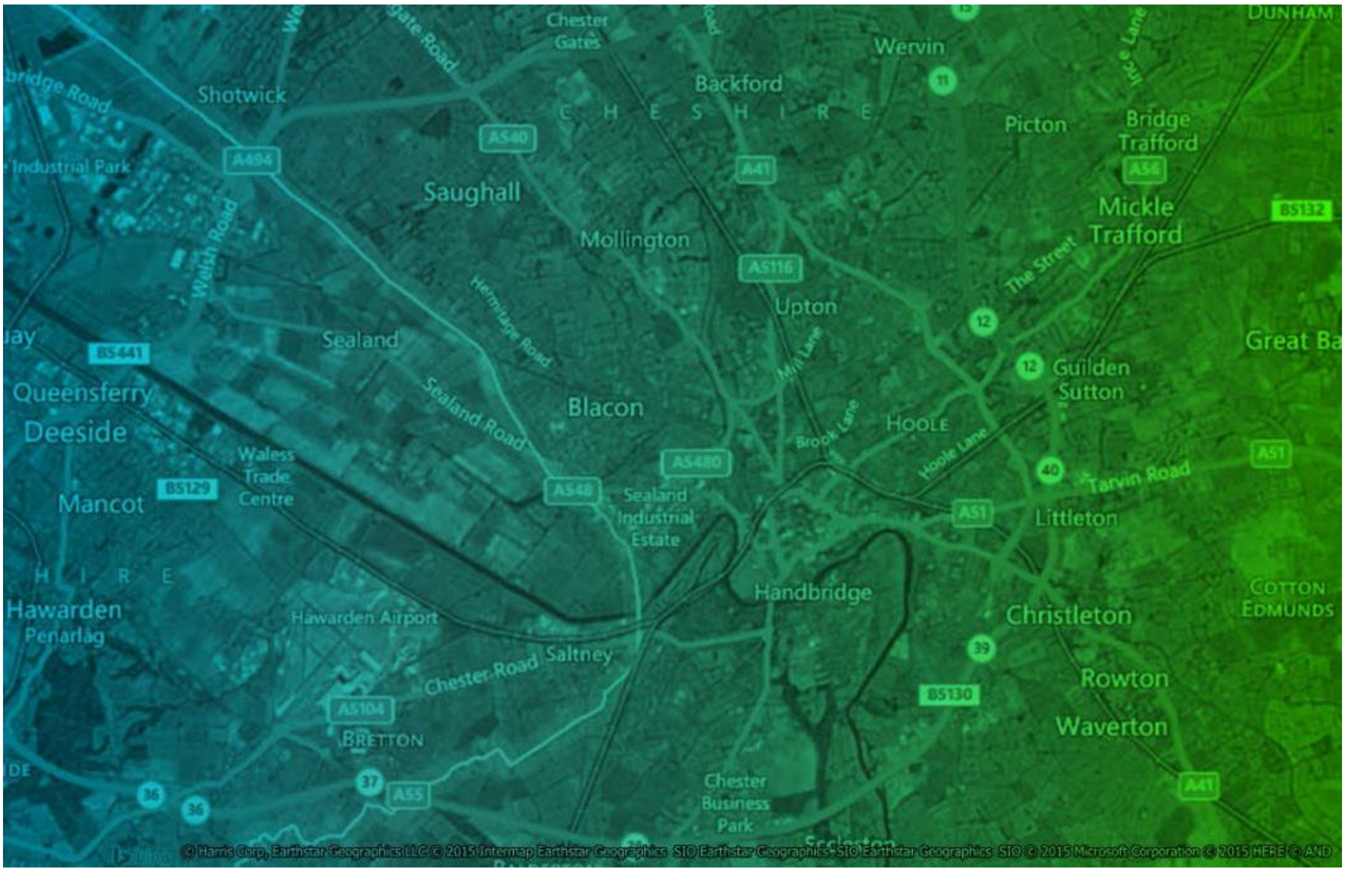
Chester Transport Strategy - Phase Two

Chester Western Relief Road – Interim Report

September 2015



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Introduction

The Chester Western Relief Road (CWRR) has for some time been identified as a potential measure to mitigate congestion issues in and around Chester city centre - the Local Plan preserves a route which broadly follows the boundary with Flintshire. AECOM completed Phase 1 of the Chester Transport Strategy in February 2014; the strategy identified that improvements delivered as part of the Chester One City Plan would impact on traffic flows through the city centre, placing pressure on traffic to find alternative routes. Following a high level assessment (undertaken as part of Phase 1 of the transport strategy work), the scheme was put forward as a potential component in a wider strategy for the city. **Figure** 1 shows the original alignment for the scheme, in addition to potential alternatives to the west, which would provide enhanced connectivity to Hawarden Airport.

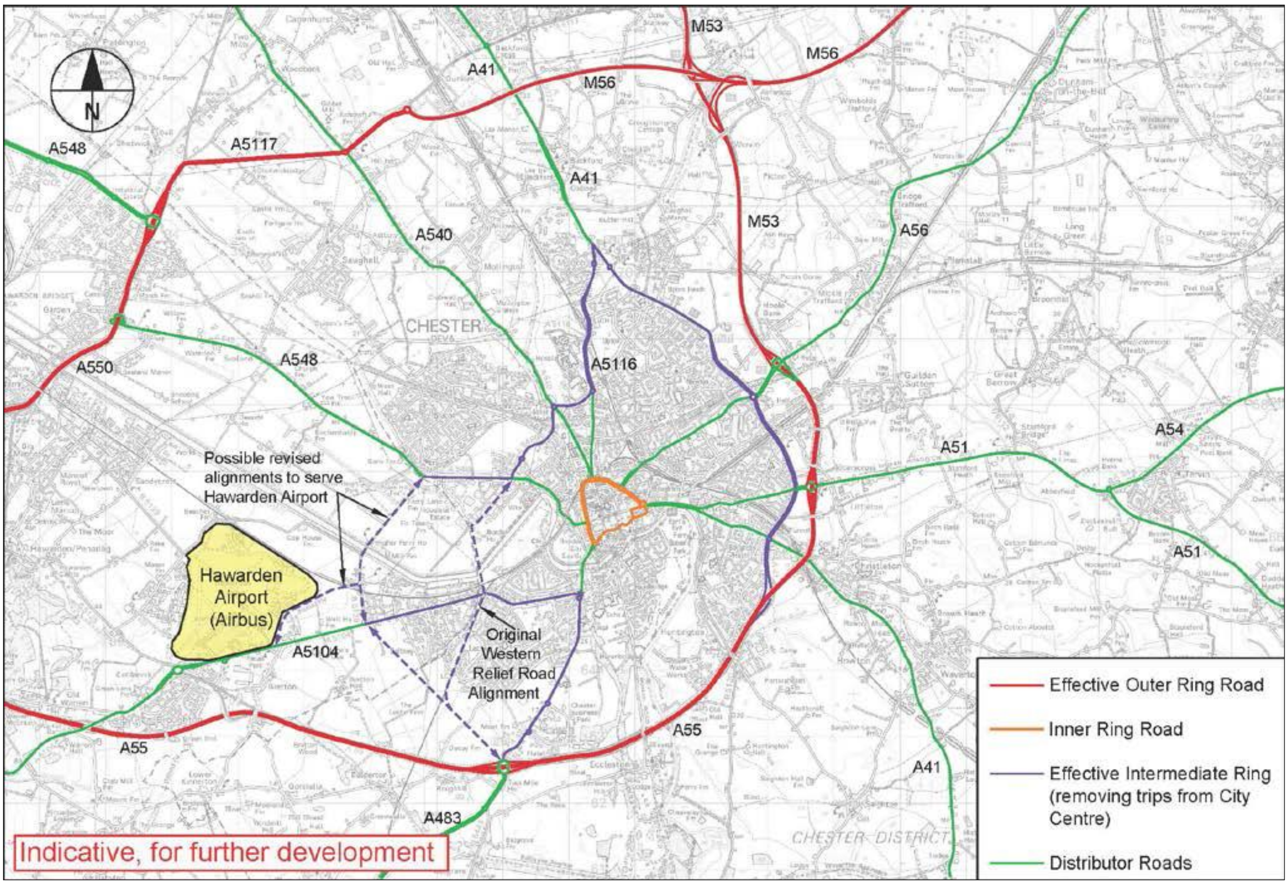


Figure 1 - Chester Western Relief Road - Potential Route Options

Scope of the Task

AECOM has been appointed by Chester West and Chester Council (CWaC) to undertake Phase 2 of the Chester Transport Strategy - an assessment of the Western Relief Road is one of six workstreams in the work programme. The study brief identified a requirement to consider potential alignments for the scheme, including indicative costs – stakeholder engagement is required with key partners in developing the options. An economic assessment of the options is required, making use of the Chester Traffic Model, which uses the SATURN software package to represent typical average weekday traffic conditions.

The work to date has not included the stakeholder engagement element of the work – it is still expected that this will proceed in the near future once CWaC has arranged the necessary high level officer discussions with Flintshire Council to facilitate the consultation. Whilst this has resulted in some delays to the work programme, a decision was taken to proceed with the assessment of the original alignment, which is within CWaC, but following the boundary with Flintshire. The assessment of any options further to the west is currently on hold until the stakeholder meetings are arranged.

This report provides a summary of the work completed on the scheme to date, including the key findings from the economic appraisal.

Option Identification

Following discussions with officers at CWaC, two variants of the original alignment for the Chester Western Relief Road were identified for assessment in the transport model. Both options provide a connection between the A483, Wrexham Road, (north of the junction with the A55) and the A548 Sealand Road.

Option 1

This would comprise a dual carriageway between the A483 and the A548 with no intermediate junctions. The A483 would be accessed via off-slips - Bumpers Lane would be accessed via a roundabout with the new link, but would otherwise be unchanged. An alternative access onto Sealand Road was identified in the form of a new link instead of traffic using Bumpers Lane, but this was discounted owing to land requirement issues.

Option 2

This option was defined in view of concerns regarding the feasibility of accommodating a dual carriageway around the central section of the route, particularly the junction with High Street. The route broadly follows the same alignment as Option 1, but is single carriageway throughout. The route would have three intermediate signalised junctions (with Boundary Lane, Chester Street/High Street and River Lane). It would connect with the A483 via the existing roundabout junction which serves the Park and Ride site/Herons Way. The lower standard of this option is likely to result in its function being more akin to a local distributor road rather than a relief road.

Option 3 Sensitivity Test

In addition to the two primary options identified above, a third option was considered as a sensitivity test, with limited analysis of traffic model results – this was completed in order to understand the comparative end BCR for this option. This scheme is similar to Option 1 in most respects, but unlike Option1 the scheme includes a junction between the proposed link road and A5104 Chester Road, between Boundary Lane and Shrewsbury Way. The junction would be a compact grade separated design, minimising land take and also delay on the link road.

Scheme Costs

High level construction costings have been calculated to inform the economic assessment. These costs are estimates based on an indicative layout using rates from Spon's Civil Engineering and Highways Works Price Book 2015 with a number of factors applied to take account of key risks. Standard industry figures for a high level costing have been applied for contractor's preliminaries, contractors profit and optimum bias/ contingency of 10%, 10% and 44% respectively. In addition, the following were applied and added to the works costs:

- Legal, 1%;
- Design and Consultancy Fees, 10%;
- Statutory Authority Fees, 10%;
- Statutory Undertakers, 20%;
- Third Party Land Acquisition, 10%;
- Drainage Outfall/ Sustainable Drainage Requirements, 1%;
- Change in Topography, 3%; and
- Ground Risk, 5%.

The estimated construction costs for the three options are:

- **Option 1: £61.98 million**
- **Option 2: £48.74 million**
- **Option 3: £74.13 million**

It should be noted that the costs are indicative at this outline assessment stage – as the scheme is developed, more detailed work would need to be undertaken to clarify the costs.

Traffic Assessment

The scheme was assessed using the Chester Traffic Model which was developed by Atkins in 2013 - a review of the model showed that the base model was found to generally validate well in the area of influence of the scheme. The model includes a forecast year of 2030 and a Do Minimum scenario has been defined which includes schemes that are expected to be in place by this date. In order to provide the necessary outputs for the appraisal, an intermediate forecast year model of 2020 was developed, in addition to an average inter peak hour model to supplement the existing AM and PM peak hour models. This work was informed by a database of proposed developments in the area (provided by CWaC) and TEMPRO.

The assessment of traffic conditions highlights a number of sections of the network that are forecast to be over capacity by 2030 without the scheme in place. During the AM Peak, the A483 (Grosvenor Road) is forecast to be particularly congested between the inner ring road and Hough Green (over the River Dee), in addition to Handbridge. Other congestion hotspots include the access from the A548 into Sealand Industrial Park and key access roads into the city centre, including the A56 (Hoole Road) and A5116 (Liverpool Road). To the west of Chester city centre, high levels of delay are also forecast on Deva Link on the approach to the A548 Sealand Road.

Tables 1 and **2** show the forecast traffic flows and volume to capacity ratios at the northern and southern ends of the relief road under Options 1 and 2 (dual and single carriageway respectively). The flow on the relief road for Option 1 is the same at both ends of the road as the option has no intermediate junctions. On the northern section of the relief road (**Table 1**), the forecast traffic flows are very similar for Option 1 and 2 in the AM Peak, although the southbound flow in PM Peak is higher in Option 2. The link is forecast to be over capacity under Option 2 (single carriageway) on this section in the AM Peak.

At the southern section of the relief road (**Table 2**), the forecast flows are significantly lower for Option 2 compared with Option 1. This is a result of Option 2 attracting less north – south through traffic as the journey time on the link is longer owing to the intermediate junctions.

Table 1 – Chester Western Relief Road – Northern Section (Bumpers Lane – A5104 High Street) Traffic Flows and Volume to Capacity Ratios (2030)

Scenario	AM Peak				PM Peak			
	Traffic Flow		Volume/Capacity		Traffic Flow		Volume/Capacity	
	North	South	North	South	North	South	North	South
Option 1	1066	457	41%	11%	582	1119	22%	27%
Option 2	1066	485	100%	47%	662	786	61%	76%

Table 2 – Chester Western Relief Road – Southern Section (A483 Wrexham Road – Lache Lane) – Traffic Flows and Volume to Capacity Ratios (2030)

Scenario	AM Peak				PM Peak			
	Traffic Flow		Volume/Capacity		Traffic Flow		Volume/Capacity	
	North	South	North	South	North	South	North	South
Option 1	1066	457	26%	11%	582	1119	14%	27%
Option 2	346	425	19%	23%	388	344	21%	18%

Table 3 shows the forecast traffic flows and volume to capacity ratios on the existing A483 to the north of the A55 around the junction with Hersonsway. This shows that the flow on this section of the road is forecast to reduce significantly under Option 1, but Option 2 does not reduce the traffic flow on this section of road. It should be noted that this is one point on the A483 and that the flow and volume to capacity ratio along the A483 varies.

Table 3 – A483/Hersonsway - Traffic Flows and Volume to Capacity Ratios (2030)

Scenario	AM Peak				PM Peak			
	Traffic Flow		Volume/Capacity		Traffic Flow		Volume/Capacity	
	North	South	North	South	North	South	North	South
Do Minimum	1571	952	96%	58%	750	1146	46%	70%
Option 1	1053	794	64%	48%	652	909	40%	55%
Option 2	1645	869	100%	53%	743	1058	45%	65%

Impact on Journey Times

Tables 4 and 5 show the impact of the scheme on journey times between key destinations during the AM Peak for Options 1 and 2 respectively. The figures represent the difference in journey times relative to the Do Minimum scenario (without the CWRR in place) – green cells denote a reduction in journey times whereas the red cells represent an increase. As would be expected, both options are forecast to deliver significant time savings from Sealand Industrial Estate, which is located to the west of Chester City Centre and at the northern end of the scheme. The new bridge over the Dee results in particularly significant journey time savings from this area to the Airport. It is also apparent that the scheme is expected to deliver notable time savings to Chester City Centre from a range of places including the Airport, Flint and Gresford. There are a number of additional smaller journey time savings owing to wider traffic assignment effects across the network.

Model outputs from Option 3 have not been assessed to the same extent as Option 1 and Option 2. In general the model performs similarly to Option 1 with respect to journey times along the link road. However, it is has been observed that in the AM peak forecast year 2030 scenario there are some delays at the access junctions. Largest of these delays is the southbound off slip approach to the signalised junction with the A5104 Chester Road, in this case a delay of approximately three and a half minutes is forecast. For this same scenario at the minor road merge point from the northbound on slip to the link road there is a modelled delay of approximately three minutes. By comparison, in Option 2 there are also signalised junction related delays, but as there are more junctions and demand on the link road is less, the delay is therefore less at the main intersection. In the case of the AM peak 2030 scenario for Option 2, the southbound delay at the junction of the link road and A5104 Chester Road is approximately two and a half minutes on average.

Table 4 – Impact on Journey Times (Mins) – Option 1

		Destination							
		Gresford	Helsby	Airport	Flint	Kelsall	Ellesmere Port	Chester City Centre	Sealand Industrial Estate
Origin	Gresford	0.0	-0.9	0.0	-0.	-0.8	-0.8	-3.5	-10.4
	Helsby	0.0	0.0	-0.1	0.1	0.0	0.0	0.0	-2.2
	Airport	-0.1	-0.3	0.0	-0.1	-0.3	-0.5	-2.4	-14.2
	Flint	0.1	-0.1	0.0	0.0	-0.2	-0.3	-3.4	-4.6
	Kelsall	0.1	0.1	0.0	0.0	0.0	0.0	0.2	-2.2
	Ellesmere Port	0.2	0.1	0.0	0.2	0.1	0.0	-0.1	-2.1
	Chester City Centre	-0.5	0.8	-3.2	0.0	0.9	0.0	0.0	-4.2
	Sealand Industrial Estate	-7.3	1.1	-8.3	0.2	2.0	1.3	0.0	0.0

Table 5 – Impact on Journey Times (Mins) – Option 2

		Destination							
		Gresford	Helsby	Airport	Flint	Kelsall	Ellesmere Port	Chester City Centre	Sealand Industrial Estate
Origin	Gresford	0.0	0.4	0.0	-0.1	0.5	0.2	-3.5	-15.5
	Helsby	-0.1	0.0	-0.2	0.1	0.0	0.0	-0.1	-3.8
	Airport	-0.1	-0.2	0.0	0.0	-0.1	-0.1	-4.3	-16.3
	Flint	-0.1	-0.1	0.0	0.0	-0.1	0.0	-4.5	-5.7
	Kelsall	-0.1	0.1	-0.1	-0.2	0.0	-0.3	-0.2	-8.5
	Ellesmere Port	-0.1	-0.1	0.1	0.3	-0.1	0.0	0.1	-3.5
	Chester City Centre	-2.1	0.3	-1.8	-0.1	0.3	0.3	0.0	-4.8
	Sealand Industrial Estate	-12.6	0.6	-7.0	0.1	-6.0	0.8	-1.3	0.0

Economic Assessment

An economic assessment of the scheme was carried out using the TUBA (Transport User Benefit Appraisal) programme – this is standard software based on the Department for Transport's WebTAG guidance. It compares transport conditions in a Do Something scenario (i.e. Options 1, 2 or 3) against conditions in the Do Minimum. The SATURN model provided information on the number and average travel cost of trips between each pair of zones in the model for each scenario. This information was then used within TUBA to estimate the benefits compared with the scheme costs; the appraisal covered a 60 year period.

For the purposes of the appraisal, annual maintenance costs were calculated and all scheme costs were discounted to 2010, in line with WebTAG guidance. The appraisal accounted for travel time benefits and changes in vehicle operating costs. At this stage of assessment, the appraisal has not considered accident impacts of the scheme or wider economic benefits. **Table 6** shows that all options are forecast to deliver a Benefit to Cost Ratio (BCR) of 5 or greater, which equates to 'very high' value for money. Option 2 is forecast to deliver the highest BCR.

Table 6 - Economic Assessment

Option	Net Present Value	Benefit to Cost Ratio
Option 1	£261.5m	5.6
Option 2	£282.5m	7.3
Option 3	£267.2m	5.0

Summary

The work to date has focused on the assessment inner options for the CWRR, including single and dual carriageway variants. The function of the two main options differs as Option 1 (dual carriageway) has no intermediate junctions, whereas Option 2 (single carriageway) includes a junction with Chester Street/High Street. Option 2 provides enhanced connectivity with the existing network, but the northern section is forecast to be operating over capacity. It also provides less relief to the A483 to the south of Chester and is more of a distributor road rather than a relief road in terms of its function. Option 3, assessed as a sensitivity test is dual carriageway, but includes a grade separated junction with Chester Road (A5104).

High level cost estimates show that the scheme is expected to cost between £48m and £74m (2015 prices). The work has highlighted that the land take implications of Options 1 and 3 may impact on the acceptability/feasibility of this option. It is recommended that more detailed work in undertaken on the design/costs if the scheme is taken forward to the next stage in terms of development. All options are expected to deliver high value for money in appraisal terms.

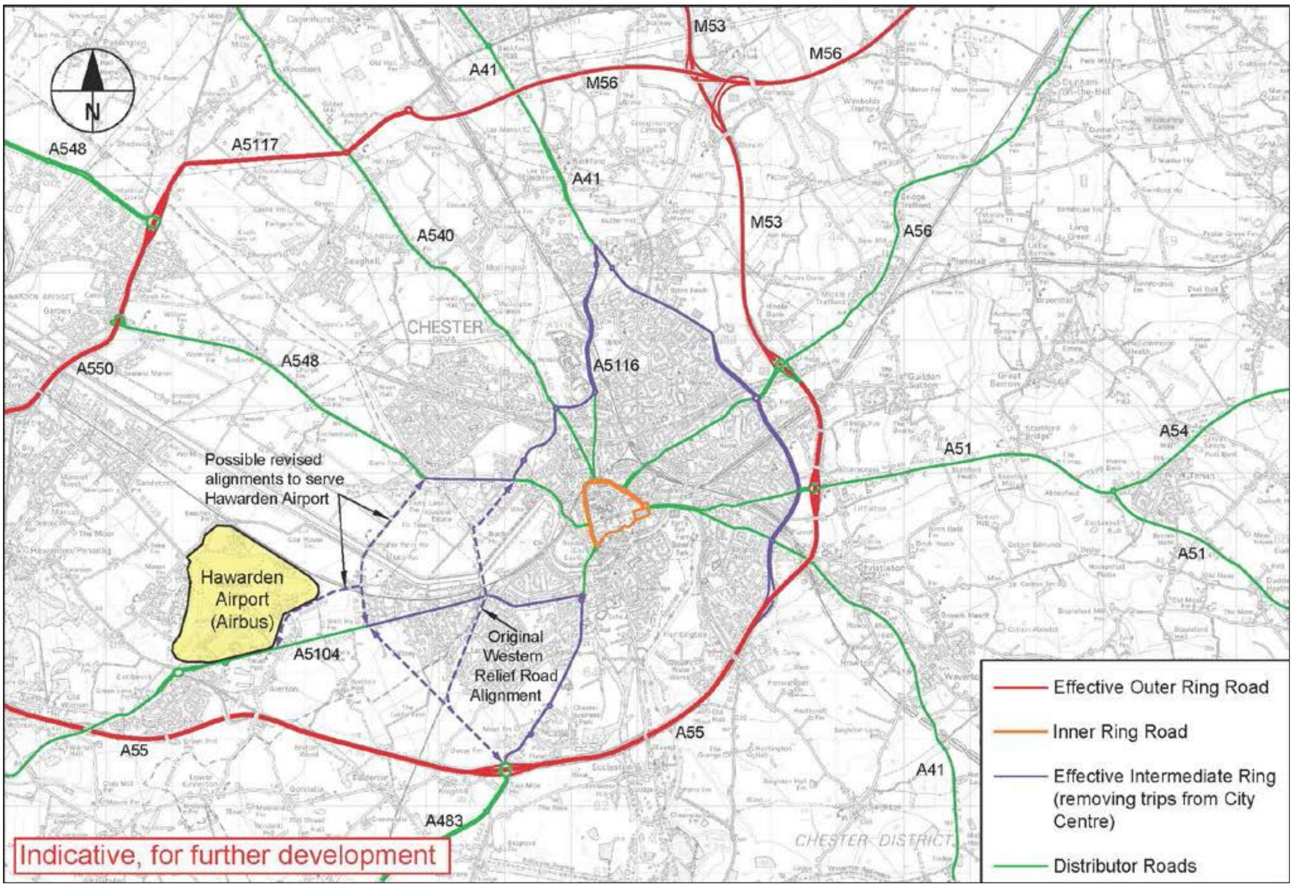
The next stage is to consider options further to the west, in consultation with partners, including Flintshire County Council. This will enable an overall conclusion to be reached regarding a preferred option to take forward for further development work.

