Cheltenham Borough Council

Cheltenham Plan Transport Assessment

Phase 2 Report

Issue | 22 February 2018

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Ove Arup & Partners Ltd
63 St Thomas Street
Bristol BS1 6JZ
United Kingdom
www.arup.com

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Contents

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1 Introduction

1.1 Background to study

In May 2017 Cheltenham Borough Council (CBC) invited proposals for a consultant team to undertake a local highways site assessment to provide the transport evidence base that would support the emerging Cheltenham Local Plan (CLP). Following the submission of proposals, CBC appointed Arup to undertake this work.

1.2 Context

To inform the emerging Cheltenham Plan a local highways site assessment is required to understand the impacts of proposed site allocations. A robust evidence base will enable an assessment of the transport impacts of both existing development as well as that proposed, and can inform sustainable approaches to transport at a plan-making level. This will include consideration of viability and deliverability.

Using the future year 2031 Central Severn Vale (CSV) SATURN strategic highway model as provided by Gloucestershire County Council (GCC), the objective of Phase 1 of the commission was to identify junctions impacted by the proposed development in the 2031 forecast year, as well as to monitor the impact on key junctions and corridors within Cheltenham. Having identified these junctions, the objective of Phase 2 will be to undertake detailed junction modelling to inform junction design and consider the mitigation strategies that may be required as a result of development.

1.3 Phase 2 Scope

The Scope of Works for Phase 2 of this commission comprises modelling the junctions identified in Phase 1 and presenting any required mitigation options. These concept mitigation options are to be quantified and an indicative cost assigned to each option that can be apportioned to the proposed developments.

1.4 Report structure

Following on from the *Phase 1 Report*, the Phase 2 Report outlines the approach to junction modelling and presents the modelling results and potential mitigation for each junction. The report structure is as follows:

- Section 2 – Modelling Methodology
- Section 3 – Modelling Results
- Section 4 - Mitigation
- Section 5 – Conclusions and Recommendations

2 Modelling Methodology

Phase 1 of this study identified 17 junctions as outlined in the *Phase 1 Report*. Phase 2 assesses each of these junctions using industry standard software – LinSig version 3.2.22.0 for signalised junctions and Junctions 9 version 9.0.2.5947 for non-signalised junctions[1]. The junctions assessed are shown in Table 1 and a plan showing their locations is included in the *Phase 1 Report*.

Junction 1: Junction with A417 and Junction 9: Drews Court / Paynes Pitch have been excluded from modelling. Junction 1 is a proposed junction with no detailed layouts available. The node in the model located at Junction 9 represents the whole of Churchdown village and not an individual junction that can be assessed.

Table 1: Junctions Assessed

No	Junction	Type
~~1~~	~~Junction with A417~~	~~Priority~~
2	A4019 - Hayden Road	Signal
3	A4019 - Hayden Road - Manor Road	Signal
4	Priors Road - Harp Hill - Hewlett Road	Roundabout
5	Old Bath Road - London Road (A40)	Signal
6	A40 - A435	Signal
7	A435 - Moorend Road - Lyefield Road	Signal
8	Arle Court Roundabout	Signalised Roundabout
~~9~~	~~Drews Court - Paynes Pitch~~	~~Priority~~
10	Shurdington Road - Leckhampton Lane	Priority
11	Zoons Road - Churchdown Lane	Priority
12	Fiddlers Green Lane- Telstar Way	Roundabout
13	A435 - Bramble Chase	Roundabout
14	North Road West - Grovefield Way	Priority
15	A46 - Church Lane	Priority
16	Old Gloucester Road - Cheltenham Road B4063	Signal
17	Stoke Orchard Road - A435	Roundabout
18	A46 - B4079	Signal
19	A417 – Zoons Court (Zoons Court Roundabout)	Roundabout

Arup has assessed the impact of the developments included in the Cheltenham Plan at these junctions for the year 2031. The junction results in the 'with development' scenario, known as 'Do Something (DS)', are compared to the results of the 2031 without development scenario. The 2031 without development scenario, known as the 'Do Minimum (DM)' scenario, comprises 2016 baseline traffic flows plus 15 years of background traffic growth and any committed developments

[1] Roundabouts are assessed using the ARCADY module and priority junctions are assessed using the PICADY module that make up Junctions 9.

in the area. Traffic flows are taken from the *2031 Central Severn Vale SATURN Strategic Highway Model* as provided by Gloucestershire County Council.

Mitigation options, and potential costs, will be presented where junction performance is significantly worsened as a result of development traffic. Mitigation could range from changing lane allocations on approach to junctions, to introducing signals at a priority junction, to completely redesigning a junction.

3 Modelling Results

The results of the DM and DS junction modelling are presented in this section for each junction assessed. For each of the 17 junctions we will show the DM traffic flows, which include background traffic growth and committed developments, the proposed development flows outlined in the *Phase 1 Report* and the DS flows, which is the DM flow combined with the development flows.

As current base year flows have not been provided it is not possible to calibrate and / or validate the junction models against base year flows and queue lengths. Therefore, there may be discrepancies or oddities within the results that would not appear in a calibrated model – such as a long queue on one arm of a roundabout which may, in reality, be spread amongst the other arms or be reduced due to drivers accepting a smaller gap than is built in to the model.

3.1 Definitions

Throughout this section, junction modelling results will be expressed in terms of capacity, average delay and maximum queue length. The average delay is the time that individual vehicles would take on average, taken across the whole junction, to cross the stop / give way line from the back of the queue for that arm.

The maximum queue length results presented represent the worst queue experienced on an individual arm throughout the modelled time period. Queue lengths are expressed in Passenger Car Units (PCUs) where one PCU represents a car of 5.75m (including the car and a gap to the next vehicle) and other vehicles are given a value based on length, e.g. a bus is classified as two PCUs.

Capacity results are expressed differently for signalised and priority junctions. Signalised junction capacities are presented using the following parameters:

- Degree of Saturation (DoS) – presents capacity for an individual lane with 100% being full capacity. In modelling signalised junctions, LinSig sets the theoretical capacity of a lane at90% DoS as this would allow the junction to accommodate day-to-day variations in traffic of up to 10%.
- Practical Reserve Capacity (PRC) – represents the additional traffic that a signalised junction could accommodate based on the worst performing lane and taking a DoS of 90% as being at capacity. PRC is expressed as a percentage with a negative number indicating that the junction is over its theoretical capacity and that traffic flow would need to be reduced.

Priority junctions and non-signalised roundabout capacities are presented using the following parameters:

- Ratio of Flow to Capacity (RFC) – similar to DoS, though for a particular give way movement (such as a right turn in to a minor road) rather than individual lanes, with 1.0 being full capacity. In modelling priority junctions, Junctions 9 sets the theoretical capacity of a movement at a RFC of 0.85, allowing the junction to accommodate day-to-day variations in traffic of up to 15%.
- Network Residual Capacity (NRC) - represents the additional traffic that a signalised junction could accommodate based on the worst performing lane and taking a RFC of 85% as being at

capacity. NRC is expressed as a percentage with a negative number indicating that the junction is over its theoretical capacity and that traffic flow would need to be reduced.

3.2 Junction Modelling Results

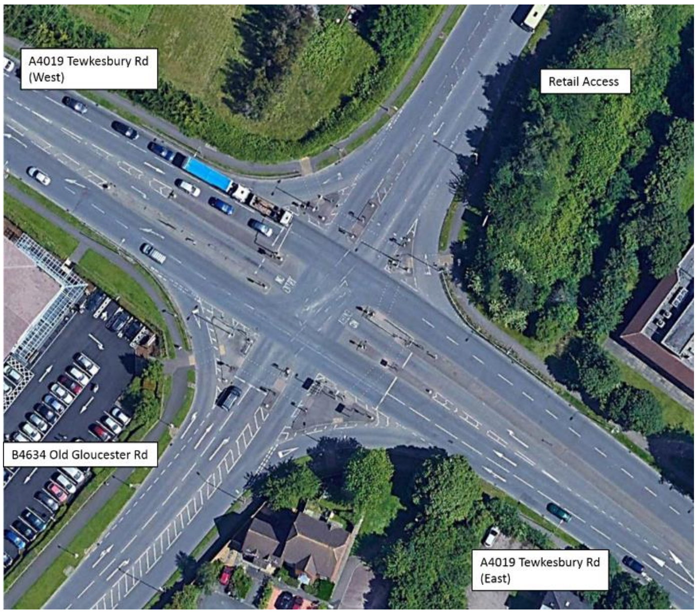
2. A4019 / B4634 Old Gloucester Road

The A4019 Tewkesbury Rd / B4634 Old Gloucester Rd junction is a large four-arm signalised crossroads with separately controlled right turns and non-signalised, give-way left turns. There are pedestrian crossings on all but the A4019 West arm. The B4634 Old Gloucester Rd provides access to the proposed Arle Nurseries / Old Gloucester Road site. The retail access arm to the north will provide access to a committed development site.

The A4019 Tewkesbury Rd (East) is a two-lane dual carriageway, widening to three lanes to facilitate the right turn plus a left turn flare, with the westbound traffic merging after exiting the junction. The A4019 West begins to flare from one lane to three around 125m back from the stopline and has a flare for the left turn. The other two arms widen to two lanes plus a dedicated left turn flare at the junction.

The junction layout is shown in Figure 1.

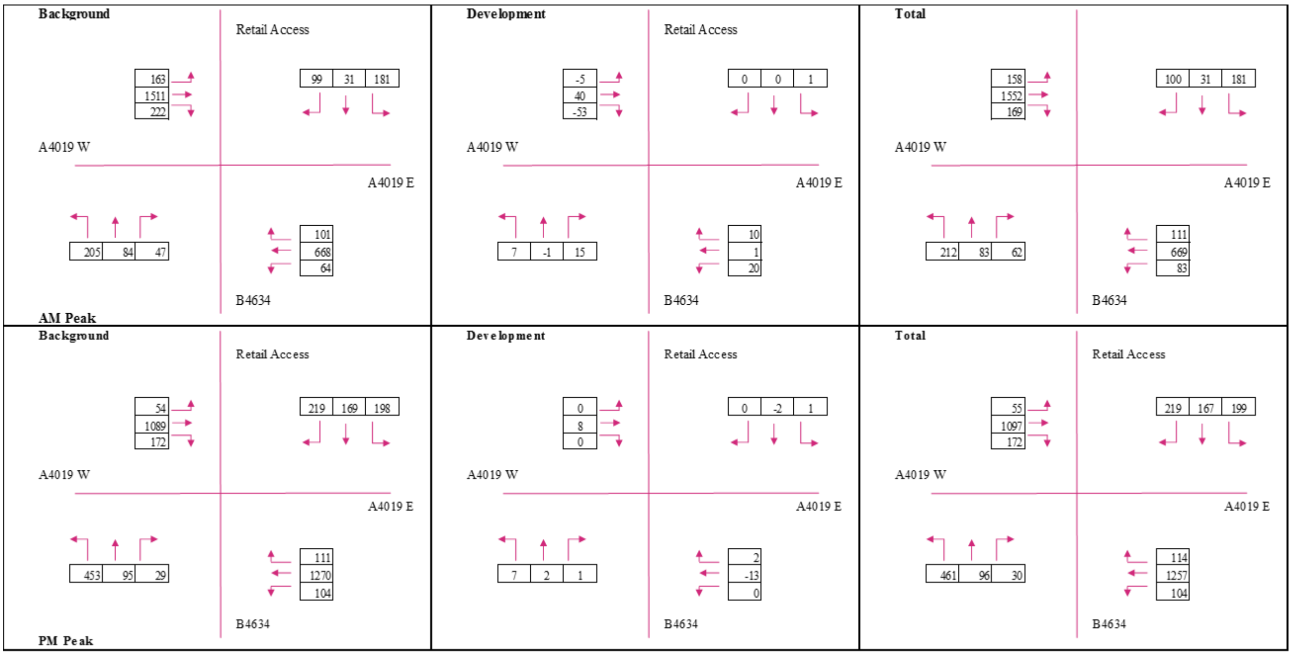
Figure 1: A4019 Tewkesbury Rd / B4634 Old Gloucester Rd Junction



Traffic Flows

The modelled flows for the junction are shown in Figure 2. The development flows result in decreases in some movements and increases in others in both peak hours. Overall, the development adds 35 vehicles in the AM peak and six in the PM peak. The development traffic would have very little impact at this junction.

Figure 2: A4019 Tewkesbury Rd / B4634 Old Gloucester Rd Junction Traffic Flows



Modelling Results

The results for the modelling of the A4019 Tewkesbury Rd / B4634 Old Gloucester Rd junction are presented in Table 2 and Table 3 for the AM and PM peak respectively. Modelling results are presented in Degree of Saturation and Practical Reserve Capacity for this junction.

The AM peak exhibits a slight overall improvement as a result of the proposed developments due to a significant reduction in right turning traffic from A4019 Tewkesbury Rd (West).

Table 2: A4019 Tewkesbury Rd / B4634 Old Gloucester Rd Junction Results, AM Peak

Arm	Do Minimum			Do Something		
	Saturation	Delay (s)	Queue (PCU)	Saturation	Delay (s)	Queue (PCU)
Retail Access	59.0%	67.7	3	59.0%	67.7	3
A4019 Tewkesbury Rd (East)	40.7%	21.1	6	49.8%	22.8	6
B4634 Old Gloucester Rd	60.4%	54.4	5	66.3%	57.0	6
A4019 Tewkesbury Rd (West)	84.1%	30.5	22	80.2%	26.3	21
Cycle Time	180 seconds			180 seconds		
PRC	7.0%			12.3%		
Average Delay	25.1 seconds			23.8 seconds		

In the PM peak, there is a slight worsening of junction performance when compared with the background flows. However, the junction is already over capacity in the Do Minimum scenario.

Table 3: A4019 Tewkesbury Rd / B4634 Old Gloucester Rd Junction Results, PM Peak

Arm	Do Minimum			Do Something		
	Saturation	Delay (s)	Queue (PCU)	Saturation	Delay (s)	Queue (PCU)
Retail Access	103.0%	220.8	16	102.4%	208.4	16
A4019 Tewkesbury Rd (East)	101.5%	118.1	39	102.2%	124.1	38
B4634 Old Gloucester Rd	102.7%	137.0	81	103.7%	147.1	83
A4019 Tewkesbury Rd (West)	81.1%	37.0	18	82.8%	37.0	16
Cycle Time	180 seconds			180 seconds		
PRC	-14.4%			-15.2%		
Average Delay	101.1 seconds			103.6 seconds		

Junction performance is improved in the AM peak despite an increase in overall traffic volumes due to relocating traffic demand away from a separately signalled right turn movement. The PM peak is already over capacity and is not made significantly worse with the introduction of additional development traffic.

3. A4019 / Hayden Road / Manor Road

The A4019 Tewkesbury Rd / Hayden Rd / Manor Rd junction is a large signalised staggered junction. Right turns are separately signalled in both directions on A4019 Tewksbury Rd with a separately signalled left turn from Manor Rd. One set of signals controls all movements from Hayden Rd. Hayden Rd can be used as an access route to the proposed Arle Nurseries / Old Gloucester Road site.

Pedestrian crossings are located over the mouth of Hayden Rd and Manor Rd, over dedicated left turn lanes leading to the minor arms and in the middle of the junction over both directions of Tewkesbury Rd.

