

New Briggate Bus Gate - Aimsun Modelling Note

Introduction

This note describes modelling work carried out using the Leeds City Centre Aimsun model to assess a proposed amendment to the LPTIP scheme at New Briggate, which would reduce Merrion St to one lane between Wade Lane and New Briggate. A proposal to introduce a 4-7pm bus gate between New Briggate and Vicar Lane was also tested, alongside road marking changes on Merrion Street, Woodhouse Lane and Great George Street, which would complement the changes on Merrion Street.

Leeds City Centre Aimsun model

The Leeds City Centre Aimsun model was developed by Fore Consulting with the base model representing the 2017 network with 2017 demand matrices derived from the Leeds Transport Model. The Aimsun model covers the Inner Ring Road and M621, the City Centre area enclosed within, and short extensions along corridors towards Armley, Kirkstall and Headingley. The modelled time periods are AM peak hour (0800-0900) and PM peak hour (1700-1800). The model represents cars, LGVs, HGVs and buses. Taxis are included in the general traffic demand but are not disaggregated.

Do-Minimum Scenario

The do-minimum scenario (DS5) includes the following additional schemes:

- Headrow Gateway LPTIP
- Corn Exchange Gateway LPTIP
- A61(S) LPTIP
- City Square Closure/Infirmary St/Park Row LPTIP
- Armley gyratory upgrade (modified preferred option)
- City Centre Package additional schemes: East Parade bus gate/Victoria St bus priority/Great George St widening
- Crown Point Road Grey to Green
- City Connect 2/3
- M621 RIS
- Globe Road/Whitehall Road signals

Do-Something Scenario

The do-something scenario (DS5+Merrion St downgrade) reduces Merrion St to one lane east of Wade Lane. A further option adds a bus gate on the turn from New Briggate to Vicar Lane (DS5+New Briggate bus gate). For the purposes of the test general traffic was also banned from Merrion Place to prevent avoidance of the bus gate via this link.

Figure 1 Do-minimum network (DS5)

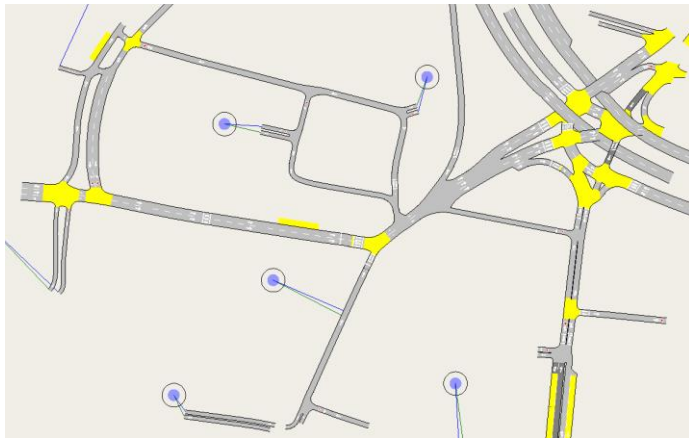
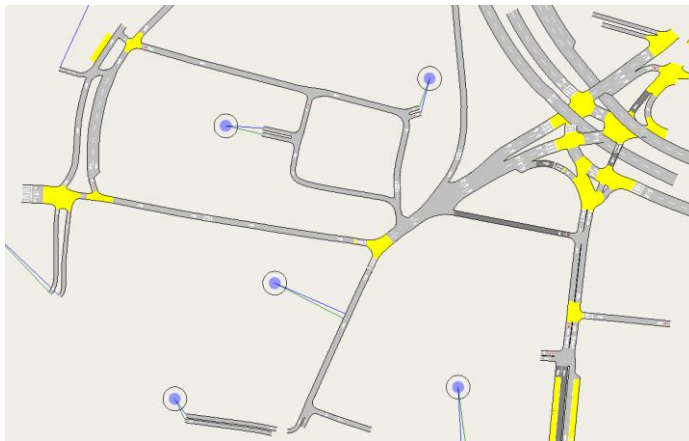


Figure 2 Do something network (DS5 + New Briggate bus gate)



Given the scope of the modelled network, the introduction of the New Briggate bus gate allows limited routing options to traffic loading southbound onto the network from zones along Lovell Park Road. The do-minimum and do-something networks were therefore modified to allow traffic from these zones to also load onto the network southbound at Blackman Lane, Clay Pit Lane, North St and Regent St.

