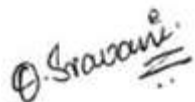




Tyburn Roundabout – Option Development and Appraisal Report



Final Report

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Tyburn Roundabout – Option Development and Appraisal Report

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Reference Tyburn Option Report

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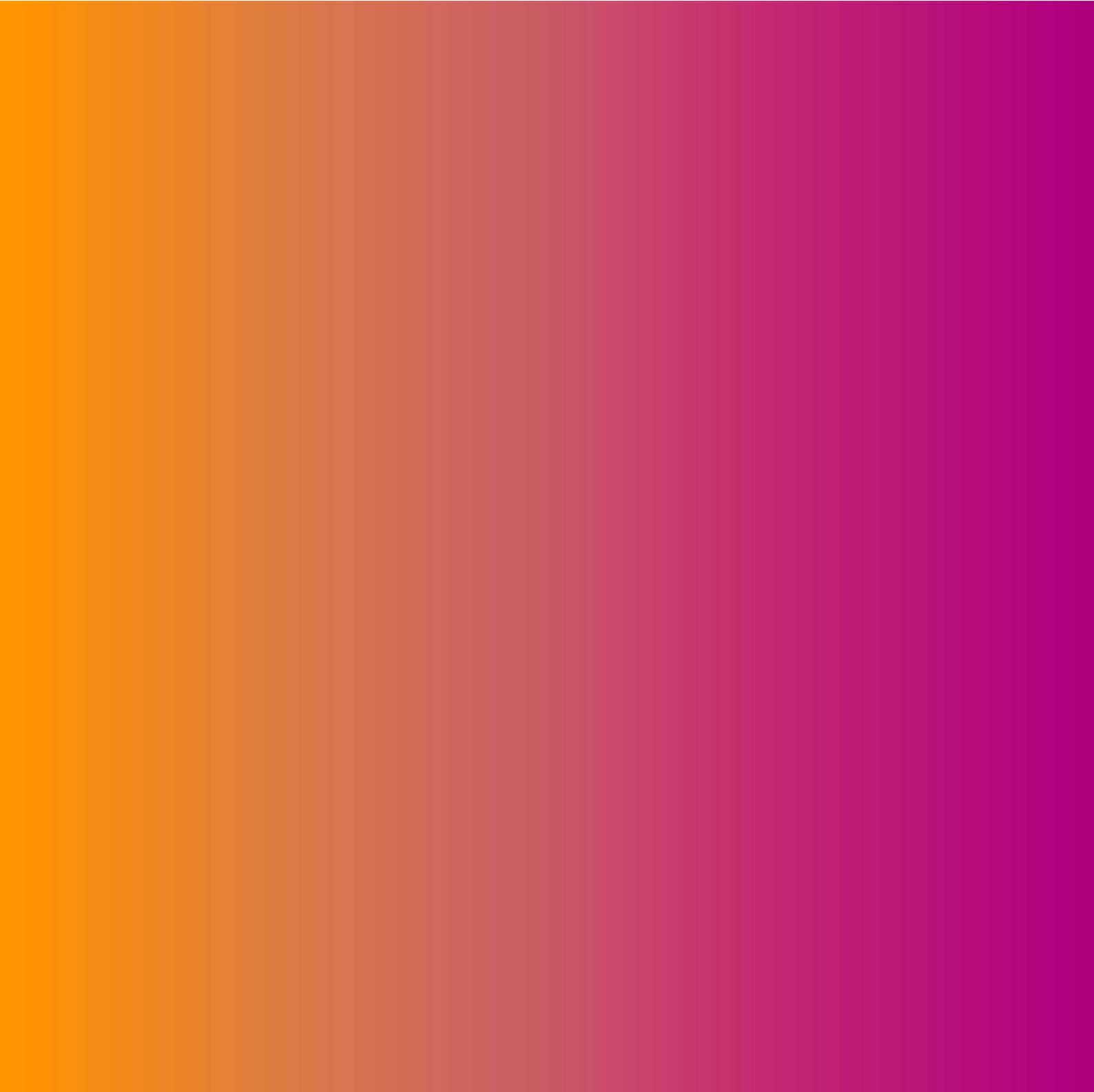
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Construction (Design and Management) Notes

There are numerous statutory undertakers in this location that are affected by the proposed mitigation measures. These are detailed in the report and also in risk register.

1 Introduction



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1 Introduction

1.1 Overview

This report details options tested for the A38/A452 Tyburn House roundabout in Birmingham to accommodate the growth projected by strategic modelling of a 2031 future year scenario.

1.2 Background

The Birmingham Development Plan (BDP) sets out the statutory planning framework that will guide development and regeneration in the period to 2031. It is anticipated that by 2031 Birmingham's population will grow by 150,000. The BDP is being formally consulted on during early 2014 and proposes to release green belt land in the north of the city, specifically in the Sutton Coldfield and Walmley areas, to accommodate around 6,000 residential dwellings (Langley) and up to 80 hectares of new employment land (the Peddimore development). In this context a transport infrastructure plan is being developed to consider necessary interventions to facilitate such development.

Birmingham City Council (BCC) has previously commissioned AECOM to develop and appraise options for improving and increasing capacity at the A38/A4097 Minworth roundabout (2.2km north of the Tyburn roundabout), to accommodate this development and to recommend a preferred option. AECOM recommended an option and also suggested that the increased demand in capacity of the junction should also be matched by increases in capacity at the downstream junctions on the A38 if the benefits of the scheme were to be fully realised. In light of this, BCC have commissioned AECOM to undertake a similar assessment for the A38/A452 Tyburn Roundabout. The roundabout already operates over capacity in the peak periods in 2014.

1.3 Study Objectives

The objectives of this study are to test and assess improvement options including:

- full signalisation of the existing junction,
- signalisation with widening on the approaches,
- a hamburger type cut through arrangement, and
- replacement of the roundabout with signalised cross roads.

A preferred option is then to be recommended, supported by traffic modelling, preliminary drawings, costings and key proposal benefits and risks.

Tyburn roundabout is illustrated in **Figure 1.1** and comprises the following four arms;

- A – A452 Chester Road (North);
- B – A38 Kingsbury Road (East);
- C – A452 Chester Road (South);
- D – A38 Kingsbury Road (West);

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Figure 1.1 Tyburn Roundabout

1.4 Option Development and Appraisal Report

This report outlines the methodology adopted to produce a validated 2009 base model and also option models for the roundabout. Following on from this introduction, the report is set out as follows:

- **Chapter 2** outlines the Observed Conditions;
- **Chapter 3** details the Base Model;
- **Chapter 4** details the Future Year Model results for the existing layout;
- **Chapter 5** outlines Option Development;
- **Chapter 6** provides the Summary and Recommendation.

2 Observed Conditions

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2 Observed Conditions

2.1 Traffic Surveys

In order to create the base models for the Tyburn roundabout, traffic surveys were obtained from the Spectrum database (a database of traffic data maintained by Mott Macdonald on behalf of BCC). The traffic surveys were undertaken on Wednesday 17th June 2009, collecting the following information:

- Manual Classified Counts (MCC)
- Queue Length Surveys.

2.2 Analysis of Observed Data

To verify the suitability of the observed data, a sense check was undertaken on the data to ensure that calculations such as the identification of the peak hour were correct in order to reduce the risk of issues arising that would prevent the successful validation of the base model. These checks are explained in more detail below.

2.2.1 Manual Classified Counts (MCC)

A sense check was carried out on the spreadsheets obtained from Spectrum to ensure that they were correct in terms of formulae used and totals given. No independent data (such as Automatic Traffic Counts) are available and therefore no checks were made to check whether it represents typical flow conditions at the junction.

2.2.2 Peak Determination

The AM and PM peak periods already identified in the data were confirmed as:

- AM peak: 07:30 to 08:30;
- PM peak: 16:30 to 17:30.

2.2.3 Queue Length Survey

Checks were made to the source data to ensure that all lanes had been included and that the formulae and average calculations were correct. Average observed queues (from 2009) for the peak hours are provided in **Table 1** and **Table 2** below.

Time (07:30-08:30)	A452 - Chester Rd (N)		A38 - Kingsbury Rd (E)		A452 - Chester Rd (S)		A38 - Kingsbury Rd (W)	
	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Average Queues (PCUs)	16	20	50	46	3	4	3	2
Average queues for arm (PCUs)	18		48		3		2	

Table 1: AM peak average queue lengths in PCUs

Time (16:30-17:30)	Chester Rd (N)		Kingsbury Rd (E)		Chester Rd (S)		Kingsbury Rd (W)	
	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2	Lane 1	Lane 2
Average Queues (PCUs)	32	28	3	3	18	22	78	79
Average queues for arm (PCUs)	30		3		20		79	

Table 2: PM peak average queue lengths in PCUs

No independent queue data is available to verify the queue data provided from the Spectrum Database. However, queue data has been compared against observations from 2014 which are detailed below.

