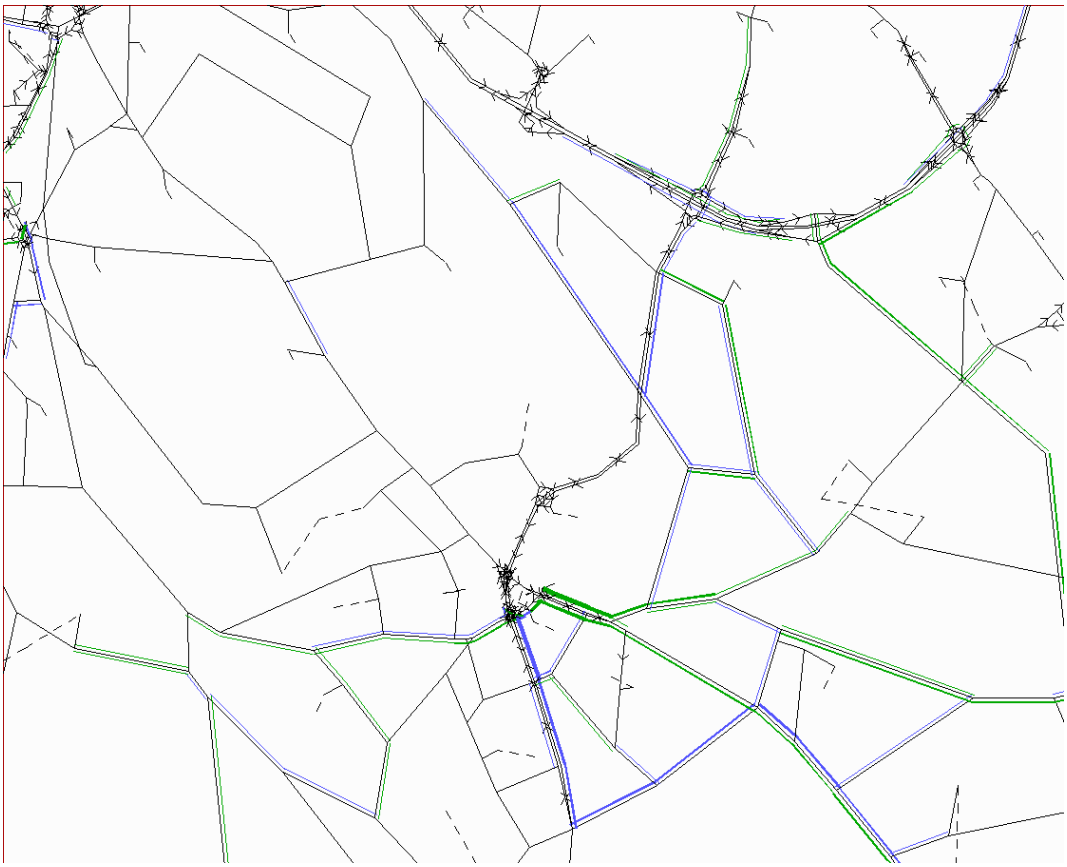


Figure 8.1 Two-way Traffic on Hurlfield Road Option versus Do Minimum

8.6.2 The plot shows that traffic heading to the north east from the development was previously heading south on Ridgeway Road and then turning east onto Hollinsend Road. Heading directly north-east on Hurlfield Road provides a more direct route. Consequently, flows on Mansfield Road have increased whilst flows on Ridgeway Road and Hollinsend Road have decreased.

8.6.3 The numeric indicators show that there is a decrease in journey time heading west through the junction on City Road. This is because there is less traffic having to turn left out of the development and queue on Hurlfield Road at the junction with Ridgeway Road.

8.7 Different Signal Timings Options

8.7.1 We tested eight different options of signal timings. The numeric indicators for all options are shown in Appendix E. The modelling results for six options showed either similar or worsening conditions, whilst two options showed an improvement compared to the Do Minimum – they reduced journey times through the junction keeping traffic flows constant or indeed increased them. Our estimated calculations for pedestrian journey times across the main junction (including delays encountered) show that it is likely that they will be maintained or improved.

8.7.2 Table 8.2 shows a summary of the indicators for the two improved options compared to the Base and Do Minimum options.

8.7.3 Signal option 2 involves extra green time being given to City Road traffic at the expense of the Ring Road. Whilst this results in a larger delay for southbound Ring Road traffic, traffic flows are maintained and a significant reduction in journey time for eastbound City Road traffic is observed. Signal option 8 involves extra green time being given to Hurlfield Road traffic at the expense of traffic on Mansfield Road. This allows greater capacity for traffic leaving the development and is expected to reduce journey times through the main junction whilst maintaining traffic flows. It is important to note, however, that the increased signal times would lead to disbenefits for the Supertram in terms of increased delays.

Table 8.2 Numeric Indicator Comparison for the Favourable Signal Changes

Indicator	Base	Do Minimum	Signal Option 2	Signal Option 8
Journey Times (seconds)				
City Road EB	345	372	228	356
City Road WB	132	192	159	183
Ring Road NB	174	175	183	169
Ring Road SB	719	719	792	719
Traffic Flows (PCUs per hour)				
City Road EB	878	890	1183	882
City Road WB	340	332	345	348
Prince of Wales NB	1052	1199	1167	1232
Prince of Wales SB	1043	1047	1032	1046
Mansfield Road EB	1219	1029	1264	1049
Mansfield Road WB	419	674	659	671
Ridgeway Road SB	1201	1248	1164	1252
Ridgeway Road NB	1229	1229	1233	1243
Hurlfield Road WB	382	419	490	348
Hurlfield Road EB	451	462	411	466
Pedestrian Crossing Times (seconds)				
Route 2 SB	123	123	123	123
Route 1 SB	166	166	158	166
Route 2 NB	112	112	122	112
Route 1 NB	165	165	106	165

8.7.4 Diagrams for the routes in the table can be found in Appendix E. Whilst conditions are improved compared to the Do Minimum option, on average conditions (particularly the journey times through the junction) are not restored to their base levels.

8.8 Traffic Calming Measures on Local Roads

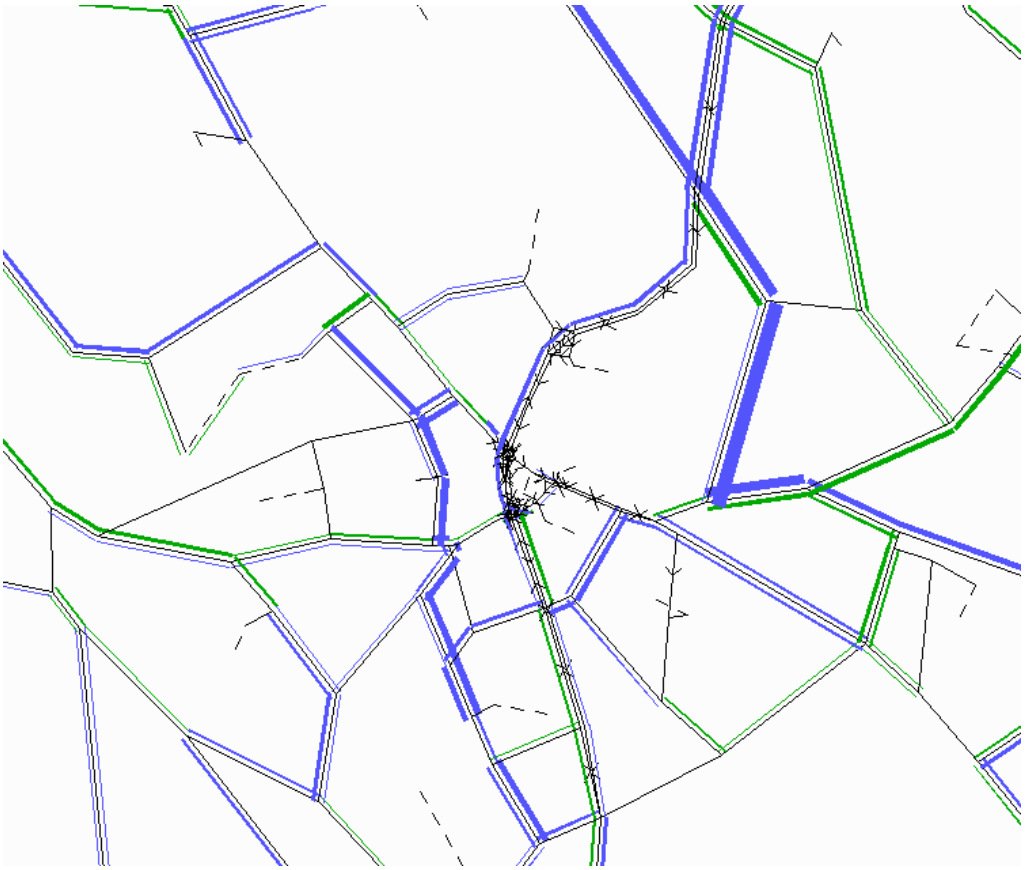


Figure 8.2 Increased Traffic Calming on Minor Roads Option versus Do Minimum

8.8.1 Figure 8.2 shows the extent to which traffic is discouraged from using the minor roads surrounding Manor Top. This has led to an increase in traffic on Ridgeway Road southbound from Hurlfield Road as well as Hurlfield Road itself. This has led to traffic exiting the estate south of the development onto Hollinsend Road rather than Mansfield Road. It is interesting to note that it has discouraged traffic from the north west from rat-running west of Manor Top and the traffic has diverted onto Ridgeway Road. This has in turn discouraged northbound traffic from using the Ring Road as a route, hence the reduced flow of traffic on Prince of Wales Road.

