Access to Bath from the East

Forecasting for A4 Eastern Park and Ride

April 2016

Bath and North East Somerset Council

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Keynsham Civic Centre, Market Walk, Keynsham BS31 1FS

Mott MacDonald, Stoneham Place, Stoneham Lane, Southampton, SO50 9NW, United Kingdom
T +44 (0)23 8062 8800 **F** +44 (0)23 8064 7251 **W** www.mottmac.com

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Contents

1 Introduction

1.1 Background

Mott MacDonald has been commissioned by Bath and North East Somerset (B&NES) council to assist in the development of a demand forecast model for analysing the impacts of its strategies on

- Improving access from the east of Bath by improvement to public transport, both bus and rail, including a possible new park and ride (P&R) site to the east of Bath; and
- Reducing impact of through traffic, particularly heavy commercial vehicles, on the city

This report aims to outline and explain the procedures used in the forecasting assessment and in predicting the future year patronage for a possible new A4 Eastern P&R site. To support the estimation of new P&R demand, the area-wide multi-modal G-BATH model has been updated to a 2014 base year. The forecasting has been carried out on a Production Attraction (PA) basis, according to current WebTAG guidance, and using the National Trip End Model (NTEM) and Road Traffic Forecasts (RTF). The forecast networks were developed on the basis of WebTAG uncertainty log principles.

1.2 Purpose of Report

The purpose of this report is to document the development of the forecasting model including:

- The basic modelling framework;
- The approach used to develop the forecasting model; and
- The results obtained from the forecasting procedures.

1.3 Structure of Report

This report is structured in the following way:

- Chapter 2 details the demand model structure;
- Chapter 3 details the forecasting approach including the development of the forecast year network and trip ends;
- Chapter 4 provides analysis and discussion in relation to the A4 Eastern P&R scheme options; and
- Chapter 5 concludes the report.

2 Modelling Framework

2.1 The Modelling Framework

The updated G-BATH model currently consists of three main elements:

Highway Traffic Model: this is a SATURN model with 459 zones with an extensive detailed simulation area that goes beyond the main Bath city urban area. The rest of the network is represented by a SATURN buffer network. This model has been validated to a 2014 base year and full details are set out in the Highway Local Model Validation Report (Mott MacDonald, 2015).

Public Transport Model: this is an EMME public transport model covering both bus and rail modes. The model covers the same area as the highway model plus the key rail routes into Bath and represents the same base year of 2014. Full details of the PT base model are explained in Public Transport Model Validation Report (Mott MacDonald, 2015).

Demand Model: this is an EMME coded demand model. The model is an incremental model, and is set up in Production-Attraction (PA) format as required by WebTAG (Unit M2). Full details of the original demand model structure can be found in G-BATH v2.3 Demand Model Development Report (Atkins, 2009). For the purpose of forecasting P&R patronage in a more accurate way, the original demand model structure has been revised to introduce additional segmentation for travellers that pay for parking and those that do not as well as representing the P&R as part of the highway model and more details are provided in the next section.

2.2 Model Definition

Forecast Year

Future Year traffic forecasts were developed for 2029 which accords with the horizon of the B&NES Core Strategy.

Time Periods

The highway and PT assignment models have been developed for three time periods:

- AM Peak hour (08:00 – 09:00);
- Average Inter Peak Hour (10:00 – 16:00); and
- PM Peak hour (17:00 – 18:00).

Demand Segmentation

The revised G-BATH travel demands have been segmented by car availability, journey purpose and whether paying for parking in the city centre as described below:

- By person type
  - car available (CA); and
  - non-car available (NCA).
- By journey purpose
  - home based work (HBW);
  - home based other (HBO);
  - non-home based other (NHBO);
  - home based employer's business (HBEB); and
  - non-home based employer's business (NHBEB).
- By pay/not pay for parking in the city centre
  - those paying for parking in the city centre; and
  - those not paying for parking in the city centre.

Note the distinction made between home-based and non-home based purposes is required for adoption of PA-based modelling. Only work (HBW) and other purposes (HBO, NHBO) are segmented by pay/not pay for parking and the corresponding splits (60/40) are obtained from *Bath Transportation Package, Update to Forecasting and Economic Appraisal* (Mott MacDonald, 2010). Employer's business purposes (HBEB, NHBEB) are assumed not to pay for parking. Table 2.1 below tabulates the segmentation within the demand model.

Table 2.1: Demand Model Segmentation

Vehicle Type	Purpose	Car Availability	Pay for Parking at City Centre	PA/OD
Highway				
Car	HBO	CA	Not Pay	PA
Car	HBO	CA	Pay	PA
Car	NHBO	CA	Not Pay	OD
Car	NHBO	CA	Pay	OD
Car	NHBEB	CA	Not Pay	OD
Car	HBEB	CA	Not Pay	PA
Car	HBW	CA	Not Pay	PA
Car	HBW	CA	Pay	PA
PT				
Bus/Rail	HBO	CA	-	PA
Bus/Rail	NHBO	CA	-	OD
Bus/Rail	NHBEB	CA	-	OD
Bus/Rail	HBEB	CA	-	PA

Vehicle Type	Purpose	Car Availability	Pay for Parking at City Centre	PA/OD
Bus/Rail	HBW	CA	-	PA
Bus/Rail	HBO	NCA	-	PA
Bus/Rail	NHBO	NCA	-	OD
Bus/Rail	NHBEB	NCA	-	OD
Bus/Rail	HBEB	NCA	-	PA
Bus/Rail	HBW	NCA	-	PA

To reduce the model runtimes, the G-BATH assignment model was undertaken in a more aggregated form where assignment segmentation is made only to represent the different generalised costs for different user classes. There are four highway demand segments assigned in the SATURN model and two PT demand segments assigned in the EMME model, which are:

Highway

- Non EB (HBW + HBO + NHBO);
- EB (HBEB + NHBEB);
- Light Goods Vehicles (LGV); and
- Heavy Goods Vehicles (HGV).