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2.3 Site observations

AECOM undertook a PM peak site visit on 6th March 2014 and an AM peak site visit on the 25th of the same month. The general observations during the site visits were:

- The A452 Chester Road north approach operates over capacity in both peaks and queues extend back to the B4148/A452 roundabout, which is 550m north of the junction.
- The A38 Kingsbury Road East approach operated with long queues (~500m) during the AM peak but with shorter queues in PM peak.
- On the A452 Chester Road south approach, long queues (~600m) were observed only in the PM peak which extended back to the A47/A452 roundabout but did not appear to affect its operation.
- The A38 Kingsbury Road west approach had short queues in the AM peak but long queues (750m) in the PM peak.

The approaches are shown in **Figures 2.1-2.4**, below, during the site visit.



Figure 2.1: A38 East Approach – Queues in AM peak



Figure 2.2: A38 West Approach – Queues in PM peak



Figure 2.3: A452 North Approach – Queues in PM peak



Figure 2.4: A452 South Approach – Queues in AM peak

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The approximate length of the queues observed during the site visit (2014) have been compared with the queue survey data (2009) and this analysis is tabulated in **Tables 3 and 4** below. All values are provided in PCUs (queue lengths that were measured in metres have been divided by the typical passenger vehicle length 5.75m).

Time	A452 Chester Road (N)	A38 Kingsbury Road (E)	A452 Chester Road (S)	A38 Kingsbury Road (W)
Average queues from survey data (17/06/09)	18	48	3	2
Average queues from site visit (25/03/14)	104	95	2	1

Note: Queues are in PCUs

Table 3: AM peak queue length comparison

Time	A452 Chester Road (N)	A38 Kingsbury Road (E)	A452 Chester Road (S)	A38 Kingsbury Road (W)
Average queues from survey data (17/06/09)	30	3	20	79
Average queues from site visit (06/03/14)	95	2	104	130

Note: Queues are in PCUs

Table 4: PM peak queue length comparison

In **Table 3**, the queues observed during the site visit are significantly longer than those recorded during the survey on the north and east approaches to the roundabout.

Similarly, **Table 4** shows that in the PM peak the queues recorded during the site visit are higher in comparison to the 2009 queue data on the north, south and east approaches to the roundabout.

Given around four years have passed between the date queue survey and the site visit it is likely to expect some increase in traffic which could impact on the operation of the junction and therefore the queue lengths. AECOM have checked the growth factors for the 2009-2014 period using TEMPRO V 6.2 and NTM AF09 and the growth was expected to be 1% in both peaks which would not explain the increase in queues.

Overall therefore it is unclear whether either data set represents typical conditions on the network. However due to the limited data available, AECOM have undertaken the validation of the base model with the 2009 queue survey data. The validation is detailed in next section of the report.

2.4 Adjacent Junctions & Crossings

In addition to the Tyburn roundabout, pedestrian crossings on the A452 approximately 100m north and 150m south of the roundabout have been modelled. This has been considered necessary to optimise the performance of the network around the junction as their behaviour directly influences the performance of the roundabout.

Brief observations were also made at the A47/A452 roundabout to check whether queues on the Chester Road south approach to the Tyburn roundabout affected its operation. In the AM peak queues on this approach did not reach above 5 PCUs (average

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maximum values), hence there was no need to evaluate the A47/A452 junction. It was observed that in the PM peak that queues from the Tyburn roundabout did not affect the operation of the A47/A452 roundabout despite extending close to it.

2.5 Statutory Undertakers Equipment

AECOM have requested statutory undertaker information from various companies to determine what buried or aerial equipment is present in the area around the junction. The responses have been collated as detailed in **Table 5** below, and relevant drawings are included in **Appendix A**.

Company Name	Apparatus at location?	Date Received	Comments	Status
BskyB	Yes	06/03/2014	Two letters have been received from BskyB with plans of the equipment within the enquiry area. Fibre Optic cables run along the central reservation of the A38 Kingsbury Road and cross this approach to the junction. Fibre optic cable also runs across the approaches and exit of the A452 Chester Road and crosses the exit to Kingsbury Road East to the central reservation. Excavators must not be used within 600mm of the equipment without permission.	C3 enquires will be required
BT	Yes	27/02/2014	Underground plant passes underneath and through the junction. Also runs across the A38 west approach to the junction.	C3 enquires will be required
Geo Networks Limited	Yes	05/03/2014	Location plans have been provided. Geo Fibre Optic cable runs directly through the junction, from the centre of the A452 Chester Road South to the A452 Chester Road North	C3 enquires will be required
Instalcom	Yes	06/03/2014	Plans have been received from Instalcom. Cabling runs along the carriageway of the A452 Chester Road South through the junction and follows the edge of the A452 Chester Road North.	C3 enquires will be required
National Grid Gas Distribution and Electricity	Yes	12/03/2014	High or intermediate pressure gas pipelines and equipment are present within the enquiry area. It can be seen that medium pressure mains run through the centre of the junction from all four approach directions. Low pressure mains also run through the junction and across the A452 Chester Road north and south. Mains also cross the A452 Chester Road north approach.	C3 enquires will be required
Severn Trent Water	Yes	27/02/2014	Drawings have been received from BCC for both the Sewer and Water pipes. A combined lateral drain runs directly underneath the roundabout. Water mains piping runs across the approaches of the junction.	C3 enquires will be required
Virgin Media	Yes	27/02/2014	Apparatus pass under the roundabout and across the A38 West approach to the roundabout. Also run along both edges of the carriageway for all approaches.	C3 enquires will be required

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Company Name	Apparatus at location?	Date Received	Comments	Status
Vodafone	Yes	10/03/2014	Ex-cable&Wireless UK Network cable runs through and across the A452 Chester Road. Ex-Energis Network (now Vodafone) cable runs across the A38 Kingsbury Road.	C3 enquires will be required
Western Power Distribution	Yes	04/03/2014	High voltage 33kV cable runs along the left edge of the A452 Chester Road South and through the junction to the A452 Chester Road North. A 33kV cable also runs around the east edge of the junction and under the A38 east approach. Low voltage cables run through the junction and also around the edges of the junction. There are also overhead cables of 11 kV within the junction enquiry area.	C3 enquires will be required
AWE Pipeline	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action needed.
BOC Limited	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
BP Midstream Pipelines	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
BPA	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Centrica Energy	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Conoco Phillips	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Coryton Energy Co Ltd	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Colt	No	12/03/2014	A response has been received that they do not have any equipment within the site area.	No further action anticipated.
EirGrid	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
ESP Utilities Group	Yes	04/03/2014	A plan of the equipment owned by ESP Utilities Group has been received. However the plans show that the equipment is located within an industrial park near to the roundabout and should not affect the works.	No further action anticipated.

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Company Name	Apparatus at location?	Date Received	Comments	Status
Electricity North West Limited	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
E-on UK Plc	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
ESSAR	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Esso Petroleum Company Limited	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Energetics Electricity	No	N/A	A reply to the enquiry has been received and has been stated that the company does not have equipment within the area.	No further action anticipated.
Fiber Speed Limited	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Fulcrum	No	12/03/2014	An email was received stating that no equipment is located within the enquiry area.	No further action anticipated.
Gamma	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Government Pipelines and Storage System	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Humbly Grove Energy	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
HV Cables	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
IGas Energy	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Ineos Enterprises limited	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.

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Company Name	Apparatus at location?	Date Received	Comments	Status
INEOS Manufacturing (Scotland and TSEP)	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Interoute	No	05/03/2014	A reply has been received from the company that they do not know of any equipment within the area.	No further action anticipated.
Lark Energy	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Mainline Pipelines Limited	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Manchester Jetline Limited	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Marchwood Power Ltd	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
McNicholas	No	21/03/2014	A response has been received that no equipment is within the enquiry area.	No further action anticipated.
NPower CHP Pipelines	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Oikos Storage Limited	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.

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Company Name	Apparatus at location?	Date Received	Comments	Status
Perenco UK Limited	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Phillips 66	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Premier Transmission Ltd	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
RWEpower	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
SABIC UK Petrochemicals	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Scottish Power Generation	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Seabank Power Ltd	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Shell Pieplines	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Spiecapag UK Limited	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Teliasonera	No	21/03/2014	A response has been received that no equipment is within the enquiry area.	No further action anticipated.
Total	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Transmission Capital	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.