A4019 Tewkesbury Rd is a 2-lane dual carriageway with both directions widening to four lane to accommodate the left and right turning movements. Manor Rd is also two lanes in each direction leading to / from a 4-arm roundabout providing access to a retail and business park. Hayden Rd is single carriage way providing access to residential developments, accessed via mini-roundabouts, and to B4634 Old Gloucester Rd.

The junction layout is shown in Figure 3.

File Note

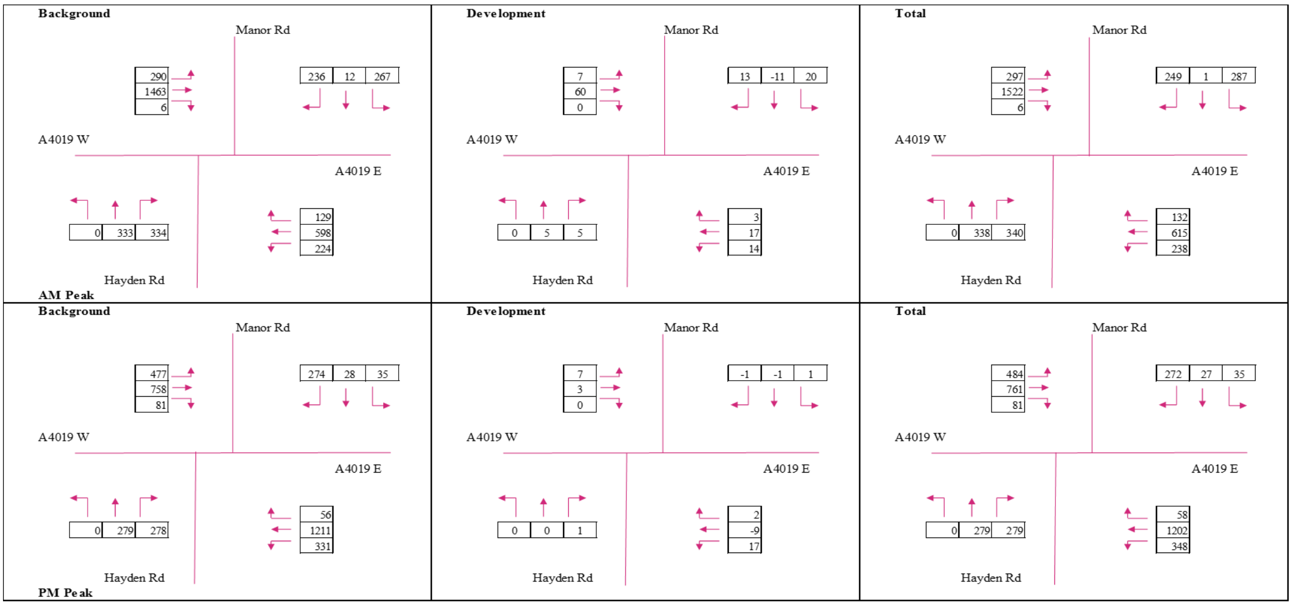
256784 22 February 2018

Figure 3: A4019 Tewkesbury Rd / Hayden Rd / Manor Rd Junction

Traffic Flows

The modelled flows for the junction are shown in Figure 3. The development flows result in decreases in some movements and increases in others in both peak hours. Overall, the development adds 134 vehicles in the AM peak and 19 in the PM peak. The development traffic would have very little impact at this junction.

Figure 4: A4019 Tewkesbury Rd / Hayden Rd / Manor Rd Junction Traffic Flows



Modelling Results

The results for the modelling of the A4019 Tewkesbury Rd / Hayden Rd / manor Rd junction are presented in Table 4 and Table 5 for the AM and PM peak respectively. Modelling results are presented in Degree of Saturation and Practical Reserve Capacity for this junction.

In both the AM and PM peak, the junction is already over capacity as a result of background traffic. Development traffic appears to have very little impact on the capacity of the junction, though there are significant increases in the average delay experienced of around 50-60 seconds per vehicle.

Table 4: A4019 Tewkesbury Rd / Hayden Rd / Manor Rd Junction Results, AM Peak

Arm	Do Minimum			Do Something		
	Saturation	Delay (s)	Queue (PCU)	Saturation	Delay (s)	Queue (PCU)
Manor Rd	108.3%	284.4	25	109.5%	300.0	26
A4019 Tewkesbury Rd (East)	106.8%	311.4	26	109.3%	341.4	28
Hayden Rd	109.7%	252.8	61	111.5%	279.5	61
A4019 Tewkesbury Rd (West)	109.3%	242.3	84	113.4%	305.6	103
Cycle Time	150 seconds			150 seconds		
PRC	-21.9%			-26.0%		
Average Delay	214.1 seconds			262.0 seconds		

Table 5: A4019 Tewkesbury Rd / Hayden Rd / Manor Rd Junction Results, PM Peak

Arm	Do Minimum			Do Something		
	Saturation	Delay (s)	Queue (PCU)	Saturation	Delay (s)	Queue (PCU)
Manor Rd	89.2%	101.1	16	66.9%	63.0	12
A4019 Tewkesbury Rd (East)	86.2%	51.9	27	103.6%	157.8	56
Hayden Rd	103.7%	174.9	38	103.7%	175.0	46
A4019 Tewkesbury Rd (West)	103.2%	161.1	44	103.2%	161.9	45
Cycle Time	150 seconds			150 seconds		
PRC	-15.4%			-16.6%		
Average Delay	134.9 seconds			191.6 seconds		

Although the change in capacity is negligible, the increase exhibited in average delay is significant, adding nearly a minute in each time period. It is likely, however, that the impact of the additional development traffic has been exaggerated as the junction is already over capacity with long delays.

4. Priors Road / Harp Hill / Hewlett Road

The Priors Rd / Harp Hill / Hewlett Rd junction is a double mini-roundabout with four arms and around 25m separating the two mini-roundabouts. Each approach to the junction comprises a single lane, with minimal flaring at the give-way line. The connecting lanes are also single lanes with a greater flare at the junction. All of the entry, exit and connecting lanes are separated by refuge islands that also provide uncontrolled pedestrian crossings.

This junction is located on a major circular route that provides indirect access to three of the proposed developments – Lands off Oakhurst Rise; Premiere Products, Bouncers Lane; and Priors Farm Fields – with others located nearby.

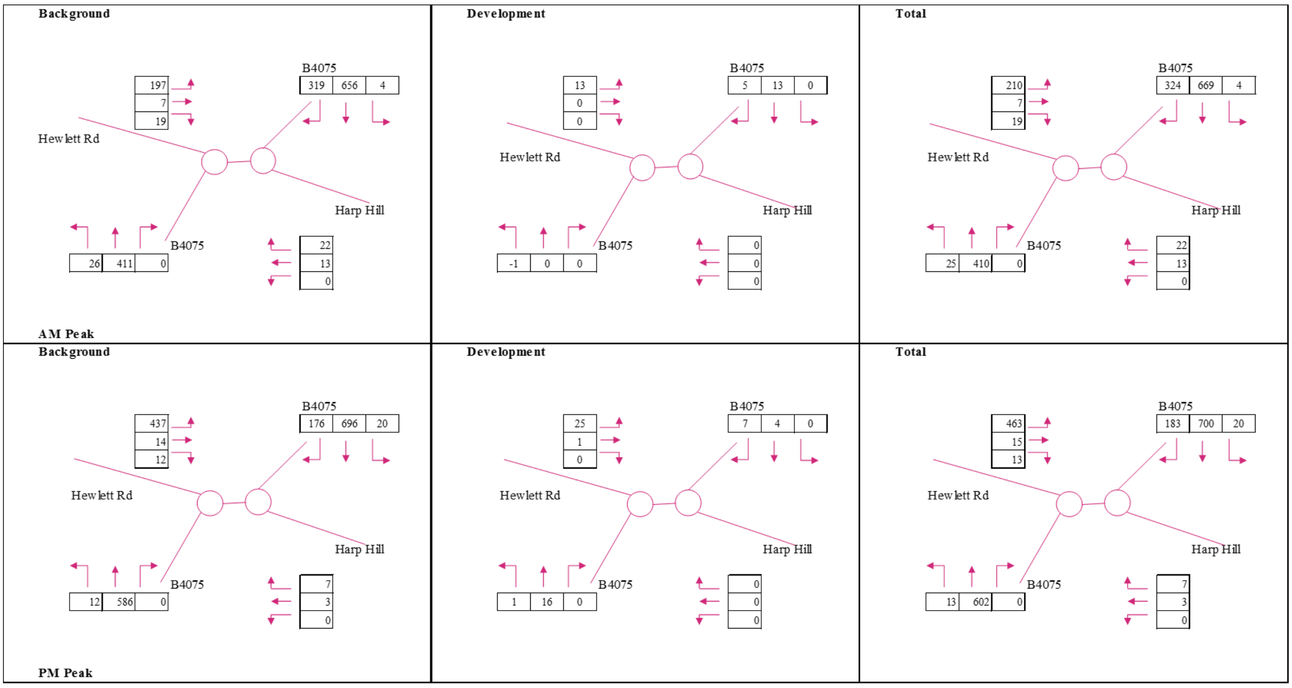
The junction layout is shown in Figure 5.

Figure 5: Priors Rd / Harp Hill / Hewlett Road Double Mini-roundabout

Traffic Flows

The modelled flows for the junction are shown in Figure 6. The development flows result in decreases in one movement in the AM peak and increases in others in both peak hours. Overall, the development adds 30 vehicles in the AM peak and 55 in the PM peak. None of the development traffic is routed on to Harp Hill as the developments are accessed via the B4075. With baseline traffic flows of around 1,650-2,000 vehicles the development traffic would have very little impact at this junction.

Figure 6: Priors Rd / Harp Hill / Hewlett Road Double Mini-roundabout Traffic Flows



Modelling Results

The results for the modelling of the Priors Rd / Harp Hill / Hewlett Rd junction are presented in Table 6 and Table 7 for the AM and PM peak respectively. Modelling results are presented in Ratio of Flow to Capacity and Network Residual Capacity for this junction.

Table 6: Priors Rd / Harp Hill / Hewlett Rd Junction Results, AM Peak

Arm	Do Minimum			Do Something		
	RFC	Delay (s)	Queue (PCU)	RFC	Delay (s)	Queue (PCU)
Hewlett Road	0.34	7.4	1	0.36	7.7	1
Priors Rd	1.21	445.8	109	1.24	503.38	124
Harp Hill	0.10	10.2	0	0.10	10.2	0
B4075 Hale's Rd	0.78	25.5	3	0.77	25.2	3
Eastbound Connector	0.65	9.7	2	0.66	10.1	2
Westbound Connector	0.74	11.5	3	0.74	11.5	3
NRC	-26%			-28%		
Average Delay	272.0 seconds			306.65 seconds		

In the AM peak the majority of arms are within capacity, with Hewlett Rd and Harp Hill significantly under capacity. Priors Rd, however, is significantly over capacity in both scenarios. The development traffic represents an impact of around 2% on both the Priors Rd arm and the junction as a whole in the AM peak but has a disproportionate impact on queues and delay as the junction is already over capacity.

Table 7: Priors Rd / Harp Hill / Hewlett Rd Junction Results, PM Peak

Arm	Do Minimum			Do Something		
	RFC	Delay (s)	Queue (PCU)	RFC	Delay (s)	Queue (PCU)
Hewlett Road	0.83	33.0	4	0.89	45.6	6
Priors Rd	1.11	212.3	60	1.12	240.4	66
Harp Hill	0.03	9.21	0	0.03	9.23	0
B4075 Hale's Rd	0.96	74.4	13	1.00	95.9	18
Eastbound Connector	1.07	135.1	45	1.10	210.6	61
Westbound Connector	0.71	10.2	2	0.71	10.3	2
NRC	-19%			-20%		
Average Delay	170.1 seconds			223.2 seconds		

In the PM peak in the Do Minimum, two of the approach arms – Priors Rd and Hale's Rd – and the eastbound connector between the two mini-roundabouts are over capacity with significant queues and delays. Hewlett Rd is also approaching theoretical capacity and has delay of around 30 seconds. In the Do Something scenario the capacity on these arms is further reduced but not by any significant amount. The largest impact is on the eastbound connector, where queues and delays are significantly affected, and on Hewlett Rd which is taken over its theoretical capacity.

Overall, there is a minor change in NRC and a 30-50 second increase in delay in both time periods. Although the change in capacity is negligible, the increase exhibited in average delay is fairly significant, adding 30-50 seconds in each time period. It is likely, however, that the impact of the additional development traffic has been exaggerated as the junction is already over capacity with relatively long delays.

5. Old Bath Road / London Road (A40)

The Old Bath Rd / London Rd junction is a four-arm, signalised crossroads with uncontrolled pedestrian crossings on all but the London Rd (South) arm. All four arms are single lane approaches, but Old Bath Rd widens to allow a dedicated right turn lane (to London Rd South) of around 30m and London Rd (North) widening to allow a dedicated left turn lane (to Hale's Rd) of around 40m. The right turn from London Rd (South) to Hale's Rd is facilitated by a right turn storage area large enough for around two PCUs.

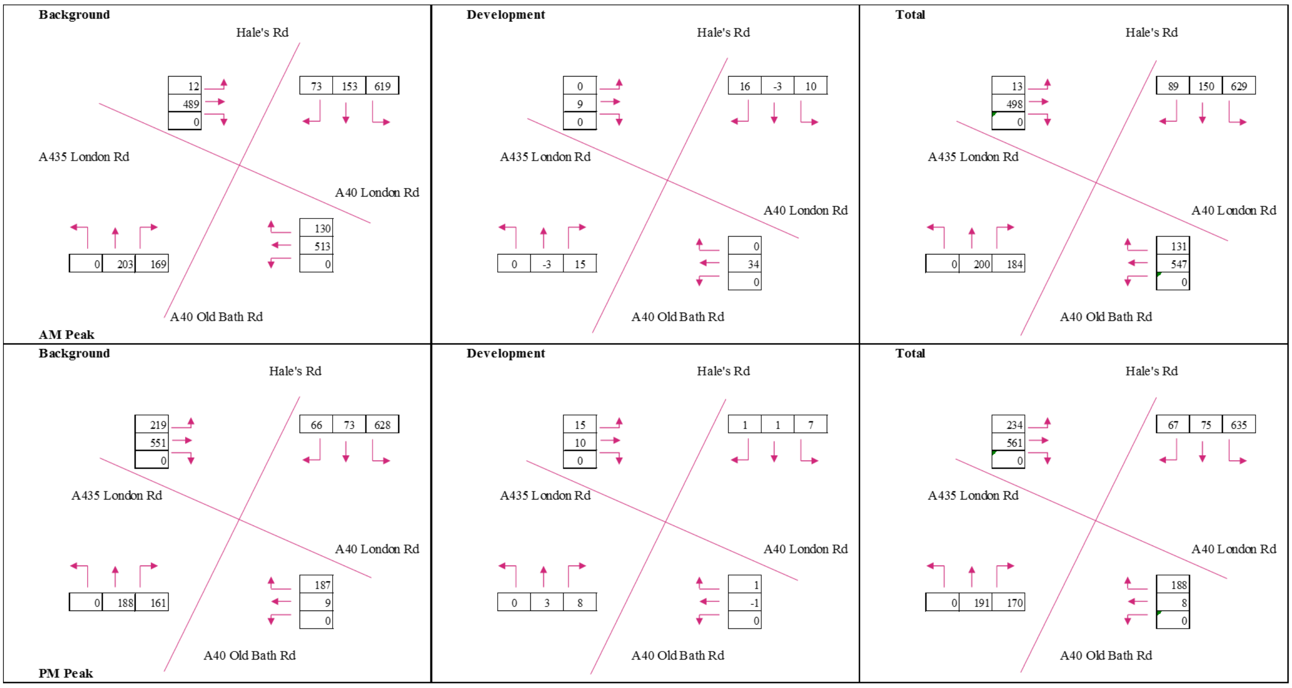
The junction is located on major routes heading northeast and southeast out of Cheltenham and also provides an access route to four of the proposed developments: Reeves Field; Lands off Oakhurst Rise; Priors Farm Fields; and Premiere Products, Bouncers Lane.