1. INTRODUCTION

1.1 Background

1.1.1 The Chester Western Relief Road (CWRR) has for some time been identified as a potential solution to congestion issues in Chester City Centre - the Local Plan preserves a route which broadly follows the boundary with Flintshire. AECOM completed Phase 1 of the Chester Transport Strategy in February 2014; the strategy identified that improvements delivered as part of the Chester One City Plan would impact on traffic flows through the city centre, placing pressure on traffic to find alternative routes. Following a high level assessment (undertaken as part of Phase 1 of the transport strategy work), the scheme was put forward as a potential component in a wider strategy for the city. **Figure 1:1** shows the original alignment for the scheme, in addition to potential alternatives to the west, which would provide enhanced connectivity to Hawarden Airport.

Figure 1:1 – Chester Western Relief Road – Potential Route Options



1.2 Purpose of the Task

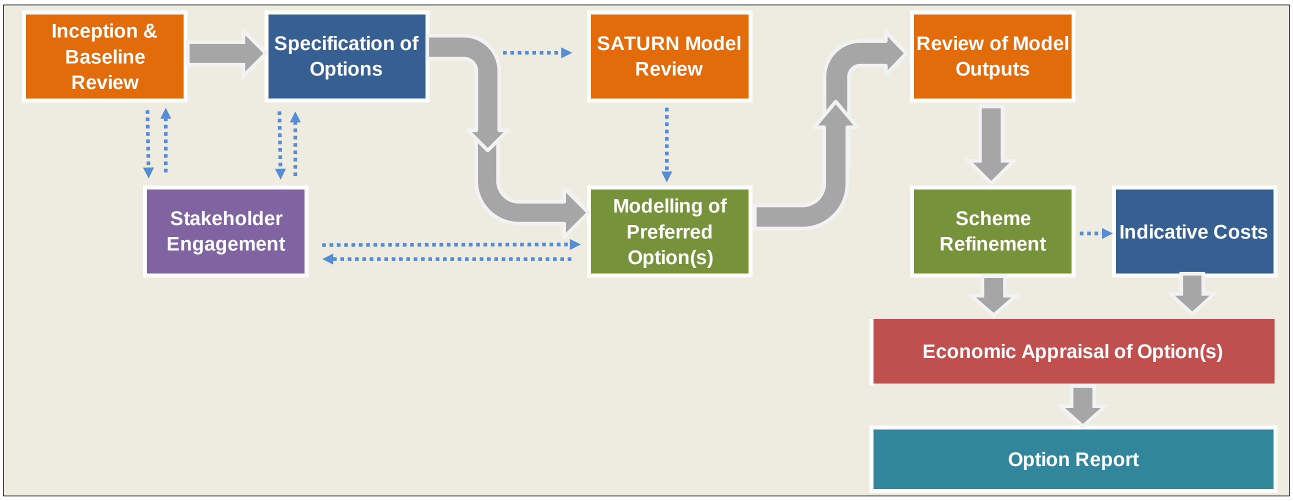
1.2.1 AECOM has been appointed by Chester West and Chester Council (CWaC) to undertake Phase 2 of the Chester Transport Strategy - an assessment of the Western Relief Road is one of six workstreams in the work programme. The study brief identifies the following tasks:

- Review case for CWRR including full assessment of economic benefits on both sides of the border;
- Use Council's SATURN model to review the need for the scheme and impact of this on the local highway network;
- Identify key partners (including Welsh Local Authorities, Government, Mersey Dee Alliance and other interests as appropriate) and undertake initial top level, stakeholder and wider community dialogue and consultation;
- Consider options for scheme alignment, taking into account any enabling Local Plan, development or growth aspirations, and identify potential route option(s);
- Assess potential constraints and risks; and
- Estimate likely indicative costs, likely funding opportunities and potential delivery timetables (including phased options).

1.3 Approach

1.3.1 A methodology was developed as part of AECOM's proposal and agreed with CWaC at the Inception stage. This proposed that options would be developed through stakeholder engagement and that preferred options would be tested using the SATURN model - SATURN is a strategic modelling software package widely used for such highway traffic analysis. High level cost estimates would then be produced and an economic appraisal would be undertaken using TUBA (Transport User Benefit Appraisal) – this is standard software based on the Department for Transport's WebTAG guidance. An overview of the approach is set out in **Figure 1:2**.

Figure 1:2 – Overview of Approach



1.3.2 The work to date has not included the stakeholder engagement element of the work – it is still expected that this will proceed in the near future, but CW&C has not been able to arrange the necessary high level officer discussions with Flintshire Council to facilitate the consultation. Whilst this has resulted in some delays to the work programme, a decision was taken to proceed with the assessment of the original alignment, which is within CW&C, but following the boundary with Flintshire. The assessment of any options further to the west is currently on hold until the stakeholder meetings are arranged.

1.4 Report Structure

1.4.1 The following sections covered by this report are outlined in the chapter headings listed below:

- **Chapter 2 – Option Development**
- **Chapter 3 – Scheme Costs**
- **Chapter 4 – Model Specification**
- **Chapter 5 – Model Results**
- **Chapter 6 – High Level Economic Analysis**
- **Chapter 7 - Summary**

2. OPTION DEVELOPMENT

2.1 Scope of Option Development

2.1.1 As identified in Chapter 1, the option development work to date has focussed around the original alignment (protected in the Local Plan), which follows the border with Flintshire. It is intended to explore options to the west of this route following the commencement of discussions with stakeholders.

2.2 Definition of Options for Testing

2.2.1 Following discussions with officers at CWaC, two variants of the original alignment for the Chester Western Relief Road were identified for assessment in the transport model. Both main options provide a connection between the A483, Wrexham Road, (north of the junction with the A55) and the A548 Sealand Road. Further to this, a third option was considered and assessed as a sensitivity test.

Option 1

2.2.2 This would comprise a dual carriageway between the A483 and the A548 with no intermediate junctions. The A483 would be accessed via off-slips - Bumpers Lane would be accessed via a roundabout with the new link, but would otherwise be unchanged. An alternative access onto Sealand Road was identified in the form of a new link instead of traffic using Bumpers Lane, but this was discounted owing to land requirement issues. An indicative alignment for this option is shown in **Figure 2:1.**

Figure 2:1 – Option 1 : Indicative Alignment

Option 2

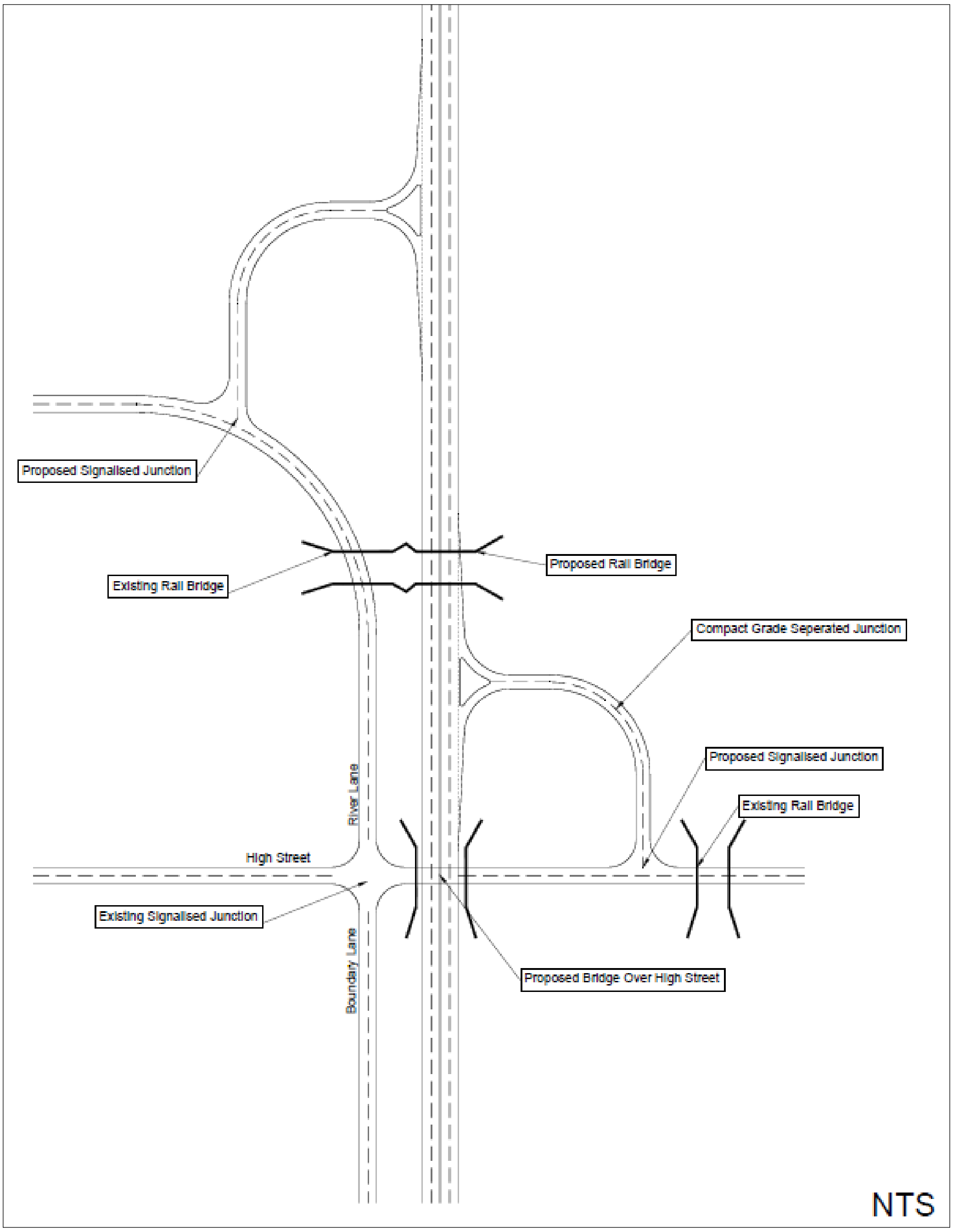
2.2.3 This option was defined in view of concerns regarding the feasibility of accommodating a dual carriageway around the central section of the route, particularly the junction with High Street. The route broadly follows the same alignment as Option 1, but is single carriageway throughout. The route would have three intermediate signalised junctions (with Boundary Lane, Chester Street/High Street and River Lane). It would connect with the A483 via the existing roundabout junction which serves the Park and Ride site/Herons Way. It should be noted that the lower standard of this option is likely to result in its function being more akin to a local distributor road rather than a relief road. An alignment for Option 2 is shown in **Figure 2:2**.

Figure 2:2 – Option 2 : Indicative Alignment

Option 3

2.2.4 In addition to the two primary options identified above, a third option was considered. This option has been treated as a sensitivity test, with limited analysis of traffic model results, which have been generated for the purpose of generating a comparative end BCR for this option. This scheme is similar to Option 1 in most respects, but unlike Option1 the scheme includes a junction between the proposed link road and A5104 Chester Road, between Boundary Lane and Shrewsbury Way. The junction would be a compact grade separated design, minimising land take and also delay on the link road. An indicative sketch is shown below;

Figure 2:3 – Option 3: Indicative Link Road & A5104 Junction Alignment



2.3 Assessment Work

2.3.1 Both Options 1 and 2 were assessed in the transport model and high level cost estimates have been produced. The transport modelling work was carried out to understand the performance of the options in terms of value for money, in addition to impacts in terms of changes journey times between key destinations, delays at key junctions and changes in the distribution of traffic flows across the network.

3. SCHEME COSTS

3.1 Introduction

3.1.1 High level costings for the options identified in Chapter 2 have been calculated to inform the economic assessment. These costs are estimates based on an indicative layout using rates from Spon's Civil Engineering and Highways Works Price Book 2015 with a number of factors applied to take account of key risks.

3.2 Assumptions

3.2.1 The specification for the two options is as follows:

Option 1 (Dual Carriageway)

- Two 7.3m carriageway with a 2m central reserve;
- Grade separated junction with A483;
- Bridge over Chester Street;
- Road under existing railway embankment with new rail bridge;
- Bridge over the River Dee; and
- Upgrade to existing signal junction with the A584.

Option 2 (Single Carriageway Option)

- 7.3m carriageway with two 3m footways;
- Tie into park and ride access;
- Bridge over Railway and Green Lane;
- Signal junction with Boundary Lane;
- Signal junction with Chester Street;
- Road under existing railway bridge;
- Junction with River Lane;
- Bridge over the River Dee;

- Signal junction with Bumpers Lane; and
- Upgrade to existing signal junction with the A584.

Option 3 (Dual Carriageway)

- As Option 1 plus with a compact grade separated junction with the A5104.

3.2.2 The following standard assumptions were applied to all of the Options:

- Overall carriageway depth of 1000mm, overall footway depth of 220mm;
- No recycling of existing materials; and
- Ground conditions minimum 2.5% California Bearing Ratio (CBR).

3.2.3 Standard industry figures for a high level costing have been applied for contractor's preliminaries, contractors profit and optimum bias/ contingency of 10%, 10% and 44% respectively. In addition to this a number of factors have been applied to the following key risks:

- Legal, 1%;
- Design and Consultancy fees, 10%;
- Statutory Authority Fees, 10%;
- Statutory Undertakers, 20%;
- Third Park Land Acquisition, 10%;
- Drainage Outfall / Sustainable Drainage requirements, 1%
- Change in Topography, 3%; and
- Ground Risk, 5%.

3.3 Cost Schedules

3.3.1 Full cost schedules, including assumed quantities and rates are included in **Table 3:1, Table 3:2** and **Table 3:3**.

Table 3:1 – Option 1 (Dual Carriageway) Cost Schedule

Section 1 - Grade Separated Junction With A483					
Item	**Description**	**Rate (£)**	**Quantity**	**Total (£)**	**Units of Measure**
	Excavation and Disposal	£ 614.23	100	£ 61,423.36	m
	Carriageway including drainage, street lighting and vehicle restraint	£ 2,099.71	100	£ 209,970.74	m
	Embankment	£ 105,686.35	2	£ 211,372.70	No.
	Retaining Wall	£ 179,659.80	2	£ 359,319.60	No.
	Bridge	£ 747,000.00	1	£ 747,000.00	No.
	Traffic Management	£ 160,000.00	1	£ 160,000.00	No.
	Sub-total			**£ 1,749,086.40**	
Section 2					
Item	**Description**	**Rate (£)**	**Quantity**	**Total (£)**	**Units of Measure**
	Excavation and Disposal	£ 614.23	1390	£ 853,784.70	m
	Carriageway including drainage, street lighting and vehicle restraint	£ 2,099.71	1390	£ 2,918,593.33	m
	Sub-total			**£ 3,772,378.04**	
Section 3 - Bridge Over Railway and Green Lane					
	Excavation and Disposal	£ 614.23	600	£ 368,540.16	m
	Carriageway including drainage, street lighting and vehicle restraint	£ 2,099.71	600	£ 1,259,824.46	m
	Embankment	£ 105,686.35	2	£ 211,372.70	No.
	Retaining Wall	£ 77,734.80	2	£ 155,469.60	No.
	Bridge Over Green Lane	£ 560,250.00	1	£ 560,250.00	No.
	Bridge Over Railway	£ 747,000.00	1	£ 747,000.00	No.
	Sub-total			**£ 3,302,456.92**	
Section 4					
Item	**Description**	**Rate (£)**	**Quantity**	**Total (£)**	**Units of Measure**
	Excavation and Disposal	£ 614.23	300	£ 184,270.08	m
	Carriageway including drainage, street lighting and vehicle restraint	£ 2,099.71	300	£ 629,912.23	m

Item	Description	Rate (£)	Quantity	Total (£)	Units of Measure
	Footbridge Replacement	£ 296,300.00	1	£ 296,300.00	No.
	Sub-total			**£ 1,110,482.31**	
	Section 5 - Bridge Over Chester Street				
Item	**Description**	**Rate (£)**	**Quantity**	**Total (£)**	**Units of Measure**
	Excavation and Disposal	£ 614.23	200	£ 122,846.72	m
	Carriageway including drainage, street lighting and vehicle restraint	£ 2,099.71	200	£ 419,941.49	m
	Embankment	£ 105,686.35	2	£ 211,372.70	No.
	Retaining Wall	£ 77,734.80	2	£ 155,469.60	No.
	Bridge	£ 1,456,650.00	1	£ 1,456,650.00	No.
	Traffic Management	£ 250,000.00	1	£ 250,000.00	No.
	Sub-total			**£ 2,616,280.51**	
	Section 6 - Road Under Existing Railway Embankment to be Replace with Bridge				
Item	**Description**	**Rate (£)**	**Quantity**	**Total (£)**	**Units of Measure**
	Excavation and Disposal	£ 614.23	200	£ 122,846.72	m
	Carriageway including drainage, street lighting and vehicle restraint	£ 2,099.71	200	£ 419,941.49	m
	Retaining Wall	£ 77,734.80	2	£ 155,469.60	No.
	Bridge	£ 1,120,500.00	1	£ 1,120,500.00	No.
	Sub-total			**£ 1,818,757.81**	
	Section 7 - Bridge Over River Dee				
Item	**Description**	**Rate (£)**	**Quantity**	**Total (£)**	**Units of Measure**
	Excavation and Disposal	£ 614.23	500	£ 307,116.80	m
	Carriageway including drainage, street lighting and vehicle restraint	£ 2,099.71	500	£ 1,049,853.72	m
	Bridge	£ 4,468,500.00	1	£ 4,468,500.00	No.
	Sub-total			**£ 5,825,470.52**	
	Section 8				
Item	**Description**	**Rate (£)**	**Quantity**	**Total (£)**	**Units of Measure**
	Excavation and Disposal	£ 614.23	300	£ 184,270.08	m

Item	Description	Rate (£)		Quantity	Total (£)		Units of Measure
	Carriageway including drainage, street lighting and vehicle restraint	£	2,099.71	300	£	629,912.23	m
	Sub-total				**£**	**814,182.31**	
	Section 9 - Upgrade Existing Signal Junction Tie in with A584						
Item	**Description**	**Rate (£)**		**Quantity**	**Total (£)**		**Units of Measure**
	Excavation and Disposal	£	614.23	50	£	30,711.68	m
	Carriageway including drainage, street lighting and vehicle restraint	£	2,099.71	50	£	104,985.37	m
	Traffic Management	£	70,000.00	1	£	70,000.00	No.
	Existing Junction Upgrade	£	500,000.00	1	£	500,000.00	No.
	Sub-total				**£**	**705,697.05**	
	Uplift						
	Sub-Total				£	21,714,791.86	
	Contractors Preliminaries @ 10%				£	2,171,479.19	
	Sub-Total				£	23,886,271.05	
	Contractors Profit @ 10%				£	2,388,627.10	
	Construction Total				**£**	**26,274,898.15**	

Key Risks

Description	Factor	Total (£)	
Legals	1%	£	262,748.98
Design and Consultancy Fees	10%	£	2,627,489.82
Statutory Authority Fess	10%	£	2,627,489.82
Statutory Undertakers	20%	£	5,254,979.63
Third Party Land Acquisition	10%	£	2,627,489.82
Drainage Outfall/ Sustainable Drainage Requirements	1%	£	262,748.98

Change in topography	3%	£	788,246.94
Ground Risk	5%	£	1,313,744.91
Network Rail Possession Risk and Contingency	-	£	1,000,000.00
Risk Total		£	16,764,938.89
Sub-Total		£	43,039,837.04
Optimum Bias/ Contingency	44%	£	18,937,528.30
Project Total		**£**	**61,977,365.34**

Table 3:2 – Option 2 (Single Carriageway) Cost Schedule

Item	Description	Rate (£)		Quantity	Total (£)		Units of Measure
Section 1 - Tie Into Existing Park and Ride Access Road							
	Excavation and Disposal	£	352.04	270	£	95,051.02	m
	Carriageway including drainage and street lighting	£	1,274.03	270	£	343,988.93	m
	Embankment	£	94,939.43	2	£	189,878.85	No.
	Retaining Wall	£	170,690.40	2	£	341,380.80	No.
	Bridge	£	598,500.00	1	£	598,500.00	No.
	Traffic Management	£	160,000.00	1	£	160,000.00	No.
	Sub-total				**£**	**1,728,799.59**	
Section 2 - Bridge Over Lache Lane							
Item	**Description**	**Rate (£)**		**Quantity**	**Total (£)**		**Units of Measure**
	Excavation and Disposal	£	352.04	1300	£	457,653.04	m
	Carriageway including drainage and street lighting	£	1,274.03	1300	£	1,656,242.99	m
	Embankment	£	94,939.43	2	£	189,878.85	No.
	Retaining Wall	£	68,765.40	2	£	137,530.80	No.
	Bridge Over Lache Lane	£	448,875.00	1	£	448,875.00	No.
	Sub-total				**£**	**2,890,180.68**	

Item	Description	Rate (£)		Quantity		Total (£)	Units of Measure
	Section 3 - Bridge Over Railway and Green Lane						
	Excavation and Disposal	£	352.04	180	£	63,367.34	m
	Carriageway including drainage and street lighting	£	1,274.03	180	£	229,325.95	m
	Embankment	£	94,939.43	2	£	189,878.85	No.
	Retaining Wall	£	68,765.40	2	£	137,530.80	No.
	Bridge Over Green Lane	£	448,875.00	1	£	448,875.00	No.
	Bridge Over Railway	£	598,500.00	1	£	598,500.00	No.
	Sub-total				**£**	**1,667,477.95**	
	Section 4 - Signal Junction With Boundary Lane						
Item	**Description**	**Rate (£)**		**Quantity**	**Total (£)**		**Units of Measure**
	Excavation and Disposal	£	352.04	980	£	344,999.98	m
	Carriageway including drainage and street lighting	£	1,274.03	980	£	1,248,552.41	m
	Signal Junction	£	300,000.00	1	£	300,000.00	No,
	Footbridge Replacement	£	296,300.00	1	£	296,300.00	No.
	Sub-total				**£**	**2,189,852.39**	
	Section 5 - Junction Upgrade to Chester Street Junction						
Item	**Description**	**Rate (£)**		**Quantity**	**Total (£)**		**Units of Measure**
	Excavation and Disposal	£	352.04	200	£	70,408.16	m
	Carriageway including drainage and street lighting	£	1,274.03	200	£	254,806.61	m
	Junction Upgrade	£	500,000.00	1	£	500,000.00	No.
	Traffic Management	£	250,000.00	1	£	250,000.00	No.
	Sub-total				**£**	**1,075,214.77**	
	Section 6 - Road Under Existing Railway Bridge and Signal Junction With River Lane						
Item	**Description**	**Rate (£)**		**Quantity**	**Total (£)**		**Units of Measure**
	Excavation and Disposal	£	352.04	270	£	95,051.02	m
	Carriageway including drainage and street lighting	£	1,274.03	270	£	343,988.93	m
	Signal Junction	£	300,000.00	1	£	300,000.00	No.