Demand Matrices

Base demand matrices were reduced by 5% for all tests to represent reductions in traffic due to the impact of transport policy measures to promote public transport and active travel, and to remove through traffic from the City Centre.

Network Statistics

Table 1Error! Reference source not found. shows total flows through the network along with delays and speeds for all vehicles and buses.

During the AM peak hour with Merrion St reduced to one lane, there is a very minor reduction in overall delay to all vehicles and buses in comparison to the do-minimum (DS5), and a very small further improvement with the bus gate. Bus delays and speeds with the downgrade remain much

improved over the base scenario, whereas all vehicle delays are higher (and speeds lower) in the do-minimum (DS5) and with the downgrade compared to the base scenario.

During the PM peak hour there is a small reduction in delay to all vehicles but an increase in delay of 6 s/km to buses compared to the do-minimum (DS5). However, further investigation of the model indicates this increase in delay to buses across the network with the Merrion Street downgrade scheme is the result of model noise on the extremities of the model and is not related to the Merrion Street downgrade scheme. It is not expected, therefore, that the Merrion Street downgrade would yield this level of delay to buses across the network, compared to the do-minimum (DS5) scenario.

With the additional introduction of the bus gate between Merrion St and Vicar Lane, overall delay to all vehicles is equal to the do-minimum, with bus journey times only increasing by 4 s/km. Delay and speeds to both all vehicles and buses without and with the bus gate are much improved when compared to the base scenario.

Table 1 Aimsun Network Statistics

Statistic	Units	AM Peak 8-9				PM Peak 5-6			
		Base 95%	DS5 95%	DS5 + Merrion St downgrade 95%	New Briggate bus gate 95%	Base 95%	DS5 95%	DS5 + Merrion St downgrade 95%	DS5 + New Briggate bus gate 95%
Flow	veh/h	37,780	36,677	36,514	36,965	39,358	39,081	39,247	39,180
Delay (All Vehicles)	s/km	81.6	93.0	91.8	89.1	147.6	118.7	115.9	118.2
Delay (Bus)	s/km	126.5	119.2	120.3	119.7	193.2	140.3	146.2	144.4
Speed (All Vehicles)	km/h	31.3	29.3	29.6	29.8	25.6	27.5	28.0	27.5
Speed (Bus)	km/h	14.0	14.7	14.7	14.7	12.0	13.6	13.4	13.5

Traffic Flows

Table 2 shows vehicle flows along Merrion St (between Wade Lane and New Briggate) and eastbound along Lady Lane. The downgrade removes over 100 vehicles from Merrion St in the PM, and over 80 vehicles from Lady Lane with the addition of the bus gate.

Table 2 Traffic flows

	Units	AM Peak 8-9				PM Peak 5-6			
		Base 95%	DS5 95%	DS5 + Merrion St downgrade 95%	DS5 + New Briggate bus gate 95%	Base 95%	DS5 95%	DS5 + Merrion St downgrade 95%	DS5 + New Briggate bus gate 95%
Merrion St	veh	731	517	503	455	1608	1261	1150	1143
Lady Lane	veh	275	244	244	202	476	396	387	303

Bus Journey Times

Bus journey times were recorded for all southbound services along North St/Vicar Lane and for the 51/52 route southbound along Lovell Park Road to Vicar Lane.

Figure 3 Bus route - North St to Vicar Lane



Figure 4 Bus route – 51/52 southbound



Southbound services along Vicar Lane show very little change in journey time in the AM peak whilst the PM peak shows a significant improvement when compared to the base for both the do-minimum and do-something scenarios.