Figure 7: Old Bath Rd / A40 London Rd Junction

Traffic Flows

The modelled flows for the junction are shown in Figure 8. The development flows result in decreases in some movements and increases in others in both peak hours. Overall, the development adds 79 vehicles in the AM peak and 46 in the PM peak. This equates to an impact of around 3% in both peak hours. Some individual movements do experience a greater impact – such as adding 16 PCUs to the 73 right turning movements from Hale's Rd to London Rd (North) with an impact of around 22%.

Figure 8: Old Bath Rd / A40 London Rd Junction Traffic Flows



Modelling Results

The results for the modelling of the Old Bath Rd / A40 London Rd junction are presented in Table 8 and Table 9 for the AM and PM peak respectively. Modelling results are presented in Degree of Saturation and Practical Reserve Capacity for this junction.

Table 8: Old Bath Rd / A40 London Rd Junction Results, AM Peak

Arm	Do Minimum			Do Something		
	Saturation	Delay (s)	Queue (PCU)	Saturation	Delay (s)	Queue (PCU)
London Rd (Northwest)	96.3%	96.1	24	96.5%	97.4	25
Hale's Rd	98.9%	85.5	47	102.4%	132.1	59
London Rd (Southeast)	98.9%	101.7	33	102.8%	149.5	44
Old Bath Rd	35.3%	21.9	5	36.1%	22.5	5
Cycle Time	240 seconds			240 seconds		
PRC	-9.9%			-14.2%		
Average Delay	53.8 seconds			76.07 seconds		

In the AM peak Do Minimum scenario all arms except Old bath Rd are operating over the theoretical capacity, but slightly within the maximum capacity, with delays of around 90 seconds and queues of 25-50 PCUs. In the Do Something scenario, Hale's Rd and London Rd (South) are pushed over the maximum capacity, but the increase in saturation is only around 4%, along with corresponding increases in delays and queues.

Table 9: Old Bath Rd / A40 London Rd Junction Results, PM Peak

Arm	Do Minimum			Do Something		
	Saturation	Delay (s)	Queue (PCU)	Saturation	Delay (s)	Queue (PCU)
London Rd (Northwest)	105.2%	183.9	57	106.8%	211.4	66
Hale's Rd	105.1%	185.1	63	107.5%	228.3	73
London Rd (Southeast)	26.4%	27.5	5	26.1%	27.1	5
Old Bath Rd	37.4%	27.8	5	38.8%	28.7	6
Cycle Time	240 seconds			240 seconds		
PRC	-16.8%			-19.5%		
Average Delay	82.73 seconds			100.1 seconds		

In the PM peak, London Rd (North) and Hale's Rd are both over the maximum capacity and saturation is increased slightly in the Do Something but only by around 2%. Queues and delays also increase slightly in the Do Something.

Overall, the PRC decreases by less than 5% and delays increase by around 20 seconds in both time periods. Although the development traffic does push the junction over capacity in the AM peak, the

Do Minimum traffic levels do not allow for any day-to-day variation. The PM peak is already over capacity in the Do Minimum and is not significantly worsened by the additional development traffic.

6. A40 / A435

The A40 London Rd / A435 Cirencester Rd junction is a four-arm signalised Y-shaped junction, where the A40 and A435 merge, with a minor road to the north (Hayward's Rd), located on a major route into the city from the south east. All four approaches are single lanes but the A40 London Rd (North) widens to allow a dedicated slight right turn to A435 Cirencester Rd. A435 Cirencester Rd is ahead only to A40 London Rd (North) with the two right turns being banned.

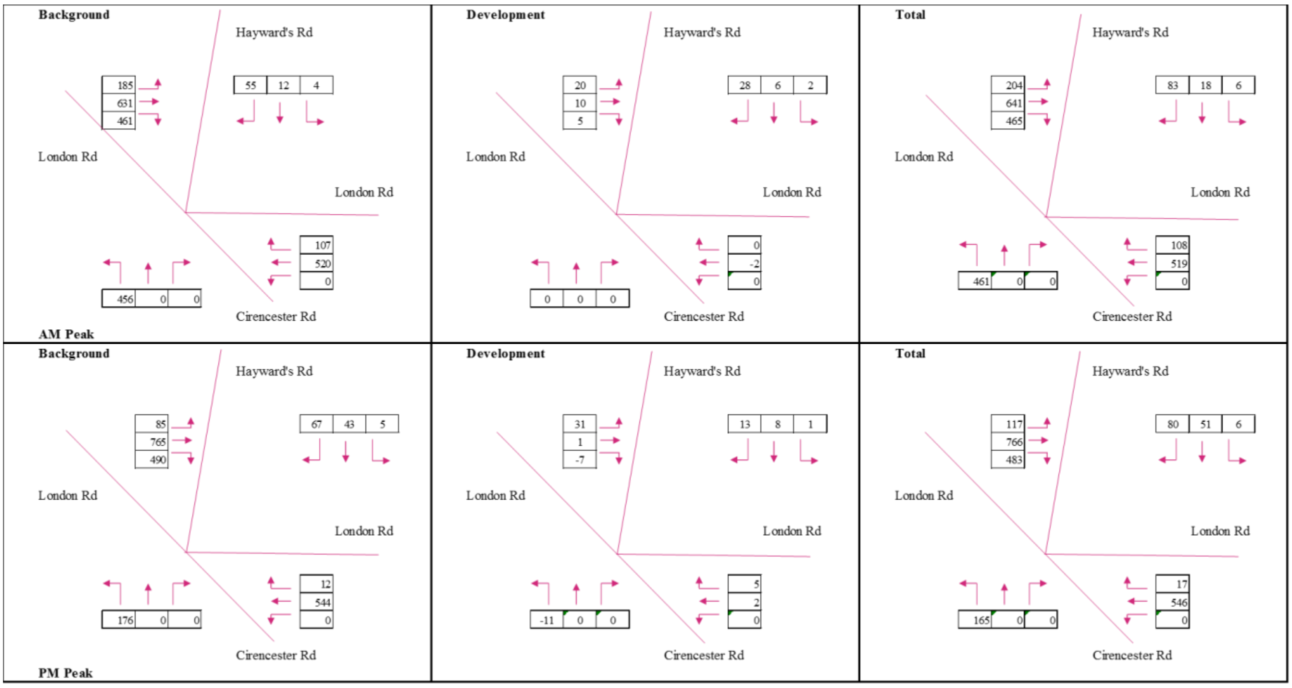
Two of the proposed development sites are located near to the junction – Reeves Field and Lands off Oakhurst Rise – but are not directly accessed by using the junction. Reeves Field development traffic would only use this junction if coming from outside the city (or heading out of the city). Oakhurst Rise development traffic does pass through the junction en route to the city centre and heading out of the city.

Figure 9: A40 London Rd / A435 Cirencester Rd Junction

Traffic Flows

The modelled flows for the junction are shown in Figure 10. The development flows result in decreases in some movements and increases in others in both peak hours. Overall, the development adds 69 vehicles in the AM peak and 44 in the PM peak. This equates to an impact of around 3% in the AM peak and 2% in the PM peak. Some individual movements do experience a greater impact – such as adding 36 PCUs to Hayward's Rd (base flow of 71) in the AM peak resulting in an impact of around 50%.

Figure 10: A40 London Rd/ A435 Cirencester Rd Junction Traffic Flows



Modelling Results

The results for the modelling of the A40 / A435 junction are presented in Table 10 and Table 11 for the AM and PM peak respectively. Modelling results are presented in Degree of Saturation and Practical Reserve Capacity for this junction.

Table 10: A40 London Rd/ A435 Cirencester Rd Junction Results, AM Peak

Arm	Do Minimum			Do Something		
	Saturation	Delay (s)	Queue (PCU)	Saturation	Delay (s)	Queue (PCU)
Hayward's Rd	55.1%	85.2	3	83.5%	126.8	6
A40 London Rd (East)	107.9%	225.8	52	110.9%	270.4	60
A435	42.8%	19.4	9	42.7%	18.8	9
A40 London Rd (West)	108.3%	194.0	98	110.1%	221.2	111
Cycle Time	120 seconds			120 seconds		
PRC	-20.3%			-23.2%		
Average Delay	112.1 seconds			133.58		

In the Do Minimum scenario the AM peak is already over capacity on both London Rd arms and these are not significantly worsened in the Do Something scenario. Hayward's Rd, however, is significantly affected by the development traffic with a reduction in capacity of around 30%, but is still slightly under the theoretical maximum capacity. Queues and delays are not significantly worsened in the Do Something.

Table 11: A40 London Rd/ A435 Cirencester Rd Junction Results, PM Peak

Arm	Do Minimum			Do Something		
	Saturation	Delay (s)	Queue (PCU)	Saturation	Delay (s)	Queue (PCU)
Hayward's Rd	89.0%	146.8	7	106.3%	282.5	13
A40 London Rd (East)	108.5%	239.0	48	109.7%	256.3	51
A435	15.6%	13.8	3	14.6%	13.7	3
A40 London Rd (West)	107.7%	181.8	100	110.3%	221.9	116
Cycle Time	120 seconds			120 seconds		
PRC	-20.5%			-22.5%		
Average Delay	109.8 seconds			135.29 seconds		

The results for London Rd (both arms) are almost the same in the PM peak with the Do Something not making it significantly worse. Hayward's Rd, however, is approaching theoretical maximum capacity in the Do Minimum and is significantly worsened in the Do Something.

Overall, the junction performance is not significantly affected by the development traffic in either peak as the worst performing arms (London Rd) are only slightly worsened by development traffic.

7. A435 / Moorend Road / Lyefield Road

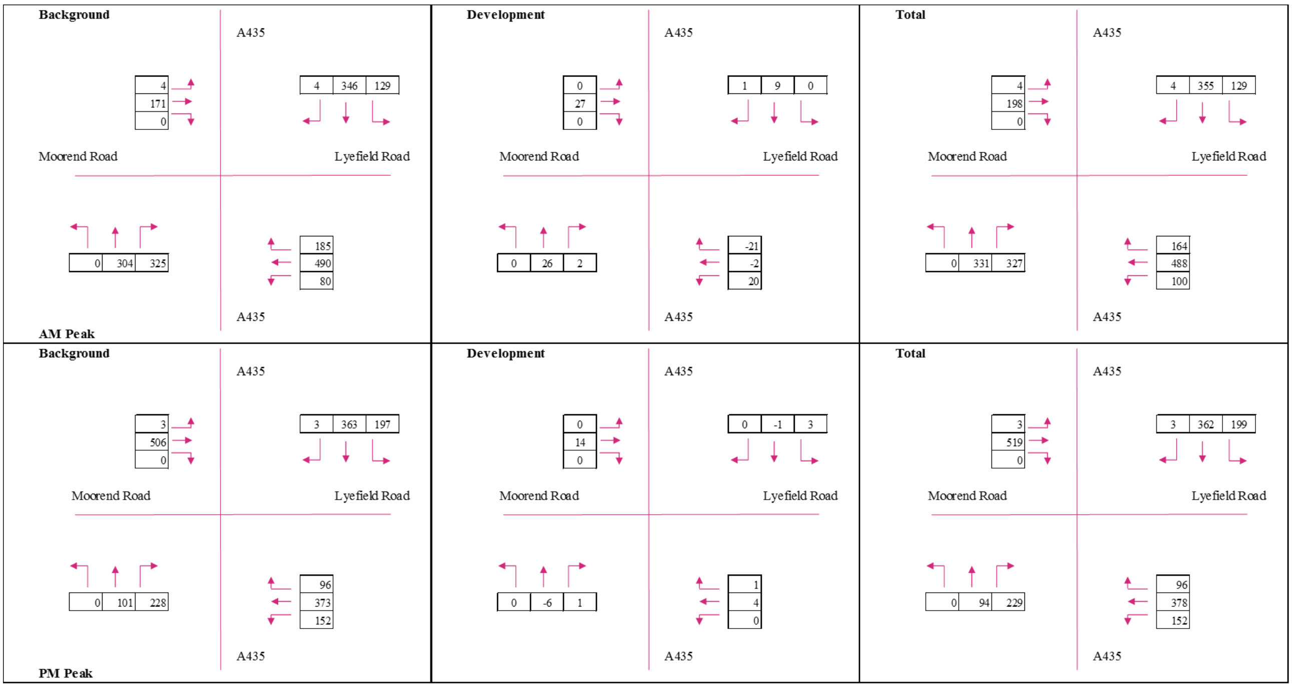
The A435 / Moorend Rd / Lyefield Rd junction is a four-arm signalised crossroads with controlled pedestrian crossings on all four arms. Each arm comprises a single lane approach with a lead-in cycle lane and advanced cycle stopline. This junction is located around 750m from Junction 6: A40 London Rd / A435 Cirencester Rd on a major route in to the city.

Figure 11: A435 / Moorend Rd / Lyefield Rd Junction

Traffic Flows

The modelled flows for the junction are shown in Figure 12. The development flows result in decreases in some movements and increases in others in both peak hours. Overall, the development adds 61 vehicles in the AM peak and 15 in the PM peak. This equates to an impact of around 3% in the AM peak and 1% in the PM peak. Some individual movements do experience a greater impact – such as adding 27 PCUs to Moorend Rd (base flow of 175) in the AM peak resulting in an impact of around 15%.

Figure 12: A435 / Moorend Rd / Lyefield Rd Junction Traffic Flows



Modelling Results

The results for the modelling of the A435 / Moorend Rd / Lyefield Rd junction are presented in Table 12 and Table 13 for the AM and PM peak respectively. Modelling results are presented in Degree of Saturation and Practical Reserve Capacity for this junction.

Table 12: A435 / Moorend Rd / Lyefield Rd Junction Results, AM Peak

Arm	Do Minimum			Do Something		
	Saturation	Delay (s)	Queue (PCU)	Saturation	Delay (s)	Queue (PCU)
A435 Cirencester Rd (North)	62.6%	37.6	14	65.5%	36.9	14
Lyefield Rd	88.5%	47.7	28	89.8%	50.7	29
A435 Cirencester Rd (South)	88.0%	53.7	23	89.8%	55.8	25
Moorend Rd	20.4%	22.6	4	23.9%	23.8	5
Cycle Time	240 seconds			240 seconds		
PRC	1.6%			0.2%		
Average Delay	25.4 seconds			27.04		

The junction operates within capacity in both scenarios and time periods, though Lyefield Rd and A435 Criencester Rd (South) are approaching the theoretical maximum capacity in the AM peak. The development traffic has a slight impact on the junction, but not enough to require mitigation.