Item	Description	Rate (£)	Quantity	Total (£)	Units of Measure
	Sub-total			**£ 739,039.94**	
	Section 7 - Bridge Over River Dee				
Item	**Description**	**Rate (£)**	**Quantity**	**Total (£)**	**Units of Measure**
	Excavation and Disposal	£ 352.04	390	£ 137,295.91	m
	Carriageway including drainage and street lighting	£ 1,274.03	390	£ 496,872.90	m
	Bridge	£ 3,591,000.00	1	£ 3,591,000.00	No.
	Sub-total			**£ 4,225,168.81**	
	Section 8 - Including Upgrade to Bumpers Lane and Signal Junction				
Item	**Description**	**Rate (£)**	**Quantity**	**Total (£)**	**Units of Measure**
	Excavation and Disposal	£ 352.04	1210	£ 425,969.37	m
	Carriageway including drainage and street lighting	£ 1,274.03	1210	£ 1,541,580.01	m
	Signal Junction	£ 300,000.00	1	£ 300,000.00	No,
	Sub-total			**£ 2,267,549.38**	
	Section 9 - Upgrade Existing Signal Junction Tie in with A584				
Item	**Description**	**Rate (£)**	**Quantity**	**Total (£)**	**Units of Measure**
	Excavation and Disposal	£ 352.04	80	£ 28,163.26	m
	Carriageway including drainage and street lighting	£ 1,274.03	80	£ 101,922.65	m
	Traffic Management	£ 70,000.00	1	£ 70,000.00	No.
	Existing Junction Upgrade	£ 500,000.00	1	£ 500,000.00	No.
	Sub-total			**£ 700,085.91**	
	Uplift				
	Sub-Total			£ 17,483,369.44	
	Contractors Preliminaries @ 10%			£ 1,748,336.94	
	Sub-Total			£ 19,231,706.38	
	Contractors Profit @ 10%			£ 1,923,170.64	

Construction Total		£	**21,154,877.02**
Key Risks			
Description	**Factor**	**Total (£)**	
Legals	1%	£	211,548.77
Design and Consultancy Fees	10%	£	2,115,487.70
Statutory Authority Fess	10%	£	2,115,487.70
Statutory Undertakers	20%	£	4,230,975.40
Third Party Land Acquisition	10%	£	2,115,487.70
Drainage Outfall/ Sustainable Drainage Requirements	1%	£	211,548.77
Change in topography	3%	£	634,646.31
Ground Risk	5%	£	1,057,743.85
Risk Total		**£**	**12,692,926.21**
Sub-Total		£	33,847,803.23
Optimum Bias/ Contingency	44%	£	14,893,033.42
Project Total		**£**	**48,740,836.65**

Table 3:3 – Option 3 (Dual Carriageway) Cost Schedule

Section 1 - Grade Separated Junction With A483							
Item	**Description**	**Rate (£)**		**Quantity**	**Total (£)**		**Units of Measure**
	Excavation and Disposal	£	614.23	100	£	61,423.36	m
	Carriageway including drainage, street lighting and vehicle restraint	£	2,099.71	100	£	209,970.74	m
	Embankment	£	105,686.35	2	£	211,372.70	No.
	Retaining Wall	£	179,659.80	2	£	359,319.60	No.
	Bridge	£	747,000.00	1	£	747,000.00	No.
	Traffic Management	£	160,000.00	1	£	160,000.00	No.

Item	Description	Rate (£)	Quantity	Total (£)	Units of Measure
	Sub-total			**£ 1,749,086.40**	
	Section 2 - Bridge over Lache Lane				
Item	**Description**	**Rate (£)**	**Quantity**	**Total (£)**	**Units of Measure**
	Excavation and Disposal	£ 614.23	1390	£ 853,784.70	m
	Carriageway including drainage, street lighting and vehicle restraint	£ 2,099.71	1390	£ 2,918,593.33	m
	Embankment	£ 145,306.35	2	£ 290,612.70	No.
	Retaining Wall	£ 179,659.80	2	£ 359,319.60	No.
	Bridge	£ 747,000.00	1	£ 747,000.00	No.
	Sub-total			**£ 5,169,310.34**	
	Section 3 - Bridge Over Railway and Green Lane				
	Excavation and Disposal	£ 614.23	600	£ 368,540.16	m
	Carriageway including drainage, street lighting and vehicle restraint	£ 2,099.71	600	£ 1,259,824.46	m
	Embankment	£ 145,306.35	2	£ 290,612.70	No.
	Retaining Wall	£ 77,734.80	2	£ 155,469.60	No.
	Bridge Over Green Lane	£ 560,250.00	1	£ 560,250.00	No.
	Bridge Over Railway	£ 747,000.00	1	£ 747,000.00	No.
	Sub-total			**£ 3,381,696.92**	
	Section 4				
Item	**Description**	**Rate (£)**	**Quantity**	**Total (£)**	**Units of Measure**
	Excavation and Disposal	£ 614.23	300	£ 184,270.08	m
	Carriageway including drainage, street lighting and vehicle restraint	£ 2,099.71	300	£ 629,912.23	m
	Footbridge Replacement	£ 296,300.00	1	£ 296,300.00	No.
	Sub-total			**£ 1,110,482.31**	
	Section 5 - Bridge Over Chester Street				
Item	**Description**	**Rate (£)**	**Quantity**	**Total (£)**	**Units of Measure**
	Excavation and Disposal	£ 614.23	200	£ 122,846.72	m
	Carriageway including drainage, street lighting and vehicle restraint	£ 2,099.71	200	£ 419,941.49	m
	Embankment	£ 120,345.75	2	£ 240,691.50	No.
	Retaining Wall	£ 179,659.80	2	£ 359,319.60	No.

Item	Description	Rate (£)	Quantity	Total (£)	Units of Measure
	Bridge	£ 1,456,650.00	1	£ 1,456,650.00	No.
	Connector Road	£ 508,742.22	2	£ 1,017,484.43	No.
	Signalised Junction	£ 300,000.00	2	£ 600,000.00	No.
	Traffic Management	£ 250,000.00	1	£ 250,000.00	No.
	Sub-total			**£ 4,466,933.74**	

Section 6 - Road Under Existing Railway Embankment to be Replace with Bridge

Item	Description	Rate (£)	Quantity	Total (£)	Units of Measure
	Excavation and Disposal	£ 614.23	200	£ 122,846.72	m
	Carriageway including drainage, street lighting and vehicle restraint	£ 2,099.71	200	£ 419,941.49	m
	Retaining Wall	£ 77,734.80	2	£ 155,469.60	No.
	Bridge	£ 1,120,500.00	1	£ 1,120,500.00	No.
	Sub-total			**£ 1,818,757.81**	

Section 7 - Bridge Over River Dee

Item	Description	Rate (£)	Quantity	Total (£)	Units of Measure
	Excavation and Disposal	£ 614.23	500	£ 307,116.80	m
	Carriageway including drainage, street lighting and vehicle restraint	£ 2,099.71	500	£ 1,049,853.72	m
	Bridge	£ 4,468,500.00	1	£ 4,468,500.00	No.
	Sub-total			**£ 5,825,470.52**	

Section 8

Item	Description	Rate (£)	Quantity	Total (£)	Units of Measure
	Excavation and Disposal	£ 614.23	300	£ 184,270.08	m
	Carriageway including drainage, street lighting and vehicle restraint	£ 2,099.71	300	£ 629,912.23	m
	Sub-total			**£ 814,182.31**	

Section 9 - Upgrade Existing Signal Junction Tie in with A584

Item	Description	Rate (£)	Quantity	Total (£)	Units of Measure
	Excavation and Disposal	£ 614.23	50	£ 30,711.68	m
	Carriageway including drainage, street lighting and vehicle restraint	£ 2,099.71	50	£ 104,985.37	m
	Traffic Management	£ 70,000.00	1	£ 70,000.00	No.
	Existing Junction Upgrade	£ 500,000.00	1	£ 500,000.00	No.

Sub-total		**£**	**705,697.05**
Uplift			
Sub-Total		£	25,041,617.39
Contractors Preliminaries @ 10%		£	2,504,161.74
Sub-Total		£	27,545,779.13
Contractors Profit @ 10%		£	2,754,577.91
Construction Total		**£**	**30,300,357.05**
Key Risks			
Description	**Factor**	**Total (£)**	
Legals	1%	£	303,003.57
Design and Consultancy Fees	10%	£	3,030,035.70
Statutory Authority Fess	10%	£	3,030,035.70
Statutory Undertakers	20%	£	6,060,071.41
Third Party Land Acquisition	10%	£	3,030,035.70
Drainage Outfall/ Sustainable Drainage Requirements	1%	£	303,003.57
Change in topography	3%	£	909,010.71
Ground Risk	5%	£	1,515,017.85
Network Rail Possession Risk and Contingency	-	£	1,000,000.00
Relocation of pumping station and associated substation		£	2,000,000.00
Risk Total		**£**	**21,180,214.23**
Sub-Total		£	51,480,571.27
Optimum Bias/ Contingency	44%	£	22,651,451.36
Project Total		**£**	**74,132,022.63**

4. MODEL SPECIFICATION

4.1 Introduction

4.1.1 The Chester SATURN model was developed and updated by Atkins consultancy in 2010. A version of the model was provided to AECOM in 2014 for the assessment of highway schemes in the Chester area, including Chester Western Relief Road options.

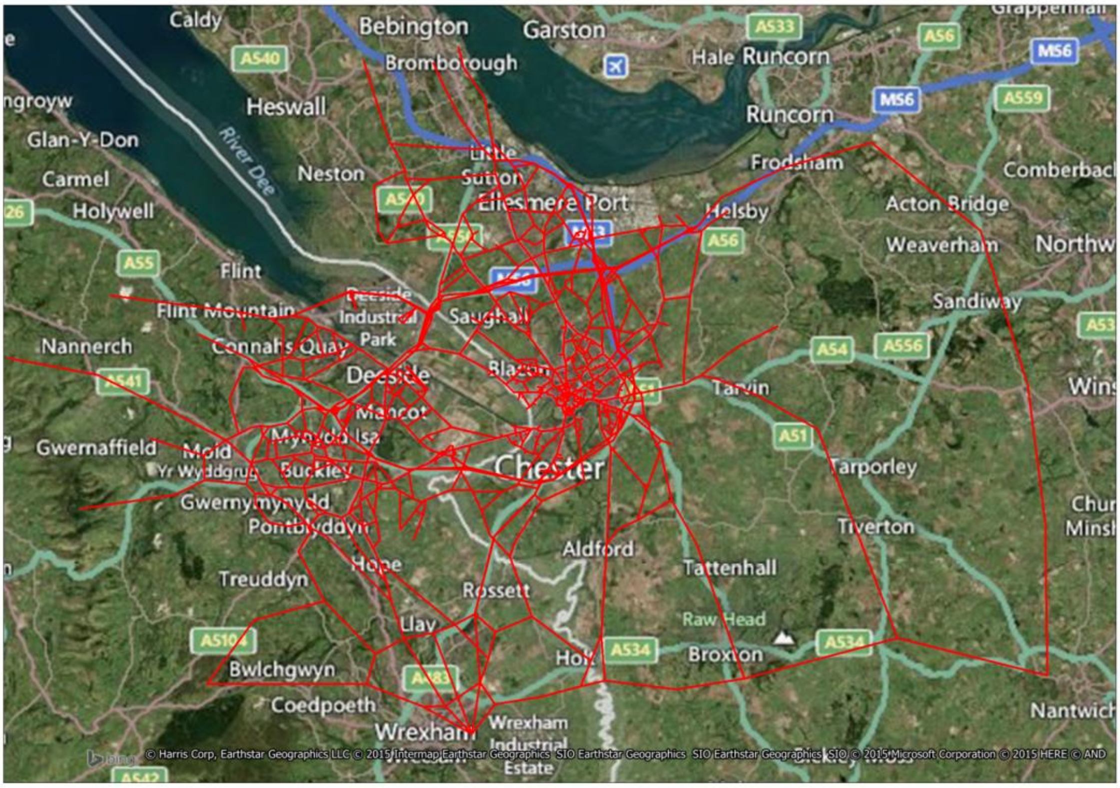
4.1.2 The purpose of the strategic SATURN model analysis conducted as part of this task is to enable the forecasting of future year traffic conditions around Chester. By assessing traffic conditions with and without the Western Relief Road in place, the model can indicate the impact of the scheme relative to the Do Minimum scenario.

4.2 Existing SATURN Model

Base Year Model

4.2.1 The base year model was previously developed as a separate task to represent a base year of 2010, developed in 2010/11. It was an update to the original 2007/2008 model. An image of the network coverage is shown in red in **Figure 4:1**.

Figure 4:1 – Model Network Coverage



4.2.2 Thee versions of the Base model were created, comprising the AM Peak (08:00 – 09:00), Inter Peak (IP) (10:00 – 16:00) and PM Peak (17:00 – 18:00) time periods.

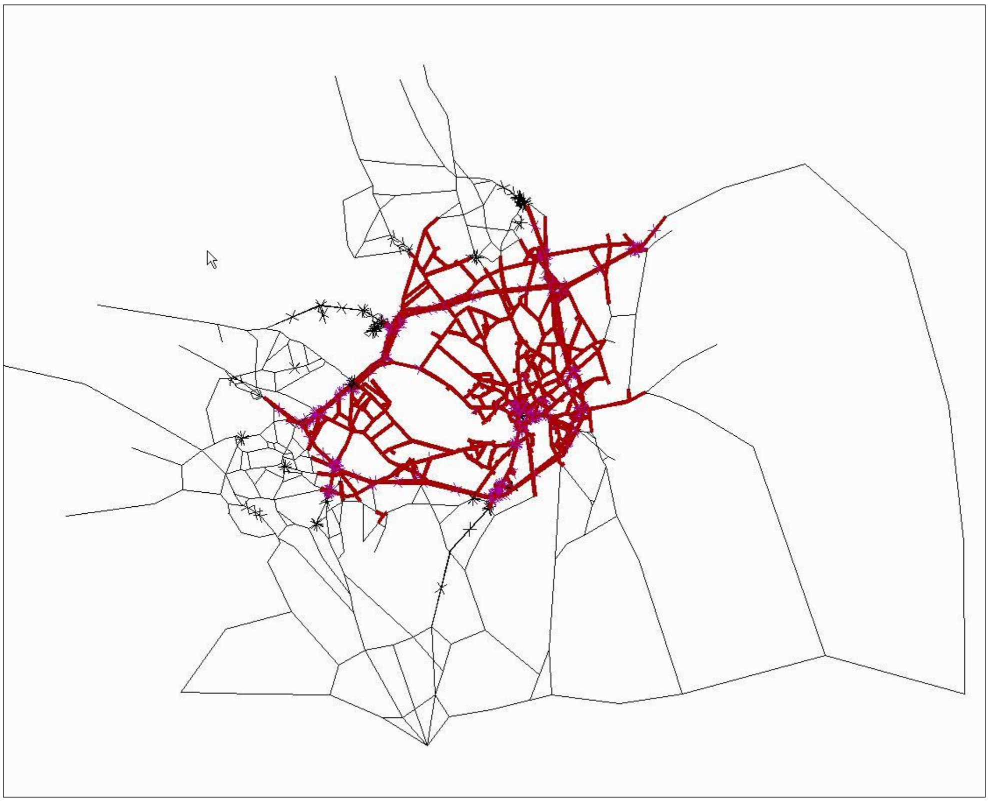
Network Structure

4.2.3 Network building in SATURN is based on three basic elements:

- **Centroids** – which represent the zones that feed traffic demand onto the network;
- **Nodes** – representing junctions and other points at which highway characterisitics change; and
- **Links** – joining nodes and representing the road network and virtual links, which connect centroids with the road network.

4.2.4 The network comprises a more detailed inner 'simulation' area and outer 'buffer' area. The respective extents are shown in **Figure 4.2**.

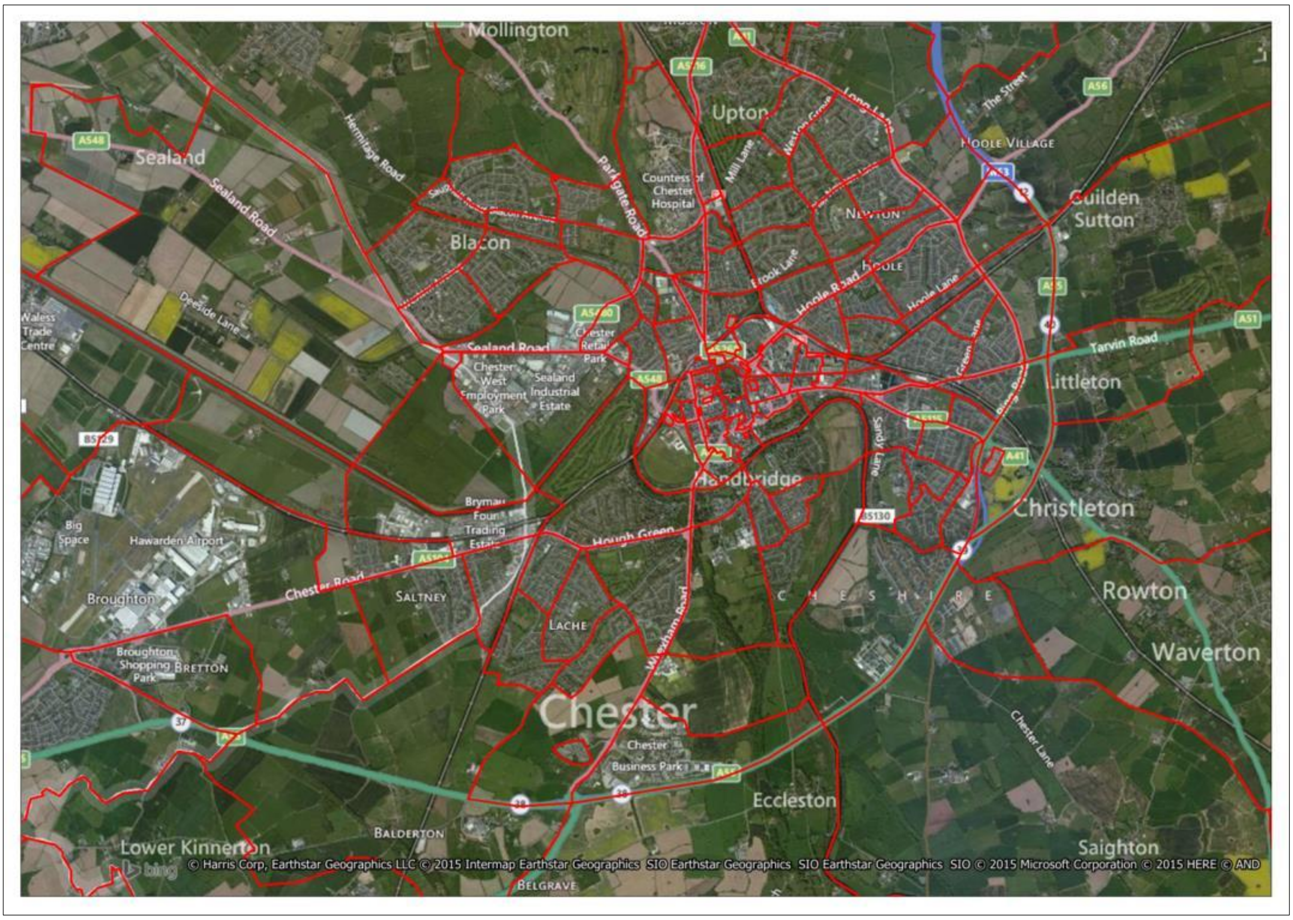
Figure 4:2 – Model Network Simulation and Buffer Network Extents



Zoning

4.2.5 The Chester Model contains relatively disaggregated demand zones within the centre of Chester, which becomes increasingly aggregated further away from the centre. The localised zoning is presented in **Figure 4.3**.

Figure 4:3 – SATURN Model Zoning



4.2.6 For further information on the original Base model development, refer to the 'Chester Traffic Model' 'Local Model Validation Report' produced by Atkins for CWaC, dated July 2011. The Base model has not been updated as part of this commission.

Zoning

4.2.7 A Forecast Year model was originally developed by Atkins in 2013, representing traffic conditions for a forecast year of 2030, for AM and PM peak periods as defined in the Base model. It includes expected changes, with amendments to the network and demand components. Just one scenario was generated – the 'Do-Minimum' (DM) which included only committed growth and network changes.

4.2.8 In terms of the network, relevant committed network schemes between 2010 and 2030 were identified with CWaC and the highway network was updated accordingly. In terms of demand, background external traffic was factored up using TEMPRO. TEMPRO is a standard DfT tool which is used for forecasting purposes. TEMPRO generates these factors from the National Trip End Model. Internally generated traffic was based on housing and employment development, multiplied by trip rates taken from the TRICS database. TRICS is another standard tool, which is essentially a database of developments by type and location and provides trip rates by development size, equating it to a rate per metre square.

4.2.9 For further information on the Forecast Model refer to the 'Chester Traffic Model' 'Model Forecasting Report' produced for CWaC, dated October 2013.

4.2.10 As part of this commission, the development demand has been updated. In addition, an IP model has been created, as have scenarios for an intermediate year of 2020. As part of the original Atkins work, the DM model included committed scheme changes to the network relative to the Base model, these changes were agreed with CWaC. As part of our update AECOM have not undone those or made any additional changes, leaving the DM network as it was. This approach was agreed with CWaC.

4.3 Model Scenarios

4.3.1 In order to generate an appropriate economic analysis of the potential highway-related benefits of the scheme, an intermediate year was required. To enable interpolation of conditions and benefits across multiple years, a scenario year of 2020 was selected. Based on information on the committed schemes included by 2030, it was taken that these same schemes would be in place by 2020 and therefore the 2030 networks were used for 2020 analysis also. Six scenario periods have been created in total; AM Peak, PM Peak and IP hourly periods for 2020 and 2030.

2030 Forecast Year

4.3.2 The demand generation is based on that used for the forecast year model development in 2013. Essentially it comprises a spreadsheet which takes the base year demand and increases it to take into account the projected increase in traffic.

4.3.3 For the AM and PM peaks, the spreadsheets were updated with latest development projections as received from CWaC. Trip rates for development types were not altered. No spreadsheet was available for the inter peak (IP) period. A similar spreadsheet was therefore generated along the same structure as the AM and PM versions, but with corresponding IP base year demand, TRICS and TEMPRO inputs.

4.3.4 **Figure 4.4** and **Figure 4.5** show the distribution of proposed employment and housing developments, as indicated by CWaC. **Figure 4.4** shows the wider Chester area while **Figure 4.5** focuses closer in on the city centre.