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Company Name	Apparatus at location?	Date Received	Comments	Status
Utilicom Limited	No	06/03/2014	A reply has been received from the company that they do not know of their equipment within the area.	No further action anticipated .
Verizon Limited	No	05/03/2014	A response has been received that they do not have any equipment within the site area.	No further action anticipated.
Wingas Storage UK Ltd	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
York Potash	No	04/03/2014	A response has been received from LinesearchbeforeUdig that they do not have any equipment within the site area.	No further action anticipated.
Vtesse Networks	Unclear	-	No data provided	A further enquiry should be made at detailed design stage
GTC	Unclear	-	No data provided	A further enquiry should be made at detailed design stage

Table 5: Statutory Undertaker information

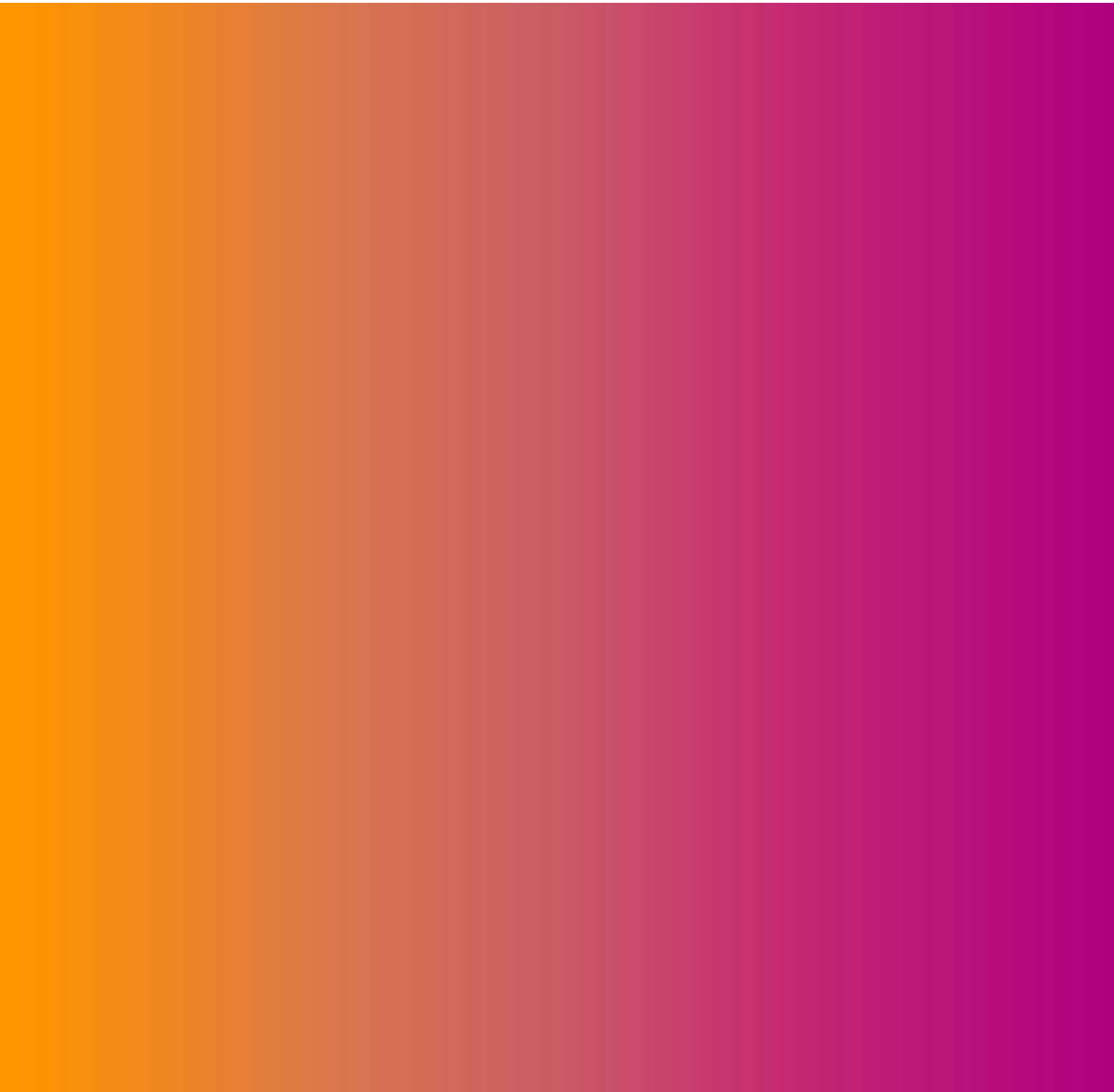
From the enquiries received it is understood that the following equipment is in the vicinity of the junction and could be impacted by the proposals:

- BskyB
- BT
- ESP Utilities Group
- Geo Networks Limited
- Instalcom
- National Grid Gas Distribution and Electricity
- Severn Trent Water
- Virgin Media
- Vodafone
- Western Power Distribution.

No data has been received from vtesse Networks or GTC.

Further C3 enquiries should be made to these undertakers at the next stage of design. At the same time an up to date C2 enquiry should also be made to all undertakers to ensure that no changes have occurred.

3 Base Model



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3 Base Model

3.1 Modelling Approach Overview

A 2009 base model has been built with ARCADY 6 software using 2009 flows and subsequently validated against the 2009 queue survey data. This has enabled improvement options to be evaluated against a 'Do nothing' future year scenario.

3.2 Model Inputs

The geometric parameters used in the ARCADY model were measured using AutoCAD against OS Master Map mapping. Traffic data from the Spectrum database has been used to prepare the Origin and Destination matrix. Heavy Goods Vehicles (HGV) proportions have been calculated using the traffic count data and used to convert the flows to PCU's which have been entered in ARCADY for both peaks. The inputs used in the ARCADY model are detailed in **Appendix B**.

3.3 Base Model Validation

The model was run and the modelled queues were compared with the observed (2009) queues to check the level of validation for both the AM and PM peak models.

A comparison of the observed and modelled queues for the AM peak is shown in **Table 6** below.

Time (07:30-08:30)	Chester Rd (N)	Kingsbury Rd (E)	Chester Rd (S)	Kingsbury Rd (W)
Average queue from 2009 survey data	18	48	3	2
Modelled Queue	4	2	5	1

Table 6: AM Peak Modelled and Observed queues in pcus

Table 6 indicates that the initial model does not represent the observed queues on the A452 Chester Road North or A38 Kingsbury Road East approaches to the roundabout. Due to the limitations of ARCADY in representing lane usage and the effect of approach gradients at the roundabout, validation of the model using the standard ARCADY settings is likely to be difficult. Therefore a site intercept correction was applied to the two aforementioned arms with the aim of better representing 2009 operation. The intercept correction used in the AM peak was -6 veh/min for the A452 Chester Road North approach and -8 veh/min for A38 Kingsbury Road East approach.

A comparison of the observed and modelled queues for the PM peak is shown in **Table 7** below.

Time (16:30-17:30)	Chester Rd (N)	Kingsbury Rd (E)	Chester Rd (S)	Kingsbury Rd (W)
Average queue from 2009 survey data	30	3	20	79
Modelled Queue	4	1	56	1

Table 7: PM Peak Modelled and Observed queues in PCUs

Table 7 shows that the initial PM peak model does not represent 2009 operation based on the observed queues on the Chester Road North and South and Kingsbury Road West approaches. Therefore, following the same procedure as the AM peak model, site intercept corrections were applied for three arms of the roundabout. These were -7 veh/min for the A452 Chester Road North approach, +2 veh/min for the A452 Chester Road South approach and -18.5 veh/min for A38 Kingsbury Road West approach.

3.4 Base Model Results

The results from the revised AM and PM peak models with the intercept corrections applied are shown below in **Table 8** and outputs in **Appendix C**.

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Results		2009 AM - Site Intercept correction		2009 PM - Site Intercept correction	
Arm	Approach	RFC	Queue	RFC	Queue
A	Chester Rd N	0.972	18	1.021	34
B	Kingsbury E	1.072	42	0.405	1
C	Chester Rd S	0.816	4	0.978	21
D	Kingsbury W	0.436	1	1.229	77

Note: RFC is Ratio of Flow to Capacity; Queues are in PCUs

Table 8: 2009 AM and PM Peak - Base Model Results

The queue results from the validated models have been compared to the 2009 survey data and as shown in **Tables 9** and **10** below for the AM and PM peaks respectively.