Table 13: A435 / Moorend Rd / Lyefield Rd Junction Results, PM Peak

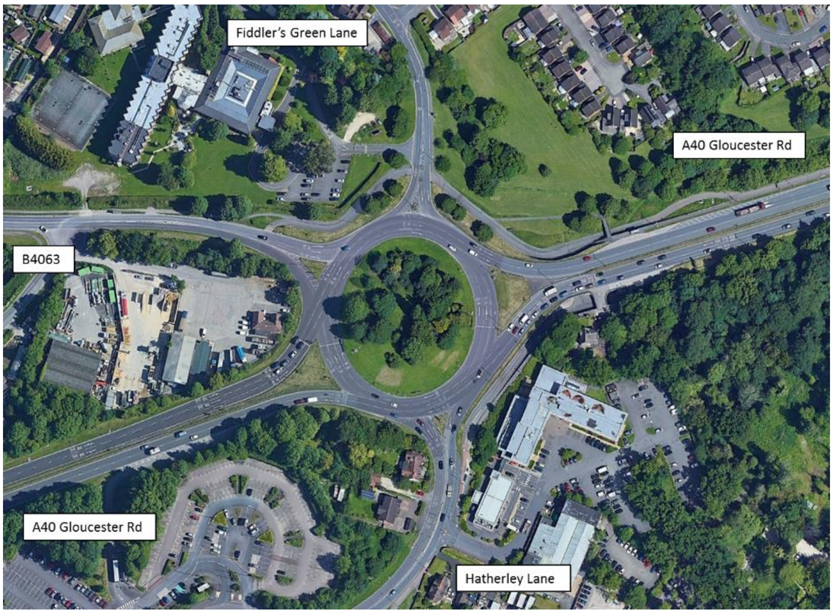
Arm	Do Minimum			Do Something		
	Saturation	Delay (s)	Queue (PCU)	Saturation	Delay (s)	Queue (PCU)
A435 Cirencester Rd (North)	81.3%	39.2	15	81.6%	39.5	15
Lyefield Rd	80.5%	35.4	16	81.1%	35.9	17
A435 Cirencester Rd (South)	48.3%	26.7	7	47.6%	26.6	7
Moorend Rd	64.6%	27.7	12	66.3%	28.3	12
Cycle Time	180 seconds			180 seconds		
PRC	10.7%			10.3%		
Average Delay	18.5 seconds			18.9 seconds		

Overall, the junction operates within capacity, though only slightly within in the AM peak, in both scenarios.

8. Arle Court Roundabout

The Arle Court Roundabout is a large five-arm partially signalised roundabout on one of the most heavily used routes into Cheltenham, connecting the M5 to GCHQ and the city centre. The A40 east and westbound approaches, and the corresponding section of the gyratory, are signalised.

Figure 13: Arle Court Roundabout Junction



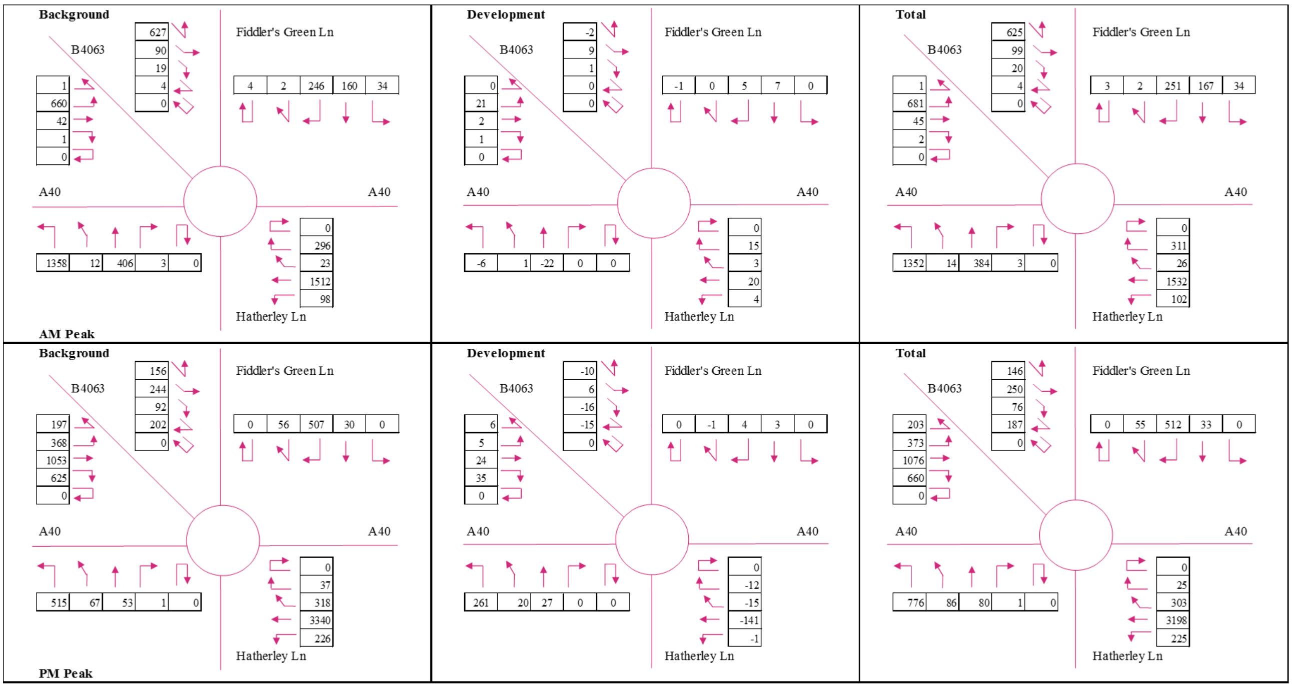
The A40 in this location is a dual carriageway, which widens to three lanes at the junction, on both approaches. The Hatherley Lane and B4063 arms are single carriageway roads that widen to three lanes at the junction with two lanes signed for the A40 into Cheltenham. The Fiddler's Green Lane arm, to the north, is also a single lane approach that widens to two lanes at the junction. The gyratory comprises three lanes with two of the lanes designated for the A40 (in either direction) throughout – though other movements are signed in these lanes in places – with the remaining lane to accommodate other movements.

Whilst Arle Court Roundabout does not directly provide access to any of the proposed development, it is on the route between the majority of the developments and the motorway network and Gloucester. It is likely that traffic from all of the developments except for the Arle Nurseries / Old Gloucester Rd and Leckhampton sites would use this roundabout to access the motorway network.

Traffic Flows

The modelled flows for the junction are shown in Figure 14. The development flows result in decreases in some movements and increases in others in both peak hours. Overall, the development adds 60 vehicles in the AM peak and 180 in the PM peak. This equates to an impact of around 1% in the AM peak and 2% in the PM peak. In the Do Minimum scenario around 5,600 PCUs use the roundabout, increasing to 8,100 in the PM peak.

Figure 14: Arle Court Roundabout Junction Traffic Flows



In the AM peak, 1,993 PCUs are heading north on Fiddler's Green Lane with only 169 heading in to Cheltenham on the A40 East. In the PM peak, 614 vehicles head north on Fiddler's Green Lane and 1,298 head into Cheltenham on the A40 East.

Modelling Results

The results for the modelling of the Arle Court Roundabout are presented in Table 14 and Table 15 for the AM and PM peak respectively. Modelling results are presented in Degree of Saturation and Practical Reserve Capacity for this junction.

Table 14: Arle Court Roundabout Junction Results, AM Peak

Arm	Do Minimum			Do Something		
	Saturation	Delay (s)	Queue (PCU)	Saturation	Delay (s)	Queue (PCU)
Fiddler's Green Lane	46.2%	3.5	0	47.7%	3.6	1
A40 Gloucester Rd (East)	201.8%	1024.3	312	205.3%	1048.1	329
Hatherley Lane	202.9%	1029.3	447	202.2%	1030.6	444
A40 Gloucester Rd (West)	68.8%	23.7	14	69.4%	23.2	14
B4063	115.0%	281.8	99	114.8%	281.1	99
Cycle Time	90 seconds			90 seconds		
PRC	-125.4%			-128.2%		
Average Delay	1005.0 seconds			1029.2 seconds		

Table 15: Arle Court Roundabout Junction Results, PM Peak

Arm	Do Minimum			Do Something		
	Saturation	Delay (s)	Queue (PCU)	Saturation	Delay (s)	Queue (PCU)
Fiddler's Green Lane	119.7%	353.8	82	118.1%	328.5	73
A40 Gloucester Rd (East)	202.4%	1016.3	586	229.3%	1138.1	627
Hatherley Lane	195.6%	990.0	166	229.2%	1144.6	278
A40 Gloucester Rd (West)	96.2%	42.2	30	96.7%	43.1	32
B4063	134.7%	556.6	58	135.1%	564.9	53
Cycle Time	90 seconds			90 seconds		
PRC	-124.9%			-154.8%		
Average Delay	1388.3 seconds			1564.1 seconds		

Junction 8: Arle Court Roundabout is significantly over capacity in both scenarios and time periods but the level of congestion is further increased by the proposed development traffic. It is difficult to determine the true impact of development traffic at Arle Court due to the significant amount of background traffic heading to and from a new development at Junction 12: Fiddler's Green Lane / Telstar Way. In the AM peak, 3,829 vehicles enter this site with 3,826 exiting in the PM peak.

The Arle Court roundabout is currently arranged to facilitate movements to and from the A40 in both directions, as this is a major route in and out of Cheltenham. Fiddlers Green Lane is a single lane exit with the lane on the gyratory also exiting on the A40 in to Cheltenham. This results in all northbound traffic being directed into one lane on each approach and on the gyratory.

In the Do Minimum AM peak, 1,993 vehicles head north to Fiddler's Green Lane with only 169 heading in to Cheltenham on the A40. This causes long queues in single lanes on the entrances to the roundabout and on the gyratory that would usually be split over several lanes. In the PM peak, the majority of southbound vehicles exiting the new development at Junction 12 are routed past GCHQ to the A40 and approach Arle Court from the east with the remainder approaching from Fiddler's Green Lane. In total, around 4,500 vehicles head west at the roundabout on the A40 and the total for the junction is 8,086, around 2,500 more vehicles than the AM peak.

Therefore, the additional 180 vehicles in the Do Something model appear to have a much greater impact due to the junction being significantly over capacity. Before any mitigation can be investigated for the Cheltenham Plan this junction would need to be redesigned for the background traffic flows and this assessment re-run to determine the true impact. Attempting to mitigate the development impact on a junction that is already so far over capacity would not be appropriate as it would be impossible to apportion costs to the proposed developments as any mitigation would also improve results for the Do Minimum model.

10. Shurdington Road / Leckhampton Lane

The Shurdington Rd / Leckhampton Lane junction is a priority T-junction located in the village of Shurdington, around 1.1km south west of the Cheltenham urban area along the A46 Shurdington Rd. Shurdington Rd is a single-lane carriageway in this location with no right turn ghost island provided for access to Leckhampton Lane, which is also single carriageway.

The Leckhampton development is located on the A46 to the northeast, within the Cheltenham urban area, and could, theoretically, be accessed from either the A46 or Leckhampton Lane depending on highways access requirements for the completed development.

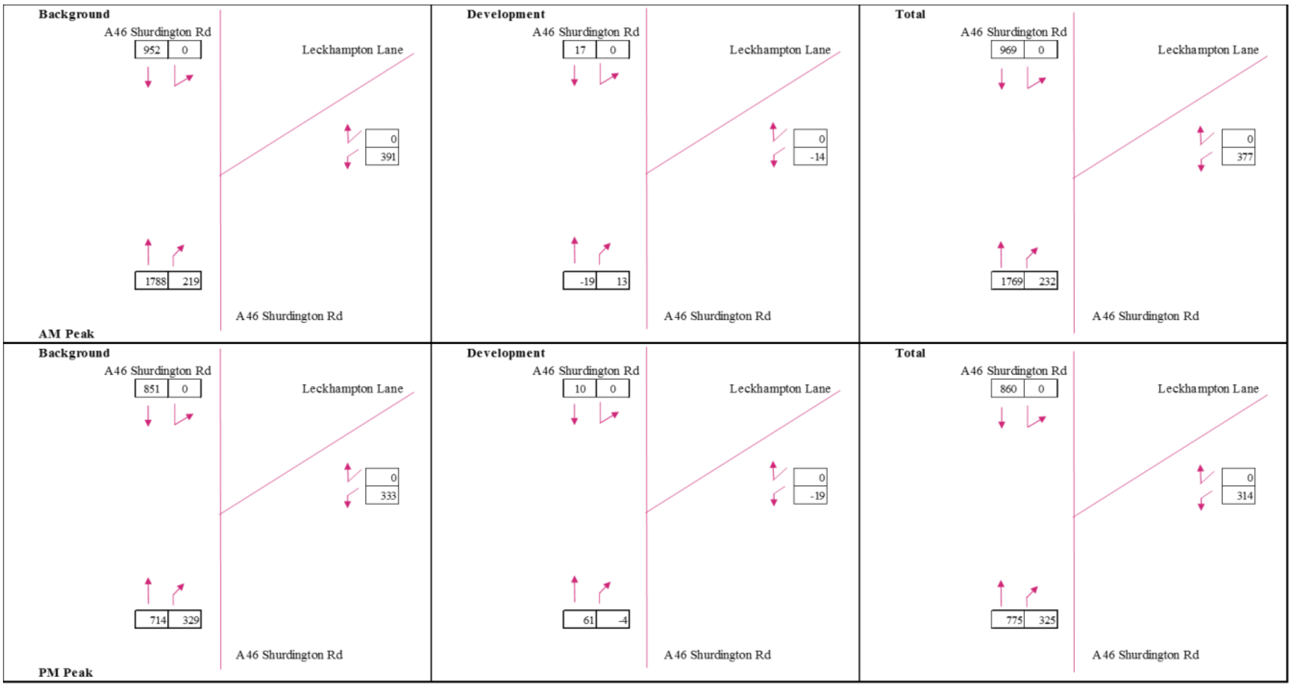
Figure 15: Shurdington Rd / Leckhampton Lane Junction

Traffic Flows

The modelled flows for the junction are shown in Figure 16. The modelled flows show no right turn movements from Leckhampton Lane in any of the scenarios and the movement does not appear to be banned. It is considered likely that there would, usually, be some right turn movements from Leckhampton Lane, even if limited in number. This discrepancy could be an error with the coding in the SATURN model or as a result of traffic demand forcing any potential right turners elsewhere.

The development flows result in decreases in some movements, particularly the left turn from Leckhampton Lane, and increases in others in both peak hours. Overall, the development results is a reduction of four vehicles in the AM peak and an increase of 49 in the PM peak. This equates to an impact of around 2% in the PM peak.

Figure 16: Shurdington Rd / Leckhampton Lane Junction Traffic Flows



Modelling Results

The results for the modelling of the Shurdington RD / Leckhampton Lane junction are presented in Table 16 and Table 17 for the AM and PM peak respectively. Modelling results are presented in Ratio of Flow to Capacity and Network Residual Capacity for this junction.