8.8.2 The journey times on City Road through the junction have increased, whilst the flows on the key routes serving Manor Top have stayed roughly the same. This indicates wider rerouting effects.

8.9 Reduction in Development Traffic by 10%

8.9.1 The results show very little change in the traffic flows on the main routes serving Manor Top compared to the Do Minimum. Whilst development traffic on the arms has reduced, less traffic is rerouting and therefore traffic flows are restored to the Do Minimum levels. Journey times westbound on City Road have decreased, demonstrating that there is less traffic

leaving the development which reduces delays at the Hurlfield Road junction with Ridgeway Road. There is less rerouting in the model as demonstrated by a reduction in PCU-kms.

8.10 Combination of Options

8.10.1 We tested a cominbation of the following three options:

- a 10% reduction in trips attracted by the development;
- increased traffic calming on residential streets; and
- allowing eastbound traffic on Hurlfield Road.

8.10.2 We have seen in the individual tests that the reduction in traffic and altering a section of Hurlfield Road to be two way have a positive effect on traffic conditions in the area. The increased traffic calming was included as it is likely that this will have to be incorporated to mitigate the effects of increased rat-running in the area. Unfortunately, the disbenefits to traffic caused by the traffic calming overshadowed any benefits of the reduced trips and alterations to Hurlfield Road. We recommend that, as part of any detailed design, traffic calming measures are included in the Do Minimum option so that the benefits of the options can be clearly observed.

8.11 Restricting Rerouting

8.11.1 Whilst SATURN models are well suited to demonstrating rerouting, it is important to remember that the routing is calculated using time and distance as factors only. The model cannot take into account other factors such as people's personal preference. Therefore it is likely rerouting as wide as the model predicts may not happen in reality but instead cause increased traffic flows (and possibly congestion) closer to the study area.

8.11.2 We have restricted rerouting by "cordoning" the model. This involves effectively extracting the local junction from the model, and fixing the demand balance between the five arms serving the junction. We have then adjusted the demand to take into account that a proportion of trips *will* divert. We then added the development demand to see the effect on the local network.

8.11.3 Figure 8.3 shows the *change* in actual flows on the network. Green lines indicate an increase in traffic whilst blue lines a decrease. All roads show a significant increase, with the exception of the small section of Ridgeway Road (demonstrating 23 Ring Road through trips that have rerouted) and Mansfield Road eastbound (demonstrating 112 City Road through trips that have rerouted due to a large proportion of the development trips having to use City Road for access).

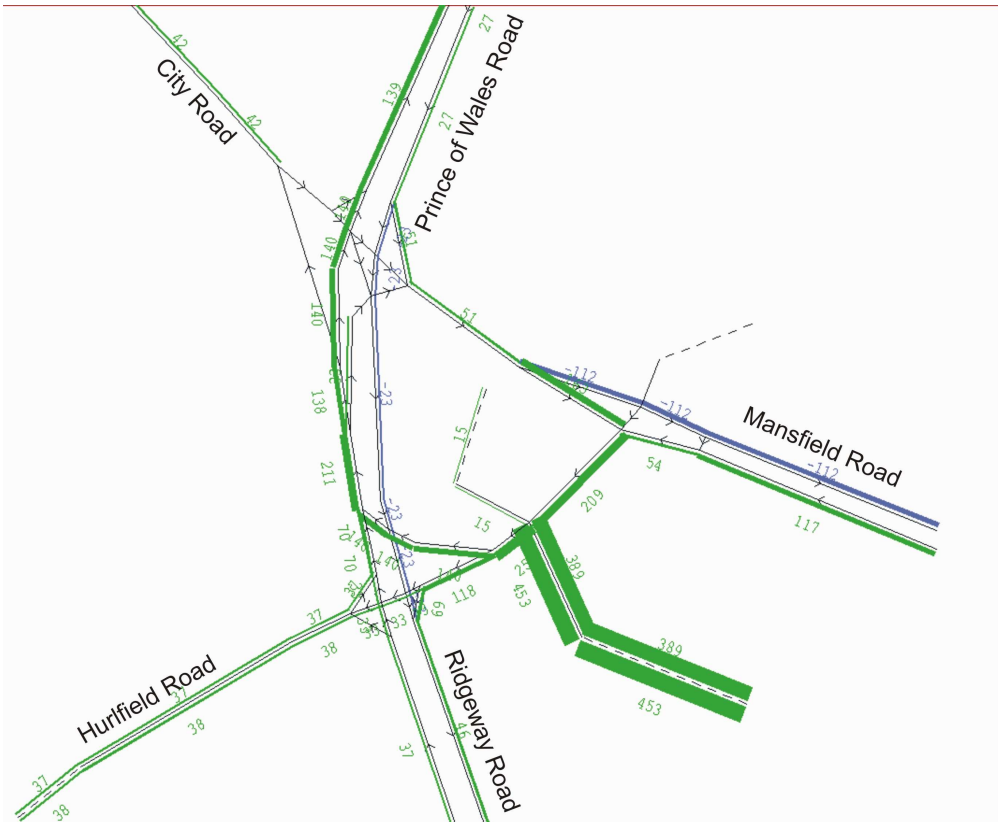


Figure 8.3 Change in Traffic Flows for Restricted Rerouting (Do Minimum versus Base)

8.11.4 Figure 8.4 shows the corresponding *change* in queue lengths at the junction (again green showing an increase and blue a decrease). The length of the lines are proportional to the length of the queues expected. Significant increases in queues form eastbound on City Road (up around 60m), westbound on Mansfield Road (up over 100m) and for traffic turning right off Ridgeway Road onto City Road (up around 30m). Increased queues also form on Hurlfield Road at the junction with Ridgeway Road in both directions. This is especially significant as the partial Supertram priority already causes intermittent congestion on Hurlfield Road backing up to the junction with Mansfield Road.

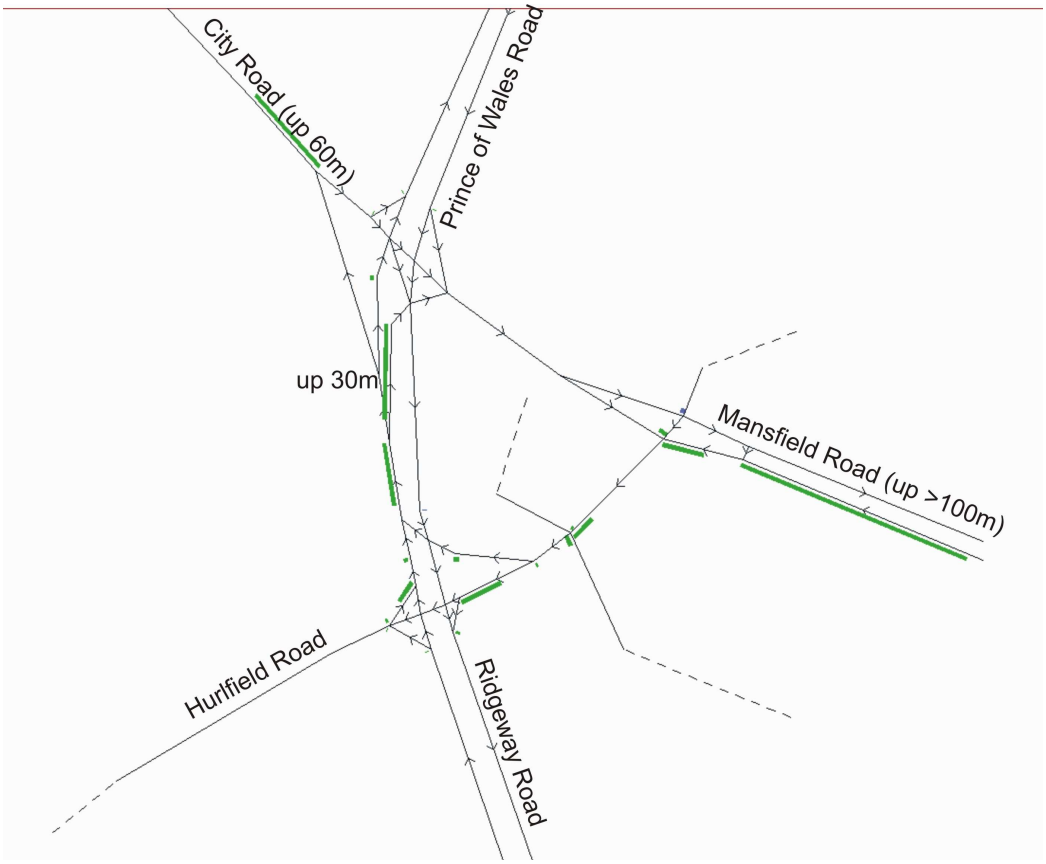


Figure 8.4 Change in Queue Lengths for Restricted Rerouting (Do Minimum versus Base)

9 Conclusions

9.1 Introduction

9.1.1 Our modelling indicates that, whilst feasible, the consequences of a supermarket being developed at Manor Top will be as follows:

- 300 person-hours of extra travel time between 5 and 6pm each weekday evening;
- 4,000 vehicle-kms of extra driving each weekday evening; and
- 600kg of extra Carbon Dioxide produced each weekday evening.