For the 51/52 SB route there is a considerable reduction in journey time when compared to the base for both the do-minimum and do-something scenarios across both AM and PM time periods. Whilst the do-something AM journey times are unchanged from the do-minimum, the PM do-something journey times are 19 seconds and 28 seconds slower than the do-minimum for the options without and with the bus gate respectively. However given the relative sort length of the journey time route and the variability in journey time between individual services this reduction is not considered to be significant.

Moreover, further investigation of the model has indicated that this increase in delay with the Merrion Street downgrade scheme could be eliminated if the operation of the standalone pedestrian crossing on Merrion Street was adjusted to ensure that buses turning left from Wade Lane to Merrion Street are not held up at this crossing. It is not expected, therefore, that the Merrion Street downgrade would produce this additional delay to the 51/52 bus services, compared to the do-minimum (DS5) scenario.

Table 3 Bus Journey Times

Route	Units	AM Peak 8-9				PM Peak 5-6			
		Base 95%	DS5 95%	DS5 + Merrion St downgrade 95%	DS5 + New Briggate bus gate 95%	Base 95%	DS5 95%	DS5 + Merrion St downgrade 95%	DS5 + New Briggate bus gate 95%
51/52 SB	s	05:32	04:37	04:37	04:28	07:52	05:55	06:14	06:23
All services Vicar Lane SB	s	03:15	03:15	03:16	03:16	04:59	03:16	03:26	03:26

Alternative Options

Two other alternative options were tested.

- Great George St bus gate – Merrion St downgrade with banned straight-ahead movement from Great George St to Merrion St

Figure 5 Great George St bus gate



- Merrion St bus gate – Merrion St downgrade with additional bus gate east of Wade Lane

Figure 6 Merrion St bus gate

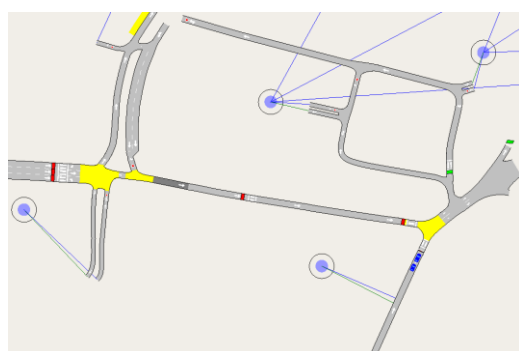


Table 4 shows results for the two scenarios, along with the New Briggate to Vicar Lane option. These tests are based on a full base demand matrix and use an older model version with the Armley 1B option. Both alternative options give a considerable increase in overall delay to general traffic and buses and create congestion around the Woodhouse Lane/Portland Way junction and around the northbound Inner Ring Road onslip at Westgate. Figure 7 and Figure 8 show the degree of queuing throughout the area between the Headrow and the Inner Ring Road for the two alternative scenarios.

Table 4 Alternative options - Aimsun network results

Statistic	Units	PM Peak 17-18		
		New Briggate to Vicar Lane	Great George St	Merrion St
Flow	veh/h	39,777	39,646	38,097
Delay (All Vehicles)	s/km	148.4	154.9	163.8
Delay (Bus)	s/km	157.4	160.9	186.5
Speed (All Vehicles)	km/h	24.6	24.3	24.7
Speed (Bus)	km/h	12.7	12.7	12.0

Figure 7 Great George bus gate 17:15



Figure 8 Merrion St bus gate 17:15



Scenarios excluding City Centre Package

Further tests were carried out using a future year network (DM5) with the following schemes excluded:

- City Square Closure
- Armley gyratory upgrade
- City Centre Package additional schemes: East Parade bus gate/Victoria St bus priority/Great George St widening
- M621 RIS

Table 5 shows overall network statistics for the base scenario, a scenario excluding City Centre Package schemes (DM5 network), a third scenario with the Merrion St downgrade and a fourth with the additional New Briggate bus gate.