PT

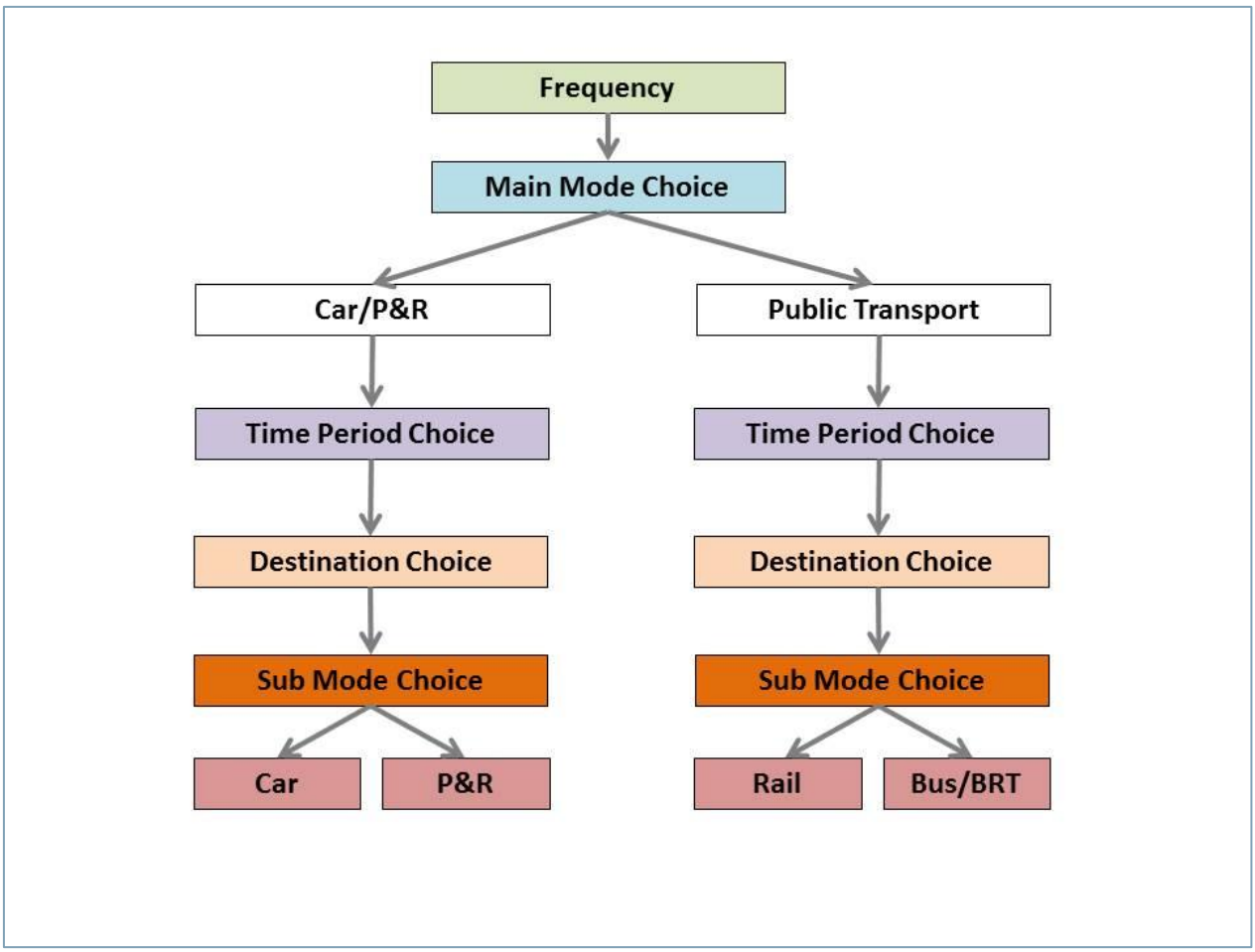
- Bus (combined by all demand segments); and
- Rail (combined by all demand segments).

LGV and HGV are treated as fixed demand hence they are treated outside the demand model.

2.3 Demand Modelling

The original G-BATH demand model adopts a hierarchical logit choice structure as shown in Figure 2.1. G-BATH uses an incremental demand modelling approach, as required by WebTAG, which responds to changes from the base generalised costs, measured in generalised minutes. The P&R choice appears in the bottom of the car nest of the main mode choice and therefore is treated as a highway sub-mode. The demand model structure passes composite costs up from the lower levels of the nest to higher levels – thereby P&R generalised costs influence destination choice, time period choice and main mode choice as shown in Figure 2.1.