9.1.2 These disbenefits are as a result of:

- large scale rerouting of traffic onto other strategic routes;
- local rerouting of traffic onto residential streets; and
- an increase in queues and delays at the main Manor Top junction.

9.1.3 It should be noted that our work analyses traffic conditions at a time when the roads are busiest both in terms of background traffic on the network and demand at the development. Also, whilst our estimate of current pass-by trips entering the development is based on actual survey data in Sheffield, it is considered a pessimistic figure.

9.2 The Effects

9.2.1 Rerouting of traffic locally around Manor Top onto residential streets is clearly undesirable : residents will obviously be against an increase in traffic passing their houses. Rerouting could be limited by introducing traffic calming measures on the affected streets however this is still no guarantee that traffic will not increase.

9.2.2 Large scale rerouting results in traffic using alternative key routes, most notably Mosborough and Sheffield Parkways. These are already congested routes and additional traffic would cause major disruption. This rerouting is considered even less desirable given that the Outer Ring Road and City Road are major routes themselves – the aim is to keep traffic on these roads, not discourage their use. Rerouting results in an overall slowing of vehicles in a wide region of East Sheffield and may limit the potential for further developments elsewhere in the area. **It is important that any Transport Assessment performed for such a development includes a detailed study of the impact of the development on key routes (such as Sheffield Parkway) which our modelling shows are negatively affected.**

9.2.3 We restricted the rerouting of traffic away from Manor Top to simulate the likely option that not all traffic will reroute. We observed that queues on the approaches to the junction and delays through the junction increased dramatically. This would also impact on public transport journey times through the junction.

9.2.4 We do not consider the proposals of full pedestrian green times as being of great benefit to pedestrians and would almost certainly be of disbenefit to traffic. The effect on pedestrians of any alterations to the junction to mitigate the effects of increased traffic cannot be accurately determined until the detailed design stage. However our modelling indicates that

if managed correctly it is likely that any negative impact on pedestrians can be minimal or indeed conditions can be improved.

9.3 Mitigation

9.3.1 We have examined the possible alterations that could be made to the roads in the area in order to mitigate the impact of the development. We have concluded that whilst improvements could be made, it is highly unlikely that these will offset the major impact of the development and return traffic flows and delays to their existing conditions.

9.3.2 An alternative course of action to minimise the impact would be to reduce the number of trips that are made to the development. This could be achieved by reducing the size of the development. Whilst this would be effective, it may make the development less attractive to an operator.

9.3.3 The impact of the development could also be mitigated by reducing the number of through trips which pass the site. This may be done by introducing measures such as a park and ride scheme further out from Sheffield City Centre. Even in conjunction with reducing the size of the development it is expected that this would reduce the scale of the impact rather than totally mitigate it.

9.4 Summary

9.4.1 A major development situated so close to the intersection of a key strategic route for Sheffield and a well-used main road will have a major impact on traffic conditions. Large volumes of existing traffic will reroute (both widely onto other strategic routes and locally onto residential streets) whilst the remaining traffic and the new development traffic will encounter larger queues and delays at the junction.

9.4.2 The modelling indicates that without any measures to mitigate the impact of the development, an extra 300 person-hours will be spent travelling during each weekday evening between 5pm and 6pm. This equates to around £600,000 of disbenefits per year in the evening peak alone. Around 4,000 extra vehicle kilometres will be travelled as a result of rerouting, equating to an extra £60,000 spent in fuel alone. An extra 600kg of Carbon Dioxide will be produced by vehicles each weekday evening between 5 and 6pm.

9.4.3 Measures can be taken to mitigate the impact of the development in the area, both by reducing the number of trips to the development and managing the extra demand in the area. However, our modelling suggests that irrespective of the measures that are introduced, such a development will have a significant negative impact on the traffic conditions in the area.

9.4.4 The impact of the development on pedestrians will be governed by the detailed design of any alterations in the area. However our modelling indicates that it is likely that the effect on pedestrian journey times will be minimal given thoughtful design.

9.4.5 This report has been a feasibility assessment and whilst the analysis is based on a calibrated and validated strategic model, further detailed analysis of both Manor Top and the key junctions which receive the rerouted trips on Sheffield and Mosborough Parkway is needed.

This will also provide the evidence to demonstrate that the internal operation of the gyratory is viable and does not become gridlocked at peak times.

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Appendix A – Base Model Enhancements

1 Introduction

1.1.1 As described in Section 2, we needed to enhance the 2006 Sheffield District Model in the Manor Top area. This section describes the improvements we made to both the network and zone system.

2 Network Refinement

2.1.1 We needed to add detail in the network around Manor Top for two key reasons:

- the District model does not contain very many minor roads which can be used as rat-runs which will affect local routing; and
- several turning movements at each junction in the area are represented by a single node in the District model which, whilst providing acceptable modelling at a district wide level, lacks some of the subtleties of lane choice and distances that affect the model on a local level.

2.1.2 The network refinement resulted in over one hundred new nodes being added to the network.

2.2 Minor Roads

2.2.1 The existing SATURN model contains all motorways, A roads, B roads and C roads in Sheffield and Rotherham Districts. Whilst this provides an accurate representation of routing within the districts as a whole, there may be subtle differences in local routing that do not show up due to the absence of local rat-runs, for example residential estates that act as a through route to provide a rat-run to avoid a busy junction.

2.2.2 Figure A1 shows the extent to which minor roads were added to the model. The blue lines represent the roads in the model and the red lines represent those which were added.

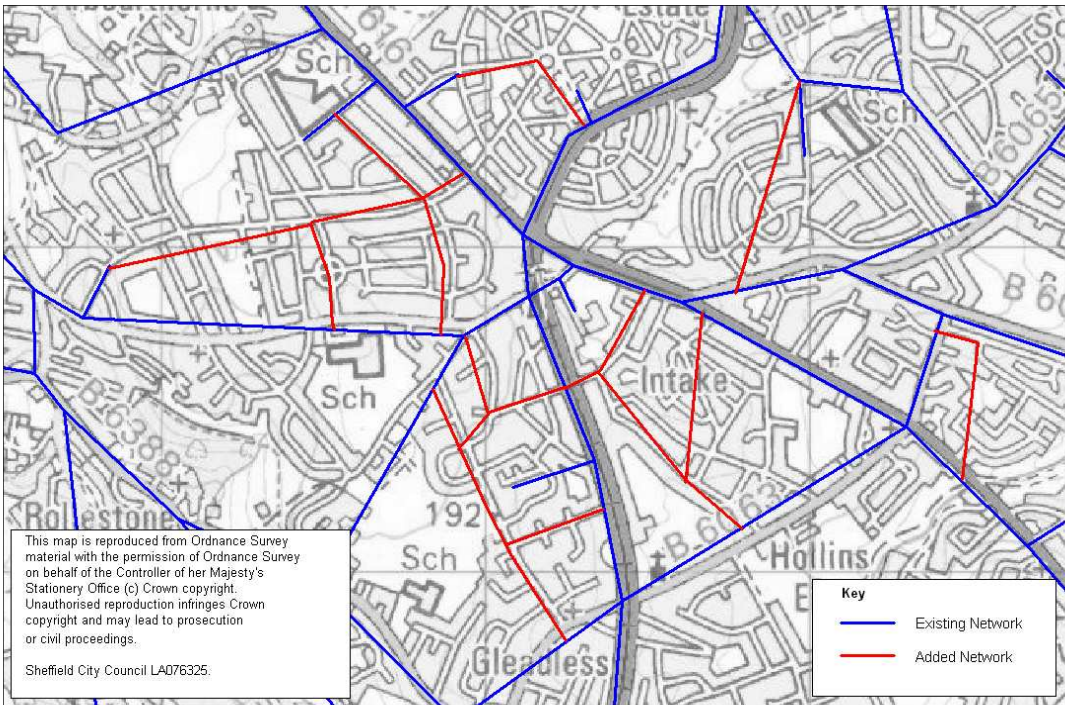

Figure A1 Existing Network with Minor Roads Added for Study

2.3 Disaggregation of Single Nodes

2.3.1 We added further detail to the network by splitting single nodes that represented several turning movements into several nodes. This was done for the following effects:

- each turning movement has its own link. This restricts any problems associated with lane choice at junctions;
- each stop line has its own node. This allows for more realistic representation of the actual locations of stop lines and thus the actual distances between movements;
- where the number of lanes in the road changes, this is represented by a node. This is so that queues are more representative of the conditions in reality; and
- dual carriageways have been expanded so that there is a separate link in each direction. This is so that the road ties in more realistically at the main junctions.