The AM network statistics are unaffected by the addition of the Merrion St scheme. The PM results show a small increase in delay to all vehicles with a small improvement in delay to buses.

Table 5 Aimsun Network Statistics, excluding City Centre package schemes

Statistic	Units	AM Peak 8-9				PM Peak 5-6			
		Base 95%	DM5 95%	DM5 + Merrion St downgrade 95%	DM5 + New Briggate bus gate 95%	Base 95%	DM5 95%	DM5 + Merrion St downgrade 95%	DM5 + New Briggate bus gate 95%
Flow	veh/h	37,780	36,843	36,899	37,039	39,358	38,338	38,475	38,399
Delay (All Vehicles)	s/km	81.6	86.4	86.9	87.8	147.6	133.9	137.6	136.7
Delay (Bus)	s/km	126.5	123.1	124.6	129.5	193.2	161.7	156.7	152.9
Speed (All Vehicles)	km/h	31.3	30.3	30.1	29.9	25.6	25.0	25.4	25.6
Speed (Bus)	km/h	14.0	14.2	14.0	13.8	12.0	12.5	12.6	12.8

Table 6 shows bus journey times for the 51/52 southbound route and Vicar Lane southbound route. Across both peaks journey times along these routes are either unchanged or improved in comparison to the do-minimum by the addition of the Merrion St/New Briggate scheme.

Table 6 Bus journey times, excluding City Centre Package schemes

Route	Units	AM Peak 8-9				PM Peak 5-6			
		Base 95%	DM5 95%	DM5 + Merrion St downgrade 95%	DM5 + New Briggate bus gate 95%	Base 95%	DM5 95%	DM5 + Merrion St downgrade 95%	DM5 + New Briggate bus gate 95%
51/52 SB	s	05:32	05:57	05:58	05:57	07:52	06:22	06:04	05:46
All services Vicar Lane SB	s	03:15	03:18	03:09	03:08	04:59	03:12	03:17	03:17

Arena Event Traffic

Evening event

A further test was carried out to assess the impact of the scheme on traffic leaving the area following an event at the Leeds Arena.

For this test the following assumptions were made

- PM peak traffic reduced by 30% to reflect an event finishing during the evening rather than during the 5-6 PM peak hour.
- New Briggate bus gate not in operation

- The following car parks assumed to be at capacity with all vehicles attempting to leave during the first 30 minutes of the 60 minute modelled period.
 - Merrion Centre
 - St Johns
 - Woodhouse
 - The Light
 - The Core
 - Albion St
 - Templar St/Edward St

In total this gives 4100 cars leaving the area from the adjacent car parks, in comparison to the total Arena capacity of 13,781.

- Simulated barrier control was added at the exits from Merrion Centre, St Johns, The Light, The Core and Albion St car parks with a flow rate allowing a single vehicle to exit every 8 seconds. (Merrion St every 4 seconds to reflect the twin barriers).

Both modelled scenarios operate adequately with some general network delays in the immediate vicinity of the car parks and in some cases virtual queues forming within the car parks.

Overall network statistics are shown in Table 7. The addition of the Merrion St downgrade gives very small improvement in delay to both general vehicles and buses.

Table 7 Network Statistics - Arena Event

Statistic	Units	Arena Event	
		DS5	DS5 + Merrion St downgrade
Flow	veh/h	31,188	30,927
Delay (All Vehicles)	s/km	79.6	77.2
Delay (Bus)	s/km	127.0	120.4
Speed (All Vehicles)	km/h	33.8	34.2
Speed (Bus)	km/h	14.5	14.7