Figure 2.1: Demand Model Choice Structure



Source: G-BATH v2.3 Demand Model Development Report, Atkins, 2009

According to the original demand model development report (Atkins, 2009), the G-BATH model was set up to model the following demand responses as shown in Table 2.2 below:

Table 2.2: G-BATH v2 Demand Model Overview

Stage	Model	Form	Person Type
1	Frequency Modelling	PA Tripends	CA & NCA
2	Main Mode Choice	PA Tripends	CA
3	Time Period Choice	PA Tripends	CA & NCA
4	Destination Choice	Translate PA Tripends to PA matrices	CA & NCA
5	Sub Mode Choice	PA matrices	CA & NCA
6	Assignment	OD matrices	CA & NCA

Source: G-BATH v2.3 Demand Model Development Report, Atkins, 2009

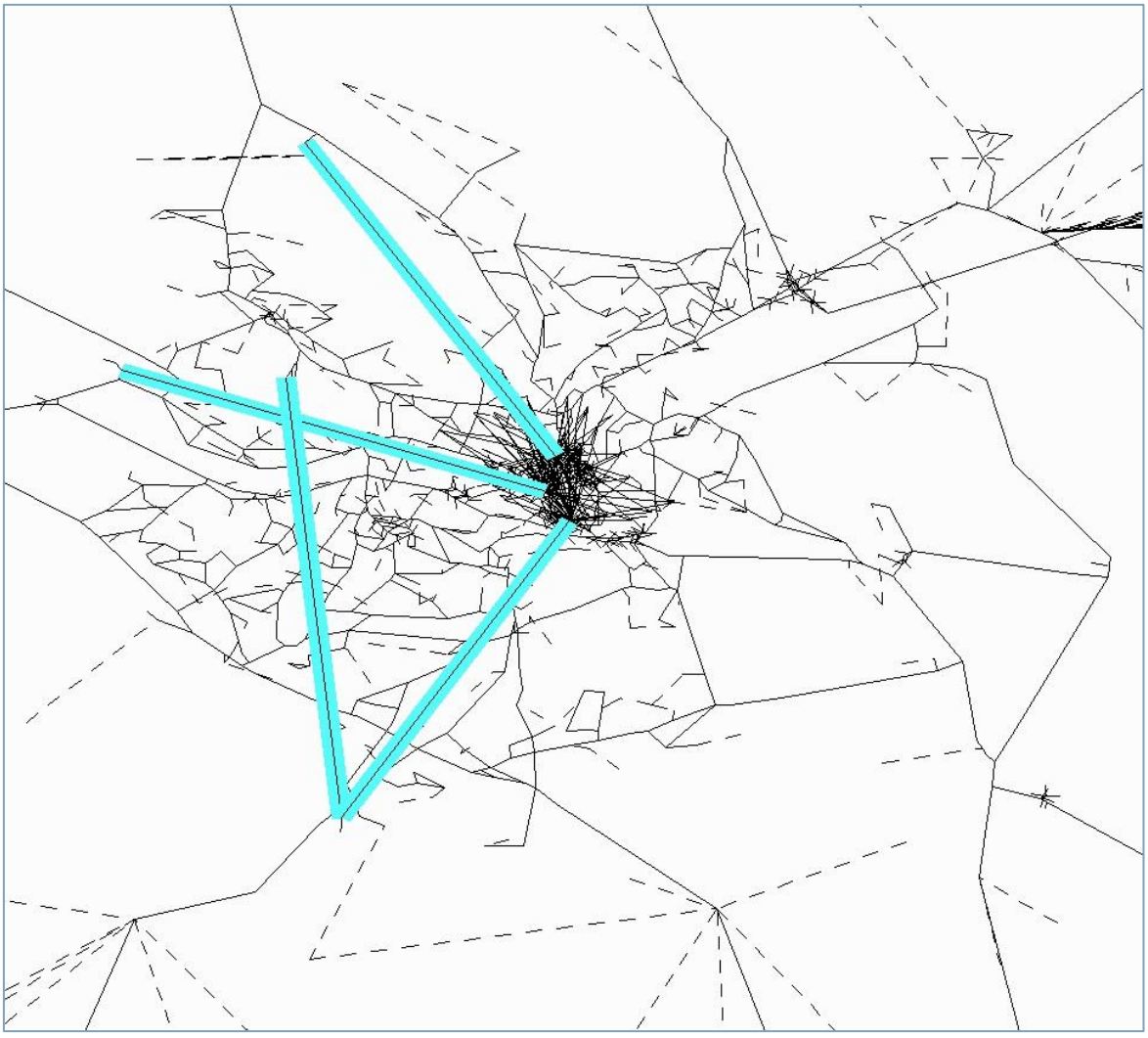
The frequency modelling (Stage 1) is undertaken for HBO and NHBO trips only as suggested by WebTAG. The main mode choice (Stage 2) between car and PT operates for Car Available (CA) person type only. The demand model operates at the 24-hour level until the time of day choice (Stage 3) is undertaken. For destination choice modelling (Stage 4), the demand model considers all time periods for all person types in parallel. The resulting PA matrices are converted into OD matrices after the sub mode choice (Stage 5) and before the individual highway and PT assignments (Stage 6) are undertaken.

Demand model parameter values have been retained from the previous G-BATH model, all of which were calibrated in line with WebTAG as explained in Atkins' demand model report (2009).