2.3.2 Figures A2 and A3 show the extent to which single node junctions were split up into different turning movements.

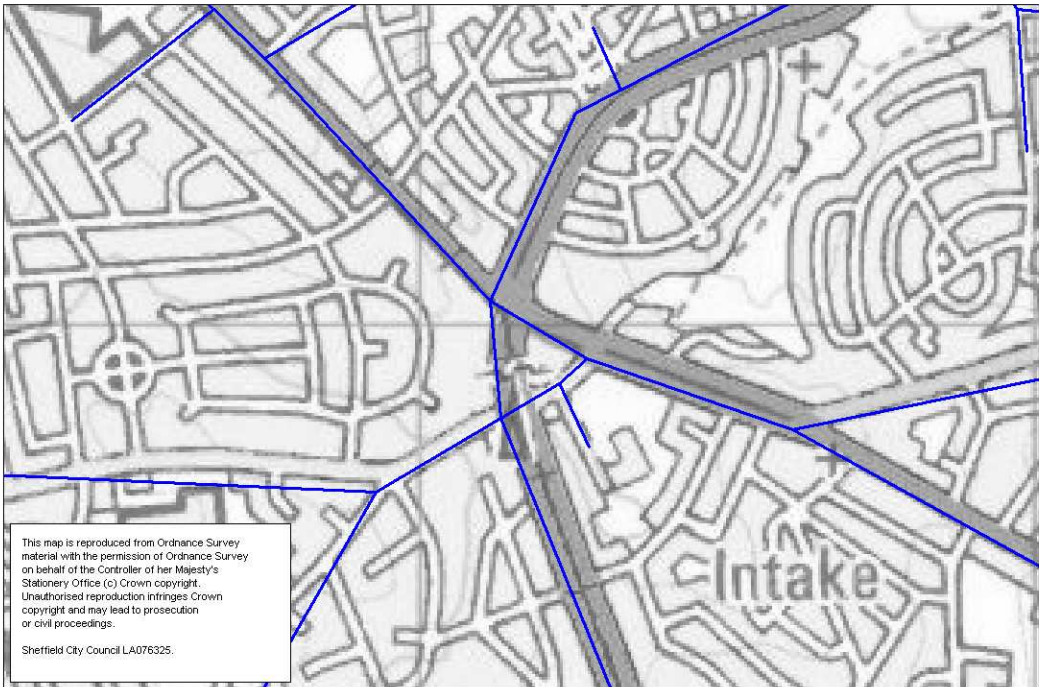

Figure A2 Network Before Exploding Nodes

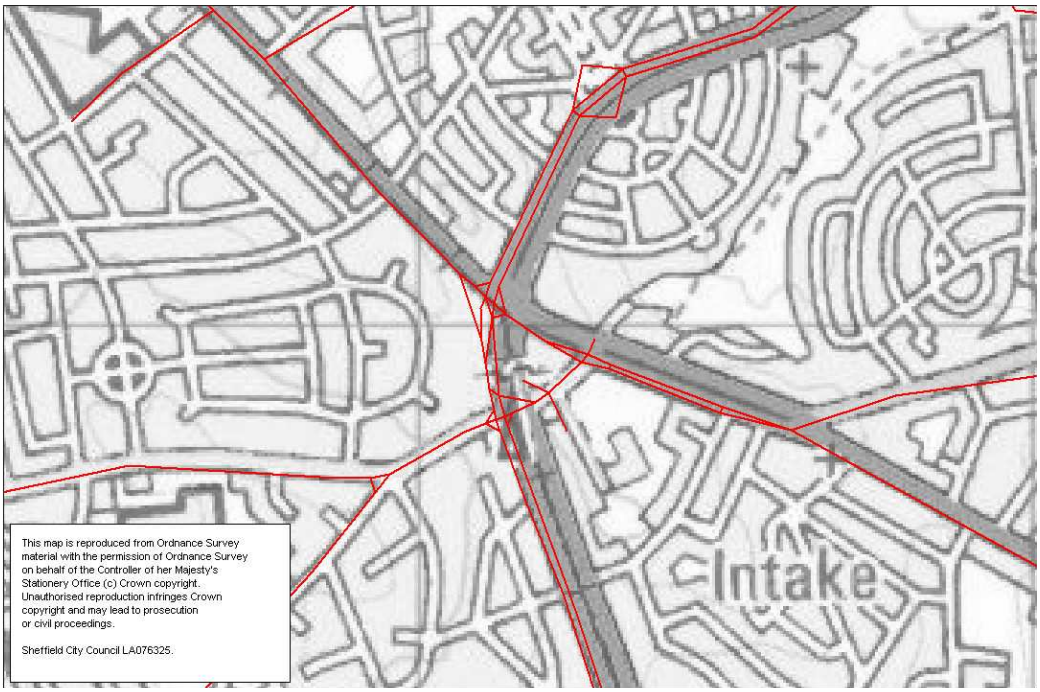

Figure A3 Network After Exploding Nodes

3 Zone Refinement

3.1.1 As well as refining the network to enable us to model the local rerouting effects, we refined the zone system in the area. This was done for the following reasons:

- to represent the new development;
- to match the level of detail provided by the network added to represent minor roads; and
- to provide zones which wholly include sites that are ear-marked for future development.