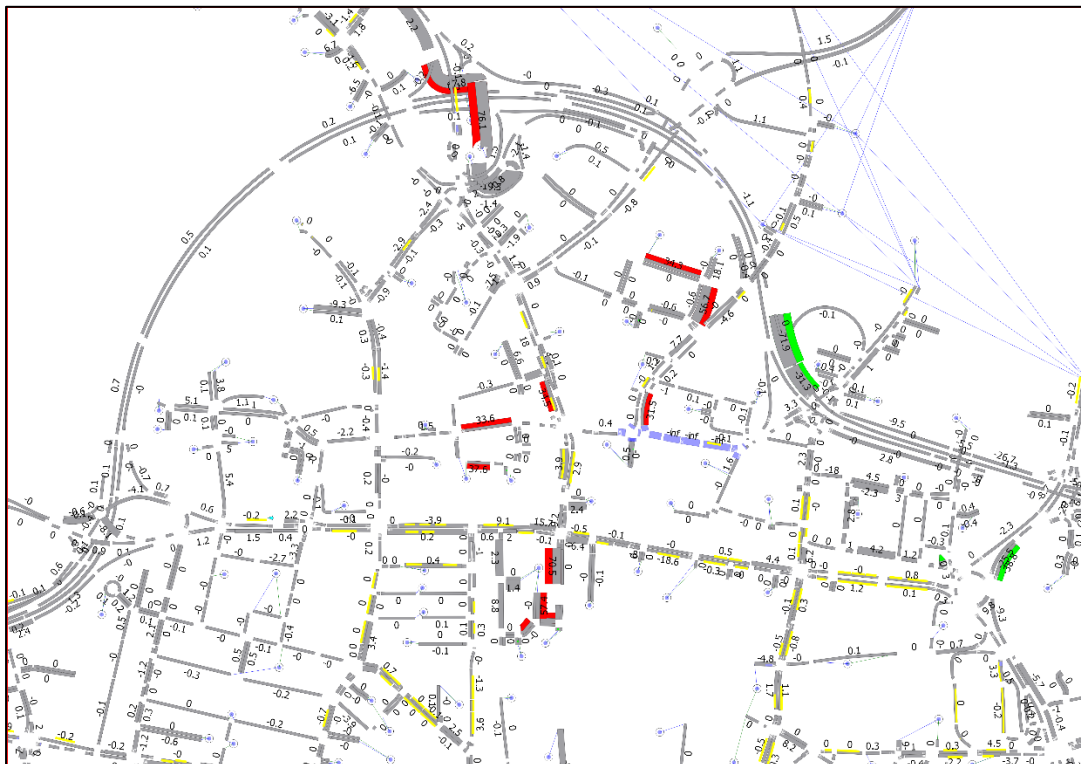
Figure 9 shows a comparison of simulated flows with/without the Merrion St downgrade (red shows an increase in 50 or more vehicles, green a reduction of 50 or more vehicles.) With the downgrade 486 vehicles are removed from Merrion St, with an increase of 136 vehicles northbound on Woodhouse Lane and traffic re-assigning onto the Inner Ring Road.

Figure 9 Arena Event flow comparison



Figure 10 shows a comparison of average delay (red an increase of over 30s per network section, green a reduction of over 30s), There is a small increase in delay to traffic exiting car parks heading northbound along Woodhouse Lane and southbound along Wade Lane

Figure 10 Arena event delay comparison



Saturday afternoon event

A similar test was carried out with PM traffic reduced by 20% to represent an estimation of traffic conditions on Saturday afternoon. Adjacent car parks were assumed to generate departures equal to 60% of capacity during the first 30 minutes of the modelled period.

Overall network statistics are shown in Table 8. As for the evening event, the addition of the Merrion St downgrade gives very small improvement in delay to both general vehicles and buses.

Table 8 Network Statistics - Arena Event – Saturday afternoon

Statistic	Units	Arena Event - Saturday afternoon	
		DS5	DS5 + Merrion St downgrade
Flow	veh/h	34,462	34,965
Delay (All Vehicles)	s/km	93.4	87.3
Delay (Bus)	s/km	140.3	129.7
Speed (All Vehicles)	km/h	31.8	32.1
Speed (Bus)	km/h	14.0	14.1

Figure 11 shows a comparison of simulated flows for the Saturday event with/without the Merrion St downgrade (red shows an increase in 50 or more vehicles, green a reduction of 50 or more vehicles). With the downgrade 312 vehicles are removed from Merrion St, with an increase of 97 vehicles northbound on Woodhouse Lane. Outbound traffic also re-assigns to routes via Westgate and onto the Inner Ring Road.