Time (07:30-08:30)	Chester Rd (N)	Kingsbury Rd (E)	Chester Rd (S)	Kingsbury Rd (W)
Average queue from 2009 survey data	18	48	3	2
Modelled Queue	18	42	4	1

Note: Queues are in PCUs

Table 9: Comparison of 2009 AM Peak Modelled and Observed queues

Time (16:30-17:30)	Chester Rd (N)	Kingsbury Rd (E)	Chester Rd (S)	Kingsbury Rd (W)
Average queue from 2009 survey data	30	3	20	79
Modelled Queues	34	1	21	77

Note: Queues are in PCUs

Table 10: Comparison of 2009 PM Peak Modelled and Observed queues

Following the application of the site intercept corrections, the models replicate the surveyed queues on the 2009 network. It is therefore considered the ARCADY model is a suitable tool which can be used for further assessment.

3.5 Chester Road Improvements

AECOM understands that BCC have planned works along Chester Road and have been provided with the relevant drawings which have influence on the Tyburn roundabout. The works comprise:

- Widening the A38 Kingsbury Road west approach to three lanes for 112m and provision of a controlled pedestrian crossing 25m west of the approach.
- Widening the A452 Chester Road south approach to three lanes from the junction for around 375m, where there is an entrance to a retail park, and upgrading the existing pelican crossing to a toucan crossing.

AECOM have reviewed and modelled these improvements to understand how they affect the operation of the junction and to determine if any further improvements are required to accommodate the 2031 future year flows.

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The validated 2009 models were updated to include the Chester Road improvements. The geometric parameters were updated in ARCADY as detailed in **Appendix B**. The results of this updated modelling are shown below in **Table 11** and outputs in **Appendix C**; which compares the operation of the roundabout with and without the Chester Road improvements.

Results		2009 AM - No improvements		2009 AM - Including Chester Rd Improvements		2009 PM - No improvements		2009 PM - Including Chester Rd Improvements	
Arm	Approach	RFC	Queue	RFC	Queue	RFC	Queue	RFC	Queue
A	Chester Rd N	0.972	18	0.935	12	1.021	34	1.073	57
B	Kingsbury E	1.072	42	1.077	44	0.405	1	0.736	3
C	Chester Rd S	0.816	4	0.674	2	0.978	21	0.826	5
D	Kingsbury W	0.436	1	0.407	1	1.229	77	1.058	33

Note: RFC is Ratio of Flow to Capacity; Queues are in PCUs

Table 11: 2009 AM and PM Peak Validated models - Comparison of operation with and without Chester Road improvements

As shown in **Table 11**, in the AM peak there is virtually no change in operation as a result of the BCC Chester Road works. However in the PM peak, the works improve the operation of the Chester Road south and Kingsbury Road west approaches, but result in longer queues on the A452 Chester Road north approach. The worsening of operation on the Chester Road north approach is likely to be due to vehicles having fewer gaps to accept to enter the circulatory, because of the increased throughput (as demonstrated by the lower queues) on the two upstream arms that have been improved.

To understand whether the Chester Road works result in overall improvement to the operation of the junction, total delay with and without the improvements is compared in **Table 12** below.

Queuing Delay (Min/Veh)	Without Improvements	Including Chester Rd Improvements
AM Peak (07:30-08:30)	0.32	0.29
PM Peak (16:30-17:30)	0.69	0.42

Table 12: Queuing delay per vehicle with and without Chester Road works

Table 12 shows that in the AM peak, delay across the whole junction is reduced by an average 0.03 min/veh the whilst the PM peak, delay is reduced by an average 0.27 min/veh across the junction, demonstrating that the works have an overall benefit to the operation of the junction.

4 Future Year Model

Capabilities on project:
Transportation

4 2031 Do Nothing Model

4.1 Introduction

This section describes the modelling for the 2031 future year flow test for the Tyburn roundabout for the existing network. The do nothing models include the Chester Road Improvements as these are considered as committed.

4.2 2031 Future Year Flows

Mott MacDonald on behalf of BCC have provided 2031 future year flows based on the strategic PRISM model which was developed in support of the BDP. Mott MacDonald have advised that the flows are based on the 2031 'Development Case' PRISM forecasts (i.e. including the greenbelt development). Actual Vehicle Flows have been provided for the AM and PM average hour models. AECOM have not checked the PRISM model flows and have used them as provided by Mott Mac Donald.

DMRB (Volume 12, Section 1, Part 1, TAM) discusses the use of strategic model flows for junction design. It recommends that the turning movements used to develop junction designs should not be taken directly from outputs from the traffic model. Further detail on the approach to be taken on this matter is provided in Sections 13.5 and 13.6 of the DMRB. Furthermore, TA 23/81 (Junctions and Accesses: determination of size of roundabouts and major/minor junctions) also cautions against the use of model output directly and refers the user to TAM.

AECOM have therefore reviewed the flows provided from the PRISM model directly for future year assessment and compared them against the 2009 flows. All detailed calculations are provided in **Appendix D**.

The comparison has shown that the flows from the model for some of the movements are lower than the 2009 existing flows. For example, flows from Chester Road S to Chester Road N are reduced by around 250 pcus in the AM peak and similarly flows from Chester Road N to Chester Road S are reduced by around 200pcus.

PRISM is a strategic model and it considers alternative trip routes between origin and destination points. Therefore we have considered that in the strategic model it is likely that this traffic will have been assigned via the B4148 as this is the shortest and least congested route. However AECOM do not consider this to be realistic, therefore we have developed two sets of flows for assessment.

Flow Test 1

In the first flow test, AECOM have used maintained the same volume of traffic at the junction as forecast by PRISM, but have made adjustments based on the following assumptions:

- The turning proportions will remain similar to the 2009 flows and we have derived the 2031 future year flows by adjusting the PRISM flows using 2009 turning proportions.
- For modelling purposes it has been assumed that the HGV percentages for the future year are the same as in the base year.
- 2031 future year flows have been calculated in PCUs so that the results from the existing network can be compared against the preferred option identified in the further section of this report.

The resulting 2031 future year flows used for further modelling are tabulated below and detailed calculations are in **Appendix D**.

Capabilities on project:
Transportation

2031 AM peak Flows in PCUS						
Arm	Approach	A	B	C	D	Total
A	Chester Rd N	0	185	1032	29	1248
B	Kingsbury E	187	0	583	1091	1860
C	Chester Rd S	515	748	0	253	1515
D	Kingsbury W	76	706	250	0	1032
Total		779	1638	1865	1372	5654

Table 13: Flow Test 1 - 2031 Future Year Model AM flows

2031 PM peak Flows in PCUS						
Arm	Approach	A	B	C	D	Total
A	Chester Rd N	0	203	873	20	1096
B	Kingsbury E	508	0	893	718	2118
C	Chester Rd S	827	491	0	488	1807
D	Kingsbury W	102	1274	173	0	1549
Total		1437	1968	1938	1230	6574

Table 14: Flow Test 1 - 2031 Future Year Model PM Flows

In this test, the 2031 future year flows through the junction in the PM peak are around 900pcus more than the AM peak.

Flow Test 2

In the second flow test, AECOM have used the PRISM flows directly, but have made adjustments based on the following assumptions:

- If the 2031 flow for any movement is less than the 2009 flows, that movement has been uplifted to match with the 2009 flows.
- The flows on the remaining arms of the matrix are same as produced by PRISM model.
- For modelling purposes it has been assumed that the HGV percentages for the future year are the same as in the base year.
- 2031 future year flows have been calculated in PCUs so that the results from the existing network can be compared against the preferred option identified in the further section of this report.

The flows derived by applying the above methodology are tabulated below and are used as sensitivity test flows on the preferred option.

Capabilities on project:
Transportation

2031 AM peak Flows in PCUS						
Arm	Approach	A	B	C	D	Total
A	Chester Rd N	0	212	1184	34	1430
B	Kingsbury E	194	0	645	1182	2021
C	Chester Rd S	827	825	0	265	1917
D	Kingsbury W	71	824	302	0	1197
Total		1092	1862	2131	1481	6566

Table 15: Flow Test 2 - 2031 Future Year Model AM flows – Sensitivity Test

2031 PM peak Flows in PCUS						
Arm	Approach	A	B	C	D	Total
A	Chester Rd N	0	323	1057	25	1405
B	Kingsbury E	516	0	925	766	2207
C	Chester Rd S	855	704	0	506	2065
D	Kingsbury W	50	1518	86	0	1654
Total		1421	2545	2068	1296	7331

Table 16: Flow Test 2 - 2031 Future Year Model AM flows – Sensitivity Test

4.3 2031 Do Nothing Model Results

The ARCADY model has been run with the 2031 future year flow test 1 flows and the results from the model are as shown in **Table 17** below. The full model input and output report can be found in **Appendix E**.