3.1.2 Figures A4 and A5 show the zone system both before and after refinement respectively.

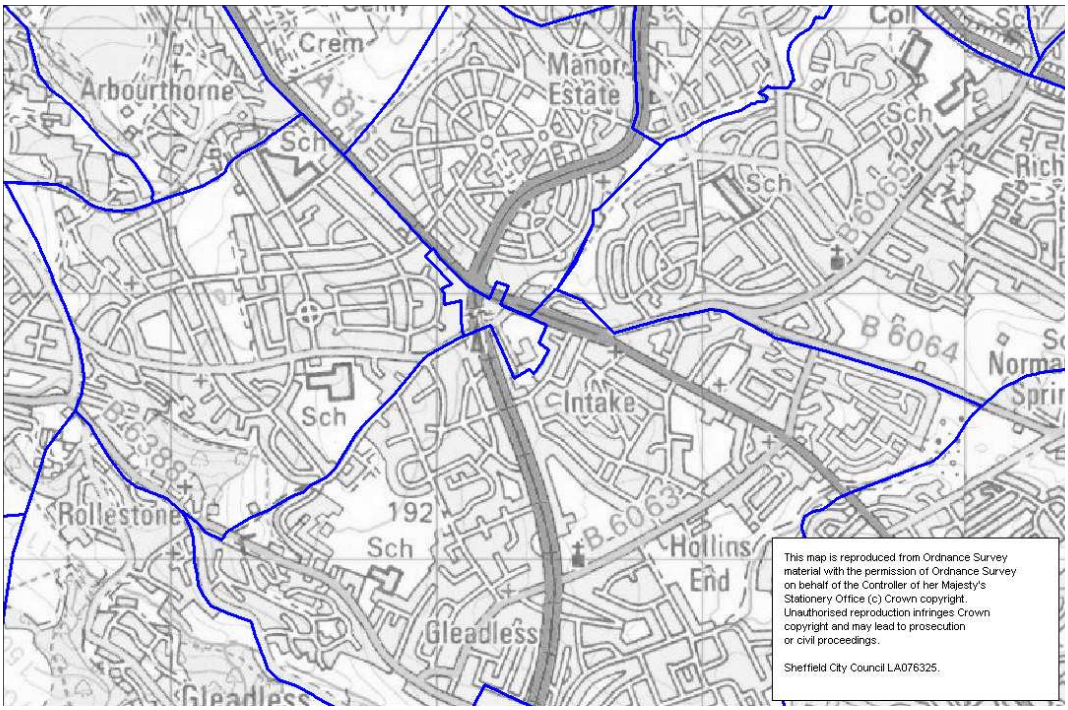

Figure A4 Zones Before Refinement

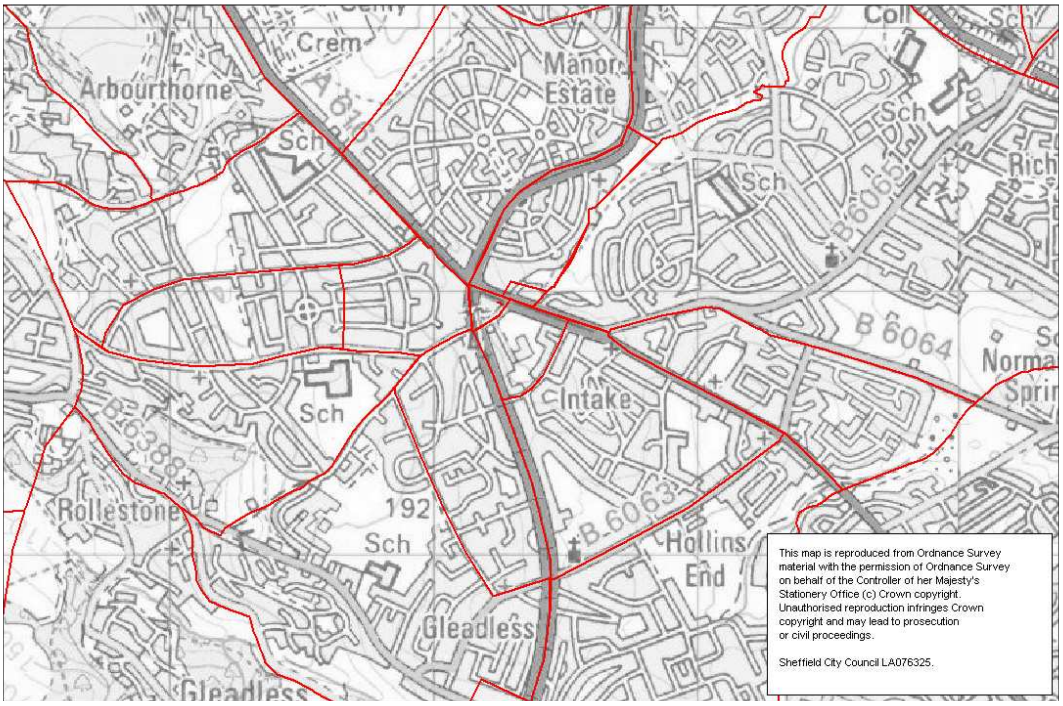

Figure A5 Zones After Refinement

Appendix B – Local Model Calibration

1 Introduction

1.1 We used the existing 2006 Sheffield District SATURN model and added detail in the Manor Top area. Using both new and existing Manual Classified Counts and Automatic Traffic Counts we re-calibrated the model specifically at Manor Top.

1.2 We added detail to the network at Manor Top and also disaggregated the zones. The model was then calibrated locally so that the model was an accurate representation of conditions in reality.

2 The District Model

2.1 We used the 2006 Sheffield District SATURN model as the base model for this study. The model was an update of the 2003 version, built using the following data:

- nearly 100 roadside interview surveys;
- existing traffic counts obtained from Sheffield City Council and Rotherham Metropolitan Borough Council;
- bus routes and frequencies obtained from the SYPTE timetable database; and
- aerial photos and site visits.

2.2 The model was then calibrated using the following data:

- over 800 manual classified vehicle counts;
- times from 15 independent journey time routes; and
- typical routes from common origins to common destinations.

2.3 SATURN assigns an origin-destination trip matrix to a network such that no trip can reduce its generalised cost (based on distance travelled and time taken) by being assigned to a different path through the network. Therefore each trip is assigned to its least-cost path.

2.4 SATURN is therefore a very suitable tool to test the effects of both network (ie highway) and demand (ie development) changes. Whilst it demonstrates effects local to any changes, it also is very good at demonstrating the wider effects of traffic avoiding an area and using a route which may, for example, be several kilometres away from the area of interest.

3 Alignment to Friday Demand

3.1 We performed five Automated Traffic Counts (ATCs) over the course of a week to see the changes in demand day to day. This would indicate whether or not we should factor up the counts to match demand on a Friday, as the model is based on an average weekday.

3.2 Our aim was blanket coverage of all radial routes both inbound and outbound to the Manor Top area. However, the location of the Supertram tracks restricted where the rubber tubes used to detect the traffic could be placed. Figure B1 shows the location of the ATCs used.

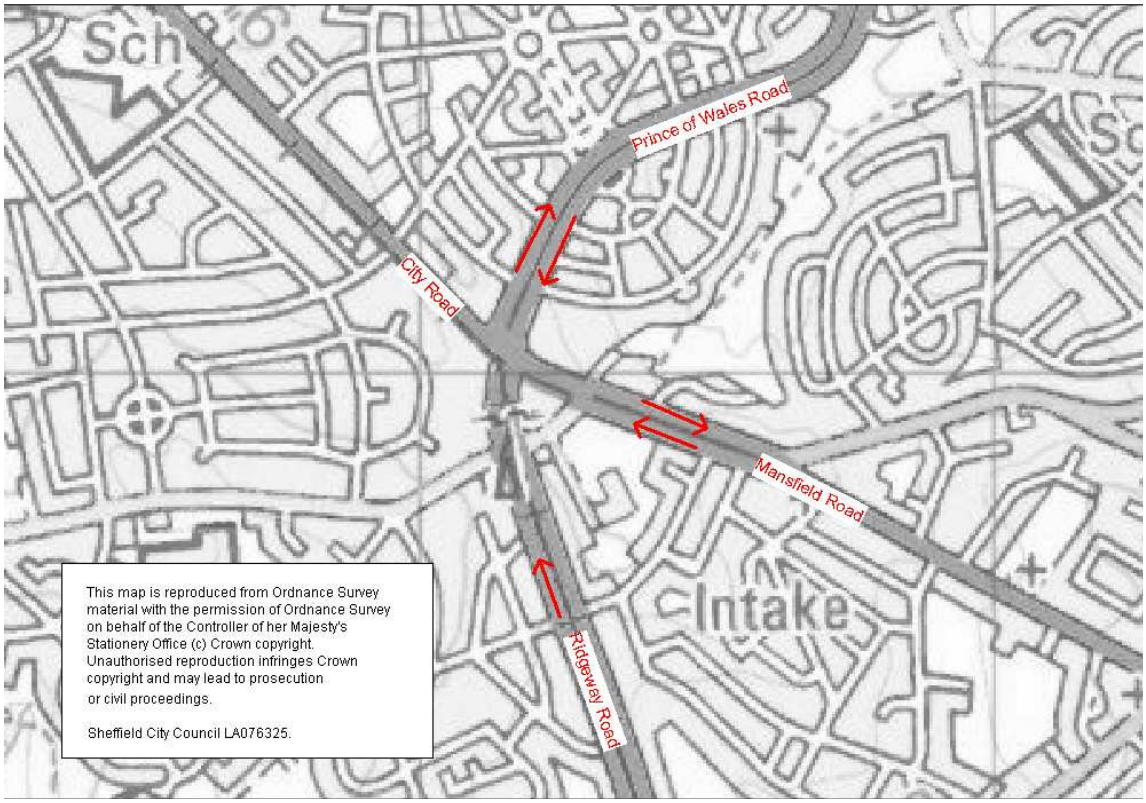

Figure B1 Location of ATCs performed around Manor Top

3.3 Tables B1 and B2 shows the relationship between the counts recorded on an average weekday and those recorded on the Friday. Counts are shown for both the modelled hour (5-6pm) and the modelled period (4-7pm). There is no consistent pattern and so we decided not to factor the demand from the base model. The figures quoted have units of axle pairs.

Table B1 Automated Traffic Counts during the Modelled Hour (5-6pm)

Road	Direction	Mon-Fri Average	Friday	Factor
Prince of Wales Road	NB	974	984	1.010
Prince of Wales Road	SB	1,225	1,379	1.126
Mansfield Road	EB	1,382	1,298	0.939
Mansfield Road	WB	685	646	0.943
Ridgeway Road	NB	1,174	1,177	1.003

Table B2 Automated Traffic Counts during the Modelled Period (4-7pm)

Road	Direction	Mon-Fri Average	Friday	Factor
Prince of Wales Road	NB	2,897	2,935	1.013
Prince of Wales Road	SB	3,697	3,927	1.062
Mansfield Road	EB	3,779	3,675	0.972
Mansfield Road	WB	1,970	1,982	1.006
Ridgeway Road	NB	3,343	3,290	0.984

4 Model Calibration

4.1 In order to replicate conditions on the ground as accurately as possible, we added large amounts of detail to the network in the Manor Top area. This involved the addition of over 100 new nodes and resulted in each turning movement and stop line at the junctions having their own set of links and nodes. This results in more accurate modelling of lane choice in the model.

4.2 Calibration involves comparing the assigned traffic and conditions in the model to those in reality and adjusting both the network and demand matrices so the two match as closely as possible. This is necessary to ensure that both the network and demand matrices represent reality accurately so that changes made to the model result in realistic changes in traffic conditions on the network.