Figure 11 Saturday Arena Event flow comparison

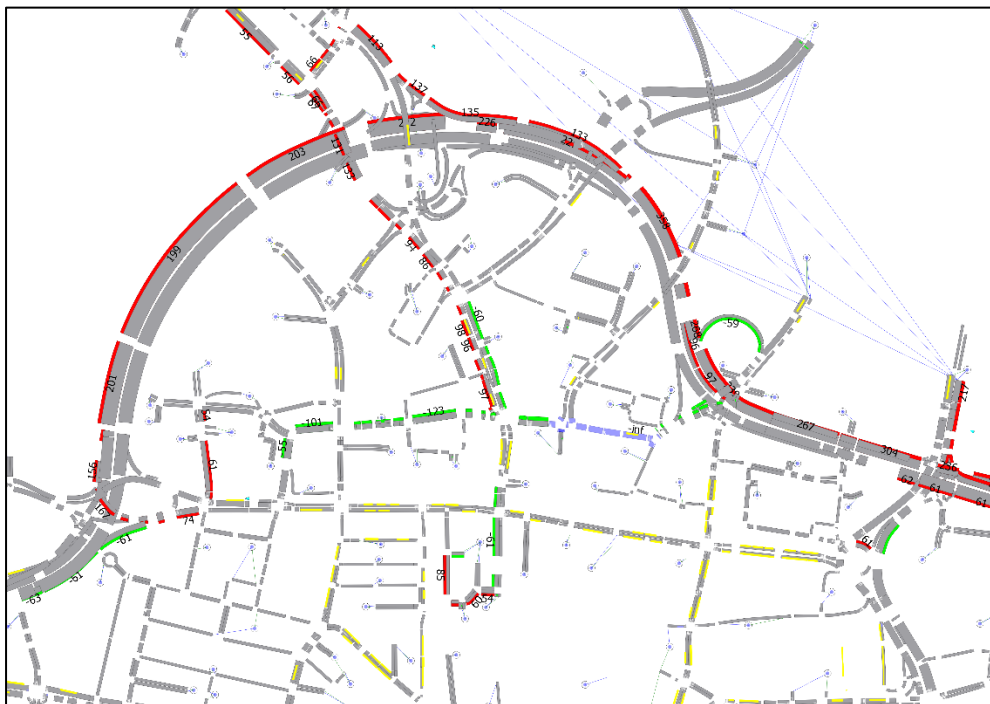
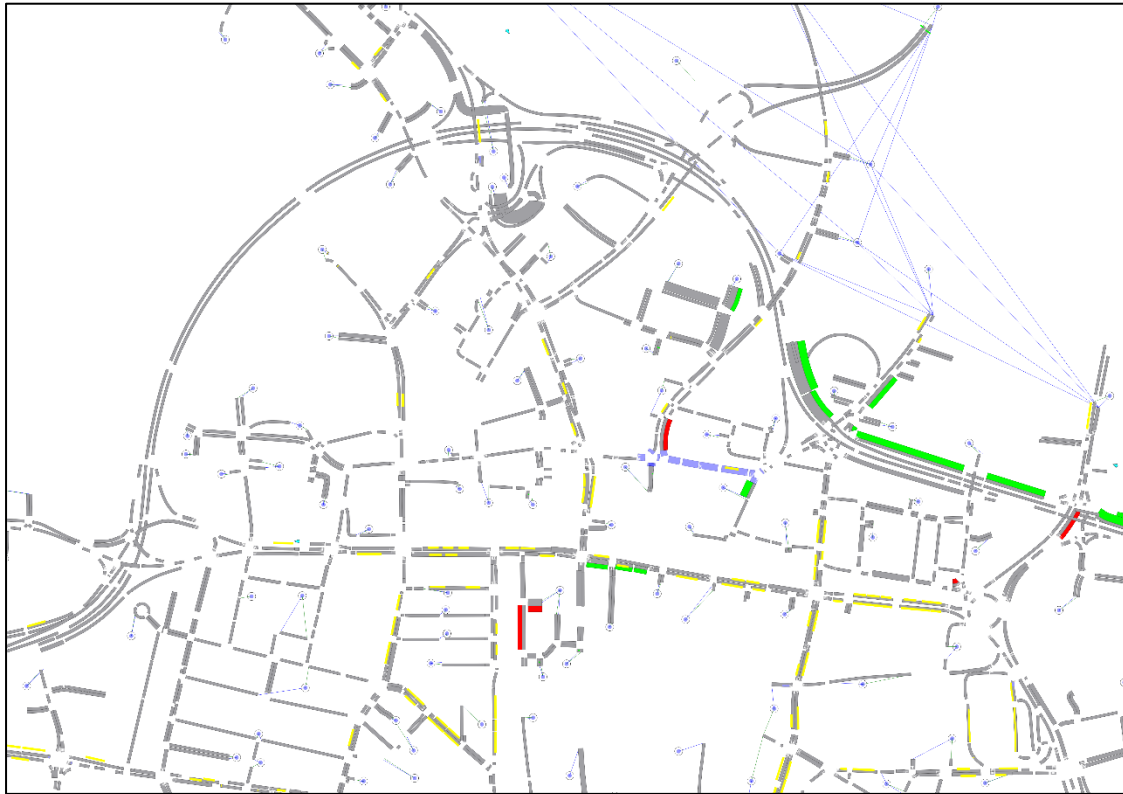