2.4 Representing P&R

Although the G-BATH model was set up to model the highway sub-mode choice through the demand model, we have generally found the above model structure to be fairly insensitive to the changes of parking charges and the new P&R sites. As a result, the sub-mode choice between highway only and P&R for a trip into the city centre has been revised by using the highway model to make the choice through the assignment process. The P&R elements were represented by pseudo links (Figure 2.2) in the model from each of the P&R sites to the city centre with only AM in, IP in/out and PM out being considered; the service between Odd Down and RUH has also been represented in the model. The segmentation of the demand according to pay / not pay for parking means that those that would normally pay for parking would be much more attracted to using the P&R. With this potential demand the P&R link costs were calibrated to achieve the observed demand for the existing sites, as explained in the next section.

Figure 2.2: P&R Links in the base highway model



Source: Mott MacDonald

2.5 P&R Calibration

The P&R calibration was accomplished by inputting generalised times onto P&R links so that the modelled P&R demands in the base year model have a good fit with the observed. The generalised time is considered to comprise the following elements:

$$Generalised\ Time = In\ Vehicle\ Time + Wait\ Time + Calibrated\ Penalty$$

The in vehicle time and wait time are taken as the starting point for estimating the total generalised time. This generalised time (which will also include interchange / calibration penalties) was then adjusted based on an iterative approach until achieving the observed demand. It should be noted that the P&R fares which are separately coded are also accounted for in the total generalised time for P&R. This is then used as the basis for forecasting and costs applied for new sites. The calculated calibration penalty for Lansdown has been used to determine the total generalised time for the A4 Eastern P&R site's generalised times, accounting for the different in vehicle times from the proposed site to the city centre. In addition, for the purpose of estimating maximum potential demand, a service frequency for the new site of 10 minutes to Queen Square and 20 minutes to RUH has been assumed (compares with 12-15 minutes for existing P&R services). The calibration is set out in Section 4 of this report.

2.6 Forecasting approach

Because the demand model structure is fairly insensitive to the changes of parking charges and new P&R sites, the demand model has been run only for the Do-Minimum (DM) scenario. The demand modelling assesses the changes in travel costs as a result of traffic growth so it requires reference travel costs which are taken from the 2014 base model and used as a baseline for measuring changes in travel costs in future years.

The final forecast demand produced by the demand model has been extracted. This has then been assigned on the highway DM and DS networks with the assignment applications used to predict the patronage for all P&R sites.

3 Forecasting Approach

3.1 Forecast Year Network

For forecasting purposes transport networks representing the supply and cost of transport in future years were required as a basis to assess the impact of the proposed scheme. Future year transport supply and costs relate to changes in the transport networks, for example new transport infrastructure or public transport services, and the cost of transport e.g. car parking charges or bus fares.

Do Minimum (DM) Network

Table 3.1 shows both the highway and PT schemes identified in consultation with B&NES and the uncertainty level (see Table 3.2 for classification) attributed to each scheme. Only those which are built, near certain and more than likely as well as located within the model's simulation area have been included in the 2029 DM networks.

Table 3.1: Uncertainty Log

Scheme	Type	Year	Level of Uncertainty	Included	Comment
A39/B3116 Two Headed Man	Junction improvement – signals	2013	Built	N	Not in the simulation area
A39/A368 Marksbury	Junction improvement – filter lane	2020	Hypothetical	N	-
Lower Bristol Road/ Midland Road, Bath	Junction improvement - signals	2020	Hypothetical	N	-
A39/B3355, Hallatrow	Junction improvement – mini roundabout	2018	Reasonably Foreseeable	N	Not in the simulation area
North Road/ Ralph Allen Drive, Bath	Junction improvement – mini roundabout	2015	Built	Y	-
Bath Hill/ Temple Street, Keynsham	Highway & public realm improvements	2015	Built	N	Not in the simulation area
20mph zone at Westmoreland, Oldfield, Lyncombe & Widcombe	Speed limit	2014	Built	Y	-
A4 Saltford	Toucan crossing	2017	Reasonably Foreseeable	N	Not in the simulation area
A4 Globe Roundabout	Toucan crossing	2015	Built	N	Not modelled
Stall Street, Bath	Highway & public realm improvements	2015	Under Construction	N	Not modelled
London Road regeneration, Bath	Highway & public realm improvements	2015	Built	Y	-
Keynsham regeneration	Highway & public realm improvements	2015	Built	N	Not in the simulation area
Paulton	Speed limit	2015	Built	N	Not in the

Scheme	Type	Year	Level of Uncertainty	Included	Comment
					simulation area
Hallatrow	Speed limit	2015	Built	N	Not in the simulation area
Hallatrow	Weight Limit	2015	Built	N	Not in the simulation area
Seven Dials, Bath	Highway & public realm improvements		Built	N	No need to change in the model
Darlington Street, Bath	Pelican to toucan crossing conversion	2016	Reasonably Foreseeable	N	Not modelled
A4 Newbridge P&R expansion	Signal & expansion	2015	Built	Already included	-
A36 Rossiter Road/ Widcombe Parade	Check	2015	Built	Y	-
Stall street & access restriction to Lower Borough Walls		2015	Under Construction	N	Not modelled
Enterprise Area	New bus route		More than likely	Y	-
Cold Ashton Roundabout	New Roundabout	2016	More than likely	N	Not in the simulation area
A350 Yarnbrook/ West Ashton relief road	Road scheme	2017	More than likely	Y	-
Improvements to A350 north of Chippenham	Road scheme	2015	Built	Y	-
Improvements to A350 (dualling) at Chippenham between Badger and Chequers roundabouts	Road scheme	2017	Near certain	Y	-
A350 Farmers roundabout	Road signalisation	2016	Near certain	Y	-
Improvements to M4 J17	Road scheme	2016	Near certain	N	Not in the simulation area
Corsham Station	Rail	2021	Reasonably foreseeable	N	No need to change in the model
Link Road east of Chippenham (between A350 & A4)	Road	2026	More than likely	Y	-

Table 3.2: Classification of Future Inputs

Probability of the Input	Description	Status
Near Certain	The outcome will happen or there is a certain probability that it will happen.	Intent announced by proponent to regulatory agencies.