4.3.5 Most of the proposed housing sites are located on the edge of Chester itself in relatively close proximity to the inner ring road. There is a second, wider distribution close to the strategic roads of the A55 and A41. A notable exception to this is the area around Blacon, where the two sites total in the region of 150 dwellings. More significant in terms of traffic generation in that area however, is the expansion of the employment site at Sealand Industrial Estate; this is proposed to be in the order of several thousand square metres of floor space.

4.3.6 Access to these areas around Blacon and Sealand Industrial Estate is currently relatively poor compared to the rest of Chester, particularly when approaching from the south as routing options are limited, resulting in vehicles typically routing through Chester.

Figure 4:4 – Development Distribution – Housing and Employment Wide View

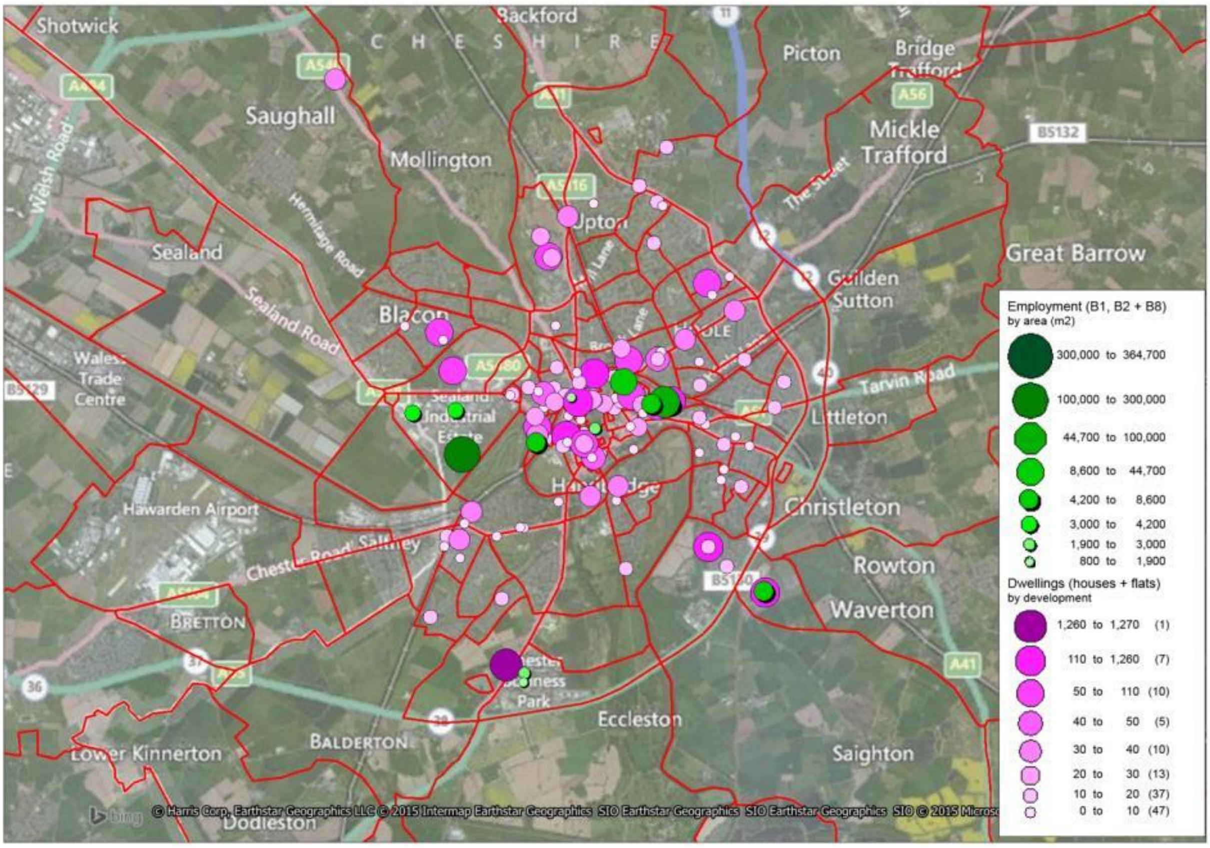
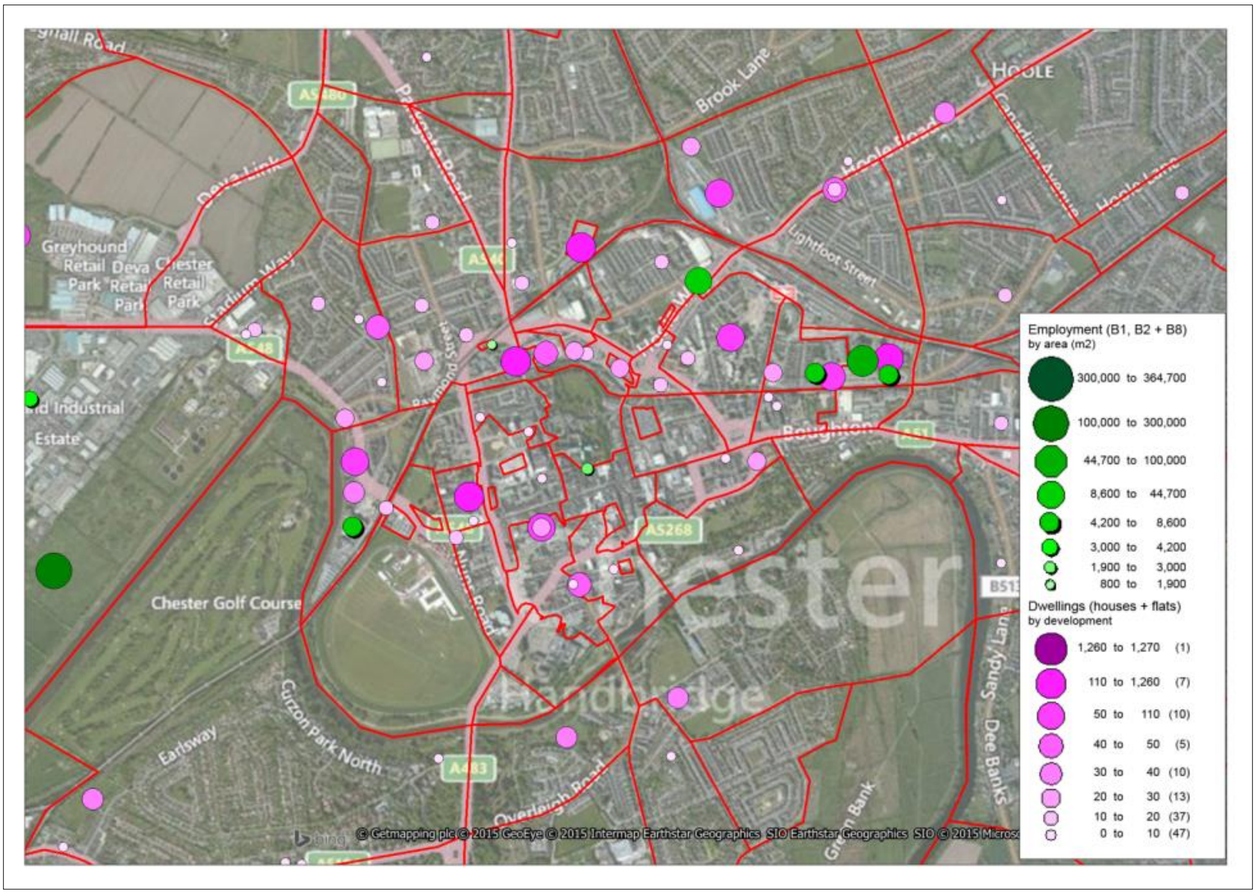


Figure 4:5 – Development Distribution – Housing and Employment Near View



4.3.7 The related employment and housing related trip arrivals and departures generation are shown in **Appendix A**.

2030 Forecast Year

4.3.8 A simple interpolation between 2010 and 2030 demand was used to generate the 2020 forecast year demand, assuming that development growth would be linear.

5. MODEL RESULTS

5.1 Introduction

5.1.1 This section includes an analysis of forecast traffic conditions in 2030, including the Do Minimum scenario and options for the Chester Western Relief Road. The assessment looks at traffic flows across the network, volume to capacity ratios, delays and journey travel times between key destinations. The assessment of the scheme considers Options 1 and 2, as defined in Chapter 2. Forecast 2020 model results have also been produced, but the results are less pronounced and not included here. This is also the case for the Inter Peak time period.

5.2 Do Minimum 2030

5.2.1 The following analysis focuses on the Do Minimum scenario, without the relief road in place. **Figure 5:1** shows the modelled traffic flows forecast during the AM peak in 2030. In addition to the A55, the A483 heading into Chester is highlighted as having high flows (which will be quantified in **Table 5.1** to **Table 5.2**). In particular, northbound on the approach and exit of the A55 junction has a high flow (2,700 and 3,100 Passenger Car Units (PCUs)/hr respectively), as does the A483 northbound directly south of the Chester inner ring road north of the A5104 (1,800 PCUs). The A55 itself carries up to 4,000 PCUs, the northern section of the inner ring road reaches up to 2,200 PCUs.

5.2.2 The PM peak flows in **Figure 5:2** show broadly similar patterns to that of the AM peak, but at a lower level overall. Aside from the A55 (3,800 PCUs), the A483 approaches to the junction with the A55 show highest flows (2,700 PCUs). The northern section of the inner ring road reaches up to 2,100 PCUs.

5.2.3 **Figure 5:3** shows the extent to which particular sections of the network are forecast to be under strain by 2030, without the relief road in place. The figure shows the volume to capacity ratios, which give an indication of the level of spare capacity in the road network at those points, with a value of 1 (100%) indicating no spare capacity. Typically it is the junctions at the end of roads which will determine the volume/capacity (V/C) ratio.

5.2.4 Focussing on the A483, the model suggests it is the section directly south of the inner ring road which will be under particular strain, with a ratio of volume of traffic (V) to road capacity (C) at 1 and over. The ‘worst’ area is the intersection of the A55 and A483. There are a number of isolated junctions at capacity, including the access from A548 westbound into Sealand Industrial Park and key access roads into the city centre, including Hoole Road and Liverpool Road.

5.2.5 For the corresponding PM peak period, the model forecasts show that congestion is lower overall. The same section of the A483 is forecast to be approaching capacity, but it is more likely to be a case of localised roads in the centre of Chester which experience delay. For the PM peak, the A548 accessing the centre of Chester is noticeably congested, more so than the AM peak.

5.2.6 Having analysed the forecast traffic flows and network strain, **Figure 5:5** and **Figure 5:6** display the forecast average delay on each section of the network for the AM and PM peaks respectively. These results are for average conditions and there will be times of particular congestion when delays will be significantly higher. The results reinforce the preceding figures. For the AM peak the same section of the A483 is highlighted, showing that drivers are likely to experience consistent delay of a few minutes or more at this location. On the inner ring road there is an average delay of around three minutes. There are delays of over 7 minutes indicated on the one-way Handbridge. The model forecasts delays around 4 minutes on Deva Link approaching the A548.

5.2.7 In the case of the PM peak, delay on the A483 does not appear to be as severe, with more pronounced delays counter-clockwise on the A55 and localised junctions within the centre of Chester (around 8 minutes around George Street onto Northgate Street and 8 minutes on A548 Watergate Street approaching the inner ring road), as well as some access points around Sealand Industrial Estate.

Figure 5:1 – Do Minimum 2030 AM Peak Hour Traffic Flows (PCUs

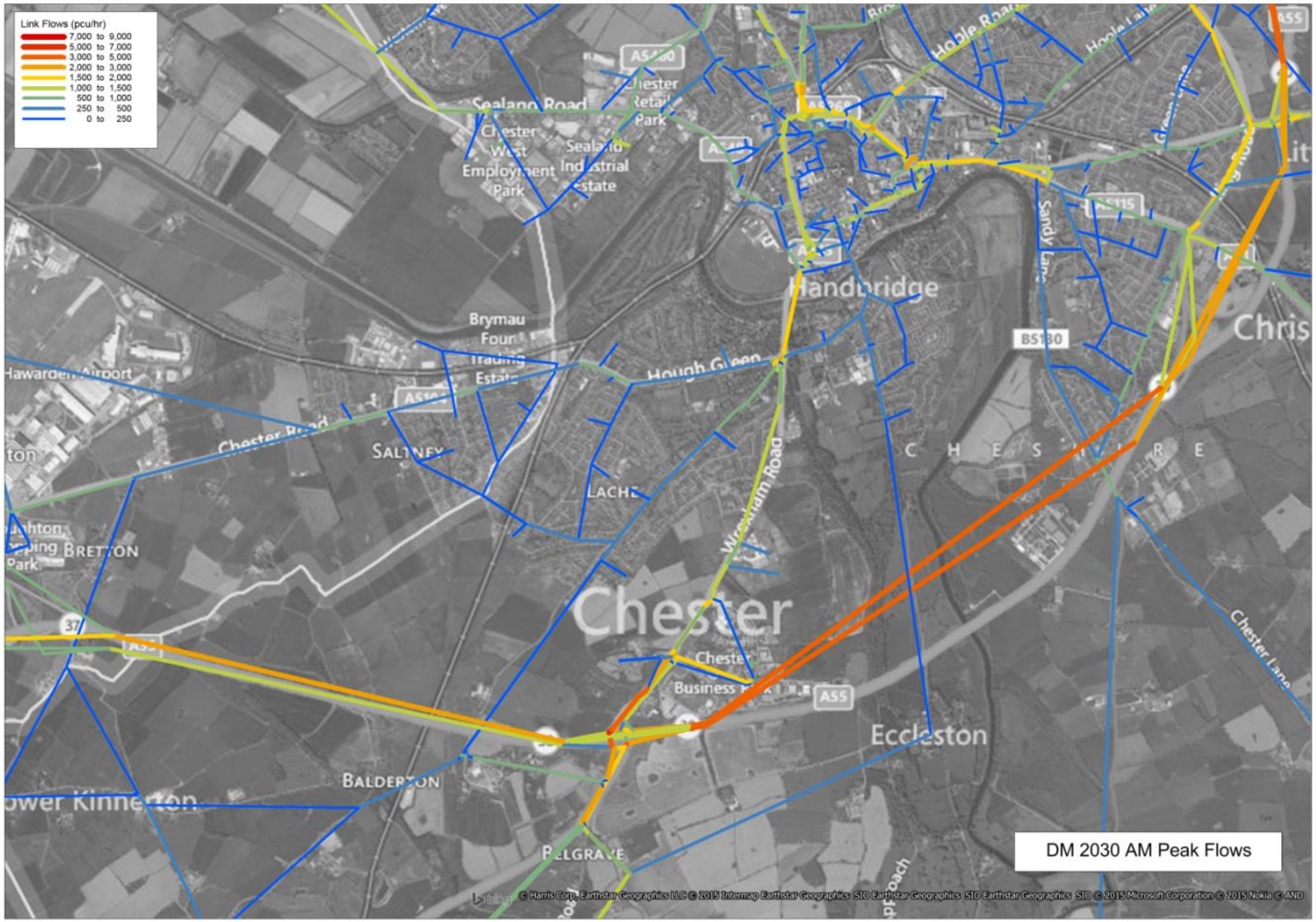


Figure 5:2 – Do Minimum 2030 PM Peak Hour Traffic Flows (PCUs)

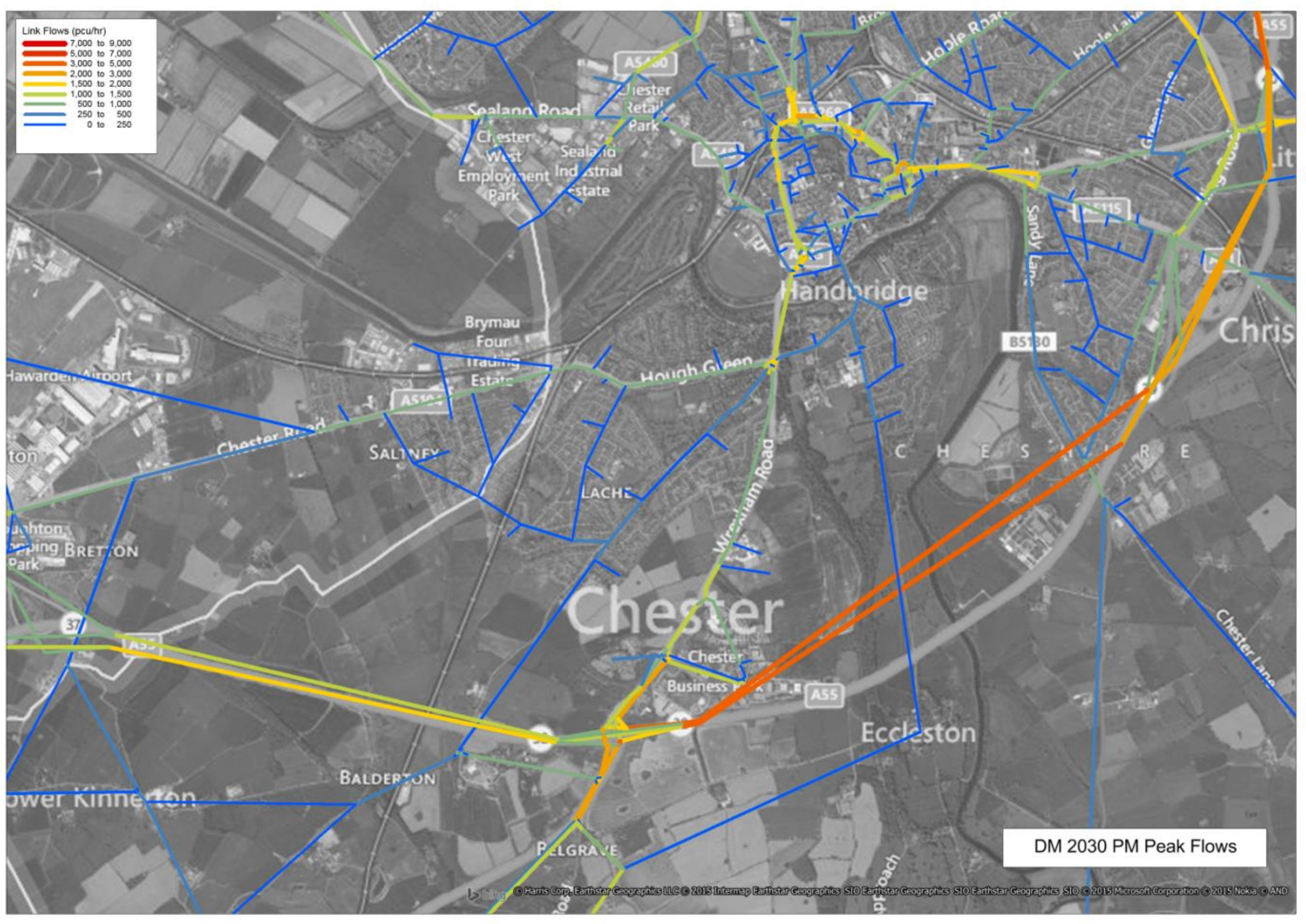


Figure 5:3 – Do Minimum 2030 AM Peak Volume to Capacity Ratios

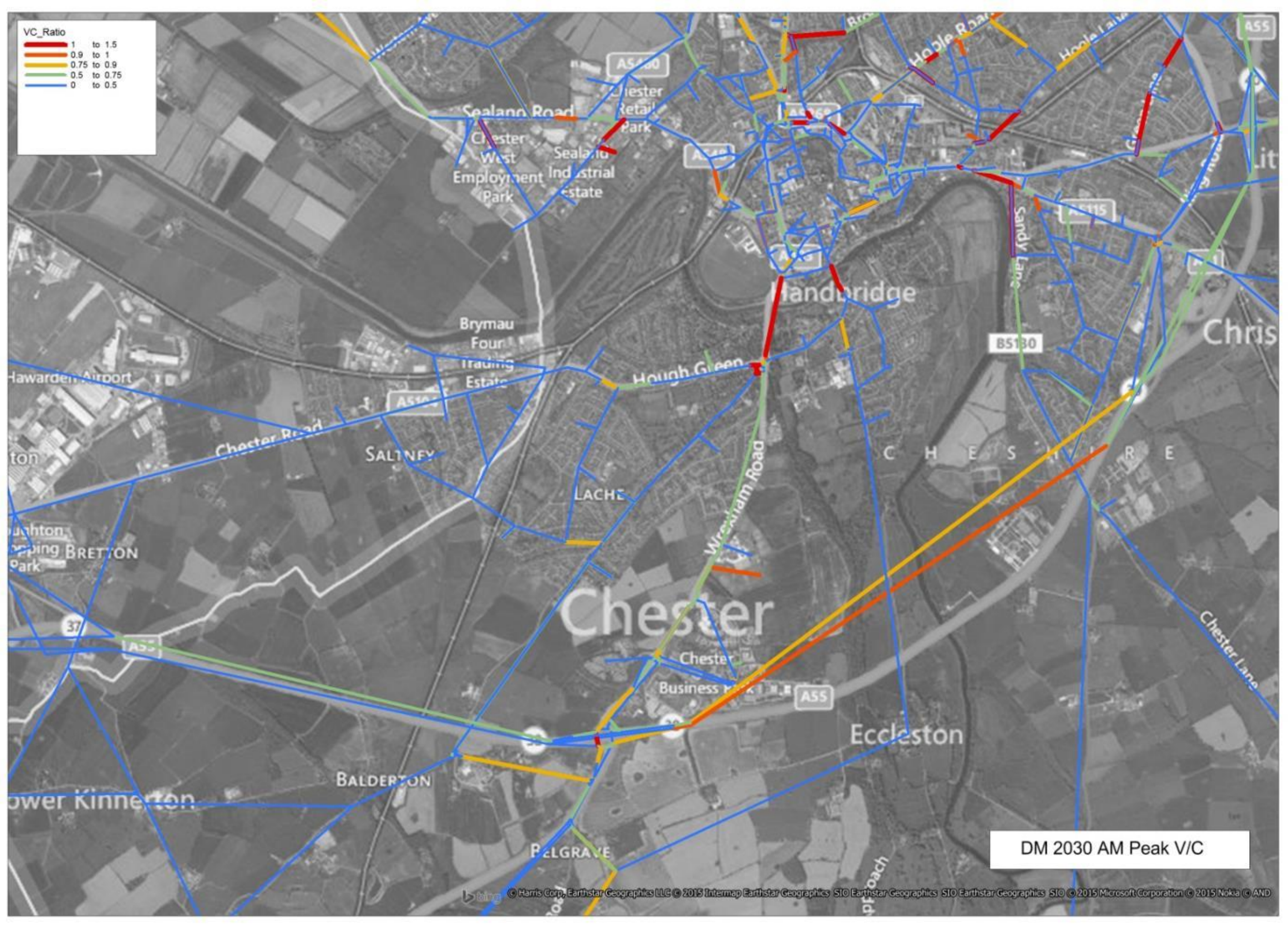


Figure 5:4 – Do Minimum 2030 PM Peak Volume to Capacity Ratios

Figure 5:5 – Do Minimum 2030 AM Peak Delay

Cheshire West and Chester

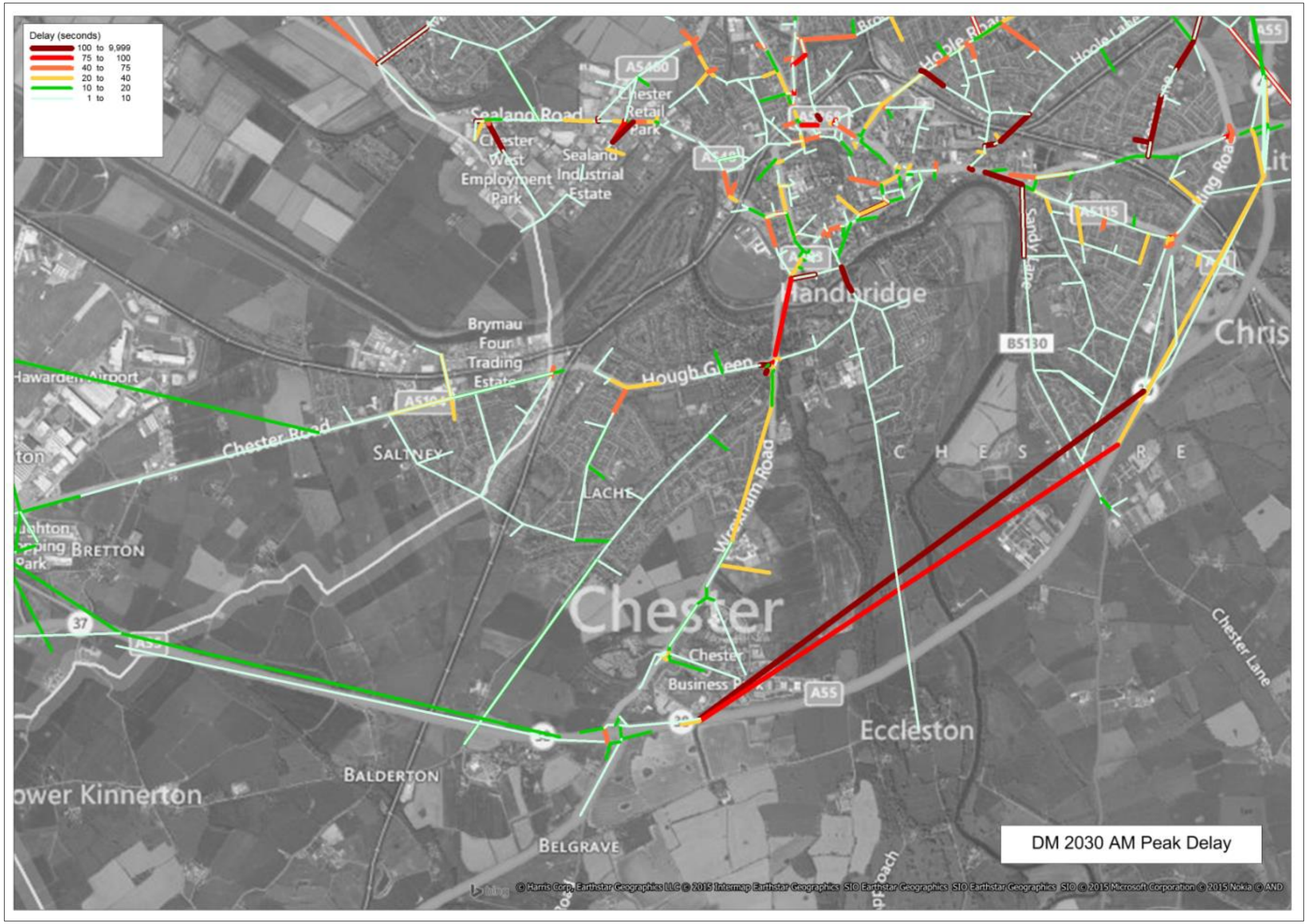


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Figure 5:6 – Do Minimum 2030 PM Peak Delay