Results		2031 AM		2031 PM	
Arm	Approach	RFC	Queue	RFC	Queue
A	Chester Rd N	1.253	147	0.809	4
B	Kingsbury E	1.282	208	0.813	4
C	Chester Rd S	0.874	6	0.930	11
D	Kingsbury W	0.542	1	2.613	802

Note: RFC is Ratio of Flow to Capacity; Queues are in PCUS

Table 17: 2031 Future Year Model Results

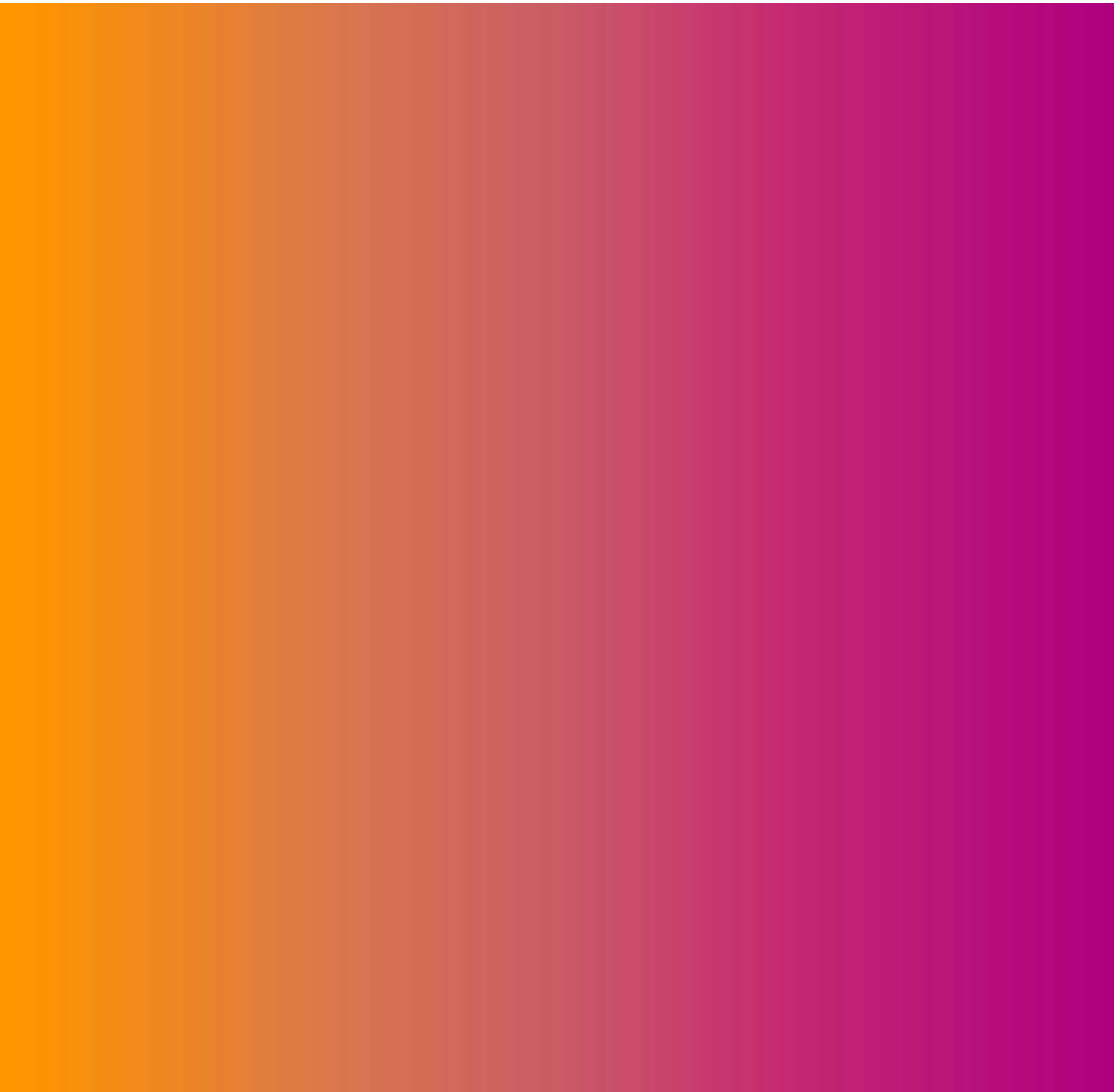
Capabilities on project:
Transportation

Queuing Delay (Min/Veh)	2031 Do-Nothing
AM Peak (07:30-08:30)	2.33
PM Peak (16:30-17:30)	7.62

Table 18: 2031 Overall Delay at the junction

The results from the model indicate that the junction would operate with severe queues on the Kingsbury Road east and Chester Road north approaches in the AM peak and Kingsbury Road west approach in the PM peak. It was noted that the junction would operate at almost double its capacity with unacceptable levels of queuing on some of the approaches and the overall delay at the junction is also severe therefore improvements are required in addition to those already identified by BCC.

5 Option Development



Capabilities on project:
Transportation

5 Option Development

5.1 Introduction

This section describes the various options considered for the A38/A452 Tyburn roundabout as mitigation measures.

In order to maintain deliverability of any improvement works, by avoiding high cost items; the following constraints were identified;

- There are both gas and electricity substations on the southern corner of the A38(E) approach, these will be too costly to move, therefore any widening is limited to widening into the footway and central reserve only.
- There is no scope to widen into the retail park on the south west corner of the junction due to the substantial retaining structures.
- Chester Road (N) approach widening and exit flares are restricted by the width of the existing canal bridge immediately to the north of the junction.
- We have not included any land take outside of the highway boundary which is included in **Appendix F**.

5.2 Options Developed

AECOM have considered the following options for the Tyburn roundabout:

5.2.1 Option 1: Signalised Cross Roads

Option 1 converts the roundabout to a signalised cross roads with the following improvements:

- The flare on the Chester Road north approach is shifted to the offside and all lanes are signalised,
- Removal of the dedicated left lane on the A38 Kingsbury Road east approach and signalising all three lanes,
- Removal of the dedicated left lane on the Chester Road south approach and extending the nearside lane to a length of 375m long until the existing cross roads junction and signalising all the three lanes.
- Extending the flare along the A38 Kingsbury Road west approach to around 100m long and signalising all the three lanes.
- Pedestrian crossings are provided on all approaches to the junction.



Figure 5.1: Draft sketch – Option 1.

Capabilities on project:
Transportation

Initial testing has been undertaken in LINSIG v 3.2.12. The results from the model are in **Table 19**.

Results		2031 AM		2031 PM	
Arm	Approach	DOS (%)	MMQ	DOS (%)	MMQ
A	Chester Rd N	158	140	134	91
B	Kingsbury Rd E	158	183	164	216
C	Chester Rd S	154	149	163	154
D	Kingsbury Rd W	94	12	128	105
Total Junction Delay (pcu hr)		787.82		1155.71	

Note: DoS is Degree of Saturation. MMQ is Mean Maximum Queue expressed in PCUs

Table 19: 2031 Future Year Model Results for Option 1

The results suggest that this option operates better than the do nothing option. However, the junction still does not operate effectively and severe queues are shown on the A38 Kingsbury Road east, Chester Road north and south approaches in the AM peak and in the PM peak severe queues are shown on all approaches, to the junction. The additional lanes required to make this junction work as a crossroads cannot be accommodated within the constraints of the available land. Due to the limited improvement, for a substantial scheme, and the difficulty of implementation this option has been discounted.

5.2.2 Option 1a: Hamburger or Fly Over arrangement

Consideration was also given as to whether a 'hamburger' or flyover cut through arrangement would work at this location. However on examination of the flows provided for the junction it was clear that there was not one predominant flow that would benefit from this arrangement with the flows in the AM and PM peak being fairly even distributed across all four arms, which is to be expected at an intersection of two major urban routes such as the A38 and A452. This makes it difficult to realise any benefits from a cut-through arrangement.

In addition to this the physical constraints of the junction make it difficult to achieve a suitable alignment, due to the gradients involved and the limited land availability at the junction.

5.2.3 Option 2: Full Signalisation

Option 2 is full signalisation of the existing Tyburn roundabout including the committed Chester Road Improvements. They are:

- Signalising and widening the A38 Kingsbury Road west approach to three lanes for 112m and provision of a controlled pedestrian crossing 25m west of the approach.
- Signalising and widening the A452 Chester Road south approach to three lanes from the junction for around 375m, where there is an entrance to a retail park, and upgrading the existing pelican crossing to a toucan crossing.
- No widening on the A452 Chester Road north and A38 Kingsbury Road east approaches but signalising these arms has been considered.