Probability of the Input	Description	Status
		Approved development proposals. Projects under construction.
More than likely	The outcome is likely to happen but there is some uncertainty.	Submission of planning or consent application imminent. Development application within the consent process.
Reasonably foreseeable	The outcome may happen, but there is significant uncertainty	Identified within a development plan. Not directly associated with the transport strategy/scheme, but may occur if the strategy/scheme is implemented. Development conditional upon the transport strategy/scheme proceeding. Or, a committed policy goal, subject to tests (e.g. of deliverability) whose outcomes are subject to significant uncertainty.
Hypothetical	There is considerable uncertainty whether the outcome will ever happen.	Conjecture based upon currently available information. Discussed on a conceptual basis. One of a number of possible inputs in an initial consultation process. Or, a policy aspiration.

Source: Insert source text here

Do Something (DS) Network

The only difference between DM and DS network is the proposed A4 Eastern Bath P&R. The DS scenario represents one of three nearby candidate site locations that have been proposed for consideration as shown in Figure 3.1. For modelling purposes, no distinction has been made between the three sites. The new site is assumed to operate alongside and in addition to the existing P&R services. Two proposed routes have been considered so far, which includes:

- DSA (Figure 3.2), which links the new site with Queen Square. The frequency is assumed to be every 10 minutes.
- DSB (Figure 3.3), which links the new site with Queen Square, then extends to Royal University Hospital (RUH), with frequency being every 10 minutes for city centre and 20 minutes for RUH (i.e. only alternate buses will serve RUH).

It is worth noting that no capacity restraint has been applied at this stage. All new P&R services are assumed to have similar operating characteristics as the existing sites, for example operating hours and fares.