5.3 Chester Western Relief Road Impact Assessment – Traffic Flows

5.3.1 The introduction of the relief road will have a direct impact on the A483, as well as the wider network. **Table 5:1** to **Table 5:2** present the AM and PM peak SATURN model output flows forecast for 2030 and the corresponding V/C ratios. The location of the selected sites from where results are derived is shown in **Figure 5:7** as four blue lines.

Figure 5:7 – A483 and Relief Road Marker Points for Table 5:1 to Table 5:2

5.3.2 **Table 5:1** and **Table 5:2** show the SATURN model outputs for the A483 for the southern and northern sections respectively. **Table 5.3** and **Table 5.4** present the results for the relief road. In each table there are three rows, containing results for each of the scenarios (DM, Option1 and Option 2).

Table 5:1 – A483 South: Traffic Flows and Volume to Capacity Ratio

	AM Peak				PM Peak			
	Traffic Flow (PCUs		V/C		Traffic Flow (PCUs)		V/C	
Scenario	n/b	s/b	n/b	s/b	n/b	s/b	n/b	s/b
Do Min	1571	952	96	58	750	1146	46	70
Option 1	1053	794	64	48	652	909	40	55
Option 2	1645	869	100	53	743	1058	45	65

Table 5:2 – A483 North: Traffic Flows and Volume to Capacity Ratio

	AM Peak				PM Peak			
	Traffic Flow (PCUs		V/C		Traffic Flow (PCUs)		V/C	
Scenario	n/b	s/b	n/b	s/b	n/b	s/b	n/b	s/b
Do Min	1571	952	96	58	750	1146	46	70
Option 1	1053	794	64	48	652	909	40	55
Option 2	1645	869	100	53	743	1058	45	65

Table 5:3 – Relief Road South: Traffic Flows and Volume to Capacity Ratio

	AM Peak				PM Peak			
	Traffic Flow (PCUs		V/C		Traffic Flow (PCUs)		V/C	
Scenario	n/b	s/b	n/b	s/b	n/b	s/b	n/b	s/b
Option 1	1066	457	26	11	582	1119	14	27
Option 2	346	425	19	23	388	344	21	18

Table 5:4 – Relief Road North: Traffic Flows and Volume to Capacity Ratio

	AM Peak				PM Peak			
	Traffic Flow (PCUs		V/C		Traffic Flow (PCUs)		V/C	
Scenario	n/b	s/b	n/b	s/b	n/b	s/b	n/b	s/b
IRR1	1066	457	26	11	582	1119	14	27
IRR2	346	425	19	23	388	344	21	18

5.3.3 **Table 5:1** suggests that the southern section of the A483 will remain busy in the single lane Option 2 scenario, but under the Option 1 scenario, where the relief road is dual lane and has no intermediate junctions, the forecast suggests there will be less congestion.

5.3.4 **Table 5:2** reflects the previous network-wide analysis above, showing that the northern A483 section remains congested in each of the three scenarios in the AM peak. The relief road does relieve congestion in the PM peak however. This suggests that in the DM scenario without the relief road, there is a substantial amount of traffic looking to use the A483 but is unable to do so due to the capacity constraints. Both Option 1 and Option 2 suggest the A483 will not quite be 100% at capacity, but even at 98% of capacity there will still be some associated delay.

5.3.5 **Table 5:3** suggests that the southern section of the relief road will not experience any particular capacity constraints in either time period for either Option 1 or Option 2. It is clear from this table that Option 1 performs quite differently to Option 2 in that more than double the traffic is forecast to use the southern section of the relief road under dual lane option without any intermediate junctions.

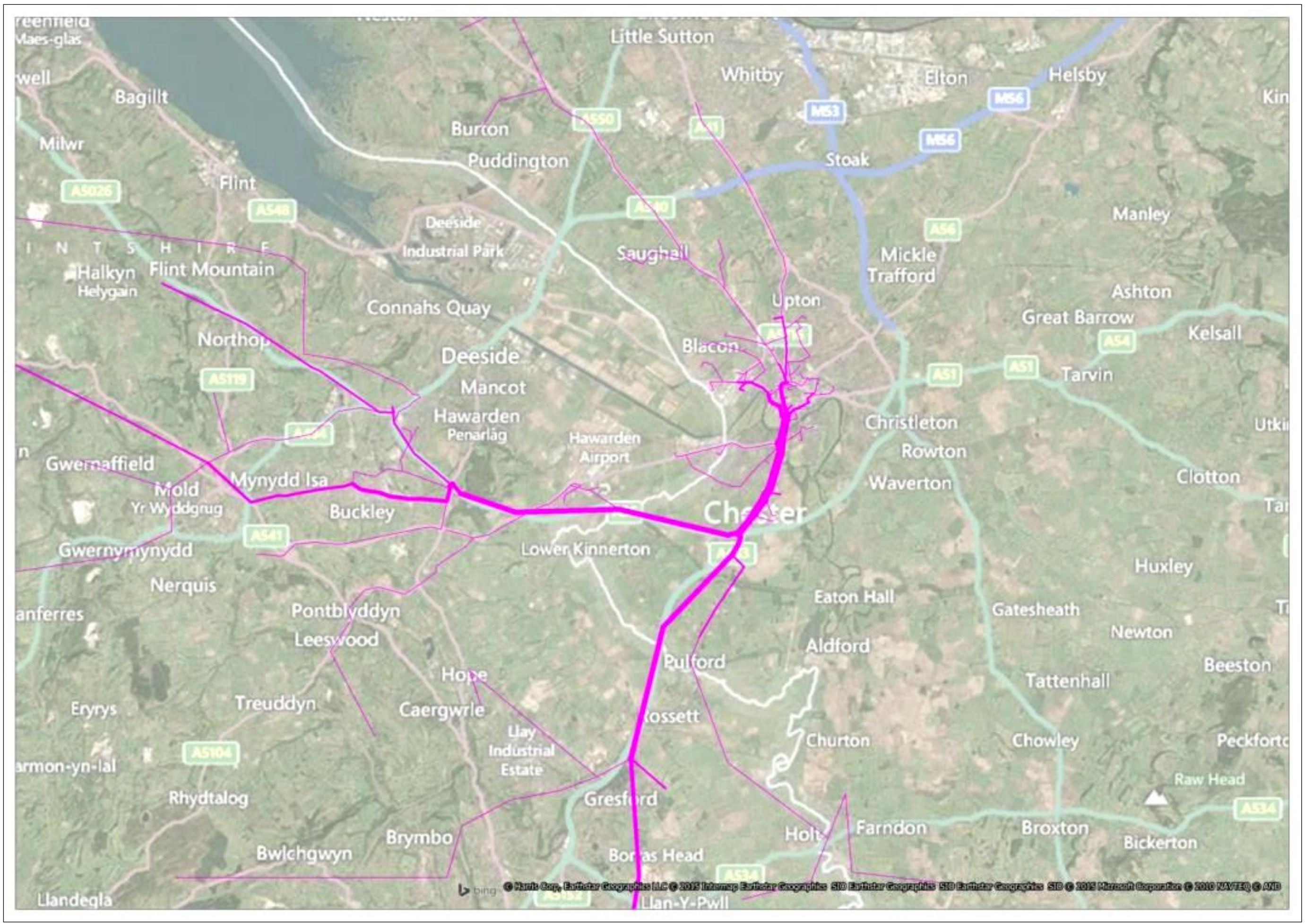
5.3.6 **Table 5:4** suggests that under both scenarios the northern section of the relief road will be highly utilised. Option 2 (single carriageway option) is forecast to be at capacity for this section.

5.3.7 This analysis suggests that from a capacity aspect, the southern section of the relief road might be best served by a single carriageway link, whereas the northern section conditions might justify a dual lane link. In terms of the impact on the city centre, the relief road impact varies on a junction by junction basis, but the overall level of traffic remains broadly the same. A general trend is a decrease in north-south traffic through the centre and an increase in east-west traffic.

5.4 Relief Road Impact – Routing

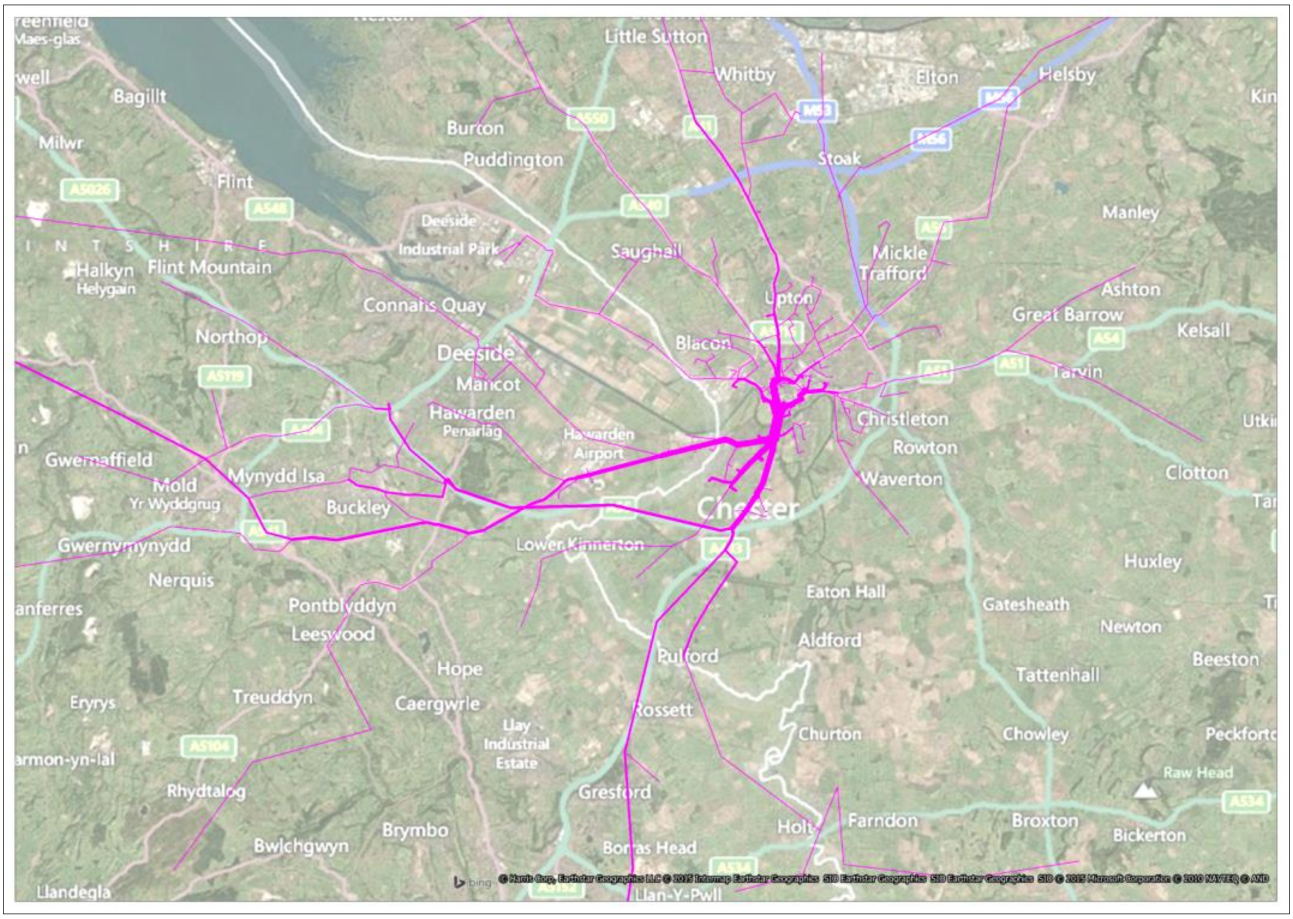
5.4.1 An assessment of the northbound traffic on the A483 during the AM peak was carried out as it is forecast to be the busiest time period and direction. **Figures 5:8** and **5:9** show 'select link' analysis, which presents the origin and destination of traffic using the A483 or the relief road in the AM peak northbound direction, focussing on one the two roads at a time.

Figure 5:8 – Do Minimum Select Link Analysis AM Peak A483 Northbound



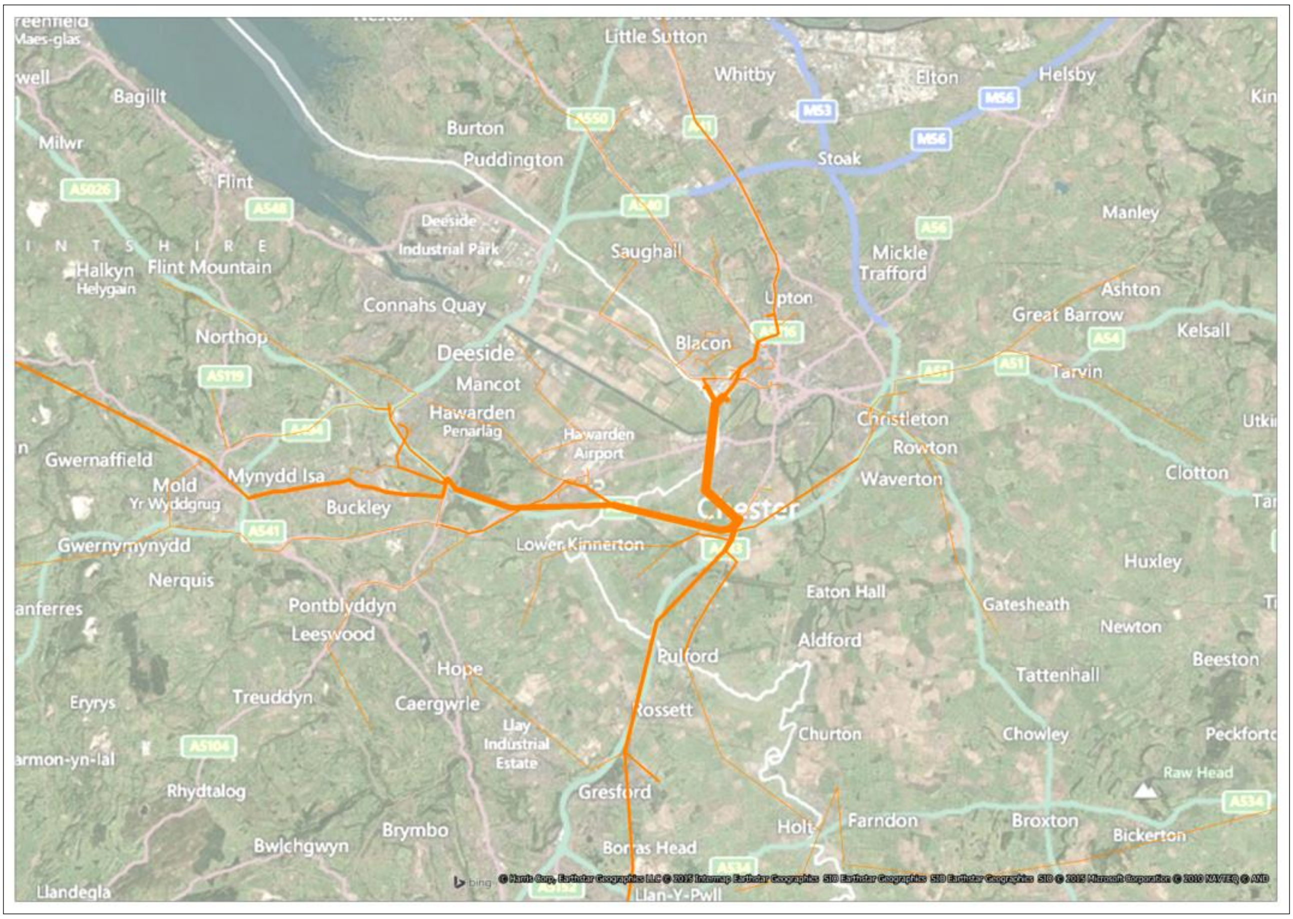
5.4.2 **Figure 5:8** shows the origin and destination of traffic which routes northbound along the A483 in the AM peak. The distribution suggests that some traffic continues north, to Upton and beyond, but much stops in and around Chester, with a substantial amount routing towards Sealand Industrial Estate.

Figure 5:9 – Option 1 Select Link Analysis AM Peak A483 Northbound



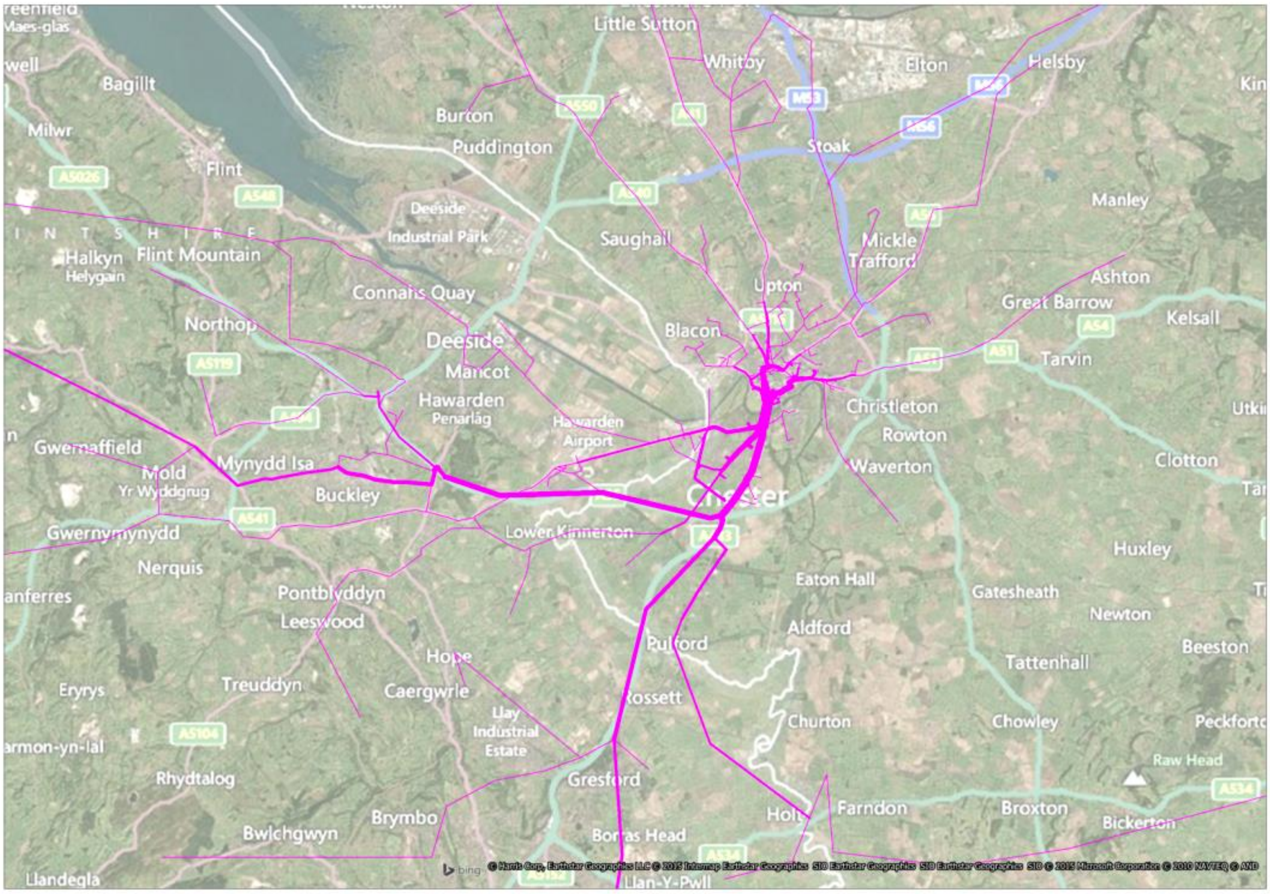
5.4.3 With the relief road in place (under Option 1), the A483 distribution pattern changes notably. There is a more dispersed pattern of destinations of traffic, but it is the routing of traffic which reaches the A483 which appears to differ more. **Figure 5:9** suggests a decrease in traffic originating from the south along the A483 and also a decrease in traffic routing via the A55, with an increase in traffic routing along the A5104 instead. There is also a notable increase in traffic using the A483 from Lache, which were previously using alternative routes.