Capabilities on project:
Transportation

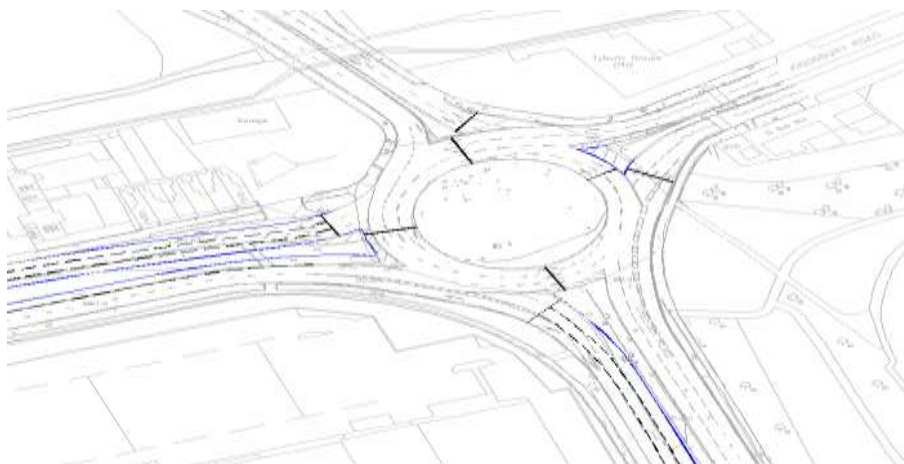


Figure 5.2: Draft sketch - Option 2.

Testing in TRANSYT v14.1.2.315 indicated that there would be severe queues on the A38 Kingsbury Road east in both peaks but the remaining approaches appear to operate reasonably. The results from the model are tabulated in **Table 20**.

Results		2031 AM		2031 PM	
Arm	Approach	DOS (%)	MMQ	DOS (%)	MMQ
A	Chester Rd N	76	3	81	5
B	Kingsbury Rd E	113	115	119	160
C	Chester Rd S	85	7	85	18
D	Kingsbury Rd W	68	7	90	10
Total Junction Delay (pcu-hr/hr)		170.06		236.44	

Note: DoS is Degree of Saturation. MMQ is Mean Maximum Queue expressed in PCUs

Table 20: 2031 Future Year Model Results for Option 2

Table 20 indicates that to improve the operation of the roundabout further modifications are necessary along the A38 Kingsbury Road East as queues exceed 115PCUs in both peak periods. Therefore this option has been refined with widening to create Option 3.

5.2.4 Option 3: Full Signalisation with Improvement

Option 3 is full signalisation of the roundabout and the following improvements:

- Additional 100m lane on the A38 Kingsbury Road east approach to the roundabout.
- Both exits onto the A38 Kingsbury Road widened to three lanes, merging to two lanes after 100m.
- An additional lane on the A38 Kingsbury Road east circulatory.
- Removal of the dedicated left turn lane from the A452 Chester Road South approach and signalisation of all three lanes on this approach.

Capabilities on project:
Transportation

- Proposed toucan crossings on the A38 Kingsbury Road west approach and the existing pedestrian crossing on the A38 Kingsbury Road east is moved in front of the stop line.

A drawing of Option 3 is included in **Appendix G**. The option has been assessed in TRANSYT 15 V15.0.1.2976 using the 2031 future year flows.

Flows in the model have been balanced using the lane balancing option in TRANSYT. Queue limits have been applied on the circulatory stop lines and delay and stop weightings have been used on the paths at the circulatory to give priority for these movements so that queues are predominantly held on the entries.

The 72 second cycle time used in the model results in better operation than a 60 second cycle time based on cycle time optimisation (CYOP) analysis. Phase minimums used for the signals are seven seconds for traffic and five seconds for pedestrians.

Flow Test 1

The model has been run with flow test 1 and the results indicate that with the doubling of demand to 2031, the roundabout operates above capacity where the highest degree of saturation, of 114%, occurs on the Chester Rd North in the AM peak and 129% on the Kingsbury Road West in the PM peak. Full model outputs for this option are in **Appendix H**.

The results from the Option 3 TRANSYT model have been compared with the 2031 Future Year Existing Layout ARCADY model in **Table 21** below.

Results		2031 AM				2031 PM			
		Do Nothing		Option 3 Model		Do Nothing		Option 3 Model	
Arm	Approach	RFC	Queue	DoS (%)	MMQ	RFC	Queue	DoS (%)	MMQ
A	Chester Rd N	1.253	147	114	50	0.809	4	91	15
B	Kingsbury Rd E	1.282	208	93	17	0.813	4	101	27
C	Chester Rd S	0.874	6	87	12	0.930	11	82	10
D	Kingsbury Rd W	0.542	1	54	6	2.613	802	129	47
Total Junction Delay (pcu-hr/hr)				109.29				199.50	

Note: RFC is Ratio of Flow to Capacity and DoS is Degree of Saturation. MMQ is Mean Maximum Queue expressed in PCUs

Table 21: Comparison of 2031 Future Year Model Results with committed and proposed layout

The results indicate that in comparison with the do nothing scenario the proposed option provides a reduction in queuing on the A452 Chester Road north and A38 Kingsbury Road east approaches in the AM peak with a slight increase in queues on the remaining approaches at the junction, although it should be noted that these queues are very short.

In the PM peak, queues on the A452 Chester Road north and Kingsbury Road east approaches are slightly increased but the queues on the Kingsbury Road west approach are significantly reduced in the proposed option when compared against Do-nothing scenario.

It should be noted that queues on the circulatory links of the roundabout briefly exceed the available storage in both peaks on some links. These queues have been reviewed and it is noted that the queues dissipate within the available green time. This is represented in the queue graphs from TRANSYT model for the circulatory links as shown in **Figures 5.1 to 5.4** for the AM peak and **Figures 5.5 to 5.8** for the PM peak. Although it is believed that these queues will be acceptable, the potential for blocking by

Capabilities on project:
Transportation

internal queues should be revisited as part of the detailed design stage. If required, modelling using software capable of assessing the impact of blocking back should also be undertaken.