Figure 3.1: Proposed A4 Eastern Bath new P&R site options

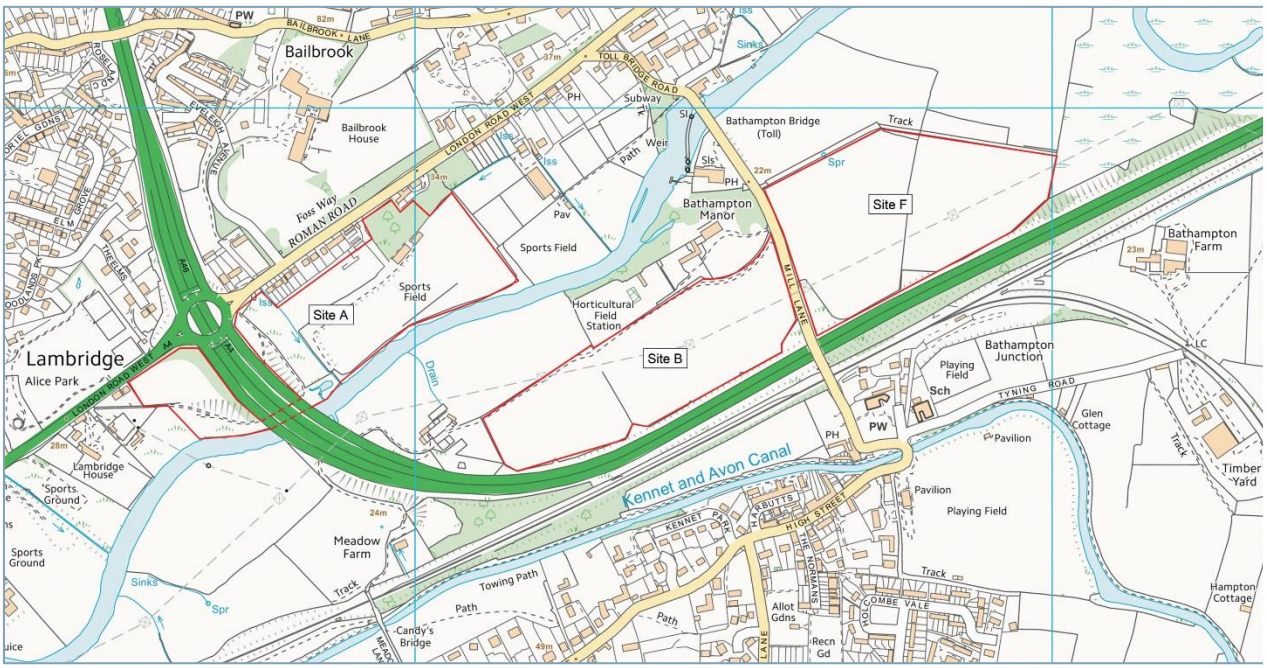
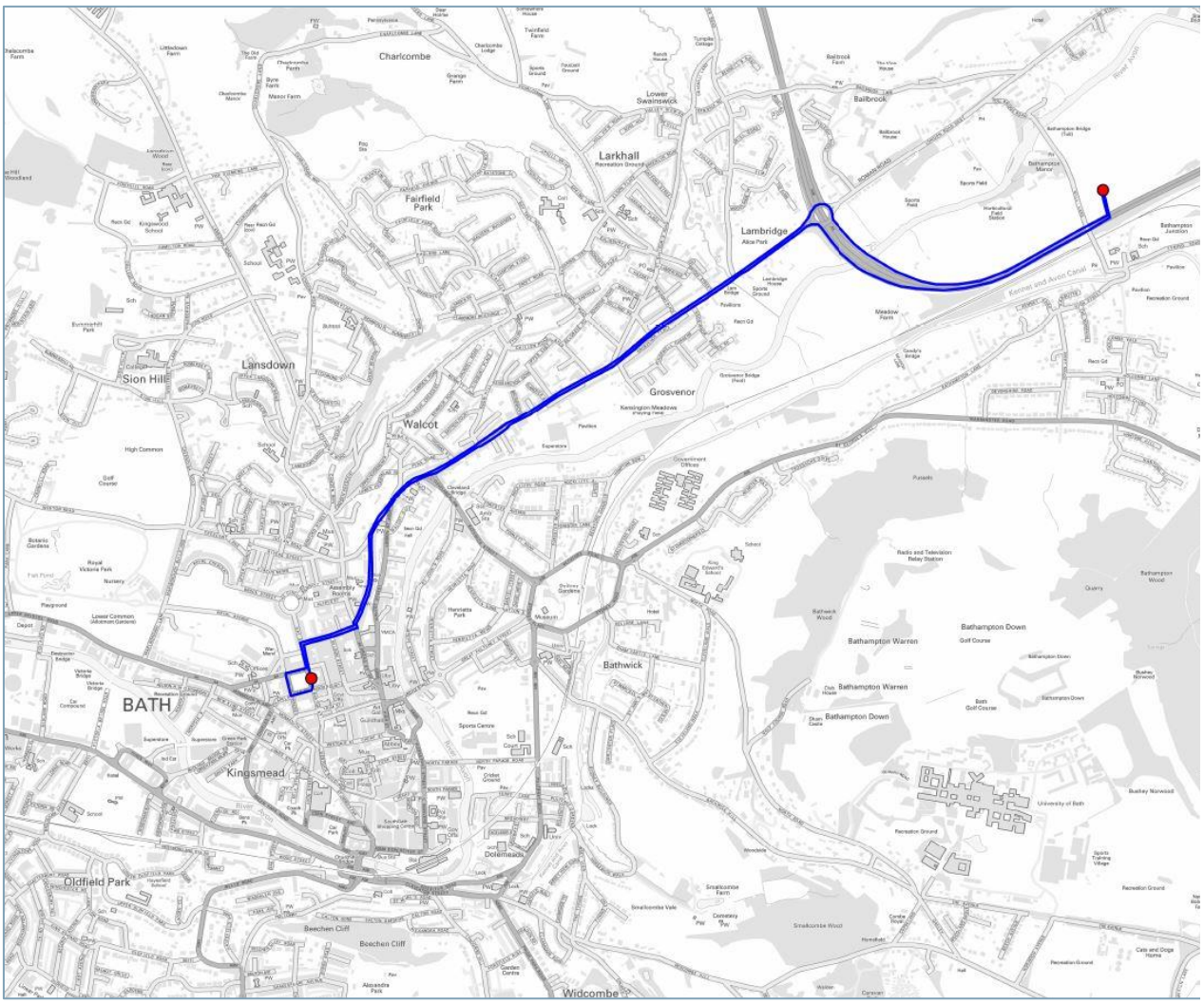
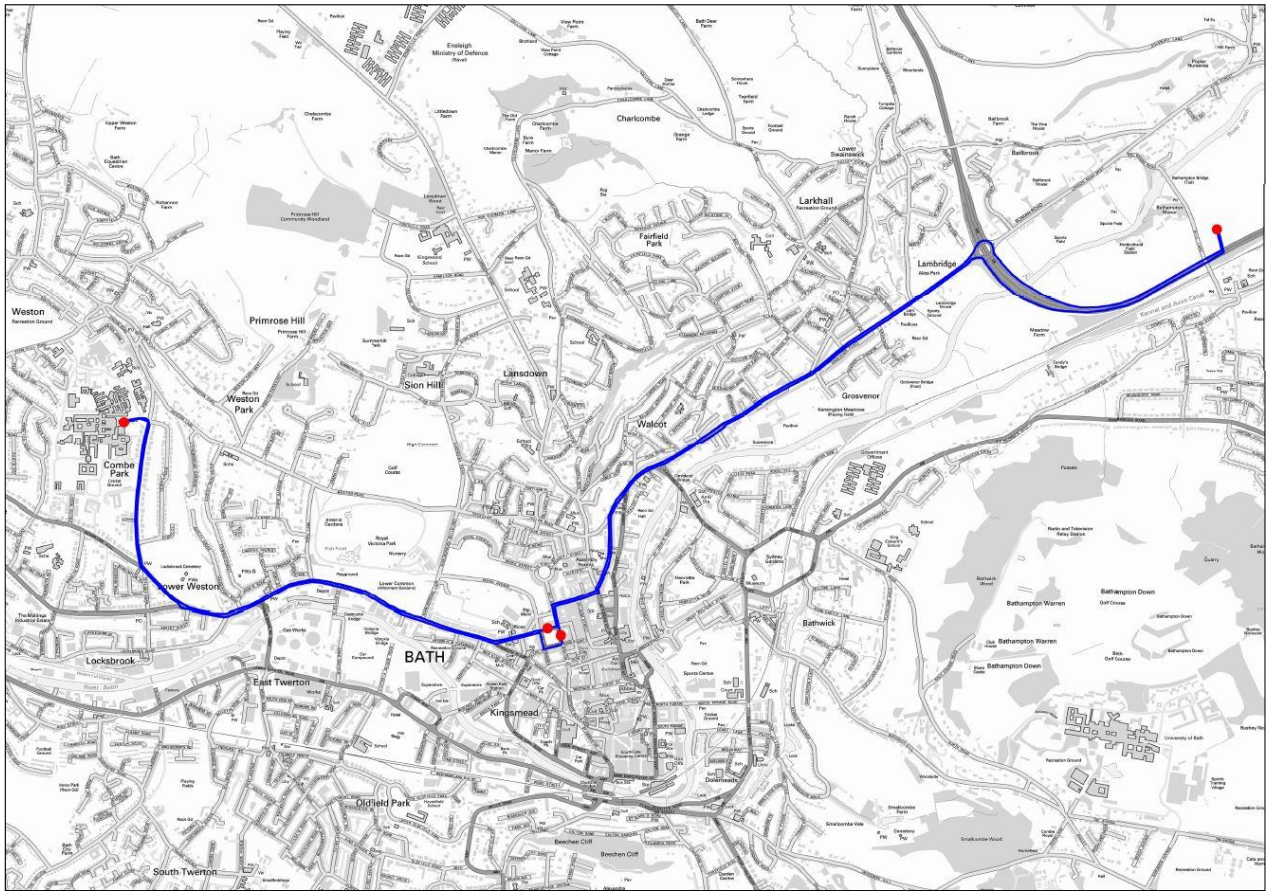