Table 16: Shurdington Rd / Leckhampton Lane Junction Results, AM Peak

Arm	**Do Minimum**			**Do Something**		
	RFC	**Delay (s)**	**Queue (PCU)**	**RFC**	**Delay (s)**	**Queue (PCU)**
Leckhampton Lane	1.04	158.6	19	1.01	136.1	16
Shurdington Rd Right Turn	1.67	1828.0	727	1.69	1917.3	752
NRC	-39%			-40%		
Average Delay	1138.8 seconds			1161.8 seconds		

The junction is significantly over capacity in the AM peak in both scenarios. In the Do Minimum, the large amount of southbound traffic combined with a right turn flow of 219 results in significant queues and delays on Shurdington Rd – over 700 PCUs stretching back around 4km with an average delay of 30 minutes. This is not significantly worsened in the Do Something scenario.

Leckhampton Lane is also over capacity in the Do Minimum with delay of around three minutes and queues of 19 PCUs. The situation in the Do Something is improved due to a reduction in vehicles as a result of the development, likely as a result of changes elsewhere on the network. The presence of right turning vehicles would significantly worsen the performance of this junction.

Table 17: Shurdington Rd / Leckhampton Lane Junction Results, PM Peak

Arm	Do Minimum			Do Something		
	RFC	Delay (s)	Queue (PCU)	RFC	Delay (s)	Queue (PCU)
Leckhampton Lane	0.83	44.5	4	0.79	37.2	3
Shurdington Rd Right Turn	1.24	445.7	126	1.27	523.4	149
NRC	-21%			-23%		
Average Delay	207.8 seconds			250.4 seconds		

In the PM peak, Leckhampton Lane operates within capacity in the Do Minimum with improved performance in the Do Something. Shurdington Rd, however, is over capacity in both scenarios but is not significantly worsened in the Do Something – though the queue does increase by 25 vehicles but this is likely an exaggeration of the true impact as the right turn movements are already blocking back before adding any more vehicles.

Overall, the junction is significantly over capacity in both scenarios and time periods but is not worsened by the proposed development. The presence of right turning vehicles would significantly worsen the performance of this junction.

11. Zoons Road / Churchdown Lane

The Zoons Rd / Churchdown Lane junction is a priority T-junction located on the north eastern edge of the Gloucester urban area. Both roads are single carriageway and there are no right turn facilities.

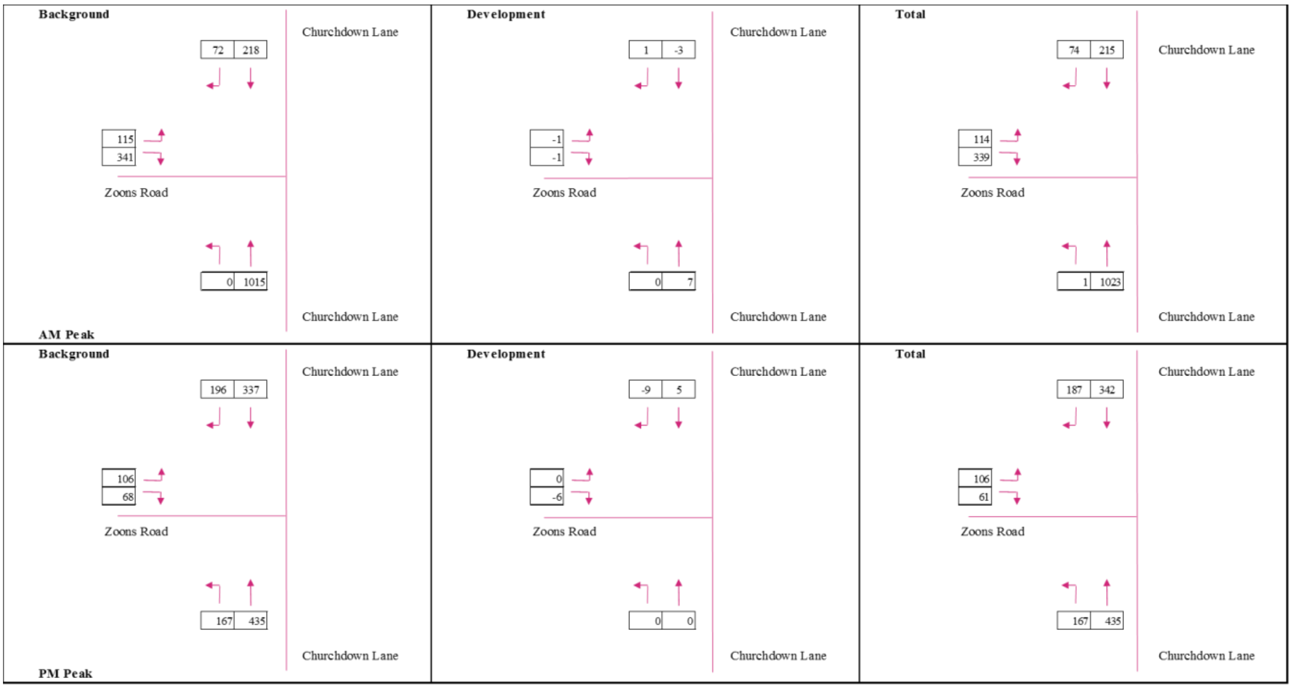
Churchdown Lane links the village of Churchdown with Gloucester to the south, passing under the main route between Gloucester and the M5 motorway. Zoons Rd provides access to a housing estate.

Figure 17: Zoons Rd / Churchdown Lane Junction

Traffic Flows

The modelled flows for the junction are shown in Figure 18. The development flows result in decreases in some movements and increases in others in both peak hours. Overall, the development results is an increase of four vehicles in the AM peak and a decrease of 10 in the PM peak. This equates to a negligible impact (0.2%) in the AM peak.

Figure 18: Zoons Rd / Churchdown Lane Junction Traffic Flows



Modelling Results

The results for the modelling of the Zoons Rd / Churchdown Lane junction are presented in Table 18 and Table 19 for the AM and PM peak respectively. Modelling results are presented in Ratio of Flow to Capacity and Network Residual Capacity for this junction.

Table 18: Zoons Rd / Churchdown Lane Junction Results, AM Peak

Arm	**Do Minimum**			**Do Something**		
	RFC	**Delay (s)**	**Queue (PCU)**	**RFC**	**Delay (s)**	**Queue (PCU)**
Zoons Rd	3.32	7188.9	843	3.34	7260.3	853
Churchdown Lane Right Turn	0.72	20.25	3	0.72	20.0	3
NRC	-67%			-67%		
Average Delay	4149.9 seconds			4212.8 seconds		

In the AM peak the junction is massively over capacity at Zoons Rd with vehicles exiting Zoons Rd subject to an average delay of around two hours and queues of around 850 PCUs (4.9km) as there are very few gaps to allow right turners to complete the manoeuvre. The right turn into Zoons Rd would occasionally block the through traffic there are sufficient gaps that this would not really become a problem. Junction performance is not significantly worsened with the introduction of the proposed developments.

Table 19: Zoons Rd / Churchdown Lane Junction Results, PM Peak

Arm	Do Minimum			Do Something		
	RFC	Delay (s)	Queue (PCU)	RFC	Delay (s)	Queue (PCU)
Zoons Rd	1.51	1178.6	160	1.49	1145.1	156
Churchdown Lane Right Turn	0.16	7.4	0	0.15	7.3	0
NRC	-41%			-41%		
Average Delay	542.8 seconds			531.6 seconds		

In the PM peak Zoons Rd is still over capacity, but with smaller queues and delays when compared with the AM peak. The right turn to Zoons Rd does not block Churchdown Lane. The Do Something scenario slightly improves the performance of the junction, but not in any significant way.

12. Fiddler's Green Lane Roundabout

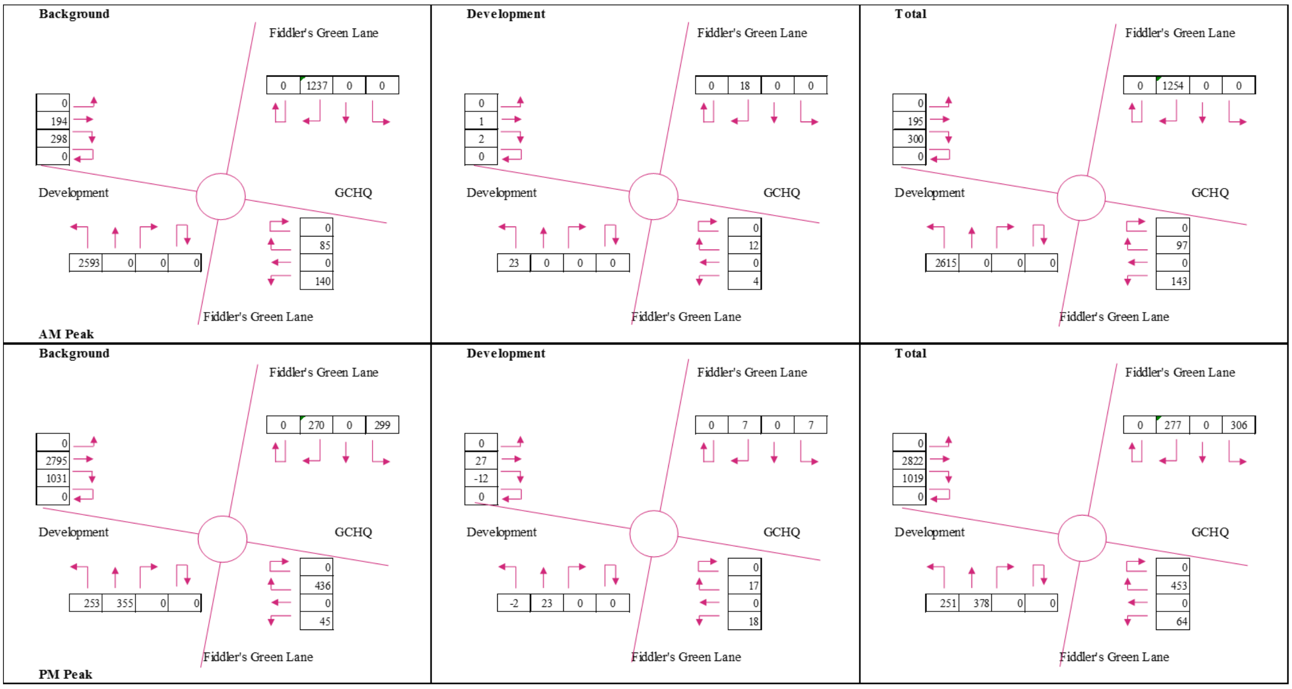
Fiddler's green lane roundabout is currently a three-arm roundabout that provides a secondary route into GCHQ from the Arle Court Roundabout and provides access to a housing estate. A major trip origin / destination is included on the empty field to the north west of the roundabout in the Do Minimum model that will add an extra arm to the roundabout. All approaches are currently single carriageway and, as no designs have been provided, it is assumed that the fourth arm will be designed in the same manner and that no changes have been made to the roundabout.

Figure 19: Fiddler's Green Lane Roundabout

Traffic Flows

The modelled flows for the junction are shown in Figure 20. The development flows result in decreases in some movements in the PM peak and increases in others in both peak hours. Overall, the development results is an increase of 59 vehicles in the AM peak and 86 in the PM peak. This equates to an impact of 1% in the AM peak and 2% in the PM peak. The committed development site accessed via the new arm on the roundabout attracts 3,829 trips in the Do Minimum AM peak and generates 3,826 in the PM peak.

Figure 20: Fiddler's Green Lane Roundabout Traffic Flows



Modelling Results

The results for the modelling of the Fiddler's Green Lane roundabout are presented in Table 20 and Table 21 for the AM and PM peak respectively. Modelling results are presented in Ratio of Flow to Capacity and Network Residual Capacity for this junction.

Table 20: Fiddler's Green Lane Roundabout Results, AM Peak

Arm	Do Minimum			Do Something		
	RFC	Delay (s)	Queue (PCU)	RFC	Delay (s)	Queue (PCU)
Fiddler's Green Lane N	2.44	4282.6	799	2.48	4427.6	825
GCHQ	0.79	50.6	3	0.84	63.7	4
Fiddler's Green Lane S	4.98	16933.3	2731	5.07	17313.1	2770
Development	0.71	16.5	2	0.72	17.2	3
NRC	-78%			-78%		
Average Delay	10826.5 seconds			11045.0 seconds		

In the AM peak Fiddler's Green Lane, north and south, are significantly over capacity with very large queues and delays. All traffic from the south is router into the proposed development so there are only right turners from the GCHQ access to block vehicles exiting the development and allow gaps for vehicles from Fiddler's Green Lane North. There are very few vehicles blocking Fiddler's Green Lane South but the sheer volume of traffic (2,593 PCUs in the Do Minimum) results in an average delay of around five minutes and a queue of 2,731 PCUs (15.7km). The development traffic does have a slight negative impact on the junction but it is not considered to be significant.

Table 21: Fiddler's Green Lane Results, PM Peak

Arm	Do Minimum			Do Something		
	RFC	Delay (s)	Queue (PCU)	RFC	Delay (s)	Queue (PCU)
Fiddler's Green Lane N	1.03	129.0	23	1.05	149.3	27
GCHQ	0.96	84.1	12	1.03	138.4	22
Fiddler's Green Lane S	1.29	521.9	82	1.35	675.8	108
Development	9.74	32921.1	4572	9.88	34029.6	4609
NRC	-85%			-85%		
Average Delay	23043.2 seconds			23569.1 seconds		

In the PM peak, the volume of traffic attempting to exit the development site results in delay of around nine minutes and queues of 4,572 PCUs (26.3km). Fiddler's Green Lane (north and south) are also over capacity with long delays. The Do Something does not significantly worsen the operation of the junction.

Overall, the development traffic has a negligible impact on the junction as is it is already so far over capacity in both peak periods.

13. A435 / Hayfield Way / Finlay Way

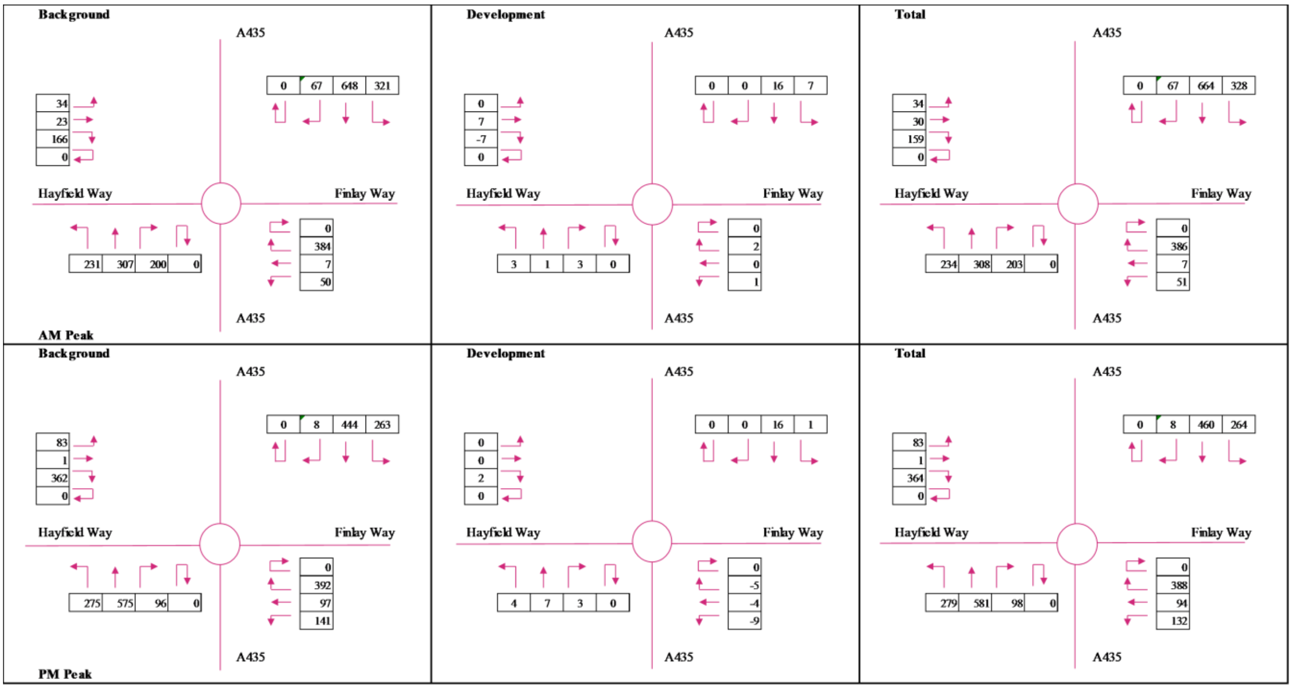
The A435 / Hayfield Way / Finlay Way roundabout is a four-arm roundabout in Bishop's Cleeve on an important route north out of Cheltenham to Tewkesbury, Evesham and an alternative access to the M5 Motorway. All four arms are single lane approaches with slight flares at the give way line, but not enough for additional entry lanes. Finlay Way provides access to the centre of Bishop's Cleeve and Hayfield Way access a housing estate.