Figure 5:10 – Option 1 Select Link Analysis AM Peak Western Relief Road Northbound



5.4.4 **Figure 5:10** confirms the relief road is an attractive route for some of the traffic from the south and traffic from the west along the A55. For a substantial amount of traffic it provides a quicker route to Upton, areas to the north of Chester and Sealand Industrial Estate.

Figure 5:11 – Option 2 Select Link Analysis AM Peak A483 Northbound



5.4.5 **Figure 5:11** shows that under the Option 2 scenario, the distribution of traffic using the A483 northbound is wider than in the DM scenario, but changes less than in the Option 1 scenario. The most notable change in terms of the destination of traffic is a decrease in the amount routing to Sealand Industrial Estate. There is also a decrease in traffic routing from the west and the south. There is a notable increase in traffic routing locally from Lache.

Figure 5:12 – Option 2 Select Link Analysis AM Peak Western Relief Road Northbound

5.4.6 As indicated in earlier analysis, relatively few vehicles route along the southern section of Option 2 compared to Option 1. The distribution of traffic using Option 1 is predominantly from the west, along the A5104. As with Option 2, some of the traffic routes to Upton and further north, but in the case of Option 2, much of the traffic routes into Sealand Industrial Estate.

5.5 Relief Road Impact – Travel Times

Network Wide Impacts

5.5.1 **Table 5:5** through to **Table 5:6** show the difference between the primary network summary statistics across the three scenarios (DM, Option 1 and Option 2) for the three time periods (AM, IP and PM). The assignment of traffic on the networks shows a similar pattern for each time period. In each case both options suggest around a 3% reduction in total travel times when comparing the Option 1 or Option 2 scenario with the DM, there is however some variation.

5.5.2 In the AM Peak, both schemes suggest a similar level of benefit in terms of decreasing total travel time and increasing average speed, though Option 1 is estimated to outperform Option 2. Option 1 shows no significant reduction in total distance travelled, but Option 2 suggests a slight reduction of 0.2%.

5.5.3 During the IP period, both Option 1 and Option 2 show benefits, but to a lesser extent that for the AM peak. This is intuitive, given the lower degree of congestion in the DM IP scenario compared to the DM AM scenario, which can be seen by comparing the two average speeds of 29.1 mph and 38.4 mph in **Table 5:5** and **Table 5:6** respectively.

5.5.4 The PM peak results in **Table 5:7** show more of a difference between Option 1 and Option 2. In this case Option 1 decreases travel time and increases average speed by around 4% whereas Option 2 is close to 2%. However, Option 2 suggests distance savings in the region of 0.7%, whereas for Option 1 is 0.1%.

5.5.5 Overall, the results suggest that across the network Option 1 generates a greater degree of travel time savings than Option 2, but Option 2 generates slightly better distance travelled savings. The former of these two results is because Option 1 contains fewer intersections and thus provides a quick route than Option 2 for traffic which travels along its entirety. The latter result is because Option 2 provides greater connectivity, enabling some traffic to choose shorter routes.

Table 5:5 – AM Peak Network-wide Summary Statistic Comparison

	DM	Option 1	Option 2	Option 1-DM	Option 2-DM
Travel Time (hrs)	14913	14421	14501	-3.3%	-2.8%
Distance (miles)	433476	433262	432432	0.0%	-0.2%
Speed (mph)	29.1	30.1	29.8	3.4%	2.6%

Table 5:6 – Inter Peak Network-wide Summary Statistic Comparison

	DM	Option 1	Option 2	Option 1-DM	Option 2-DM
Travel Time (hrs)	7851	7635	7680	-2.7%	-2.2%
Distance (miles)	301565	301388	301239	-0.1%	-0.1%
Speed (mph)	38.4	39.5	39.2	2.8%	2.1%

Table 5:7 – PM Peak Network-wide Summary Statistic Comparison

	DM	Option 1	Option 2	Option 1-DM	Option 2-DM
Travel Time (hrs)	14142	13580	13799	-4.0%	-2.4%
Distance (miles)	411599	410773	408918	-0.2%	-0.7%
Speed (mph)	29.1	30.3	29.6	4.1%	1.9%

Origin/Destination Impacts

5.5.6 Taking the journey time analysis a step further, this section analyses specific origin to destination trip patterns.

5.5.7 **Figure 5:13** shows eight locations, selected either for as they are on the edge of the SATURN model network, or located centrally, providing a range of potential through movements and city centre routing. **Table 5:8** to **Table 5:10** report the travel times (in minutes) as forecast in the SATURN model for the AM peak 2030 model scenario, for the Do Minimum, Option 1 and Option 2 networks. **Table 5:11** to **Table 5:13** present the same information but for the corresponding PM peaks.

Figure 5:13 – Strategic Origin and Destination Locations

Table 5:8 – 2030 Do Minimum AM Peak Strategic Origin-Destination Travel Times (mins)

		Destination							
		Gresford (A)	Helsby (B)	Airport (C)	Flint (D)	Kelsall (E)	Ellesmere Port (F)	Chester Centre (G)	Sealand Estate (H)
Origin	Gresford (A)	0	26	11	27	24	25	25	29
	Helsby (B)	25	0	22	27	17	13	24	30
	Airport (C)	13	21	0	16	20	21	22	26
	Flint (D)	26	25	18	0	34	22	33	30
	Kelsall (E)	24	17	21	37	0	22	27	33
	Ellesmere Port (F)	27	15	22	25	22	0	27	30
	Chester Centre (G)	18	19	16	23	19	17	0	10

	Sealand Estate (H)	23	22	16	19	24	18	8	0

Table 5:9 – 2030 Option 1 AM Peak Strategic Origin-Destination Travel Times (mins)

		Destination							
		Gresford (A)	Helsby (B)	Airport (C)	Flint (D)	Kelsall (E)	Ellesmere Port (F)	Chester Centre (G)	Sealand Estate (H)
Origin	Gresford (A)	0	25	11	27	23	25	21	19
	Helsby (B)	25	0	22	27	17	13	24	28
	Airport (C)	13	21	0	16	19	21	20	12
	Flint (D)	26	25	18	0	34	22	29	25
	Kelsall (E)	24	17	21	37	0	22	27	31
	Ellesmere Port (F)	27	15	22	26	22	0	27	28
	Chester Centre (G)	17	20	13	23	20	17	0	5
	Sealand Estate (H)	16	23	8	19	26	19	8	0

Table 5:10 – 2030 Option 2 AM Peak Strategic Origin-Destination Travel Times (mins)

		Destination							
		Gresford (A)	Helsby (B)	Airport (C)	Flint (D)	Kelsall (E)	Ellesmere Port (F)	Chester Centre (G)	Sealand Estate (H)
Origin	Gresford (A)	0	26	11	27	24	26	21	14
	Helsby (B)	25	0	22	27	17	13	24	26
	Airport (C)	13	21	0	16	20	21	18	10
	Flint (D)	26	25	18	0	34	22	28	24
	Kelsall (E)	24	17	21	37	0	22	27	24
	Ellesmere Port (F)	27	15	22	26	22	0	27	27

	Chester Centre (G)	16	19	15	23	19	18	0	5
	Sealand Estate (H)	11	23	9	19	18	19	7	0

Table 5:11 – 2030 Do Minimum PM Peak Strategic Origin-Destination Travel Times (mins)

		Destination							
		Gresford (A)	Helsby (B)	Airport (C)	Flint (D)	Kelsall (E)	Ellesmere Port (F)	Chester Centre (G)	Sealand Estate (H)
Origin	Gresford (A)	0	26	11	28	23	26	19	19
	Helsby (B)	23	0	20	23	23	14	19	18
	Airport (C)	14	21	0	20	20	20	16	16
	Flint (D)	28	26	19	0	38	23	27	19
	Kelsall (E)	23	25	20	36	0	23	22	25
	Ellesmere Port (F)	23	12	20	22	19	0	19	18
	Chester Centre (G)	21	21	18	24	21	19	0	4
	Sealand Estate (H)	33	28	27	29	28	23	13	0

Table 5:12 – 2030 Option 1 PM Peak Strategic Origin-Destination Travel Times (mins)

		Destination							
		Gresford (A)	Helsby (B)	Airport (C)	Flint (D)	Kelsall (E)	Ellesmere Port (F)	Chester Centre (G)	Sealand Estate (H)
Origin	Gresford (A)	0	25	11	28	23	25	18	10
	Helsby (B)	23	0	20	23	23	14	19	19
	Airport (C)	13	21	0	20	20	20	16	8
	Flint (D)	28	27	19	0	38	23	25	19
	Kelsall (E)	23	26	20	36	0	23	22	20

	Ellesmere Port (F)	23	12	19	22	19	0	19	19
	Chester Centre (G)	16	21	15	23	20	20	0	4
	Sealand Estate (H)	18	32	16	30	26	29	15	0

Table 5:13 – 2030 Option 2 PM Peak Strategic Origin-Destination Travel Times (mins)

		Destination							
		Gresford (A)	Helsby (B)	Airport (C)	Flint (D)	Kelsall (E)	Ellesmere Port (F)	Chester Centre (G)	Sealand Estate (H)
Origin	Gresford (A)	0	25	11	28	23	25	18	16
	Helsby (B)	23	0	20	23	23	14	20	18
	Airport (C)	14	21	0	20	20	20	16	8
	Flint (D)	28	27	19	0	38	23	26	19
	Kelsall (E)	23	25	20	36	0	23	23	26
	Ellesmere Port (F)	23	12	19	22	19	0	19	18
	Chester Centre (G)	19	21	16	24	21	20	0	4
	Sealand Estate (H)	24	32	18	30	33	29	14	0

Table 5:14 – 2030 Option 1 AM – Do Minimum AM Difference (mins)

		Gresford (A)	Helsby (B)	Airport (C)	Flint (D)	Kelsall (E)	Ellesmere Port (F)	Chester Centre (G)	Sealand Estate (H)
Origin	Gresford (A)	0.0	-0.9	0.0	-0.1	-0.8	-0.8	-3.5	-10.4
	Helsby (B)	0.0	0.0	-0.1	0.1	0.0	0.0	0.0	-2.2
	Airport (C)	-0.1	-0.3	0.0	-0.1	-0.3	-0.5	-2.4	-14.2
	Flint (D)	0.1	-0.1	0.0	0.0	-0.2	-0.3	-3.4	-4.6
	Kelsall (E)	0.1	0.1	0.0	0.0	0.0	0.0	0.2	-2.2

	Ellesmere Port (F)	0.2	0.1	0.0	0.2	0.1	0.0	-0.1	-2.1
	Chester Centre (G)	-0.5	0.8	-3.2	0.0	0.9	0.0	0.0	-4.2
	Sealand Estate (H)	-7.3	1.1	-8.3	0.2	2.0	1.3	0.0	0.0

Table 5:15 – 2030 Option 2 AM – Do Minimum AM Difference (mins)

		Destination							
		Gresford (A)	Helsby (B)	Airport (C)	Flint (D)	Kelsall (E)	Ellesmere Port (F)	Chester Centre (G)	Sealand Estate (H)
Origin	Gresford (A)	0.0	0.4	0.0	-0.1	0.5	0.2	-3.5	-15.5
	Helsby (B)	-0.1	0.0	-0.2	0.1	0.0	0.0	-0.1	-3.8
	Airport (C)	-0.1	-0.2	0.0	0.0	-0.1	-0.1	-4.3	-16.3
	Flint (D)	-0.1	-0.1	0.0	0.0	-0.1	0.0	-4.5	-5.7
	Kelsall (E)	-0.1	0.1	-0.1	-0.2	0.0	-0.3	-0.2	-8.5
	Ellesmere Port (F)	-0.1	-0.1	0.1	0.3	-0.1	0.0	0.1	-3.5
	Chester Centre (G)	-2.1	0.3	-1.8	-0.1	0.3	0.3	0.0	-4.8
	Sealand Estate (H)	-12.6	0.6	-7.0	0.1	-6.0	0.8	-1.3	0.0

5.5.8 **Table 5:14** and **Table 5:15** show a reasonably similar pattern in terms of the impact of the scheme in the AM peak. Option 1 generates slightly more benefits at a strategic level particularly for movements from Gresford and the south, similarly for traffic routing towards Ellesmere Port. This is to be expected, given that Option 1 provides a more continuous, quicker route in the north-south direction. Option 2 in contrast, provides a quick route into Sealand Industrial Estate and the centre of Chester. Neither option suggests a large benefit from the centre of Chester or Sealand towards the north, but there is a clearer benefit for traffic routing centrally towards the south, particularly in the case of Option 2.

Table 5:16 – 2030 Option 1 PM – Do Minimum PM Difference (mins)

		Destination							
		Gresford (A)	Helsby (B)	Airport (C)	Flint (D)	Kelsall (E)	Ellesmere Port (F)	Chester Centre (G)	Sealand Estate (H)
Origin	Gresford (A)	0.0	-0.2	0.2	0.1	0.1	-0.5	-0.5	-8.7
	Helsby (B)	0.0	0.0	0.0	-0.1	0.1	-0.1	0.0	1.1
	Airport (C)	0.0	-0.2	0.0	0.0	-0.1	-0.1	-0.6	-8.2
	Flint (D)	-0.2	0.2	0.0	0.0	-0.1	0.0	-2.2	0.1
	Kelsall (E)	0.3	0.6	0.3	0.3	0.0	0.0	0.3	-5.5
	Ellesmere Port (F)	-0.1	0.0	-0.3	0.0	0.0	0.0	0.1	1.4
	Chester Centre (G)	-4.6	0.2	-2.2	-0.7	-0.2	0.8	0.0	0.3
	Sealand Estate (H)	-14.5	3.8	-10.9	0.5	-2.3	5.3	1.9	0.0

Table 5:17 – 2030 Option 2 PM – Do Minimum PM Difference (mins)

		Destination							
		Gresford (A)	Helsby (B)	Airport (C)	Flint (D)	Kelsall (E)	Ellesmere Port (F)	Chester Centre (G)	Sealand Estate (H)
Origin	Gresford (A)	0.0	-0.4	0.1	0.0	0.4	-0.7	-0.5	-3.4
	Helsby (B)	-0.1	0.0	-0.1	-0.1	0.0	0.0	0.1	0.4
	Airport (C)	0.2	-0.2	0.0	0.3	-0.3	-0.2	-0.3	-8.3
	Flint (D)	-0.1	0.2	0.0	0.0	-0.3	-0.1	-1.4	0.1
	Kelsall (E)	0.3	0.1	0.2	0.1	0.0	0.0	0.4	0.4
	Ellesmere Port (F)	-0.1	0.0	-0.3	0.0	0.0	0.0	0.1	0.6
	Chester Centre (G)	-1.9	0.4	-1.9	-0.5	0.2	0.6	0.0	0.0
	Sealand Estate (H)	-8.5	3.9	-9.0	0.6	4.4	5.2	1.3	0.0

5.5.9 The pattern in the corresponding PM peak, as presented in **Table 5:18** and **Table 5:19** is less clear than the AM peak. It suggests that in both options there are clear benefits from Chester Centre and Sealand Industrial Estate for traffic heading towards Gresford and the south and Hawarden Airport to the southwest. There are however forecast increases in travel times for traffic exiting Sealand Industrial Estate. This is as a result of traffic having to access from side roads onto a busier Bumpers Lane and Sovereign Way in Option 1 and Option 2 compared to the DM scenario. The extent to which this delay is accurate, would require more detailed analysis to confirm.

Table 5:18 – 2030 Option 1 AM – Do Minimum AM Percentage Difference

		Destination							
		Gresford (A)	Helsby (B)	Airport (C)	Flint (D)	Kelsall (E)	Ellesmere Port (F)	Chester Centre (G)	Sealand Estate (H)
Origin	Gresford (A)	0%	-3%	0%	0%	-3%	-3%	-14%	-36%
	Helsby (B)	0%	0%	0%	0%	0%	0%	0%	-7%
	Airport (C)	-1%	-2%	0%	0%	-1%	-2%	-11%	-54%
	Flint (D)	0%	-1%	0%	0%	-1%	-1%	-11%	-16%
	Kelsall (E)	0%	1%	0%	0%	0%	0%	1%	-7%
	Ellesmere Port (F)	1%	1%	0%	1%	1%	0%	0%	-7%
	Chester Centre (G)	-3%	4%	-19%	0%	5%	0%	0%	-44%
	Sealand Estate (H)	-31%	5%	-52%	1%	8%	7%	0%	0%

Table 5:19 – 2030 Option 2 AM – Do Minimum AM Percentage Difference

		Destination							
		Gresford (A)	Helsby (B)	Airport (C)	Flint (D)	Kelsall (E)	Ellesmere Port (F)	Chester Centre (G)	Sealand Estate (H)
Origin	Gresford (A)	0%	1%	0%	0%	2%	1%	-14%	-53%
	Helsby (B)	0%	0%	-1%	0%	0%	0%	0%	-13%
	Airport (C)	-1%	-1%	0%	0%	0%	-1%	-20%	-62%

	Flint (D)	0%	0%	0%	0%	0%	0%	-14%	-19%
	Kelsall (E)	0%	0%	-1%	-1%	0%	-1%	-1%	-26%
	Ellesmere Port (F)	-1%	-1%	1%	1%	-1%	0%	0%	-12%
	Chester Centre (G)	-12%	2%	-11%	0%	2%	2%	0%	-50%
	Sealand Estate (H)	-54%	3%	-44%	1%	-25%	5%	-15%	0%

5.5.10 There is a forecast decrease in journey times of over 50% between the Airport and Chester centre in both options. Option 1 generates a reduction of over 50% from Sealand Industrial Estate and the Airport. Option 2 generates a 50% reduction between Sealand Industrial Estate and Gresford.

Table 5:20 – 2030 Option 1 PM – Do Minimum PM Percentage Difference

		Destination							
		Gresford (A)	Helsby (B)	Airport (C)	Flint (D)	Kelsall (E)	Ellesmere Port (F)	Chester Centre (G)	Sealand Estate (H)
Origin	Gresford (A)	0%	-1%	2%	0%	0%	-2%	-3%	-46%
	Helsby (B)	0%	0%	0%	0%	0%	-1%	0%	6%
	Airport (C)	0%	-1%	0%	0%	0%	0%	-4%	-51%
	Flint (D)	-1%	1%	0%	0%	0%	0%	-8%	1%
	Kelsall (E)	1%	2%	1%	1%	0%	0%	1%	-22%
	Ellesmere Port (F)	0%	0%	-1%	0%	0%	0%	0%	8%
	Chester Centre (G)	-22%	1%	-13%	-3%	-1%	4%	0%	6%
	Sealand Estate (H)	-44%	14%	-41%	2%	-8%	23%	14%	0%

Table 5:21 – 2030 Option 2 PM – Do Minimum PM Percentage Difference

		Destination							
		Gresford (A)	Helsby (B)	Airport (C)	Flint (D)	Kelsall (E)	Ellesmere Port (F)	Chester Centre (G)	Sealand Estate (H)
Origin	Gresford (A)	0%	-2%	0%	0%	2%	-3%	-3%	-18%
	Helsby (B)	0%	0%	-1%	0%	0%	0%	1%	2%
	Airport (C)	1%	-1%	0%	1%	-2%	-1%	-2%	-51%
	Flint (D)	0%	1%	0%	0%	-1%	0%	-5%	0%
	Kelsall (E)	1%	0%	1%	0%	0%	0%	2%	1%
	Ellesmere Port (F)	0%	0%	-1%	0%	0%	0%	1%	3%
	Chester Centre (G)	-9%	2%	-11%	-2%	1%	3%	0%	1%
	Sealand Estate (H)	-26%	14%	-34%	2%	15%	22%	10%	0%

5.5.11 As discussed previously, the PM peak pattern is less clear than the AM peak pattern, as shown in Table 5:20 and Table 5:21 above. There are clear localised benefits between Chester city centre, Seland Induistrial Estate and the Hawarden Airport, but less distinct benefits from the east (Kelsall) in particular. Part of this is due to the lower level of congestion in the DM PM peak scenario compared to the AM peak.

6. HIGH LEVEL ECONOMIC ANALYSIS

6.1 Methodology

6.1.1 The economic analysis conducted in this section is limited to highway travel distance/time and ancillary impacts (carbon, fuel tax) as output from the strategic SATURN model analysis. The model is based upon a number of generic and scenario specific assumptions, made with the best use of available information at the time.

6.1.2 SATURN generates forecast traffic level assignments and associated travel times, and enables a set of demand and travel time and distance matrices to be produced for the DM, Option 1, Option 2 and Option 3 scenarios. TUBA takes these outputs and calculates the total generalised travel cost of each scenario – it does this by multiplying the demand by the individual travel cost, using a set of standard scenario specific parameters, including value of time and future year discount rates. By comparing the total cost for each scenario, including the scheme construction costs, TUBA generates a net benefit (or loss) of the scheme and a Benefit to Cost Ratio (BCR).

6.1.3 Additional impact analysis, such as traffic accidents, environmental or social impacts have not been included at this high level analysis stage. Nor have wider economic benefits been included. It is considered that the scheme may have beneficial noise and accident reduction impacts around currently congested areas such as along the A483, but an environmental cost around the proposed alignment.

6.1.4 It is expected that there would be potentially significant commercial / employment benefits associated with the scheme, such as by improving ease of access into Chester and Sealand industrial estate.

6.2 Scheme Costs

6.2.1 High level construction costs have been generated by AECOM – the costs for the two options, in addition to the assumptions are identified in Chapter 3. The total construction cost estimate for Option 1 is £62m (2015 prices). The total construction cost estimate for Option 2 is £48.7m (2015 prices) and for Option 3 it is £74.1m.

6.2.2 For the purpose of the appraisal, indicative maintenance costs have been based on QUADRO manual Table 4/1 values (**Table 6:1**), in 2010 prices for consistency with the main TUBA analysis.

Table 6:1 – QUADRO Manual Table 4/1: Typical Maintenance Profiles, Costs and Durations for New Roads

Single 2 Lane	Year	0	11	22	32	42	52		
Initial Flow 12,000 AADT	Works	New	TS	Ov	TS	Ov	TS		
(DLP)	Cost		66	240	66	252	66		
	Duration (days)		4	12	4	12	4		
Single (2+1) Lane	Year	0	11	22	32	42	52		
Initial Flow 19,000 AADT	Works	New	TS	Ov	TS	Ov	In		
(DLP)	Cost		96	360	96	378	156		
	Duration (days)		6	15	6	15	12		
Dual 2 Lane (D2AP)	Year	0	11	22	32	42	52		
Initial Flow 30,000 AADT	Works	New	TS	Ov	In	Ov	In		
(DLP)	Cost		168	576	354	684	576		
	Duration (days)		5	12	7	12	12		
Dual 2 Lane (D2AP)	Year	0	11	22	32	42	52		
Initial Flow 30,000 AADT	Works	New	TS	In	In	In	In		
(LLP)	Cost		168	354	576	354	354		
	Duration (days)		6	7	12	7	7		
Dual 3 Lane (D3AP)	Year	0	11	22	32	41	50	59	
Initial Flow 65,000 AADT	Works	New	In	Ov	In	Ov	In	Ov	
(DLP)	Cost		480	768	480	912	480	912	
	Duration (nights)		9	16	9	16	9	16	
Dual 3 Lane (D3AP)	Year	0	11	21	31	40	49	58	
Initial Flow 65,000 AADT	Works	New	In	In	In	In	In	In	
(LLP)	Cost		480	708	480	708	480	708	
	Duration (nights)		9	15	9	15	9	15	
3 Lane Motorway (D3M)	Year	0	10	19	27	34	41	48	55
Initial Flow 80,000 AADT	Works	New	In	In	In	In	In	In	In
(DLP)	Cost		552	816	552	816	552	816	552
	Duration (nights)		14	24	14	24	14	24	14
4 Lane Motorway (D4M)	Year	0	10	19	27	34	41	48	55
Initial Flow 80,000 AADT	Works	New	In	In	In	In	In	In	In
(DLP)	Cost		738	1092	738	1092	738	1092	738
	Duration (nights)		19	32	19	32	19	32	19

Costs in £'000 per km of road (i.e. both directions), in average 2010 prices, includes treatment and traffic management costs.