4.3 We calibrated the model locally for two reasons:

- the base model was calibrated for Sheffield as a whole and in doing so, it may be that the validation around Manor Top is not as tight as it could be; and
- in adding detail to the network the network is effectively changed and therefore the validation can deteriorate.

4.4 There were several link and turn counts available in the Manor Top area, however we commissioned ten new turn counts to provide greater calibration robustness in the area. Figure B2 shows the location of existing link and turn counts along with the new turn counts.

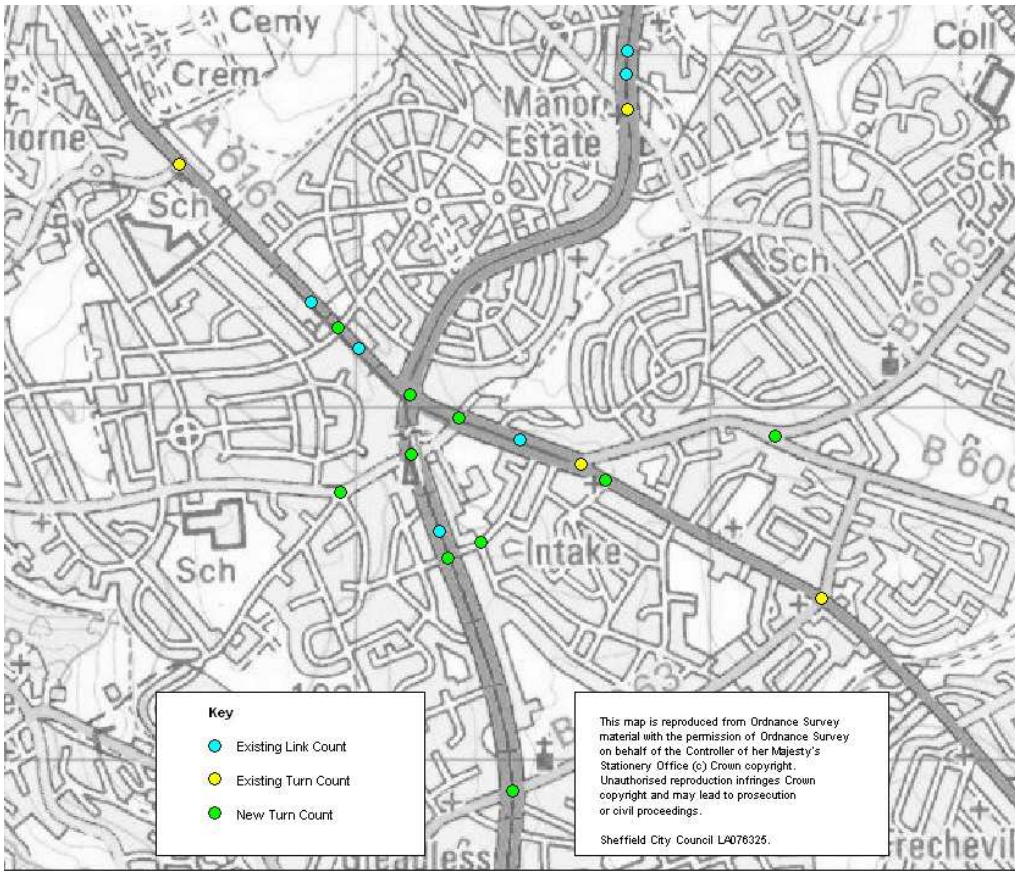

Figure B2 Location of New and Existing Traffic Counts around Manor Top

Appendix C – Car Park Occupancy

1 Method

1.1 In order to provide an estimated car park occupancy profile we used the TRICS database to estimate the hourly arrivals and departures that the development will attract. Over the 24 hour period of the surveys in the database, the arrivals and departures do not exactly match. We factored the departures each hour so that the car park occupancy at the end of the 24 hour period matched that at the beginning.

1.2 We used an approximation that at 3am there are a nominal amount of spaces occupied: we assumed 20. As we expect the capacity of the car park to be critical on Fridays and Saturdays, we estimated the occupancy on both these days.

1.3 Tables C1 and C2 show the expected arrivals and departures along with approximate car park occupancy on Fridays and Saturdays respectively. The grey shaded line indicates the figures for the modelled hour on a Friday whilst the violet shaded lines highlight the maximum occupancy on both days. The tables show that the peak occupancy is expected to occur between 11am and 12pm on a Saturday. This is also demonstrated in Figure C1 which shows the expected car park occupancy throughout a typical Friday (in blue) and Saturday (in red).

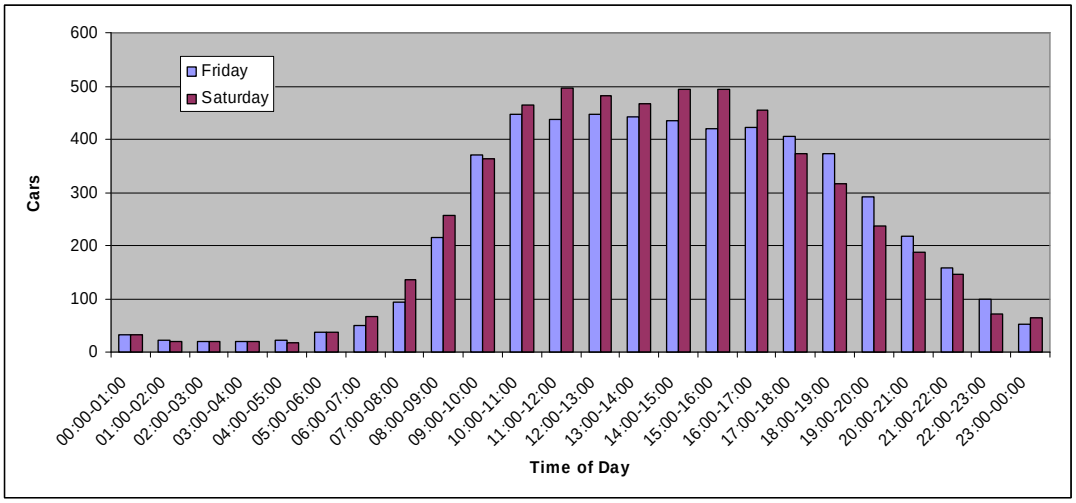

Figure C1 Car Park Occupancy by Time of Day

Table C1 Trip Arrivals and Departures and Car Park Occupancy on Fridays

Time	Trip Rate (per 100m^2)		Trips		Occupancy
	Arrivals	Departures	Arrivals	Departures	(end of hr)
00:00-01:00	0.70	0.96	58.5	79.7	32
01:00-02:00	0.33	0.47	27.6	39.0	21
02:00-03:00	0.27	0.28	22.6	23.3	20
03:00-04:00	0.21	0.22	17.6	18.3	19
04:00-05:00	0.23	0.21	19.2	17.4	21
05:00-06:00	0.57	0.37	47.7	30.7	38
06:00-07:00	1.09	0.95	91.1	78.9	50
07:00-08:00	1.92	1.39	160.5	115.5	95
08:00-09:00	3.56	2.13	297.7	176.9	216
09:00-10:00	5.35	3.52	447.3	292.4	371
10:00-11:00	5.85	4.99	489.1	414.5	446
11:00-12:00	5.77	5.92	482.4	491.8	436
12:00-13:00	6.26	6.18	523.4	513.4	446
13:00-14:00	6.09	6.18	509.2	513.4	442
14:00-15:00	5.86	6.00	490.0	498.4	434
15:00-16:00	5.82	6.04	486.6	501.7	419
16:00-17:00	6.28	6.29	525.1	522.5	421
17:00-18:00	6.42	6.65	536.8	552.4	406
18:00-19:00	6.07	6.50	507.5	540.0	373
19:00-20:00	4.84	5.85	404.7	486.0	292
20:00-21:00	3.72	4.64	311.0	385.4	217
21:00-22:00	2.58	3.33	215.7	276.6	157
22:00-23:00	1.51	2.21	126.3	183.6	99
23:00-00:00	1.31	1.87	109.5	155.3	53

Table C2 Trip Arrivals and Departures and Car Park Occupancy on Saturdays

Time	Trip Rate (per 100m^2)		Trips		Occupancy
	Arrivals	Departures	Arrivals	Departures	(end of hr)
00:00-01:00	0.81	1.21	67.7	99.5	31
01:00-02:00	0.36	0.52	30.1	42.8	19
02:00-03:00	0.33	0.32	27.6	26.3	20
03:00-04:00	0.28	0.30	23.4	24.7	19
04:00-05:00	0.23	0.24	19.2	19.7	18
05:00-06:00	0.56	0.35	46.8	28.8	36
06:00-07:00	1.06	0.72	88.6	59.2	66
07:00-08:00	1.83	1.00	153.0	82.2	136
08:00-09:00	3.74	2.35	312.7	193.3	256
09:00-10:00	5.23	4.01	437.3	329.8	363
10:00-11:00	6.69	5.59	559.4	459.8	463
11:00-12:00	7.01	6.72	586.1	552.7	496
12:00-13:00	6.66	6.96	556.9	572.4	481
13:00-14:00	6.32	6.59	528.4	542.0	467
14:00-15:00	6.63	6.41	554.4	527.2	494
15:00-16:00	6.56	6.66	548.5	547.8	495
16:00-17:00	6.26	6.86	523.4	564.2	454
17:00-18:00	5.87	6.96	490.8	572.4	373
18:00-19:00	5.20	5.97	434.8	491.0	316
19:00-20:00	3.84	4.88	321.1	401.4	236
20:00-21:00	2.38	3.01	199.0	247.6	188
21:00-22:00	1.72	2.26	143.8	185.9	145
22:00-23:00	1.18	2.09	98.7	171.9	72
23:00-00:00	0.63	0.75	52.7	61.7	63

Appendix D – Restrictions on Highway Improvements

1 Introduction

1.1 Several highway improvements and enhancements were suggested in the EDAW Report, all of which we have considered. We have modelled several of the more feasible solutions to determine their respective merits. However, there were several solutions that were not feasible from an engineering point of view. These, along with their respective problems, are detailed in this Appendix.