Figure 21: A435 / Hayfield Way / Finlay Way Roundabout

Traffic Flows

The modelled flows for the junction are shown in Figure 22. The development flows result in decreases in some movements and increases in others in both peak hours. Overall, the development traffic results is an increase of 34 vehicles in the AM peak and 15 in the PM peak. This equates to an impact of 1% in both peaks.

Figure 22: A435 / Hayfield Way / Finlay Way Roundabout Traffic Flows



The predominant movement in the AM peak is southbound on the A435, but there are relatively heavy conflicting movements from Hayfield Way and A435 South. The southbound movement from A435 North is around double that of the next highest movement. In the PM peak the flows are more balanced but the predominant movement is northbound on the A435.

Modelling Results

The results for the modelling of the A435 / Hayfield Way / Finlay Way roundabout are presented in Table 22 and Table 23 for the AM and PM peak respectively. Modelling results are presented in Ratio of Flow to Capacity and Network Residual Capacity for this junction.

Table 22: A435 / Hayfield Way / Finlay Way Roundabout Results, AM Peak

Arm	Do Minimum			Do Something		
	RFC	Delay (s)	Queue (PCU)	RFC	Delay (s)	Queue (PCU)
A435 N	1.02	94.2	31	1.05	117.7	41
Finlay Way	0.56	9.4	1	0.56	9.4	1
A435 S	0.65	8.4	2	0.66	8.6	2
Hayfield Way	0.28	5.7	0	0.28	5.7	0
NRC	-9%			-10%		
Average Delay	44.8 seconds			55.2 seconds		

In both scenarios in the AM peak the A435 North is over capacity due to the heavy conflicting movements and volume of traffic attempting to enter the roundabout. Though the delay increases by around 20 seconds and the queue by 10 PCUs – a relatively large impact in this instance – this is not considered to be significant as the arm is already over capacity to a degree that adding any amount of traffic would have an exaggerated impact upon the junction.

Table 23: A435 / Hayfield Way / Finlay Way Roundabout Results, PM Peak

Arm	Do Minimum			Do Something		
	RFC	Delay (s)	Queue (PCU)	RFC	Delay (s)	Queue (PCU)
A435 N	0.73	12.6	3	0.75	13.6	3
Finlay Way	0.78	17.9	3	0.77	17.3	3
A435 S	0.86	20.3	6	0.87	21.3	6
Hayfield Way	0.64	13.2	2	0.65	13.5	2
NRC	6%			5%		
Average Delay	16.6 seconds			17.1 seconds		

With a more balanced distribution of traffic across the four arms, the junction is under capacity in both scenarios, though approaching the theoretical maximum capacity on the A435 South. The slight worsening in the Do Something is not significant.

14. North Road West / Grovefield Way

North Rd West / Grovefield Way is a priority T-junction on the western edge of the Cheltenham urban area around 630m southwest of the Arle Court Roundabout (Junction 8) and close to a large retail park. Both roads are single carriageway with a signalised pedestrian crossing located 15m south of the junction. North Rd West provides access to a few residential properties and an alternative route to Gloucester via the B4063.

Figure 23: North Road West / Grovefield Way Junction

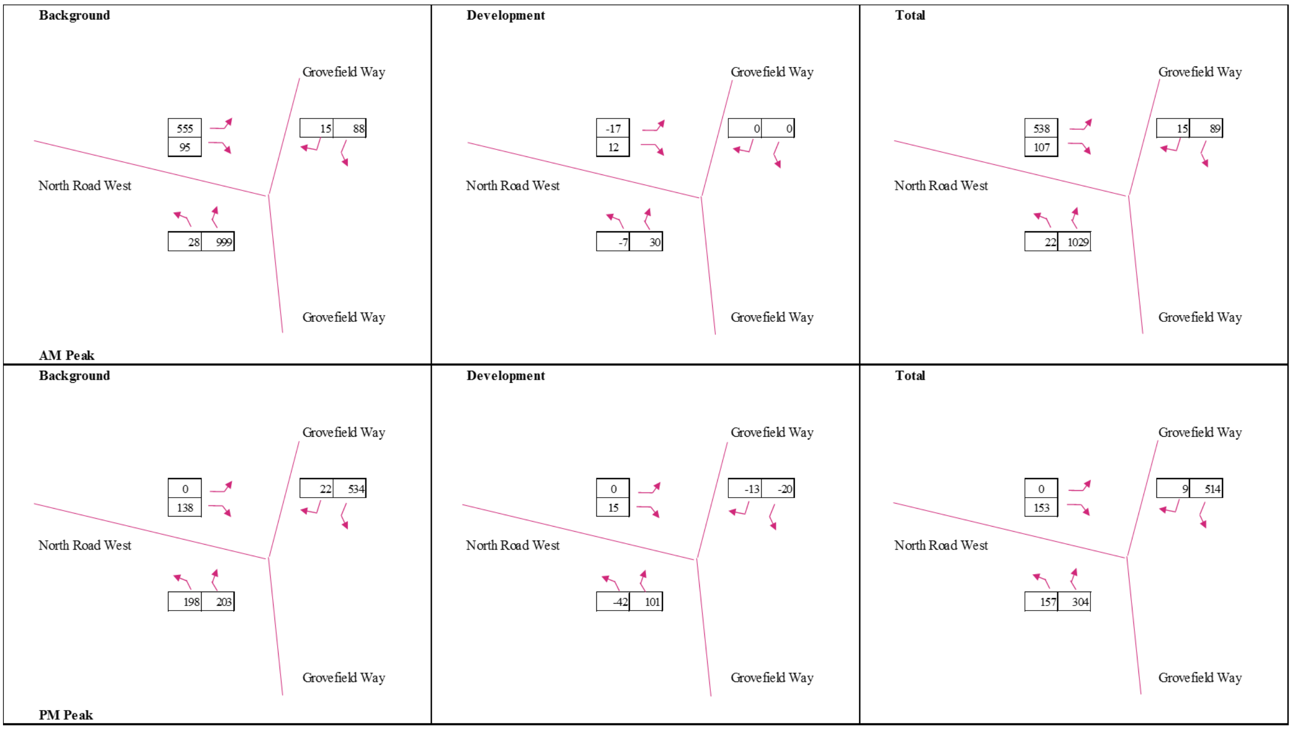
Traffic Flows

The modelled flows for the junction are shown in Figure 24. The development flows result in decreases in some movements and increases in others in both peak hours. Overall, the development traffic results is an increase of 19 vehicles in the AM peak and 41 in the PM peak. This equates to an impact of 1% in the AM peak and 4% in the PM peak.

In the AM peak 555 vehicles are exiting North Rd West turning left to Grovefield Way heading towards Arle Court. A further 999 vehicles are heading north on Grovefield Way – equivalent to 17 vehicles per minute or one vehicle every four seconds. This suggests that, at free flow conditions (which are considered to be unlikely given queuing at Arle Court) there would not be many gaps for vehicles to exit the side road or turn right in to it. Movements in the PM peak are much reduced, but the southbound movement on Grovefield way is 534 vehicles (one every seven seconds) which may restrict vehicles leaving North Rd West.

File Note

Figure 24: North Road West / Grovefield Way Junction



Modelling Results

The results for the modelling of the Priors Rd / Harp Hill / Hewlett Rd junction are presented in Table 24and Table 25 for the AM and PM peak respectively. Modelling results are presented in Ratio of Flow to Capacity and Network Residual Capacity for this junction.

Table 24: North Road West / Grovefield Way Junction Results, AM Peak

Arm	Do Minimum			Do Something		
	RFC	Delay (s)	Queue (PCU)	RFC	Delay (s)	Queue (PCU)
North Road West	1.90	1936.4	258	1.95	2036.4	267
Grovefield Way Right Turn	0.05	8.7	0	0.05	8.8	0
NRC	-42%			-43%		
Average Delay	707.3 seconds			730.1 seconds		

In the AM peak, around half of the vehicles on North Rd West are able to exit resulting in long delays and queues. The arm is almost 100% over capacity in both scenarios. The additional traffic in the Do Something does not have a significant impact but does slightly worsen the junction performance.

Table 25: North Road West / Grovefield Way Junction Results, PM Peak

Arm	Do Minimum			Do Something		
	RFC	Delay (s)	Queue (PCU)	RFC	Delay (s)	Queue (PCU)
North Road West	0.40	16.7	1	0.46	18.1	1
Grovefield Way Right Turn	0.07	4.5	0	0.03	4.5	0
NRC	38%			26%		
Average Delay	2.18 seconds			2.52 seconds		

In the PM peak the junction operates well under capacity in both scenarios, even though the Do Something traffic does appear to have a significant impact with a reduction of 12% in overall spare capacity. Therefore no mitigation is required for the PM peak.

15. A46 / Church Lane

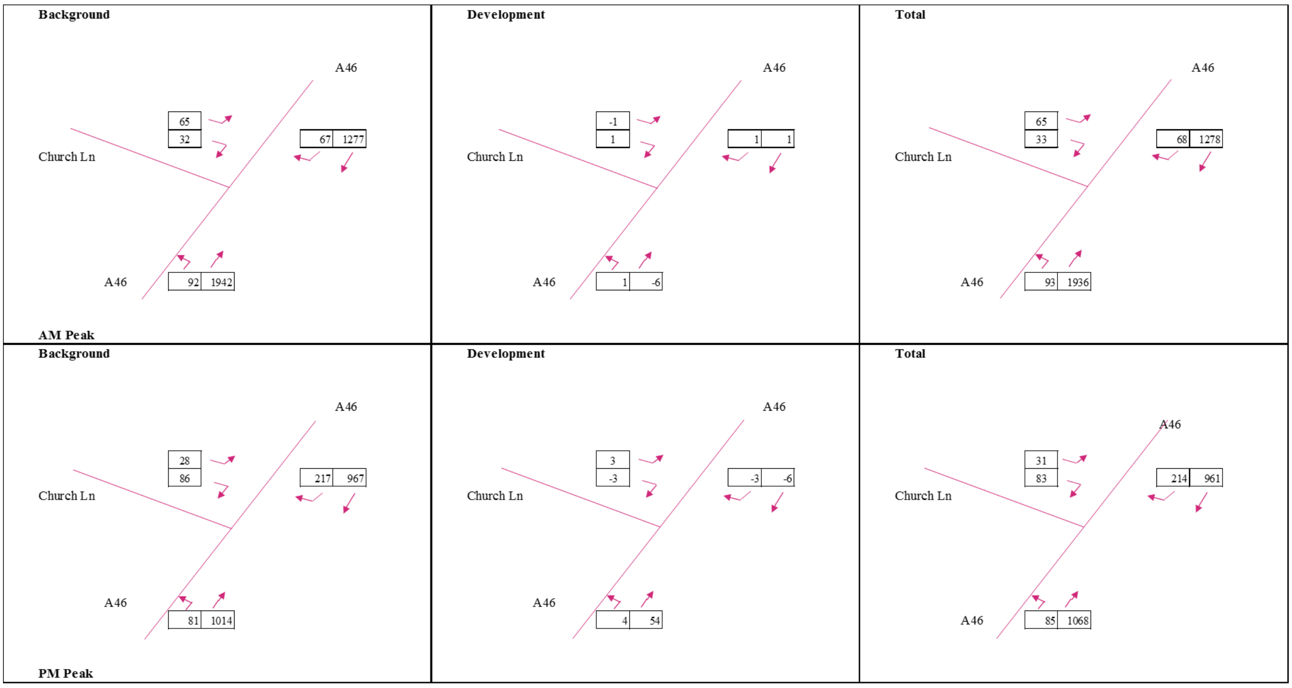
The A46 Shurdington Rd / Church Lane junction is a priority T-junction located around 215m south west of the Shurdington Rd / Leckhampton Lane junction (Junction 10). Shurdington Rd is a single-lane carriageway in this location with no right turn ghost island provided for access to Church Lane, which is also single carriageway. Church Lane provides access to a number of residential properties

Figure 25: A46 Shurdington Rd / Church Lane Junction

Traffic Flows

The modelled flows for the junction are shown in Figure 26. The development flows result in decreases in some movements and increases in others in both peak hours. Overall, the development traffic results is a decrease of 2 vehicles in the AM peak and an increase of 49 in the PM peak all on the A46. This equates to an impact of 2% in the PM peak. There are heavy flows in both directions along the A46 in both peak periods, though the AM peak combined flows are around 1,000 PCUs higher.

Figure 26: A46 Shurdington Rd / Church Lane Junction Traffic Flows



Modelling Results

The results for the modelling of the A46 Shurdington Rd / Church Lane junction are presented in Table 26 and Table 27 for the AM and PM peak respectively. Modelling results are presented in Ratio of Flow to Capacity and Network Residual Capacity for this junction.

Table 26: A46 Shurdington Rd / Church Lane Junction Results, AM Peak

Arm	Do Minimum			Do Something		
	RFC	Delay (s)	Queue (PCU)	RFC	Delay (s)	Queue (PCU)
Church Lane	999999999	5999994.0	117	999999999	5999994.0	117
A46 Right Turn	1.31	458.2	195	1.32	466.0	197
NRC	-37%			-37%		
Average Delay	1676364.7 seconds			1682000.7 seconds		

In the AM peak, Church Lane is so far over capacity that it cannot be accurately measured by the software. The 100 vehicles leaving Church Lane and 67 turning right into it are essentially blocked for the entire peak hour – any gaps that do emerge are used by right turners from the A46 North, which has a queue of 195 PCUs. If the flow along the A46 was continuous beyond the peak hour, it would take around 69 days to clear the queue on Church Lane. The Do Something has a negligible impact on the results. The results are essentially the same in the PM peak, though the overall delay on Church Lane has been reduced to 29 minutes as there are more gaps in A46 traffic.