Figure 11 shows a comparison of average delay for the Saturday event with/without the Merrion St downgrade (red representing an increase of over 30s per network section, green a reduction of over 30). There is a small increase in delay to traffic exiting car parks northbound along Upper Basinghall St, representative of traffic reassigning to routes via Westgate and the Inner Ring Road, and southbound along Wade Lane.



Lane Markings

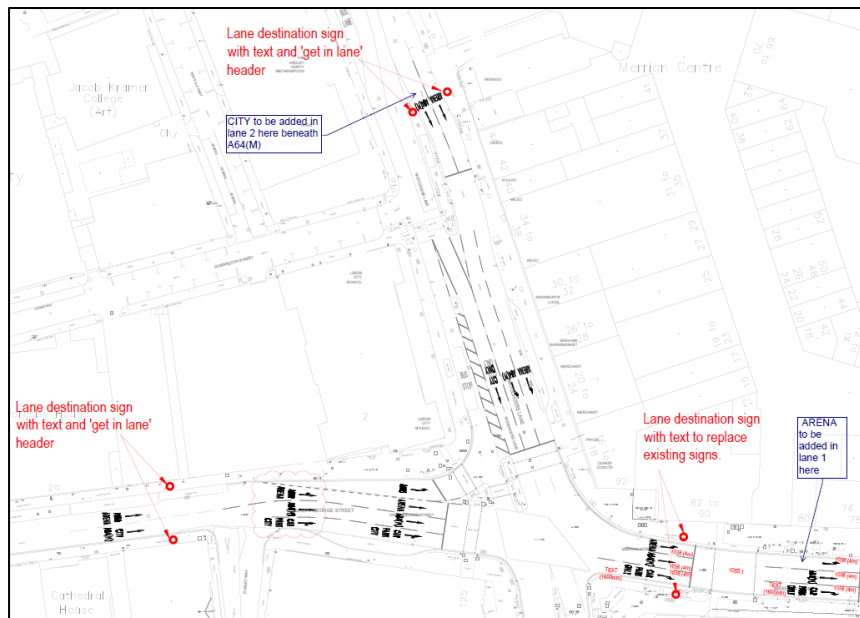
As part of the development of a detailed design for the scheme, revised lane markings are proposed on the approach to Merrion St from Woodhouse Lane and Great George St to avoid weaving on the short section on Merrion St up to the junction with Wade Lane. The proposed lane markings are shown in Figure 12.