Durations and costs are per km of road using day working rates for S2AP and D2AP roads and night working rates for D3AP, D3M and D4M.

TS = Thin Surfacing (typically 30mm) In = Inlay (depths = 50mm, 100mm)

Ov = Overlay (height = 50mm, 100mm)

National average percentages of heavy vehicles assumed for each road type.

LLP = Long Life Flexible Pavement DLP = Determinate Life Flexible Pavement

6.2.3 The QUADRO values shown in Table X have not been updated since 2004 and are used as indicative only at this early stage, for comparative purposes. Scheme specific maintenance values will be required for subsequent analysis.

6.2.4 The total scheme length for **Option 1** is given as approximately 3.9 km. This excludes the extent which routes along the existing Bumpers Lane. Taking the above 'Dual 2 Lane 30,000 AADT' parameter values and multiplying them by the road length, the additional maintenance cost (over a 60-year period) is estimated as £2.4 million, discounted to 2010 prices.

6.2.5 The total scheme length for Option 2 is given as approximately 4.0 km. This excludes the extent which routes along existing Bumpers Lane and the existing link from the Park and Ride site to the A483. Taking the above 'Single Lane 19,000 AADT' parameter values and multiplying them by the road length, the additional maintenance cost is estimated as £1.5 million (over a 60-year period), discounted to 2010 prices.

6.2.6 For Option 3, the scheme length has been taken as 4.0 km dual carriageway, plus 200m of single carriageway for the grade separated junction links towards the A5104. The total maintenance costs (60-year period) for this scenario is estimated as £2.6 million (discounted to 2010 prices).

6.3 Travel Benefits

6.3.1 DFT's standard highway travel related benefit calculator, TUBA, has been used within this assessment - TUBA version 1.9.5. This software takes the output SATURN model skimmed matrices for traffic demand, total travelled by time and distance for each origin and destination pair, to estimate the total travel costs in terms of vehicle operating costs and travel time costs. The software uses standard WebTAG compliant parameters including values of time by user type and discount rates to take into account the year of the assessment. It also takes into account knock-on impacts, primarily the impact on tax revenues.

6.3.2 By comparing the total cost of travel with and without a scheme in place, TUBA calculates the implied benefit and compares this to the scheme cost, which the user also inputs. This has been carried out for Option 1, Option 2 and Option 3, though maintenance costs have been calculated separately as discussed above.

6.4 Cost-Benefit Analysis

6.4.1 In terms of total costs, for **Option 1**, in the price base year of 2010, TUBA estimates costs as **£54.9m** with the estimated maintenance costs (over a 60-year period) of **£2.4m**, which totals **£57.2m** (over 60 years). TUBA estimates total travel benefits as **£318.7m**. The implied Net Present Value (NPV) is **£261.5m** and Benefit Cost Ratio (BCR) is **5.6**.

6.4.2 For Option 2, in the price base year of 2010, TUBA estimates costs as **£43.1m** with the estimated maintenance costs (over a 60-year period) of **£1.5m** this totals **£44.7m** (over 60 years). TUBA estimates total travel benefits as **£327.1m**. The implied Net Present Value (NPV) is **£282.5m** and Benefit Cost Ratio (BCR) is **7.3**.

6.4.3 For Option 3, in the price base year of 2010, TUBA estimates costs as **£64.6m** with the estimated maintenance costs (over a 60-year period) of **£2.6m** this totals **£67.2m** (over 60 years). TUBA estimates total travel benefits as **£334.4m**. The implied Net Present Value (NPV) is **£267.2m** and Benefit Cost Ratio (BCR) is **5.0**.

6.4.4 This suggests that Option 1, Option 2 and Option 3 all represent high value for money. However, this is based on high level analysis values, including costs which require more detailed input for future analysis.

6.4.5 Option 2 appears to generate more benefits at a lower cost and therefore produces a stronger NPV and BCR than Option 1. As discussed in Chapter 2, the feasibility/acceptability of Option 1 is also questionable, in terms of land take, design parameters and associated costs. Option 3 generates the highest level of benefits of all three options, but also has the highest costs, resulting in the lowest BCR overall – this option also presents challenges in terms of the acceptability of a grade separated junction with the A5104.

6.4.6 The full Analysis of Monetised Costs and Benefits (AMCB) and Economic Efficiency of the Transport System (TEE) tables are included in **Appendix B**.

7. CONCLUSION

7.1 Option Identification

7.1.1 The option development work to date has focussed around the original alignment (protected in the Local Plan), which follows the border with Flintshire. It is intended to explore options to the west of this route following the commencement of discussions with stakeholders. Following discussions with officers at CWaC, two variants of the original alignment for the Chester Western Relief Road were identified for assessment in the transport model. Both options provide a connection between the A483, Wrexham Road, (north of the junction with the A55) and the A548 Sealand Road. The key difference between the options is that Option 1 would be dual carriageway with no intermediate junctions, whereas Option 2 would be single carriageway with connections at intersections. Option 3 is a middle ground, with just one intersection.

7.2 Model Development Overview

7.2.1 The SATURN model, highway impact analysis has been conducted by building upon existing calibrated and validated base year (2010) models. Existing spreadsheet tools which combine TEMPRO based background traffic growth and localised development based traffic have been used to generate forecast traffic levels for forecast years 2020 and 2030, for AM, PM and IP time periods.

7.3 Forecast Year Model Results Summary

7.3.1 The results of the analysis suggest that both Option 1 and Option 2 have a positive impact in reducing the amount of traffic on the A483 and decreasing congestion across the network as a whole. Option 1 provides a quicker north-south route, but Option 2 provides greater connectivity to the network. The feasibility of Option 1 is more questionable than Option 2. Option 2 however, suggests that in the AM peak it would be operating without any spare capacity at the northern end which connects with Bumpers Lane.

7.4 Economic Results Summary

7.4.1 This high level analysis suggests that both Option 1 and Option 2 would provide high value for money, with output indicative BCRs of 5.6 and 7.3 respectively, as does the Option 3 variant, but with a lower BCR of 5.0. These values are based on a high level analysis and benefits and costs in particular would require further analysis. Option 1 provides a ‘Relief Road’ function as it has fewer connections and therefore provides a quicker route, but the land take requirements may be unacceptable from a practicality and / or cost perspective. The function of Option 2 is more akin to a Distributor Road. Option 3 has been designed with the inclusion of a compact grade separated junction at the A5104 – this would require further design work to confirm the feasibility of the option.

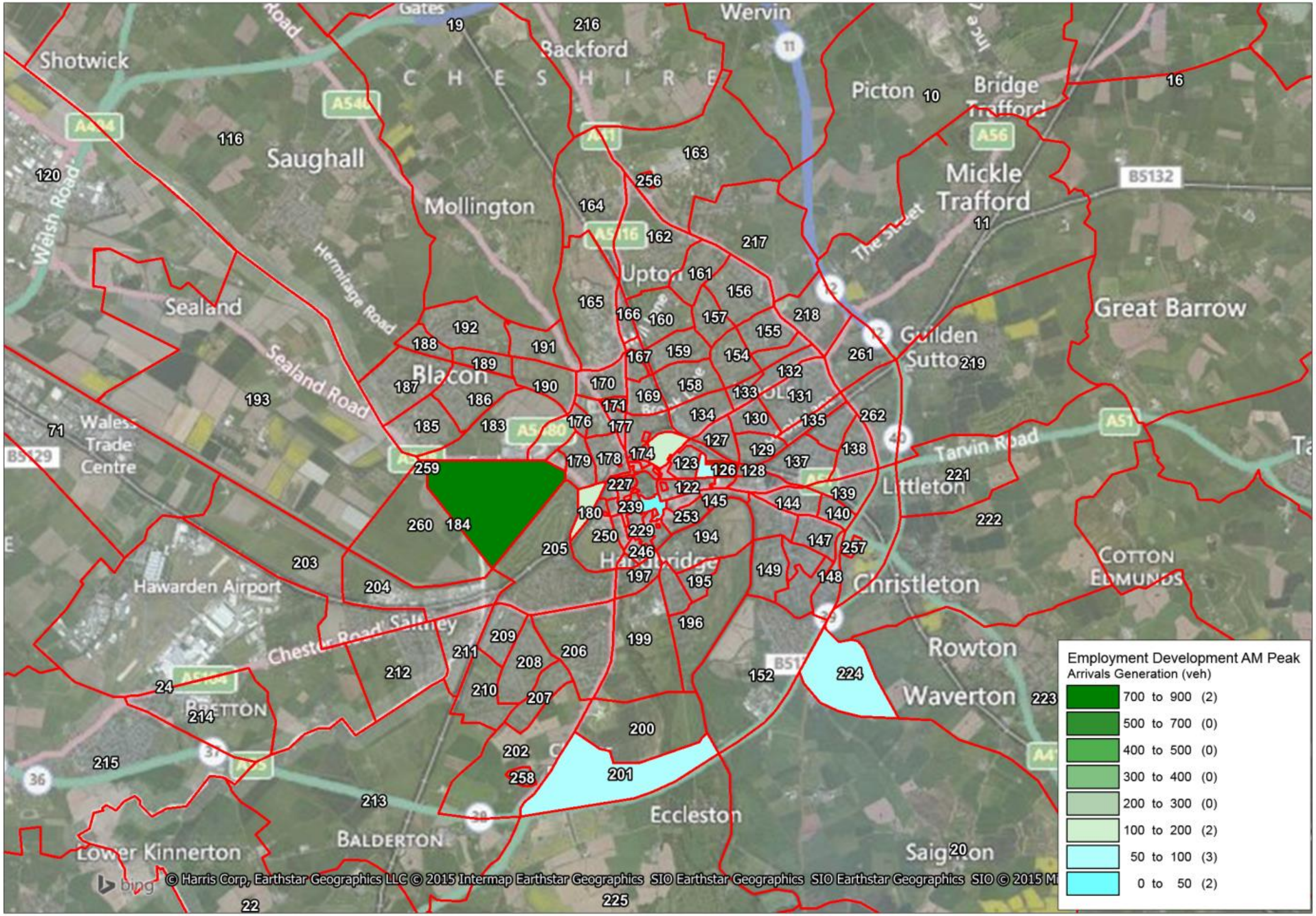
7.5 Way Forward

7.5.1 The analysis within this report suggests that the options considered would have positive traffic impacts overall and generate a significant level of economic benefits. It is proposed that an equivalent analysis is completed for an alternative option further to the West (i.e. within Flintshire) - this will be completed following the stakeholder consultation. This will enable the selection of a preferred option for further development and submission in future funding rounds.

APPENDIX A – TRIP GENERATION (AM Peak)