Table 27: A46 Shurdington Rd / Church Lane Junction Results, PM Peak

Arm	Do Minimum			Do Something		
	RFC	Delay (s)	Queue (PCU)	RFC	Delay (s)	Queue (PCU)
Church Lane	999999999	1726.2	61	999999999	2011.7	69
A46 Right Turn	1.18	310.1	114	1.19	331.3	119
NRC	-23%			-24%		
Average Delay	224.2 seconds			241.9 seconds		

16. Old Gloucester Road / Cheltenham Road East (B4063)

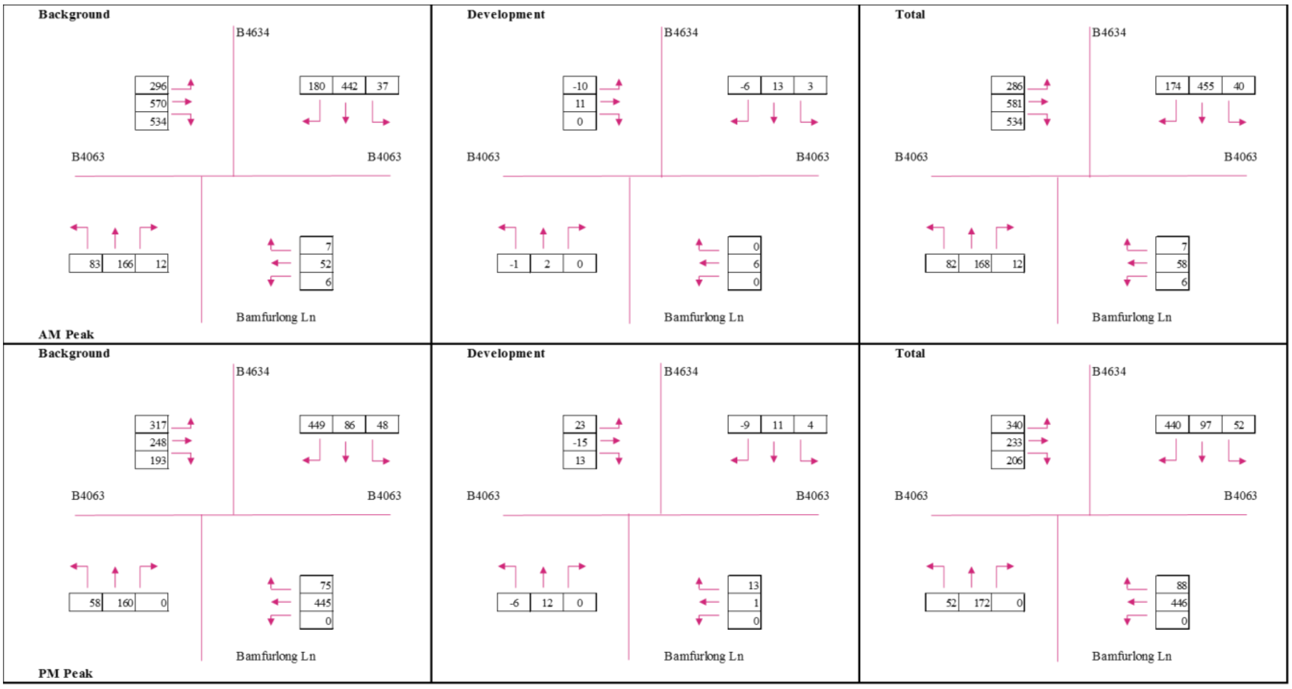
The Old Gloucester Rd / Cheltenham Rd East junction is a signalised crossroads, with a slight stagger, with signal controlled pedestrian crossings on all four arms. Old Gloucester Rd and Bamfurlong Lane are single carriageway approaches only. Cheltenham Rd East is a single carriageway road with a short flare (22m or 4 PCUs) providing a dedicated right turn lane. Cheltenham Rd is also a single carriage way road with a flared right turn lane, but the flare is much longer at around 90m or 15 PCUs. The junction is located in Staverton Bridge on a route between Cheltenham and Gloucester.

Figure 27: Old Gloucester Rd / Cheltenham Road East Junction

Traffic Flows

The modelled flows for the junction are shown in Figure 28. The development flows result in decreases in some movements and increases in others in both peak hours. Overall, the development traffic results is an increase of 18 vehicles in the AM peak and 46 in the PM peak. This equates to an impact of 1% in the AM peak and 2% in the PM peak.

Figure 28: Old Gloucester Rd / Cheltenham Road East Junction Traffic Flows



Modelling Results

The results for the modelling of the Old Gloucester Rd / Cheltenham Rd East junction are presented in Table 28 and Table 29 for the AM and PM peak respectively. Modelling results are presented in Degree of Saturation and Practical Reserve Capacity for this junction.

Table 28: Old Gloucester Rd / Cheltenham Road East Junction Results, AM Peak

Arm	**Do Minimum**			**Do Something**		
	Saturation	**Delay (s)**	**Queue (PCU)**	**Saturation**	**Delay (s)**	**Queue (PCU)**
Old Gloucester Rd	134.1%	567	113	133.2%	556.6	113
Cheltenham Rd	39.5%	71.1	2	43.6%	72.8	2
Bamfurlong Lane	49.2%	43.4	7	49.4%	43.5	8
Cheltenham Rd East (W)	136.1%	569.8	252	136.2%	571.1	253
Cycle Time	120 seconds			120 seconds		
PRC	-51.2%			-51.3%		
Average Delay	329.2 seconds			330.1 seconds		

In both peaks the junction is over capacity in the Do Minimum with Old Gloucester Rd and Cheltenham Rd East, plus Cheltenham Rd in the PM peak, being significantly over capacity. The development traffic improves the situation on some arms and worsens it on others. Overall there is a slight negative impact in both peaks but this is not significant.

Table 29: Old Gloucester Rd / Cheltenham Road East Junction Results, PM Peak

Arm	Do Minimum			Do Something		
	Saturation	Delay (s)	Queue (PCU)	Saturation	Delay (s)	Queue (PCU)
Old Gloucester Rd	121.3%	412.0	77	120.1%	396.7	75
Cheltenham Rd	119.6%	397.6	65	120.4%	408.0	69
Bamfurlong Lane	32.0%	32.5	6	32.8%	32.6	6
Cheltenham Rd East (W)	121.1%	395.5	98	124.0%	431.4	108
Cycle Time	120 seconds			120 seconds		
PRC	-34.7%			-37.8%		
Average Delay	209.3 seconds			220.4 seconds		

17. Stoke Orchard Road / A435

The Stoke Orchard Rd / A435 junction is a four-arm roundabout located around 440m from the A435 / Hayfield Way / Finlay Way roundabout (Junction 13) in Bishop's Cleeve. All four arms are single carriageway roads with uncontrolled pedestrian crossings on the A435 North and Voxwell Lane arms at the junction.

Figure 29: Stoke Orchard Rd / A435 Roundabout

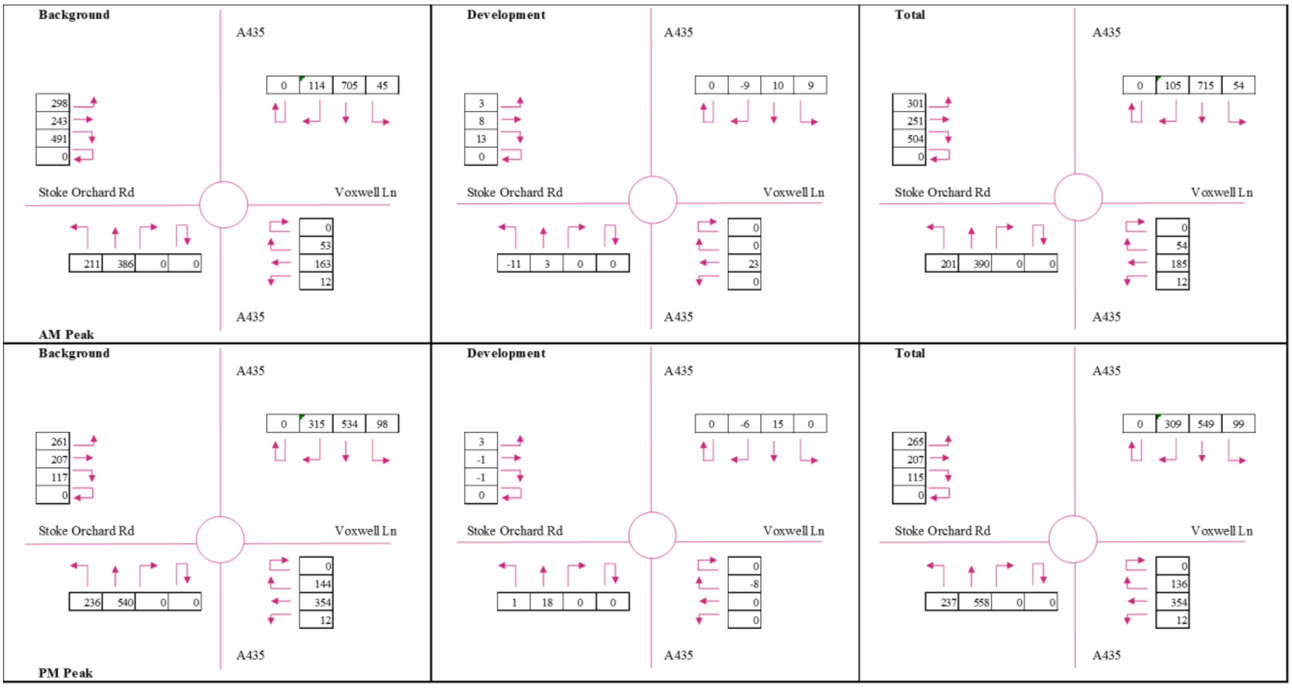
Stoke Orchard Rd provides access to a business park, Quarry and residential properties. Voxwell Lane provides an alternative route to Finlay Way into Bishop's Cleeve. The A435 connects Cheltenham to Teweksbury and Evesham via the A46.

Traffic Flows

The modelled flows for the junction are shown in Figure 30. The development flows result in decreases in some movements and increases in others in both peak hours. Overall, the development traffic results is an increase of 50 vehicles in the AM peak and 22 in the PM peak. This equates to an impact of 2% in the AM peak and 1% in the PM peak.

The predominant movement in the AM peak is southbound on the A435, but there are relatively heavy conflicting movements from Stoke Orchard Rd. In the PM peak the flows are more balanced with a fairly equal north and southbound movement on the A435.

Figure 30: Stoke Orchard Rd / A435 Roundabout Traffic Flows



Modelling Results

The results for the modelling of the Stoke Orchard Rd / A 435 junction are presented in Table 30 and Table 31 for the AM and PM peak respectively. Modelling results are presented in Ratio of Flow to Capacity and Network Residual Capacity for this junction.

Table 30: Stoke Orchard Rd / A435 Roundabout Results, AM Peak

Arm	**Do Minimum**			**Do Something**		
	RFC	**Delay (s)**	**Queue (PCU)**	**RFC**	**Delay (s)**	**Queue (PCU)**
A435 North	0.98	67.8	18	1.01	85.2	23
Voxwell Lane	0.46	12.1	1	0.51	13.4	1
A435 South	0.49	5.3	1	0.49	5.3	1
Stoke Orchard Road	0.88	22.6	7	0.90	27.1	8
NRC	-5%			-7%		
Average Delay	32.3 seconds			39.5 seconds		

The junction is over capacity in the AM Peak scenarios on the A435 North arm and close to capacity on Stoke Orchard Rd in both scenarios. The Do Something traffic flows do not significantly impact the junction.

Table 31: Stoke Orchard Rd / A435 Roundabout Results, PM Peak

Arm	Do Minimum			Do Something		
	RFC	Delay (s)	Queue (PCU)	RFC	Delay (s)	Queue (PCU)
A435 North	0.84	18.2	5	0.85	19.0	5
Voxwell Lane	0.74	17.9	3	0.73	17.6	3
A435 South	0.84	21.3	5	0.85	22.8	5
Stoke orchard Road	0.57	7.5	1	0.58	7.7	1
NRC	5%			4%		
Average Delay	16.8 seconds			17.5 seconds		

In the PM peak the junction operates slightly under capacity in both scenarios and is not significantly worsened by the Do Something traffic flows.

18. A46 / B4079

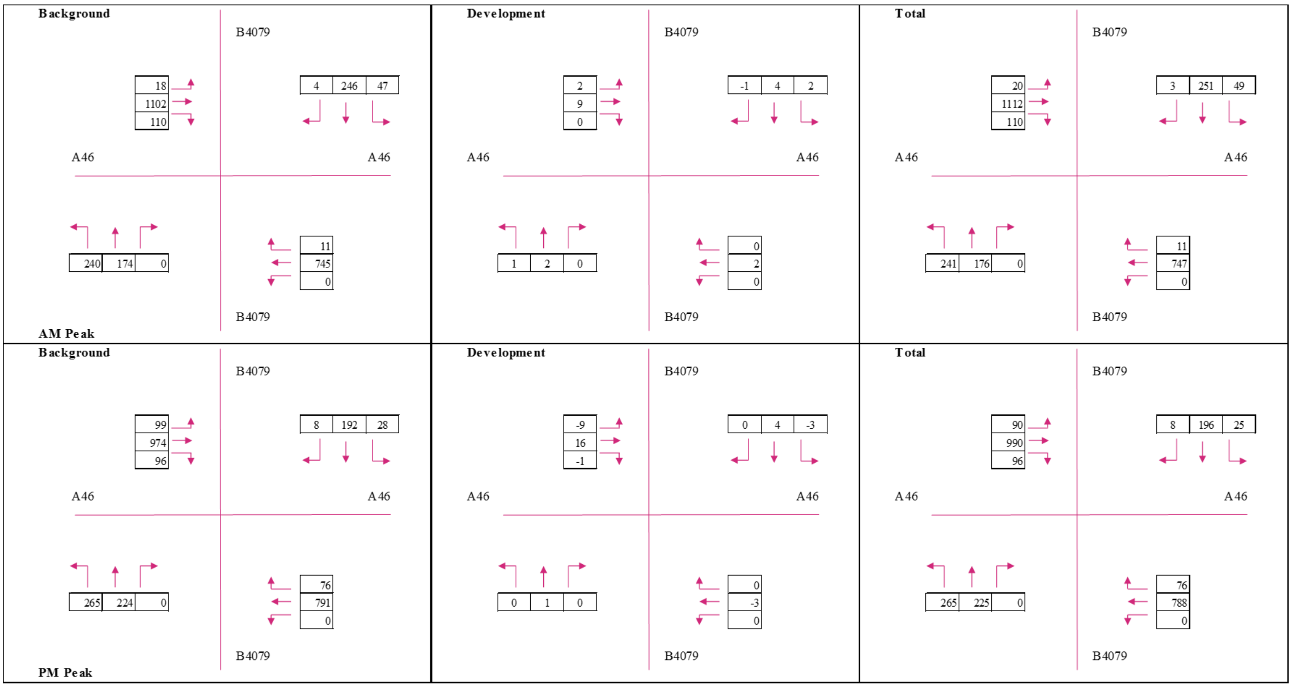
The A46 / B4079 junction is a signalised crossroads in Aston Cross on the route between Cheltenham and Tewkesbury, with the B4079 connecting to the A435 to the south. Aston Cross is a predominately military area on the A46 with a Ministry of Defence (MoD0 Defence Equipment and Support (DE&S) site to the north.