Figure 3.2: Proposed A4 Eastern Bath new P&R route – DSA Scenario



Source: Mott MacDonald

Figure 3.3: Proposed A4 Eastern Bath new P&R route – DSB Scenario



Source: Mott MacDonald

3.2 Future Year Traffic Growth

3.2.1 Requirements

For forecasting purposes, future year demand matrices are required by mode and time period in order to reflect:

- National traffic growth forecasts; and
- Proposed local developments spatially allocated within the city of Bath region, but growth constrained to national forecasts.

Future year matrices are required for the forecasting year of 2029. For home based trip purposes, demand matrices are required in 12 hour PA format. For non-home based and freight trip purposes, demand matrices are required in OD format for all time periods including:

- AM Peak Time Period (0700-1000).
- Inter Peak Time Period (1000-1600); and
- PM Peak Time Period (1600-1900).

3.2.2 Overview of Process

Two methods have been used to produce future year trip ends with the method employed being dependent on geographic location. For the city of Bath region, the trip generation of proposed development to be completed between 2014 and 2029 has been derived using specific trip rates. The trip totals for Bath have then been controlled to the growth predicted in the NTEM for all modes and purposes. In the remaining areas of the model, NTEM growth factors (Table A.1 to Table A.3) were applied directly to the base year trip ends with no attempt being made to spatially allocate developments. Growth factors for Light Goods Vehicles (LGV) and Heavy Goods Vehicles (HGV) have been calculated using data from the DfT's Road Transport Forecasts (RTF) for 2015.

3.2.3 Developments and Trip Rates

Proposed developments in Bath were assessed on the likelihood of completion and as per WebTAG only near certain or more than likely for completion have been input into the future year matrix building process for explicit representation. The full list of developments is provided in Table C.1 in Appendix C.

In order to derive a reasonable estimate of the overall increase in trip generation from these developments, a number of sources have been used to obtain average trip generation rates for residential, business and retail development land use types. The three main sources are:

- TRICS 2013(b) database;
- Getting Around Bath: Supporting Document – A Transport Strategy for Bath (Mott MacDonald, 2014); and

- Bath Western Riverside Development Transport Assessment (WSP, 2006)

For all TRICS categories that were interrogated, only similar sites with multimodal surveys were selected so that multi-modal splits could be derived. All developments have been applied with trip rates derived from TRICS except for BWR residential development where the trip rates have been obtained from previous TA. A summary of trip rates is provided in Table D.1.

All development zones have existing trips and associated distributions. Additional trips generated by the developments were assumed to have the same base year distributions.

3.2.4 Future Year Trip Ends

Origin totals for both base and future years as well as the overall growths are presented in Table 3.3 to Table 3.5 below. The figures show trip end growth from 2014 to 2029 of around 10-12% overall for car and lower figures of 1-7% for bus and rail.

Table 3.3: 2014 Origin Totals (unit: person)

		PA			OD		
Type	Car Availability	HBW	HBEB	HBO	NHBEB	NHBO	Total
AM (3 Hour Total)							
Car	CA	37,372	1,965	21,755	1,598	15,065	77,755
Bus	CA	994	2	1,334	6	128	2,464
Bus	NCA	2,683	4	3,510	16	336	6,550
Rail	CA	1,929	239	486	139	127	2,920
Rail	NCA	1,775	221	448	129	117	2,689
AM Total	**-**	**44,754**	**2,431**	**27,534**	**1,888**	**15,772**	**92,378**
IP (6 Hour Total)							
Car	CA	8,830	3,729	48,767	10,484	18,638	90,448
Bus	CA	356	7	2,601	24	654	3,643
Bus	NCA	988	19	6,844	64	1,722	9,637
Rail	CA	460	117	652	107	186	1,522
Rail	NCA	422	108	601	98	171	1,400
IP Total	**-**	**11,056**	**3,981**	**59,465**	**10,777**	**21,371**	**106,650**
PM (3 Hour Total)							
Car	CA	4,860	3,238	18,997	4,081	16,491	47,666
Bus	CA	148	0	269	10	273	701
Bus	NCA	428	0	709	27	719	1,883
Rail	CA	333	65	127	174	128	827
Rail	NCA	305	60	117	160	118	760
PM Total	**-**	**6,073**	**3,363**	**20,219**	**4,452**	**17,729**	**51,837**