2 Realignment of Supertram

2.1 The main junction at Manor Top has to accommodate the Supertram. Therefore, this would form part of a major redesign of the main Manor Top junction. In order to add turning movements or indeed increase the capacity of other movements, the Supertram may need to be realigned.

2.2 The cost of altering the path of the tram is restrictive both in terms of capital cost and the loss of the service for the duration of the works. The EDAW report agrees with this, therefore we only tested solutions that did not involve works to the Supertram layout.

3 Banning Turns

3.1 The EDAW report suggested that capacity on heavily used turning movements could be increased by banning more lightly used turns that oppose the movements. Having assessed the demand for all turning movements at the junctions surrounding Manor Top, this does not seem feasible. The gyratory system that is currently in place means that already there are limited turning movements and it appears that any under-used turning movements were banned when the current layout was designed.

4 Signal Timings Alterations

4.1 In order to provide a larger percentage of vehicle green time without reducing the absolute inter-green lengths we could increase the cycle time. However, gyratories work more efficiently using low cycle times as they rely on no internal blocking back. Longer cycle times result in increased queues which can lead to blocking back. Also, increasing the cycle time would most likely increase the average wait time for pedestrians, a consequence we are keen to avoid.

4.2 The Supertram only has partial priority. Trams will often face a "stop" signal at the junction and can only influence the lights by extending the green time if they are just about to enter the junction. Therefore, any increase in cycle time would also disbenefit Supertram passengers.

4.3 We therefore did not model changes to the cycle time, as reducing it would reduce vehicular capacity.

4.4 The traffic signal control team of Sheffield City Council have constantly monitored the main junction at Manor Top in order to optimise the signal timings for maximum capacity. We are therefore confident that for current conditions the signal timings and stage orders cannot be improved. However, it may be that with the new demand and route choice a different balance of green times between arms will prove more optimal.

5 General Junction Layout Adjustments

5.1 Having worked closely with Brent Collier of Sheffield City Council, it is our understanding that there is very little scope for significant junction changes within the current highway space. Sheffield City Council also expressed a desire to produce a solution that would not cause major disruption during implementation.

6 Removal of Gyratory Layout

6.1 One of the suggestions in the EDAW report is to remove the gyratory at the main Manor Top junction. This would involve the closure of Hurlfield Road between Mansfield Road and Ridgeway Road and the reintroduction of two way traffic on City Road between the Ring Road and Mansfield Road. This would in effect make it a four arm signalled junction.

6.2 This option would clearly reduce capacity. The right turn from City Road onto Ridgeway Road (currently bus and tram only) would have to be allowed to cars thus impacting negatively on queues up City Road. The City Road section altered from one-way to two-way would require a reduction in the number of lanes for eastbound traffic, most likely, from three to two. Whilst this may have no effect on eastbound traffic (the third lane is currently for right turning traffic which would then have turned earlier), it would allow for only one lane of westbound traffic, halving the current two lanes which can enter the gyratory. It is also likely that for such major amendments to the layout, the Supertram would have to be realigned which, as already mentioned, is undesirable. We have therefore decided that this option should be rejected.

Appendix E – Model Results Indicators

Table E1 Overall Model Statistics

Indicator	Base	Do Minimum	Full Green Pedestrian Time	Full Ped. Crossing Facility Ridgeway Rd	Two-way Traffic Hurlfield Road	Option 1 Traffic Lights	Option 2 Traffic Lights	Option 3 Traffic Lights	Option 4 Traffic Lights	Option 5 Traffic Lights	Option 6 Traffic Lights	Option 7 Traffic Lights	Option 8 Traffic Lights	Traffic Calming Measures	10% Reduction in Development Trips	Combination of Options
PCU-hours																
Actual	83,558	83,820	84,203	83,834	83,815	83,855	83,811	83,861	83,942	83,856	83,807	83,818	83,806	84,009	83,811	84,014
% change Base	-	0.31%	0.77%	0.33%	0.31%	0.36%	0.30%	0.36%	0.46%	0.36%	0.30%	0.31%	0.30%	0.54%	0.30%	0.55%
% change DM	-	-	0.46%	0.02%	-0.01%	0.04%	-0.01%	0.05%	0.15%	0.04%	-0.02%	0.00%	-0.02%	0.23%	-0.01%	0.23%
PCU-kms																
Actual	3,855,350	3,859,373	3,862,353	3,859,520	3,859,461	3,859,624	3,859,123	3,859,553	3,860,293	3,859,719	3,859,421	3,859,530	3,859,360	3,859,932	3,859,229	3,859,518
% change Base	-	0.10%	0.18%	0.11%	0.11%	0.11%	0.10%	0.11%	0.13%	0.11%	0.11%	0.11%	0.10%	0.12%	0.10%	0.11%
% change DM	-	-	0.08%	0.00%	0.00%	0.01%	-0.01%	0.00%	0.02%	0.01%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%

Table E2 Journey Times through the main junction at Manor Top (in seconds)

Indicator	Base	Do Minimum	Full Green Pedestrian Time	Full Ped. Crossing Facility Ridgeway Rd	Two-way Traffic Hurlfield Road	Option 1 Traffic Lights	Option 2 Traffic Lights	Option 3 Traffic Lights	Option 4 Traffic Lights	Option 5 Traffic Lights	Option 6 Traffic Lights	Option 7 Traffic Lights	Option 8 Traffic Lights	Traffic Calming Measures	10% Reduction in Development Trips	Combination of Options
City Road EB	345	372	574	366	371	290	228	422	500	378	395	359	356	445	368	442
City Road WB	132	192	180	206	155	165	159	172	170	172	188	176	183	211	161	158
Ring Road NB	174	175	359	191	174	177	183	174	172	178	188	172	169	174	175	174
Ring Road SB	719	719	739	734	719	774	792	715	713	719	719	719	719	719	719	719