In summary:

- Traffic from Great George St:
 - Lane 1 – Wade Lane (Arena)
 - Lane 2 – Merrion St
 - Lane 3 – Albion St / St John's car park
- Traffic from Woodhouse Lane to Merrion St:
 - Lane 1 – Wade Lane (Arena)
 - Lane 2 – Merrion St / St John's car park

These markings were modelled in Aimsun by adjusting look ahead distances for the required turn at the Merrion St/Wade Lane/car park junction to ensure traffic moved into the correct lane prior to the Great George St/Woodhouse Lane junction whenever possible.

Figure 12 Revised lane markings



Observation of the microsimulation model in the PM scenario with the revised lane markings showed that on occasion it was possible for traffic to queue back across the Woodhouse Lane/Great George St junction from the first pedestrian crossing on Merrion St, creating conflict with traffic entering the junction from Great George St heading straight ahead into Merrion St. The conditions under which this could occur are:

- Right turning traffic from Albion St runs into a red light at the Merrion St pedestrian crossing, resulting in a queue of 4-5 vehicles.
- In the following stage, left turning traffic from Woodhouse Lane into Merrion St joins this queue. The queue can then extend back across the junction if there is sufficient left turning traffic from Woodhouse Lane.
- During the next stage, straight-ahead traffic from Great George St can conflict with the queued traffic if the queue does not disperse sufficiently quickly (following the end of the pedestrian stage) during the inter-green period.

Signal timings in the model were consequently amended to increase the inter-green period between the Woodhouse Lane and Great George St stages by 5 seconds (removing green time from Great George St and starting the stage late to allow more time for traffic queued at the pedestrian crossing to disperse). This significantly improved the issue, with conflict observed only on rare occasions through the modelled hour. Nevertheless, a full review of signal timings by UTMC at the Woodhouse Lane/Great George St junction is advisable (see 'Next Steps', below).

It should also be noted that a future scheme to deliver bus and cycle enhancements at the junction of Great George Street and Woodhouse Lane will seek to improve the operation of the junction in a more comprehensive way (to benefit buses and cycles).

Revised network statistics are shown in Table 9. In both AM and PM there is a very minor improvement in overall bus journey times across the network. A slight worsening of overall delay to general traffic in the PM scenario was found to be due to model noise well away from the Merrion St area of the network. No increase in delay to buses or general traffic was observed in the area around Merrion St.

Table 9 Network statistics – revised lane markings

Statistic	Units	AM Peak 8-9		PM Peak 5-6	
		DS5 + Merrion St downgrade	Revised lane markings	DS5 + Merrion St downgrade	Revised lane markings
Flow	veh/h	36,514	36,753	39,247	39,278
Delay (All Vehicles)	s/km	91.8	89.5	115.9	120.5
Delay (Bus)	s/km	120.3	119.6	146.2	144.9
Speed (All Vehicles)	km/h	29.6	29.8	28.0	27.7
Speed (Bus)	km/h	14.7	14.8	13.4	13.5

Summary

The proposed Merrion St downgrade and New Briggate to Vicar Lane bus gate has been tested using the Leeds City Aimsun model. Overall network statistics show no significant change in overall delay to general traffic or buses in either the AM or PM peak hours compared to the original Do Something (DS5) design. Around 100 vehicles are removed in the PM peak hour from Merrion St and the through route to Lady Lane. Bus journey times are not considered to be materially affected.

Next Steps

This modelling work has informed the development of the amendment to the LPTIP scheme on New Briggate.

As part of the delivery of this scheme, the Leeds UTMCI team will make changes to signal plans for the junctions of Merrion Street/New Briggate and Merrion Street/Woodhouse Lane to maximise the efficient operation of these junctions, focusing in particular on minimising delays to buses.