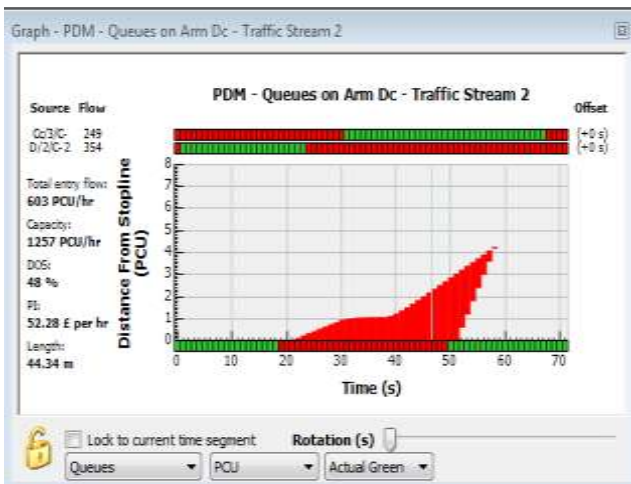


Figure 5.1 A452 Chester Road N Circulatory – AM peak

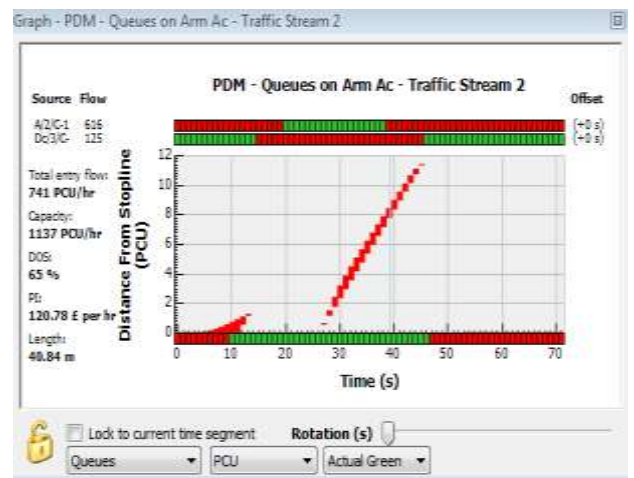


Figure 5.2 A38 Kingsbury Road E Circulatory – AM peak

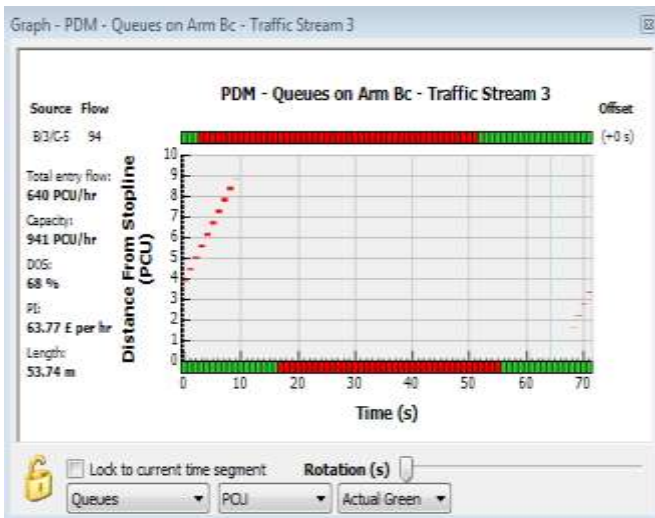


Figure 5.3 A452 Chester Road S Circulatory – AM peak

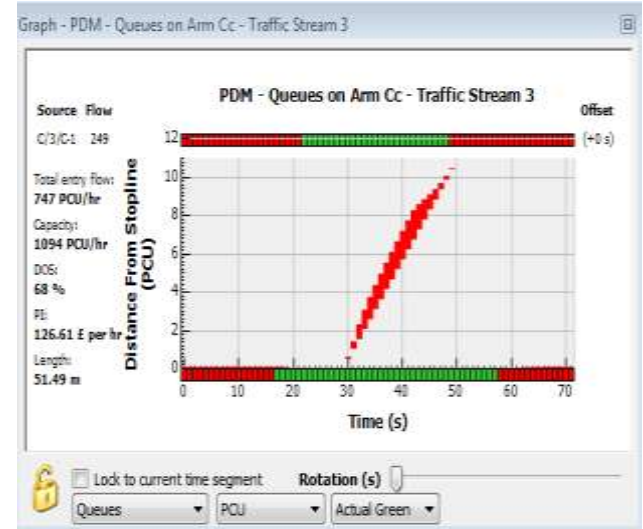


Figure 5.4 A38 Kingsbury Road W Circulatory – AM peak

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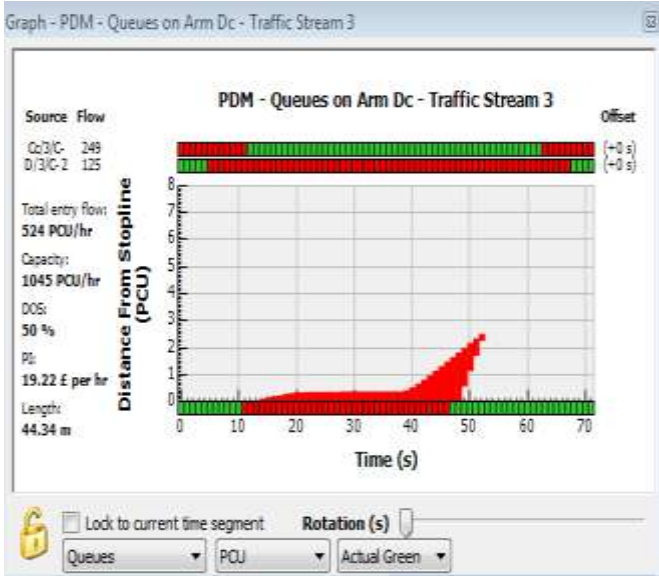


Figure 5.5 A452 Chester Road N Circulatory – PM peak

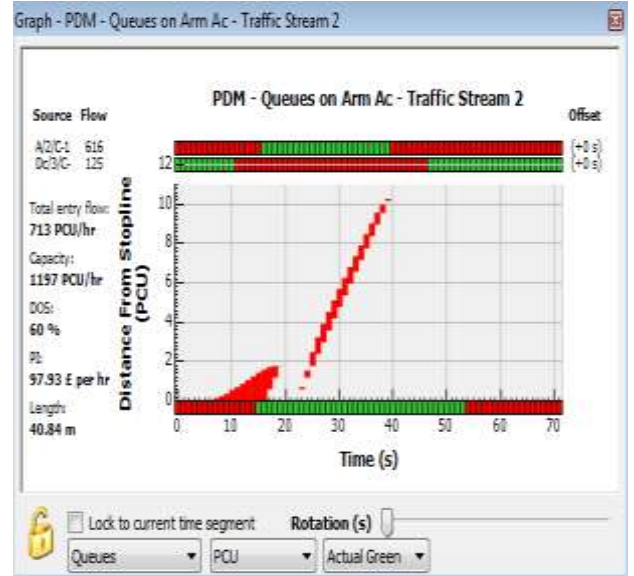


Figure 5.6 A38 Kingsbury Road E Circulatory – PM peak

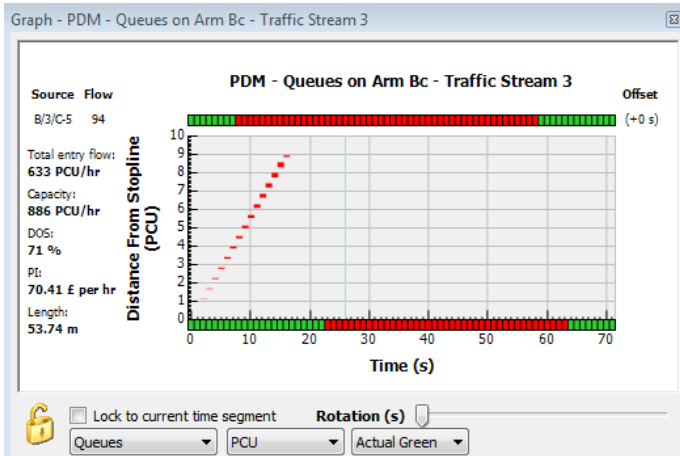


Figure 5.7 A452 Chester Road S Circulatory – PM peak

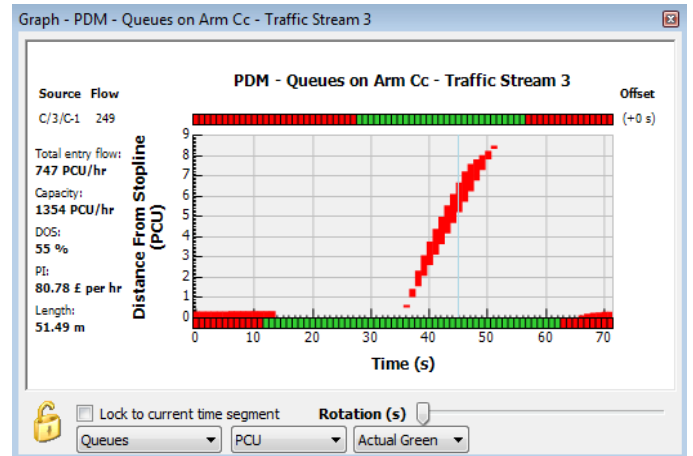


Figure 5.8 A38 Kingsbury Road W Circulatory – PM peak

Capabilities on project:
Transportation

Comparison of delay for the Do Nothing and Proposed Option 3 is shown in **Table 22** which shows that overall delay at the junction is reduced significantly as a result.

Junction Delay	2031 AM		2031 PM	
	Do Nothing (min/veh)	Option 3 Model (min/pcu)	Do Nothing (min/veh)	Option 3 Model (min/pcu)
A38/A452 Tyburn roundabout	2.33	0.21	7.62	0.39

Table 22: Comparison of 2031 Future Year Model Delay between Do Nothing and Proposed Option 3 layout

It should be noted that the high levels of delay in the base model are primarily a result of queues on the Chester Road north and Kingsbury Road east approaches in the AM peak and the Kingsbury Road west approach in the PM peak. The proposed Option 3 results in improvement over the do nothing scenario as the signals better manage the traffic demand and therefore distribute delays more effectively at the junction.

Junction Delay (min/veh)	AM peak		PM peak	
	2009 Chester Road Improvements	2031 Option 3 Model	2009 Chester Road Improvements	2031 Option 3 Model
A38/A452 Tyburn roundabout	0.29	0.21	0.42	0.39

Table 23: Comparison of 2009 Model Delay and 2031 Proposed Option 3 results

We have also compared the results from Option 3 (Table 17) to the 2009 with Chester Road improvements (Table 12). This shows that the operation of Option 3 in 2031 with development provides a similar level of service to the 2009 with Chester Road improvements scheme, indicating that whilst Option3 does not fully accommodate all the development traffic it does provide a similar level of service to the existing situation, nearly creating a 'nil detriment' operation.