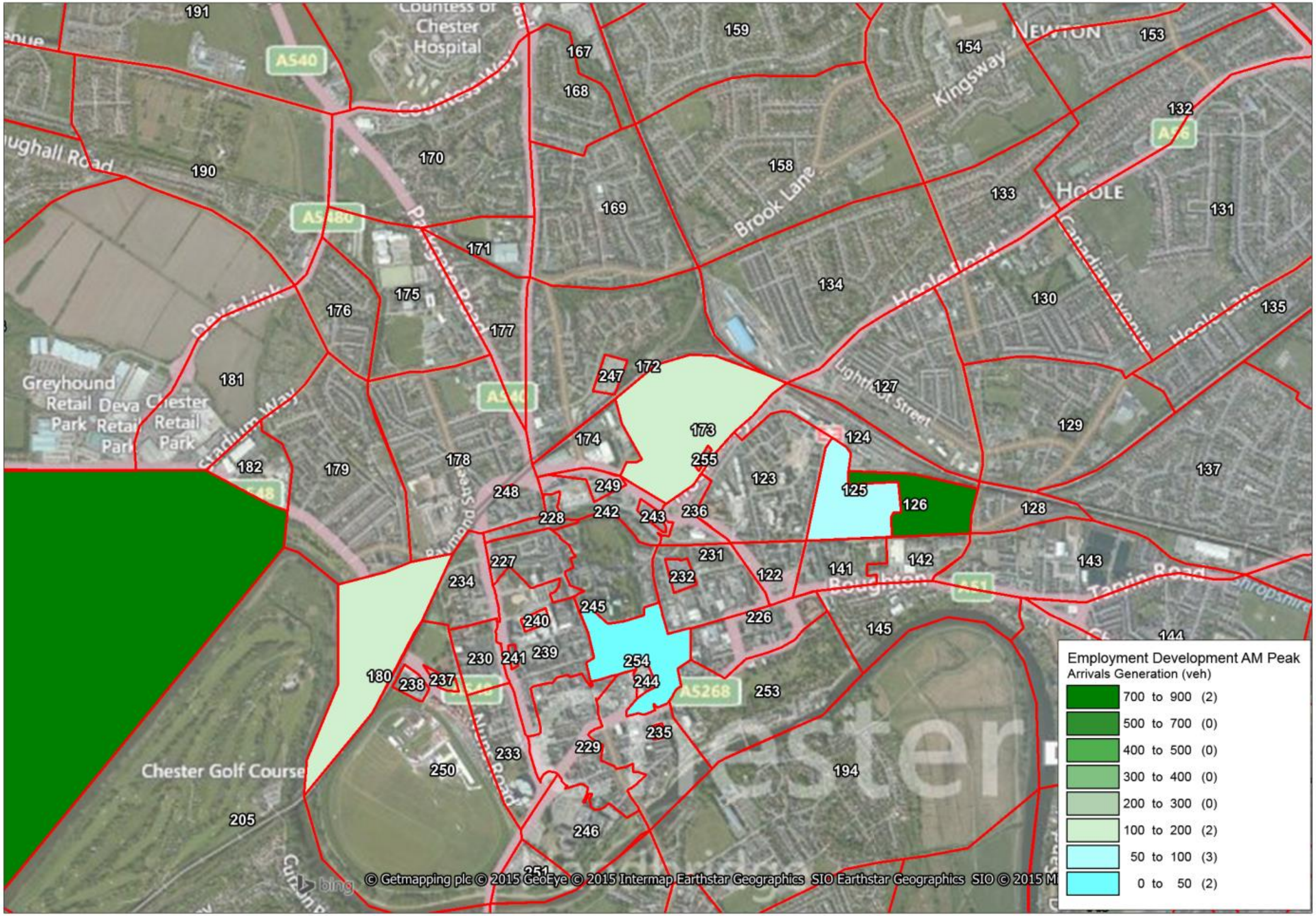
Capabilities on project:
Transportation

Figure A1 - CWaC_Employment_AM_Peak_Trip_Gen_Arrivals-wide-view



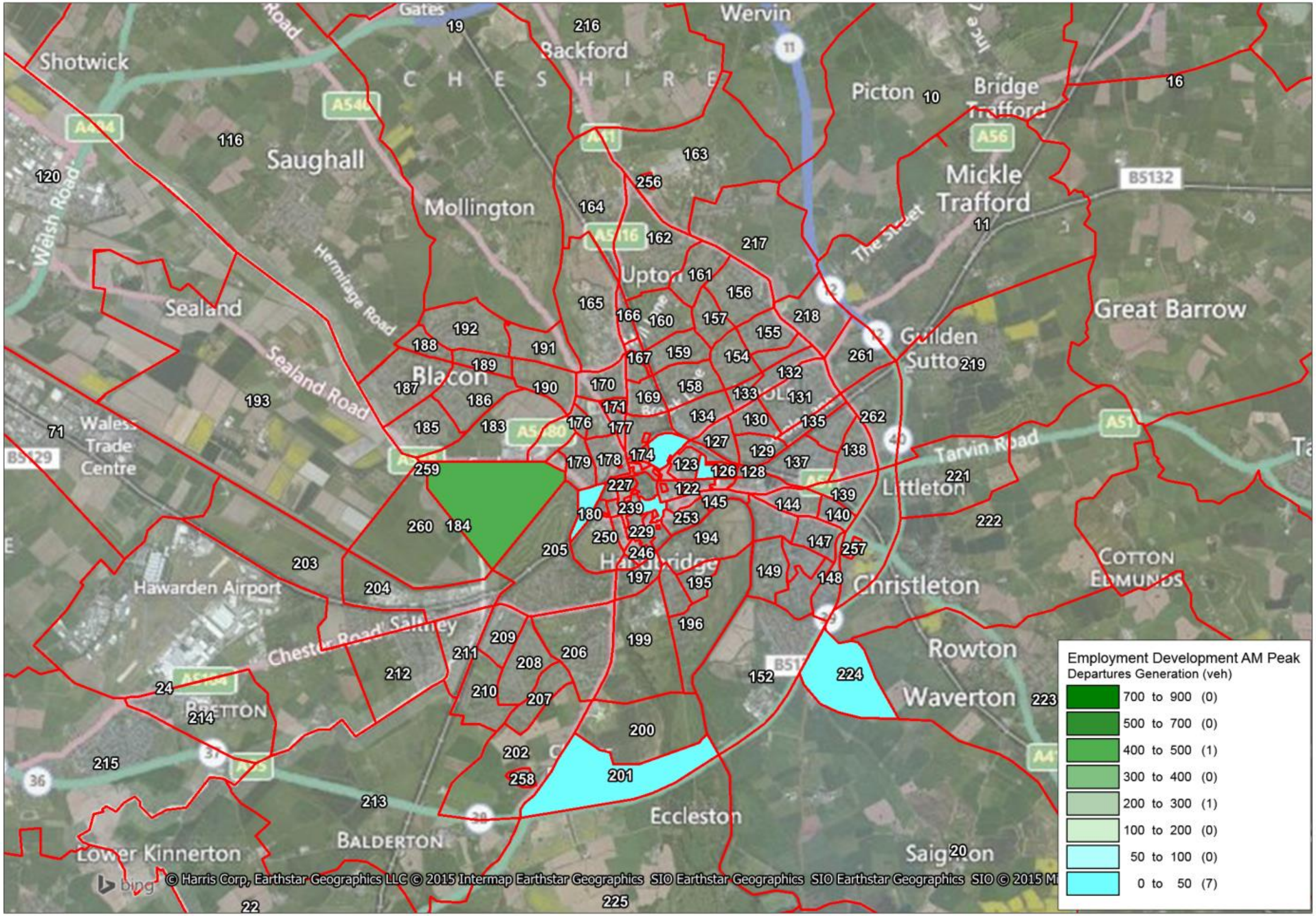
Capabilities on project:
Transportation

Figure A2 - CWaC_Employment_AM_Peak_Trip_Gen_Arrivals-near-view



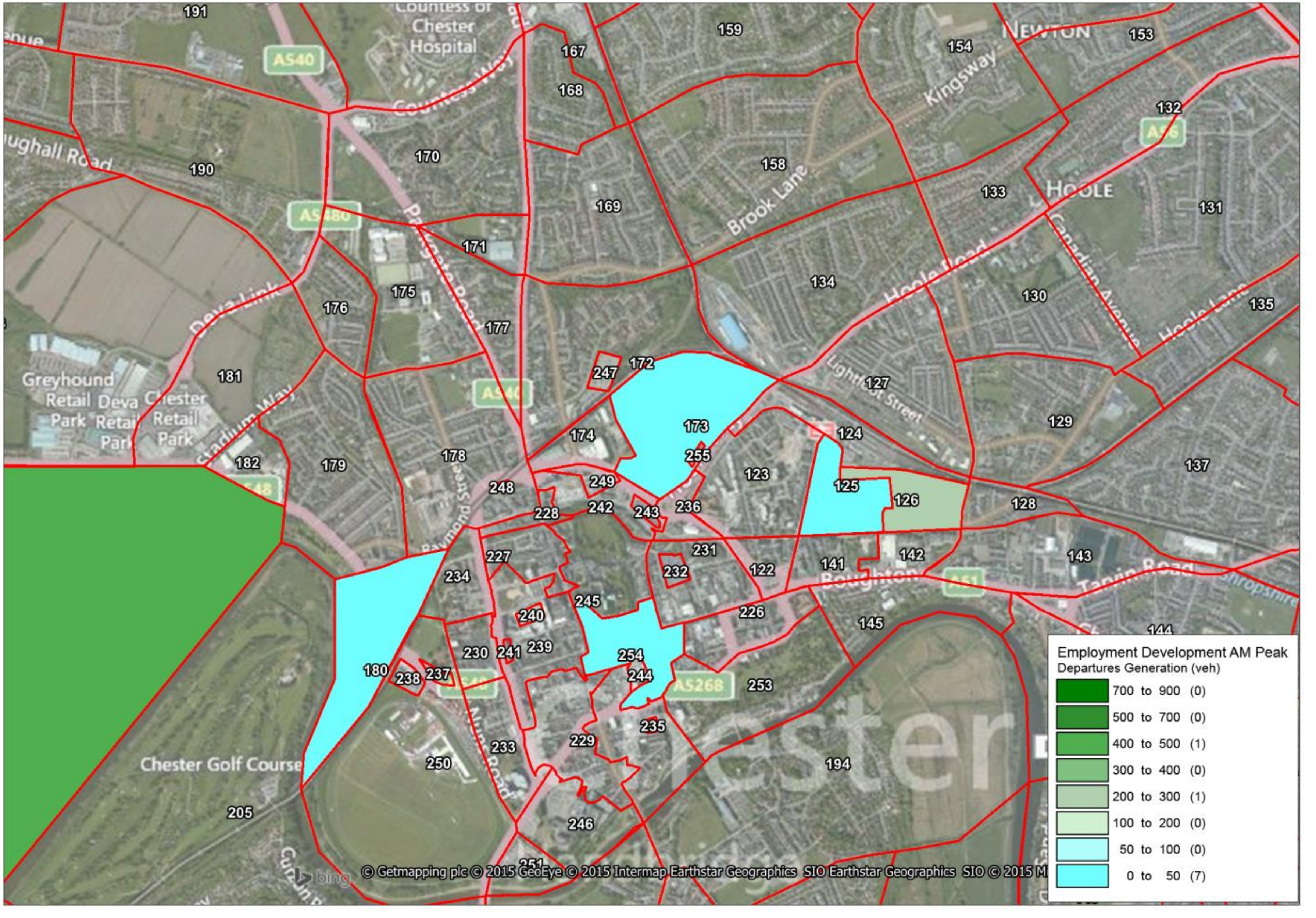
Capabilities on project:
Transportation

Figure A3 - CWaC_Employment_AM_Peak_Trip_Gen_Departures-wide-view



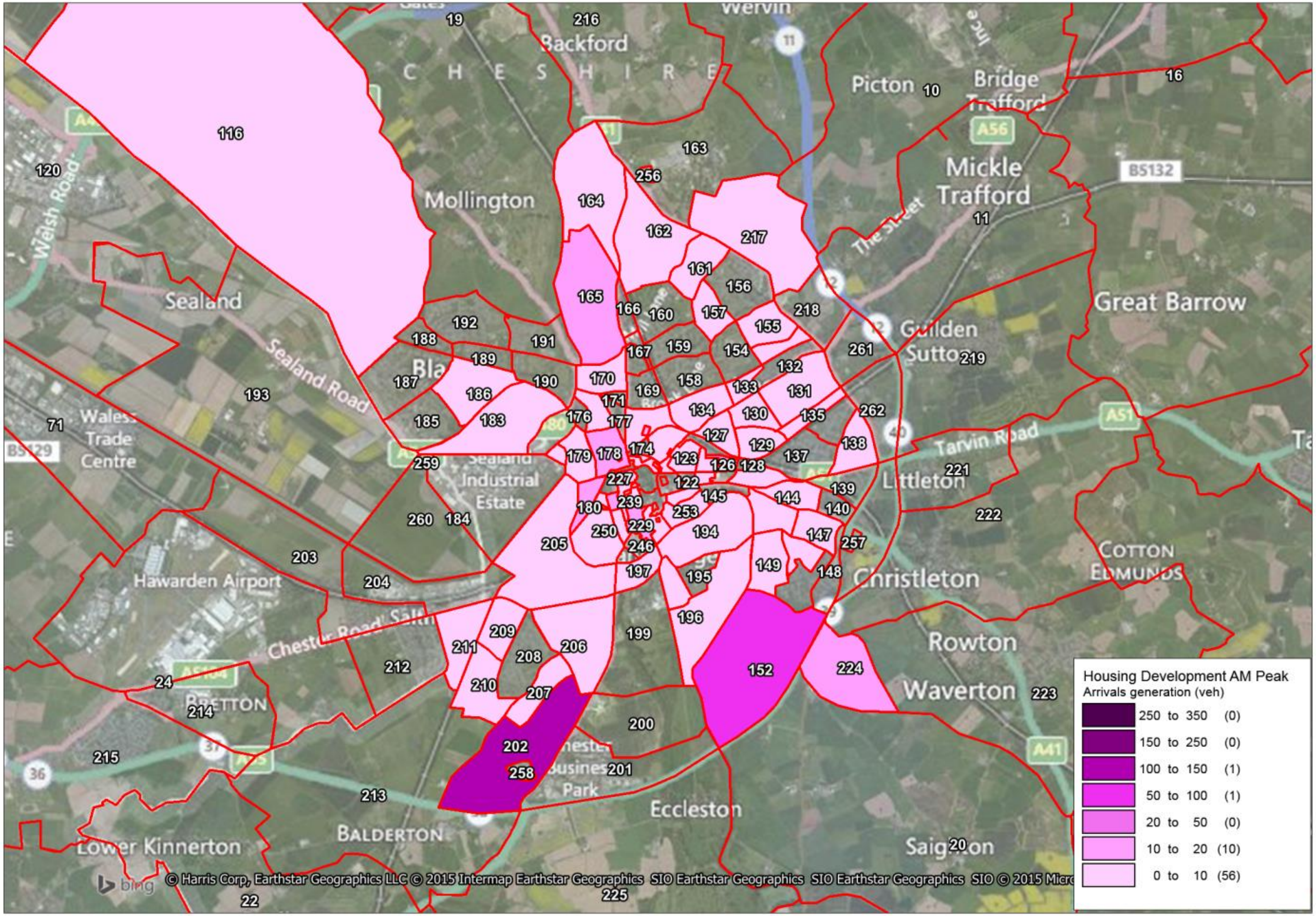
Capabilities on project:
Transportation

Figure A4 - CWaC_Employment_AM_Peak_Trip_Gen_Departures-near-view



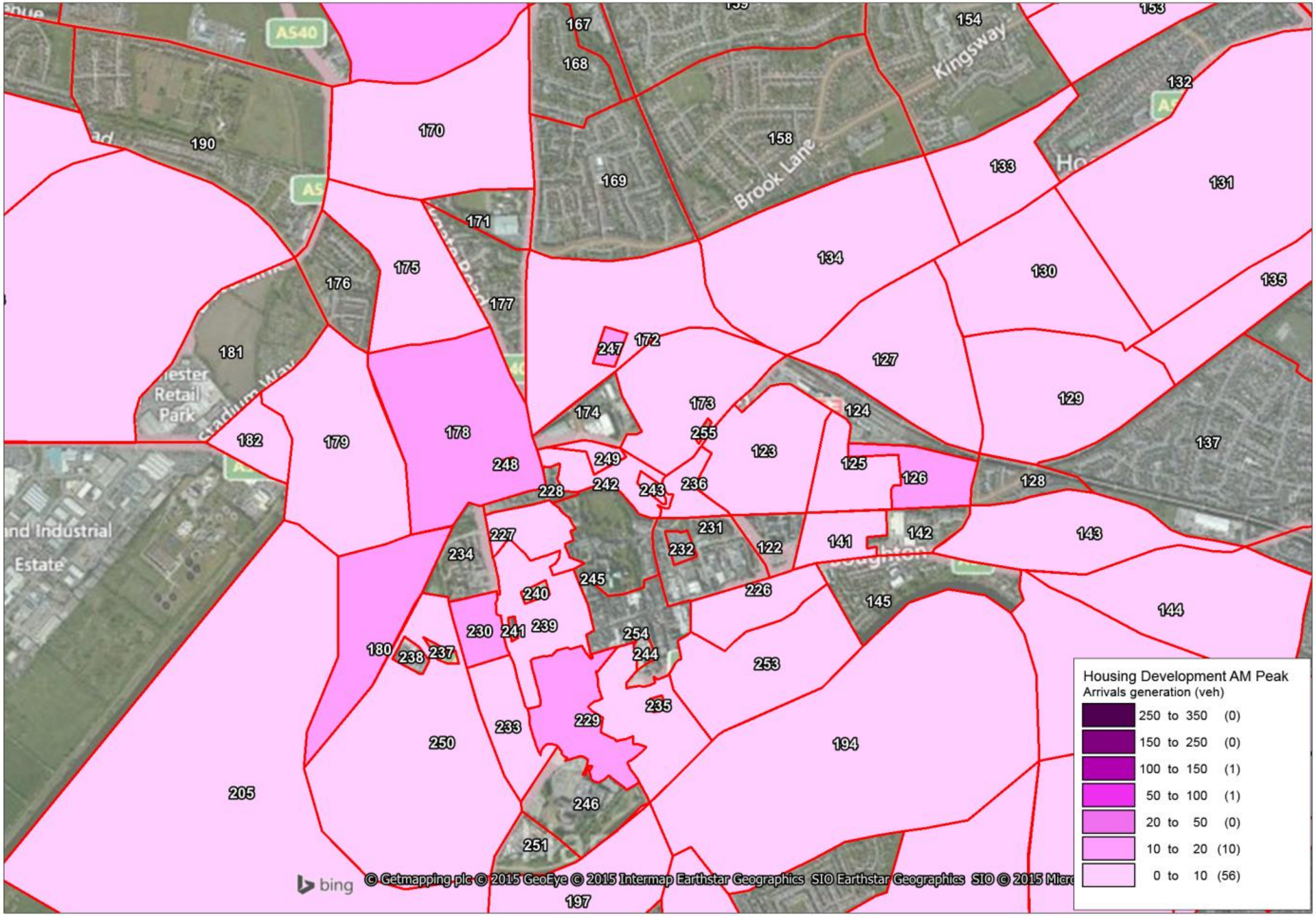
Capabilities on project:
Transportation

Figure A5 - CWaC_Housing_AM_Peak_Trip_Gen_Arrivals-wide-view



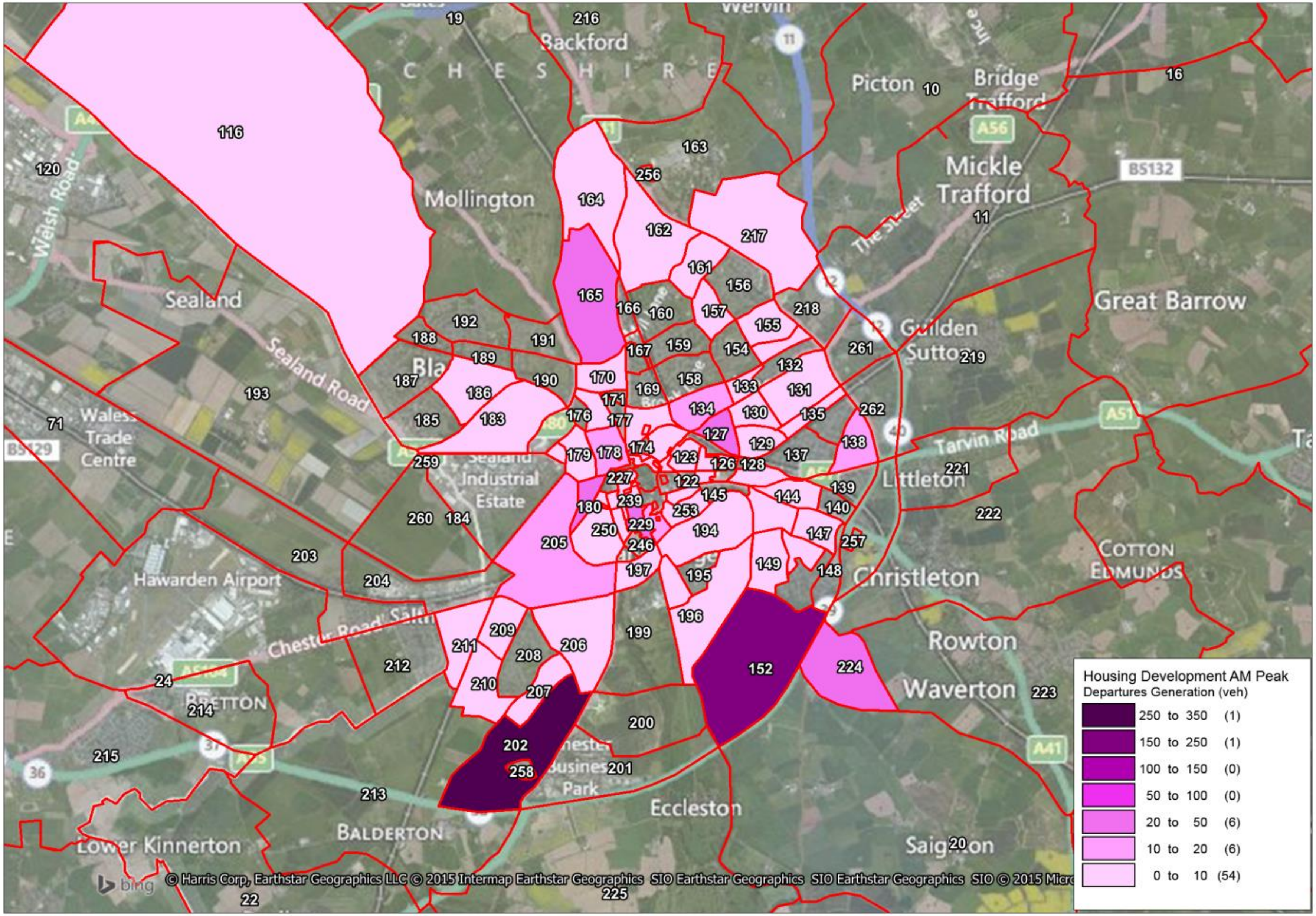
Capabilities on project:
Transportation

Figure A6 - CWaC_Housing_AM_Peak_Trip_Gen_Arrivals-near-view



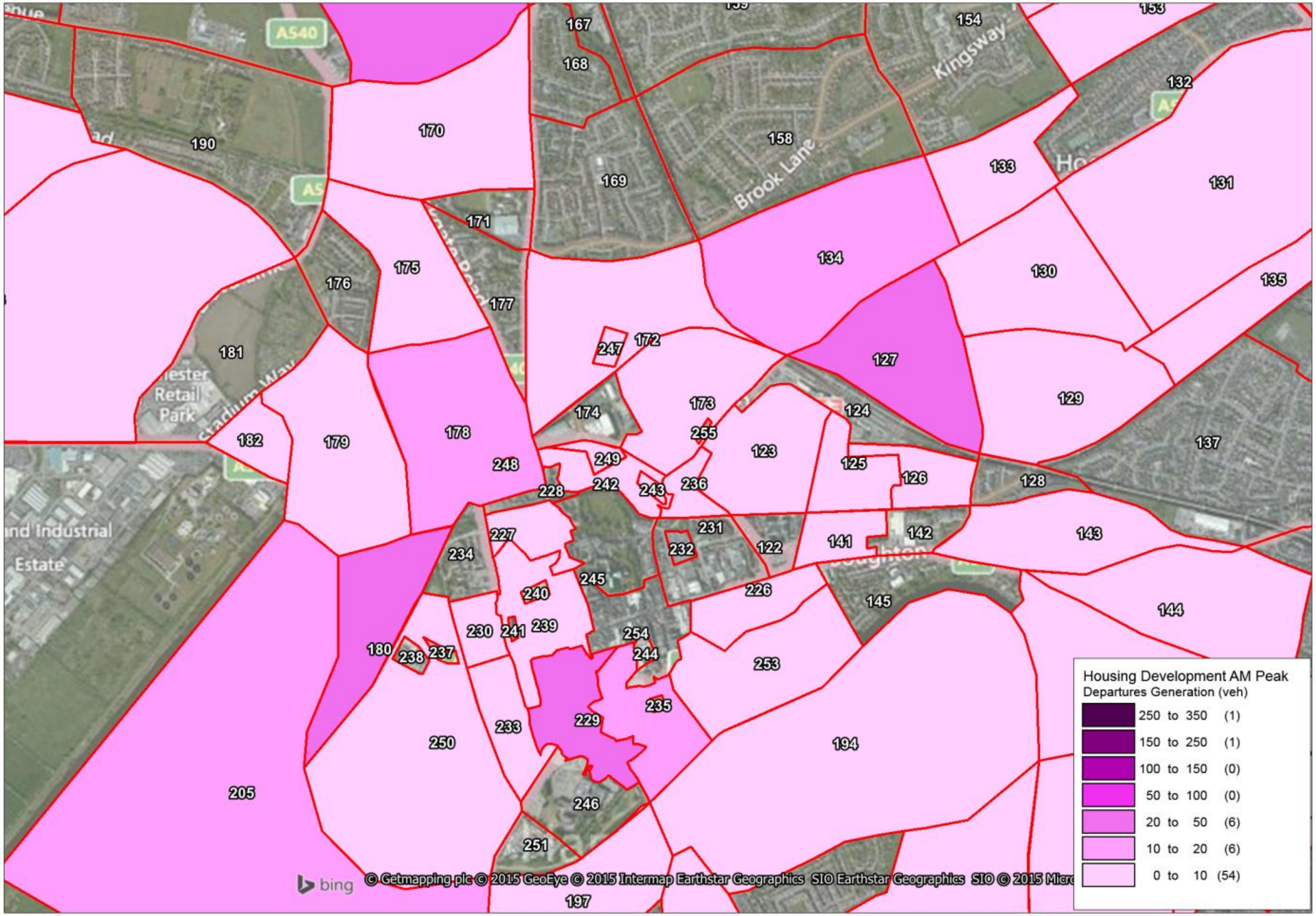
Capabilities on project:
Transportation

Figure A7 - CWaC_Housing_AM_Peak_Trip_Gen_Departs-wide-view



Capabilities on project:
Transportation

Figure A8 - CWaC_Housing_AM_Peak_Trip_Gen_Departs-near-view



APPENDIX B – AMCB AND TEE OUTPUT TABLES

Option 1

Analysis of Monetised Costs and Benefits

	£,000	
Noise		*(12)*
Local Air Quality		*(13)*
Greenhouse Gases	3257.00	*(14)*
Journey Quality		*(15)*
Physical Activity		*(16)*
Accidents		*(17)*
Economic Efficiency: Consumer Users (Commuting)	93503.00	*(1a)*
Economic Efficiency: Consumer Users (Other)	86467.00	*(1b)*
Economic Efficiency: Business Users and Providers	143959.00	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-8445.00	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	318741.00	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	57248.71	*(10)*
Present Value of Costs (see notes) (PVC)	57248.71	*(PVC) = (10)*
OVERALL IMPACTS		
Net Present Value (NPV)	261492.29	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)	5.6	BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

Economic Efficiency of the Transport System (TEE)

£,000s

Non-business: Commuting	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	86954.00		86954.00			
Vehicle operating costs	6550.00		6550.00			
User charges	0.00		0.00			
During Construction & Maintenance	0.00		0.00			
NET NON-BUSINESS BENEFITS: COMMUTING	93504.00	*(1a)*	4.53			

Non-business: Other	ALL MODES		ROAD	BUS and COACH	RAIL	OTHER
User benefits	TOTAL		Private Cars and LGVs	Passengers	Passengers	
Travel time	81081.00		81081.00			
Vehicle operating costs	5385.00		5385.00			
User charges	0.00		0.00			
During Construction & Maintenance	0.00		0.00			
NET NON-BUSINESS BENEFITS: OTHER	86466.00	*(1b)*	4.53			

Business								
User benefits			Goods Vehicles	Business Cars & LGVs	Passengers	Freight	Passengers	
Travel time	132457.00		45800.00	86657.00				
Vehicle operating costs	11502.00		6908.00	4594.00				
User charges	0.00		0.00	0.00				
During Construction & Maintenance	0.00		0.00	0.00				
Subtotal	143959.00	*(2)*	52708.00	91251.00				
Private sector provider impacts						Freight	Passengers	
Revenue								
Operating costs								
Investment costs								
Grant/subsidy								
Subtotal	0.00	*(3)*						
Other business impacts								
Developer contributions		*(4)*						
NET BUSINESS IMPACT	143959.00	*(5) = (2) + (3) + (4)*						
TOTAL								
Present Value of Transport Economic Efficiency Benefits (TEE)	323929.00	*(6) = (1a) + (1b) + (5)*						

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values

Option 2

Analysis of Monetised Costs and Benefits

	£,000	
Noise		*(12)*
Local Air Quality		*(13)*
Greenhouse Gases	3897.00	*(14)*
Journey Quality		*(15)*
Physical Activity		*(16)*
Accidents		*(17)*
Economic Efficiency: Consumer Users (Commuting)	70016.00	*(1a)*
Economic Efficiency: Consumer Users (Other)	61089.00	*(1b)*
Economic Efficiency: Business Users and Providers	202356.00	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-10217.00	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	327141.00	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	44675.92	*(10)*
Present Value of Costs (see notes) (PVC)	44675.92	*(PVC) = (10)*
OVERALL IMPACTS		
Net Present Value (NPV)	282465.08	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)	7.3	BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

Economic Efficiency of the Transport System (TEE) £,000s

	ALL MODES		ROAD		BUS and COACH	RAIL		OTHER
Non-business: Commuting								
User benefits	TOTAL		Private Cars and LGVs		Passengers	Passengers		
Travel time	60301.00		60301.00					
Vehicle operating costs	9715.00		9715.00					
User charges	0.00		0.00					
During Construction & Maintenance	0.00		0.00					
NET NON-BUSINESS BENEFITS: COMMUTING	70016.00	*(1a)*	4.53					
Non-business: Other								
User benefits	TOTAL		Private Cars and LGVs		Passengers	Passengers		
Travel time	48102.00		48102.00					
Vehicle operating costs	12988.00		12988.00					
User charges	0.00		0.00					
During Construction & Maintenance	0.00		0.00					
NET NON-BUSINESS BENEFITS: OTHER	61090.00	*(1b)*	4.53					
Business								
User benefits			Goods Vehicles	Business Cars & LGVs	Passengers	Freight	Passengers	
Travel time	193473.00		36368.00	157105.00				
Vehicle operating costs	8883.00		16455.00	-7572.00				
User charges	0.00		0.00	0.00				
During Construction & Maintenance	0.00		0.00	0.00				
Subtotal	202356.00	*(2)*	52823.00	149533.00				
Private sector provider impacts						Freight	Passengers	
Revenue								
Operating costs								
Investment costs								
Grant/subsidy								
Subtotal	0.00	*(3)*						
Other business impacts								
Developer contributions		*(4)*						
NET BUSINESS IMPACT	202356.00	*(5) = (2) + (3) + (4)*						
TOTAL								
Present Value of Transport Economic Efficiency Benefits (TEE)	333462.00	*(6) = (1a) + (1b) + (5)*						

Notes: Benefits appear as positive numbers, w hile costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values

Analysis of Monetised Costs and Benefits

	£,000	
Noise		*(12)*
Local Air Quality		*(13)*
Greenhouse Gases	4292.00	*(14)*
Journey Quality		*(15)*
Physical Activity		*(16)*
Accidents		*(17)*
Economic Efficiency: Consumer Users (Commuting)	96396.00	*(1a)*
Economic Efficiency: Consumer Users (Other)	92771.00	*(1b)*
Economic Efficiency: Business Users and Providers	152145.00	*(5)*
Wider Public Finances (Indirect Taxation Revenues)	-11235.00	*- (11) - sign changed from PA table, as PA table represents costs, not benefits*
Present Value of Benefits (see notes) (PVB)	334369.00	*(PVB) = (12) + (13) + (14) + (15) + (16) + (17) + (1a) + (1b) + (5) - (11)*
Broad Transport Budget	67151.92	*(10)*
Present Value of Costs (see notes) (PVC)	67151.92	*(PVC) = (10)*
OVERALL IMPACTS		
Net Present Value (NPV)	267217.08	NPV=PVB-PVC
Benefit to Cost Ratio (BCR)	5.0	BCR=PVB/PVC

Note : This table includes costs and benefits which are regularly or occasionally presented in monetised form in transport appraisals, together with some where monetisation is in prospect. There may also be other significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented above does NOT provide a good measure of value for money and should not be used as the sole basis for decisions.

Economic Efficiency of the Transport System (TEE) **£,000s**

Non-business: Commuting	**ALL MODES**		**ROAD**		**BUS and COACH**	**RAIL**		**OTHER**
User benefits	**TOTAL**		**Private Cars and LGVs**		**Passengers**	**Passengers**		
Travel time	86647.00		86647.00					
Vehicle operating costs	9749.00		9749.00					
User charges	0.00		0.00					
During Construction & Maintenance	0.00		0.00					
NET NON-BUSINESS BENEFITS: COMMUTING	96396.00	*(1a)*	4.53					
Non-business: Other	**ALL MODES**		**ROAD**		**BUS and COACH**	**RAIL**		**OTHER**
User benefits	**TOTAL**		**Private Cars and LGVs**		**Passengers**	**Passengers**		
Travel time	84970.00		84970.00					
Vehicle operating costs	7802.00		7802.00					
User charges	0.00		0.00					
During Construction & Maintenance	0.00		0.00					
NET NON-BUSINESS BENEFITS: OTHER	92772.00	*(1b)*	4.53					
Business								
User benefits			**Goods Vehicles**	**Business Cars & LGVs**	**Passengers**	**Freight**	**Passengers**	
Travel time	137068.00		46720.00	90348.00				
Vehicle operating costs	15076.00		10094.00	4982.00				
User charges	0.00		0.00	0.00				
During Construction & Maintenance	0.00		0.00	0.00				
Subtotal	152144.00	*(2)*	56814.00	95330.00				
Private sector provider impacts						**Freight**	**Passengers**	
Revenue								
Operating costs								
Investment costs								
Grant/subsidy								
Subtotal	0.00	*(3)*						
Other business impacts								
Developer contributions		*(4)*						
NET BUSINESS IMPACT	152144.00	*(5) = (2) + (3) + (4)*						
TOTAL								
Present Value of Transport Economic Efficiency Benefits (TEE)	341312.00	*(6) = (1a) + (1b) + (5)*						

Notes: Benefits appear as positive numbers, while costs appear as negative numbers.
All entries are discounted present values, in 2010 prices and values