Figure 31: A46 / B4079 Junction

Traffic Flows

The modelled flows for the junction are shown in Figure 32. The development flows result in decreases in some movements and increases in others in both peak hours. Overall, the development traffic results is an increase of 19 vehicles in the AM peak and 5 in the PM peak. This equates to an impact of less than 1% in both peak periods. The predominant flows in both peak periods are eastbound on the A46 followed by the eastbound A46 flow.

Figure 32: A46 / B4079 Junction Traffic Flows



Modelling Results

The results for the modelling of the A46 / B4079 junction are presented in Table 32 and Table 33 for the AM and PM peak respectively. Modelling results are presented in Degree of Saturation and Practical Reserve Capacity for this junction.

Table 32: A46 / B4079 Junction Results, AM Peak

Arm	Do Minimum			Do Something		
	Saturation	Delay (s)	Queue (PCU)	Saturation	Delay (s)	Queue (PCU)
B4079 North	85.0%	78.8	12	86.7%	82.3	13
A46 East	62.4%	18.2	16	62.6%	18.3	16
B4079 South	73.8%	57.4	9	74.1%	57.5	9
A46 West	88.5%	24.6	35	25.6%	25.6	36
Cycle Time	120 seconds			120 seconds		
PRC	1.6%			0.7%		
Average Delay	25.9 seconds			26.2 seconds		

The junction operates within capacity in both time periods and in both scenarios, though it is very close to theoretical capacity in the AM peak. the Do Something flows do not have a significant impact upon the operation of the junctions.

Table 33: A46 / B4079 Junction Results, PM Peak

Arm	Do Minimum			Do Something		
	Saturation	Delay (s)	Queue (PCU)	Saturation	Delay (s)	Queue (PCU)
B4079 North	65.0%	60.1	8	65.5%	60.3	8
A46 East	83.9%	28.9	22	85.1%	30.1	22
B4079 South	84.6%	65.6	11	85.2%	66.4	11
A46 West	84.7%	21.6	30	85.1%	21.8	30
Cycle Time	120 seconds			120 seconds		
PRC	6.2%			5.6%		
Average Delay	26.6 seconds			27.2 seconds		

19. A417 / Zoons Court (Zoons Court Roundabout)

Zoons Court Roundabout is a three arm roundabout with a bypass on the A417 southbound movement. The A417 provides access to the M5 Motorway southbound from the northeast of Gloucester. Delta Way leads to a large business and retail park on the eastern edge of Gloucester.

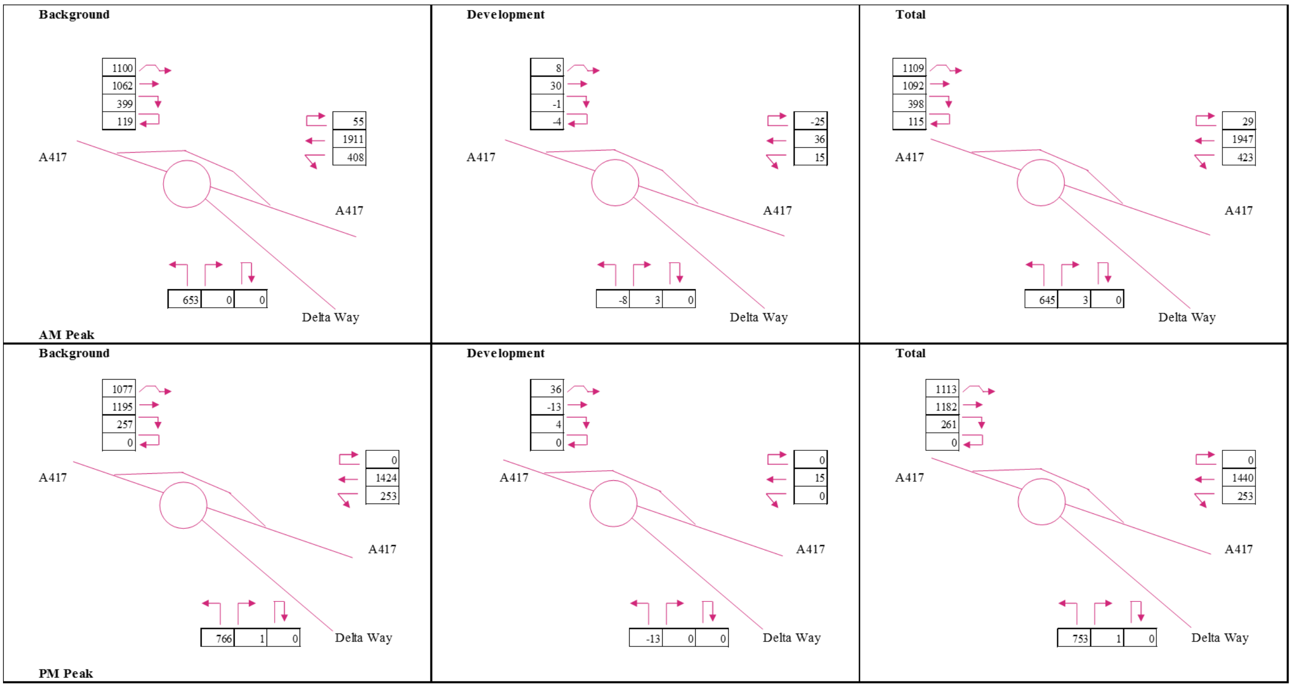
Figure 33: Zoons Court Roundabout

All three roads are dual carriageways for a substantial distance. Delta Way widens to three lanes at the junction – one left and two right onto the A417 with the right leading to the motorway. The A417 North splits, with one lane continuing as the bypass lane to A417 South and the other widening to three lanes with two of these also continuing on the A417 South suggesting a very heavy movement. The A417 South arm becomes three lanes after the merge of the M5 northbound off-slip around 360m back from the junction. At the junction, two lanes continue north on the A417 with one dedicated to the left turn to Delta Way.

Traffic Flows

The modelled flows for the junction are shown in Figure 34. The development flows result in decreases in some movements and increases in others in both peak hours. Overall, the development traffic results is an increase of 19 vehicles in the AM peak and 5 in the PM peak. This equates to an impact of less than 1% in both peak periods. The predominant flows in both peak periods are eastbound on the A46 followed by the eastbound A46 flow.

Figure 34: Zoons Court Roundabout Traffic Flows



Modelling Results

The results for the modelling of the Zoons Court Roundabout are presented in Table 34 and Table 35 for the AM and PM peak respectively. Modelling results are presented in Ratio of Flow to Capacity and Network Residual Capacity for this junction.

Table 34: Zoons Court Roundabout Results, AM Peak

Arm	Do Minimum			Do Something		
	RFC	Delay (s)	Queue (PCU)	RFC	Delay (s)	Queue (PCU)
A417 North	0.98	35.5	22	0.98	38.4	25
A417 South	0.35	2.7	1	0.35	2.7	1
Delta Way	1.02	65.1	58	1.03	72.1	66
NRC	-4%			-5%		
Average Delay	45.7 seconds			50.3 seconds		

The junction operates slightly over capacity in the AM peak in both scenarios, in particular the A417 North and Delta Way. The development traffic has a slight impact on the A417 North and Delta Way, but it is not considered to be significant.

Table 35: Zoons Court Roundabout Results, PM Peak

Arm	Do Minimum			Do Something		
	RFC	Delay (s)	Queue (PCU)	RFC	Delay (s)	Queue (PCU)
A417 North	0.65	3.9	2	0.66	4.0	2
A417 South	0.33	2.1	1	0.32	2.1	1
Delta Way	0.95	22.3	16	0.96	26.0	19
NRC	3%			2%		
Average Delay	13.0 seconds			14.9 seconds		

Although Delta Way is over the theoretical maximum capacity in the PM peak, the junction as a whole has a limited amount of spare capacity. The Do Something scenario slightly reduces this spare capacity but does not require any mitigation.

3.3 Junction Modelling Summary

The results of the Do Minimum and Do Something junction assessments are summarised in Table 36 and Table 37 for the AM and PM peaks respectively.

The results show that whilst the majority of the junctions operate significantly over capacity in both the AM and PM peaks, the development traffic would actually have very little impact on the results. The change in capacity is less than 5% at 16 of the 17 junctions assessed in the AM and 15 in the PM peak, with the majority exhibiting less than 2% difference in capacity.

Although some of the junctions exhibit increases in delay or queues, the impact is considered to be insignificant given the marginal increase in PCUs at most junctions. However, it is noted that when a junction is over capacity, additional vehicles can have a disproportionate impact in delay and queue results compared to if the junction was within capacity to begin with.

In the AM peak, the capacity at Junction 2 actually increases in the Do Something scenario and no mitigation is required. Mitigation would be required at 14 of the 17 junctions as a result of increased background traffic, but not as a result of the proposed development.

In the PM peak, two junctions exhibit significant reductions in capacity as a result of the proposed developments. Junction 14, however, is still well within capacity and does not require mitigation. It is impossible to determine if Junction 8 would require mitigation as a result of the development traffic, and how the cost of any mitigation would be apportioned, as the junction is already significantly over capacity in the Do Minimum scenario and very sensitive to further increases in traffic demand.

Table 36: Junction Modelling Results – AM Peak

No	Junction	Do Minimum			Do Something			Capacity Change
		PRC / NRC	Delay	Queue	PRC / NRC	Delay	Queue	
2	A4019 - Hayden Road	7.0%	25.1	22	12.3%	23.8	21	5.3%
3	A4019 - Hayden Road - Manor Road	-21.9%	214.1	84	-26.0%	262.0	103	-4.1%
4	Priors Road - Harp Hill - Hewlett Road	-26.0%	272.0	109	-28.0%	306.7	124	-2.0%
5	Old Bath Road - London Road (A40)	-9.9%	53.8	47	-14.2%	76.1	59	-4.3%
6	A40 - A435	-20.3%	112.1	98	-23.2%	133.6	111	-2.9%
7	A435 - Moorend Road - Lyefield Road	1.6%	25.4	28	0.2%	27.0	29	-1.4%
8	Arle Court Roundabout	-125.4%	1005.0	447	-128.2%	1029.2	444	-2.8%
10	Shurdington Road - Leckhampton Lane	-39.0%	1113.8	727	-40.0%	1161.8	752	-1.0%
11	Zoons Road - Churchdown Lane	-67.0%	4149.9	843	-67.0%	4212.8	853	0.0%
12	Fiddlers Green Lane- Telstar Way	-78.0%	10826.5	2731	-78.0%	11045.0	2770	0.0%
13	A435 - Bramble Chase	-9.0%	44.8	31	-10.0%	55.2	41	-1.0%
14	North Road West - Grovefield Way	-42.0%	707.3	258	-43.0%	730.1	267	-1.0%
15	A46 - Church Lane	-37.0%	1676364.7	195	-37.0%	1682000.7	197	0.0%
16	Old Gloucester Road - Cheltenham Road B4063	-51.2%	329.2	252	-51.3%	330.1	253	-0.1%
17	Stoke Orchard Road - A435	-5.0%	32.3	18	-7.0%	39.5	23	-2.0%
18	A46 - B4079	1.6%	25.3	35	0.7%	26.2	36	-0.9%
19	A417 – Zoons Court (Zoons Court Roundabout)	-4.0%	45.7	58	-5.0%	50.3	66	-1.0%

Table 37: Junction Modelling Results – PM Peak

No	Junction	Do Minimum			Do Something			Capacity Change
		PRC / NRC	Delay	Queue	PRC / NRC	Delay	Queue	
2	A4019 - Hayden Road	-14.4%	101.1	81	-15.2%	103.6	83	-0.8%
3	A4019 - Hayden Road - Manor Road	-15.4%	134.9	113	-16.6%	191.6	117	-1.2%
4	Priors Road - Harp Hill - Hewlett Road	-19.0%	170.1	60	-20.0%	223.2	66	-1.0%
5	Old Bath Road - London Road (A40)	-16.8%	82.7	63	-19.5%	100.1	73	-2.7%
6	A40 - A435	-20.5%	109.8	100	-22.5%	135.3	116	-2.0%
7	A435 - Moorend Road - Lyefield Road	10.7%	18.5	16	10.3%	18.9	17	-0.4%
8	Arle Court Roundabout	-124.9%	1388.3	586	-154.8%	1546.1	627	-29.9%
10	Shurdington Road - Leckhampton Lane	-21.0%	207.8	126	-23.0%	250.4	148.9	-2.0%
11	Zoons Road - Churchdown Lane	-41.0%	542.8	160	-41.0%	531.6	156	0.0%
12	Fiddlers Green Lane- Telstar Way	-85.0%	23043.2	4572	-85.0%	23569.1	4609	0.0%
13	A435 - Bramble Chase	6.0%	16.6	6	5.0%	17.1	6	-1.0%
14	North Road West - Grovefield Way	38.0%	2.2	1	26.0%	2.5	1	-12.0%
15	A46 - Church Lane	-23.0%	224.2	114	-24.0%	241.9	119	-1.0%
16	Old Gloucester Road - Cheltenham Road B4063	-34.7%	209.3	98	-37.8%	220.4	108	-3.1%
17	Stoke Orchard Road - A435	5.0%	16.8	5	4.0%	17.5	5	-1.0%
18	A46 - B4079	6.2%	26.6	30	5.6%	27.2	30	-0.6%
19	A417 – Zoons Court (Zoons Court Roundabout)	3.0%	13.0	16	2.0%	14.9	19	-1.0%

4 Mitigation

Before any mitigation for development traffic can be investigated for these junctions they would need to be mitigated for the background traffic flows and this assessment re-run to determine the true impact.

Attempting to mitigate the development impact on a junction that is already over capacity would not be appropriate. Mitigation of background traffic would be required first. Otherwise it would be challenging to apportion costs to the proposed developments as any mitigation would have a greater impact upon results for the Do Minimum model than the Do Something.

Therefore, even though some junctions and / or particular arms do appear to be significantly affected by the proposed development traffic, no mitigation options have been suggested.

5 Conclusions

Cheltenham Borough Council appointed Arup to undertake local junction assessments to provide transport evidence in support of site allocations in the emerging Cheltenham Local Plan.

Phase 1 of this commission used the year 2031 Central Severn Vale SATURN strategic highway model as provided by Gloucestershire County Council to identify junctions significantly impacted by the proposed developments. This Phase 2 report outlines the junction modelling methodology and results.

At the 17 junctions tested, the results of the junction modelling show that mitigation is not required as a result of the proposed developments as the majority are already over capacity in the Do Minimum modelling scenario and are not significantly worsened by the development traffic. Those that aren't already over capacity in the Do Minimum are either not significantly impacted by the development traffic or remain within capacity in the Do Something scenario.

No mitigation options have been suggested as the junctions would need to be mitigated for the Do Minimum traffic flows first.

5.1 Recommendations

We recommend that further work to determine the future level of traffic growth within Cheltenham and the effects this will have on the highway network is commissioned. A Cheltenham specific SATURN model could be created, increasing the level of detail at a local level, to run this assessment.

Any junctions that are forecast to operate over capacity from this traffic growth study would need to be improved and mitigation options should be considered and tested.

This study into the proposed development impact should then be repeated. Any mitigation required could then be apportioned to the developments.