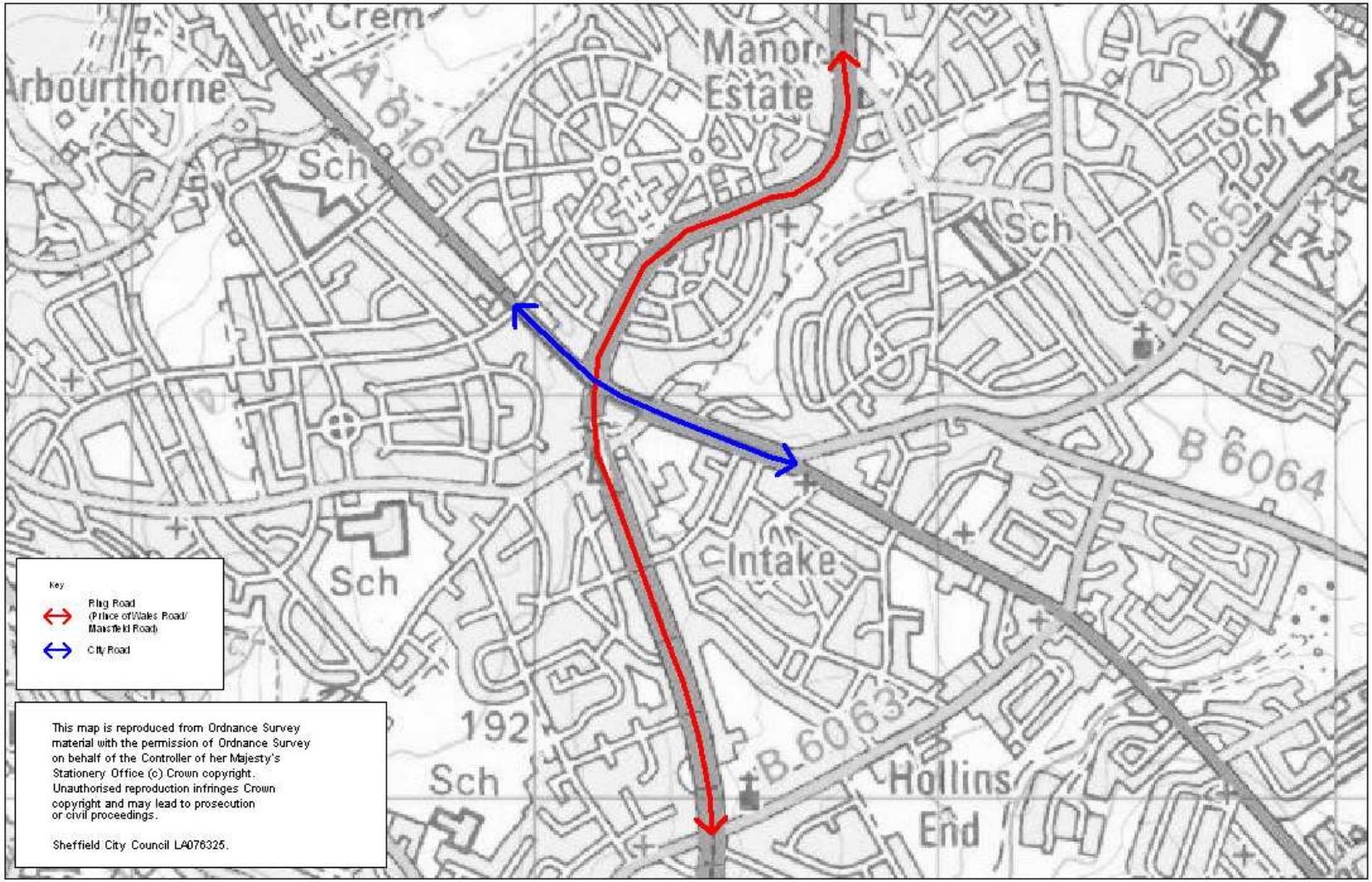

Figure E1 Journey Time Routes through the main junction at Manor Top

Table E3 Traffic Flows on Major Roads serving Manor Top (in PCUs per hour)

Indicator	Base	Do Minimum	Full Green Pedestrian Time	Full Ped. Crossing Facility Ridgeway Rd	Two-way Traffic Hurlfield Road	Option 1 Traffic Lights	Option 2 Traffic Lights	Option 3 Traffic Lights	Option 4 Traffic Lights	Option 5 Traffic Lights	Option 6 Traffic Lights	Option 7 Traffic Lights	Option 8 Traffic Lights	Traffic Calming Measures	10% Reduction in Development Trips	Combination of Options
City Road EB	878	890	504	888	890	1036	1183	716	545	892	899	884	882	829	889	926
City Road WB	340	332	259	321	336	333	345	330	333	333	315	333	348	331	336	337
P. of Wales NB	1052	1199	874	1179	1195	1166	1167	1270	1288	1194	1089	1215	1232	1131	1202	1140
P. of Wales SB	1043	1047	986	1043	1046	1037	1032	1049	1052	1046	1047	1047	1046	1047	1045	1049
Mansfield Rd EB	1219	1029	624	1032	1140	1161	1264	890	753	1031	1038	1030	1049	1033	1050	1159
Mansfield Rd WB	419	674	430	673	737	667	659	669	668	670	675	670	671	681	665	873
Ridgeway Rd SB	1201	1248	823	1242	1157	1250	1164	1236	1221	1241	1242	1270	1252	1298	1216	1319
Ridgeway Rd NB	1229	1229	951	1219	1225	1235	1233	1257	1298	1248	1393	1256	1243	1208	1249	1215
Hurlfield Rd WB	382	419	285	432	444	429	490	415	407	426	401	411	348	424	433	460
Hurlfield Rd EB	451	462	178	455	445	436	411	512	500	444	156	458	466	473	469	477

Table E4 Likely Crossing Times for Pedestrians at City Road/Ring Road junction (in seconds)

Indicator	Base	Do Minimum	Full Green Pedestrian Time	Full Ped. Crossing Facility Ridgeway Rd	Two-way Traffic Hurlfield Road	Option 1 Traffic Lights	Option 2 Traffic Lights	Option 3 Traffic Lights	Option 4 Traffic Lights	Option 5 Traffic Lights	Option 6 Traffic Lights	Option 7 Traffic Lights	Option 8 Traffic Lights	Traffic Calming Measures	10% Reduction in Development Trips	Combination of Options
Route 2 SB	123	123	165	123	123	123	123	125	136	123	123	123	123	123	123	123
Route 1 SB	166	166	93	166	166	169	158	163	160	166	166	166	166	166	166	166
Route 2 NB	112	112	162	112	112	122	122	112	112	112	112	112	112	112	112	112
Route 1 NB	165	165	170	165	165	151	106	109	105	165	165	165	165	165	165	165

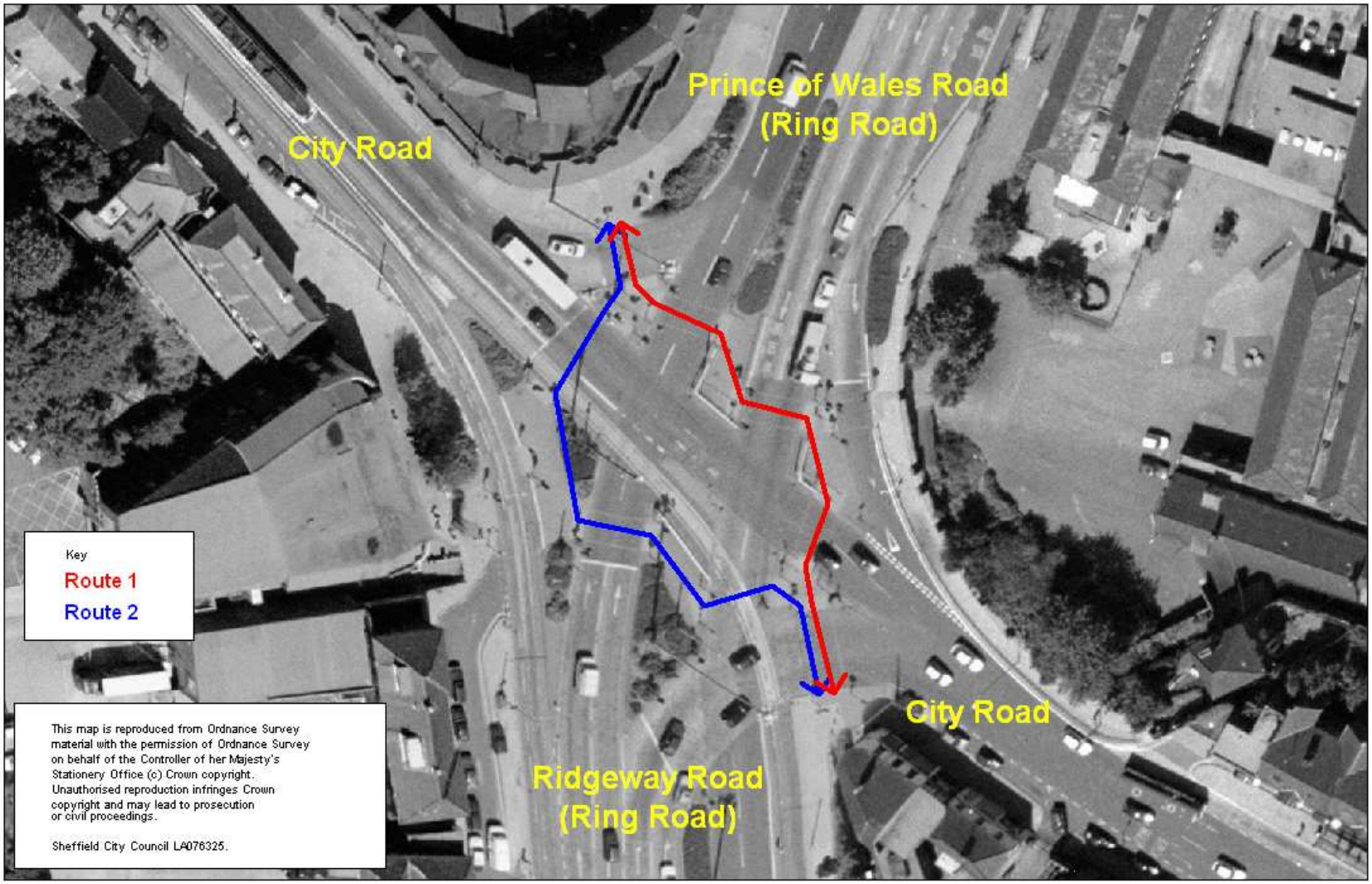

Figure E2 Pedestrian Crossing Routes for estimated crossing times