Flow Test 2

The model has been run with flow test 2 and the results indicate that with the doubling of demand to 2031, the roundabout operates above capacity where the highest degree of saturation, of 130%, occurs on the Chester Rd North in the AM peak and 172% on the Kingsbury Road West in the PM peak. Full model outputs for this option are in **Appendix H**.

The results from the Option 3 TRANSYT model have been compared with the 2031 Future Year Existing Layout ARCADY model in **Table 24** below.

Capabilities on project:
Transportation

Results		2031 AM				2031 PM			
		Do Nothing		Option 3 Model		Do Nothing		Option 3 Model	
Arm	Approach	RFC	Queue	DoS (%)	MMQ	RFC	Queue	DoS (%)	MMQ
A	Chester Rd N	1.253	147	130	93	0.809	4	160	137
B	Kingsbury Rd E	1.282	208	100	25	0.813	4	98	22
C	Chester Rd S	0.874	6	110	57	0.930	11	114	70
D	Kingsbury Rd W	0.542	1	62	7	2.613	802	172	127
Total Junction Delay (pcu-hr/hr)				251.58				689.86	

Note: RFC is Ratio of Flow to Capacity and DoS is Degree of Saturation. MMQ is Mean Maximum Queue expressed in PCUs

Table 24: Comparison of 2031 Future Year Model Results with committed and proposed layout

The results indicate that in comparison with the do nothing scenario the proposed option provides a reduction in queuing on the A452 Chester Road north and A38 Kingsbury Road east approaches in the AM peak with an increase in queues on the remaining approaches at the junction.

In the PM peak, queues on all the A452 Chester Road north, Kingsbury Road east and Chester Road south approaches are increased but the queues on the Kingsbury Road west approach are significantly reduced in the proposed option when compared against Do-nothing scenario even with the sensitivity test flows.

Comparison of delay for the Do Nothing and Proposed Option 3 with flow test 2 is shown in **Table 25** which shows that overall delay at the junction is reduced significantly as a result.

Junction Delay	2031 AM		2031 PM	
	Do Nothing (min/veh)	Option 3 Model (min/pcu)	Do Nothing (min/veh)	Option 3 Model (min/pcu)
A38/A452 Tyburn roundabout	2.33	0.43	7.62	1.15

Table 25: Comparison of 2031 Future Year Model Delay between Do Nothing and Proposed Option 3 layout

It should be noted that this option operates better than the Do-nothing even with the sensitivity test flows (flow test 2).

5.2.5 Option 4: Hamburger Arrangement

At the scoping stage a hamburger option was considered. Following receipt of the statutory undertakers drawings and highway boundary drawings it was apparent that:

- Providing a north – south cut through would require widening over the existing canal bridge on the Chester Road north approach as well as acquisition of land and property adjacent to the carriageway.

Capabilities on project:
Transportation

- Providing an east-west cut through would require acquisition and demolition of property to the north-west and north east of the junction as well as relocation of statutory undertakers equipment (including possible relocation of gas and electrical sub-stations) to the south east of the junction.

In light of these constraints and the achievement of nil-detriment with other options, this option has not been developed further.

5.3 Recommended Option

From the modelling work undertaken, it is noted that the delay at the junction is less in Option 3 compared to all the other options. This is represented below.

	Option 1		Option 2		Option 3	
	AM	PM	AM	PM	AM	PM
Total Network Delay (PCU-hr/hr)	787.82	1155.71	170.06	236.44	109.29	199.50

Table 26: Comparison of 2031 Future Year Model Delay for all options

Therefore the recommended option considered for Tyburn roundabout is Option 3. The proposed scheme drawing is shown in **Appendix G**.

6 Cost Estimate and Risks

Capabilities on project:
Transportation

6 Cost Estimate and Risks

6.1 Cost Estimate

A cost estimate for this option has been derived using Manual of Contract Documents for Highway Works (MCHW) series. The estimated cost associated with this improvement option is **£1,792,937.59**, subject to a number of exclusions and assumptions appropriate to the level of scheme design. Full details of this cost estimate are contained in **Appendix I**. It should be noted that the cost estimate includes optimism bias, traffic management measures, preliminary and detailed design costs and also the following standard caveats and exclusions:

- 3rd Party Land acquisition costs and accommodation works costs.
- Dedication of Land, Land to be passed over to the council as highway.
- Legal costs.
- Landscaping design.
- Statutory Undertakers design fee.
- Statutory Undertakers diversion and or protection costs.
- Third Party Ground Investigation costs. Trial Pits and Geotechnical surveying will be supplied by third parties.
- Traffic Regulation Orders & any associated TRO consultation.
- Contract documentation for appointment of the preferred contractor, as this is being progressed by others.
- Tendering of the works.

6.2 Risks

A number of risks have been identified in this preliminary design which may have safety, cost, programme or deliverability issues. These have been detailed in full in the risk register in **Appendix J**.

The principle risks to this project are the potential cost and programme delay of Statutory Undertakers equipment protection and diversion requirements. There are numerous undertakers that are very likely to be impacted by widening into the footway and central reserve, in order to create the capacity required to accommodate the development. Several of these are high cost items such as fibre optic cable routes and gas mains.

It is therefore recommended that C3 enquires are undertaken as soon as possible to establish the potential costs and determine if the scheme is viable for delivery within the context of the Peddimore development infrastructure requirements. It is possible that revisions to the scheme will be required to reduce these costs and hence this may affect the capacity improvements at the junction.

It is also recommended that 3-D design be undertaken at the earliest opportunity given the steep gradient across this junctions to ensure that the 2-D design presented in the report can be achieved and that vehicles will be able to negotiate the junction safely.

7 Summary & Recommendation

Capabilities on project:
Transportation

7 Summary & Recommendation

7.1 Summary

This study has reviewed the operation of the A38/A452 Tyburn roundabout, with a view to developing a preferred scheme to support the increase in traffic arising from the proposed Peddimore development to 2031.

A 2009 base model for the junction has been built to reflect the operation of the junction and to correlate with the 2009 queue survey data. Currently, the junction operates over capacity with significant queues on the A452 Chester Road North and the A38 Kingsbury Road East approaches in the AM peak. In the PM peak, significant queues are noted on all approaches except the A38 Kingsbury Road East approach.

As an output of strategic modelling, a 2031 future year development scenario has been developed. These flows have been used to develop a 2031 Do Nothing Future Year Scenario. The results of this model indicate that the existing junction (with the Chester Road improvements) would be operating at almost double its capacity, with unacceptable levels of queuing by 2031.

AECOM have considered various options for improving the junction to accommodate an increase in traffic through to 2031. Two of these options did not provide sufficient capacity, therefore a third option has been developed, based on widening of approaches and the circulatory and full signalisation. This proposal operates over capacity with the forecast 2031 flows but achieves nil detriment. This option has an estimated cost in the region of £1.7 million, plus additional costs for items excluded from this estimate. There are significant costs risk associated with this scheme due to the number of Statutory Undertakers present in the area which are likely to be affected. It is therefore recommended that C3 enquiries are carried out as soon as possible to quantify the full cost of the scheme.

The preferred option works within the constraints that surround the junction as identified in Section 5.1, therefore many of the parameters used in the design in order to achieve the capacity within the constraints have been set at the minimum acceptable design standard in the horizontal plane. Further design work will be required to ensure that the design physically works in a three dimensional environment. This is particularly important for the vertical alignment given the steep gradient across the junction, to ensure that vehicles can safely navigate the junction.

A preliminary drawing for the proposed preferred option and the initial cost estimate for this Option are undertaken and presented in the appendices.

7.2 Recommendation

AECOM recommend that Option 3 is developed as the preferred option. Modelling suggests that this option operates better than the Do nothing scenario and provides a nil-detriment solution in 2031 relative to the 2009 level of service.

There are a number of risks associated with the scheme which we recommend are investigated at the earliest opportunity in order to fully understand the impact these include:

- Statutory Undertakers C3 budget cost estimate requests to understand the cost implications of the numerous potential diversions identified as part of this report.
- 3-D design of the junction to ensure that the 2-D design option presented in this report physically works due to the steep gradients across the junction

In 2031 around 400 and 700 pcus exit the A38 Kingsbury Road west approach in AM and PM peak respectively which presumably reach the Norton Crossroads which is 1.3km west of the Tyburn roundabout. Norton Crossroads already operates at capacity in the peak periods. In light of this, it is recommended that a similar assessment is undertaken for this junction.