Table 3.4: 2029 Origin Totals (unit: person)

		PA			OD		
Type	Car Availability	HBW	HBEB	HBO	NHBEB	NHBO	Total
AM (3 Hour Total)							
Car	CA	40,101	2,150	24,531	1,778	16,995	85,555
Bus	CA	946	2	1,382	7	139	2,475
Bus	NCA	2,553	4	3,638	18	365	6,577
Rail	CA	1,980	256	522	152	140	3,051
Rail	NCA	1,822	236	481	141	129	2,809
AM Total	**-**	**47,402**	**2,648**	**30,554**	**2,095**	**17,767**	**100,467**
IP (6 Hour Total)							
Car	CA	9,474	4,080	54,989	11,648	21,103	101,294
Bus	CA	338	7	2,695	26	718	3,785
Bus	NCA	940	19	7,092	69	1,888	10,008
Rail	CA	472	126	700	116	204	1,618
Rail	NCA	433	116	645	107	188	1,489
IP Total	**-**	**11,659**	**4,348**	**66,122**	**11,967**	**24,100**	**118,196**
PM (3 Hour Total)							
Car	CA	5,214	3,542	21,420	4,530	18,669	53,377
Bus	CA	141	0	279	11	300	731
Bus	NCA	407	0	734	29	790	1,961
Rail	CA	341	70	137	190	142	879
Rail	NCA	313	64	126	175	130	809
PM Total	**-**	**6,417**	**3,677**	**22,696**	**4,935**	**20,032**	**57,758**

Table 3.5: 2014-2029 overall growth factors

		PA			OD		
Type	Car Availability	HBW	HBEB	HBO	NHBEB	NHBO	Total
AM (3 Hour Total)							
Car	CA	1.0730	1.0941	1.1276	1.1129	1.1282	1.1003
Bus	CA	0.9514	1.0095	1.0362	1.0837	1.0852	1.0047
Bus	NCA	0.9515	1.0100	1.0362	1.0837	1.0852	1.0041
Rail	CA	1.0265	1.0709	1.0743	1.0934	1.1036	1.0447
Rail	NCA	1.0265	1.0710	1.0743	1.0934	1.1036	1.0447
AM Total	**-**	**1.0592**	**1.0895**	**1.1097**	**1.1098**	**1.1265**	**1.0876**
IP (6 Hour Total)							
Car	CA	1.0730	1.0940	1.1276	1.1110	1.1323	1.1199
Bus	CA	0.9513	1.0099	1.0362	1.0819	1.0965	1.0390
Bus	NCA	0.9514	1.0099	1.0362	1.0819	1.0965	1.0386

		PA			OD		
Type	Car Availability	HBW	HBEB	HBO	NHBEB	NHBO	Total
Rail	CA	1.0267	1.0710	1.0743	1.0881	1.0988	1.0636
Rail	NCA	1.0268	1.0710	1.0743	1.0881	1.0988	1.0637
IP Total	**-**	**1.0545**	**1.0922**	**1.1120**	**1.1103**	**1.1277**	**1.1083**
PM (3 Hour Total)							
Car	CA	1.0730	1.0940	1.1276	1.1100	1.1321	1.1198
Bus	CA	0.9512	1.0356	1.0362	1.0747	1.0991	1.0434
Bus	NCA	0.9513	1.0356	1.0362	1.0746	1.0991	1.0415
Rail	CA	1.0268	1.0710	1.0743	1.0936	1.1065	1.0640
Rail	NCA	1.0268	1.0709	1.0743	1.0936	1.1065	1.0641
PM Total	**-**	**1.0566**	**1.0932**	**1.1225**	**1.1085**	**1.1299**	**1.1142**

3.2.5 Freight Growth

LGV and HGV growth factors have been extracted from RTF 2015 as shown in Table 3.6 (note that the term 'Other Goods Vehicles' is sometimes used in place of 'Heavy Goods Vehicles' in the sources referred to). The values for the South West of England were used. As the highway assignment model only has a single HGV matrix, an average growth rate based on total rigid and articulated HGV vehicle miles was derived. Their hourly totals are shown in Table 3.7 below. The growth rates for LGVs are predicted to be very high, around 41% over the period 2014-2029 but much lower for HGVs, around 9%.

Table 3.6: Freight Growth Factors

Vehicle	2014-2029
LGV	1.409
HGV	1.091

Table 3.7: LGV and HGV Hourly Totals (unit: vehicle)

	2014			2029		
Type	AM	IP	PM	AM	IP	PM
LGV	6,696	5,306	5,210	9,442	7,482	7,346
HGV	2,035	2,116	1,314	2,218	2,307	1,432

3.3 Other Assumptions

Changes in travel costs in the forecast years are to be expected due to increases in incomes and the value of time, changes in fuel costs and improvements in vehicle efficiency. Therefore, the cost assumptions adopted in the base year models also have to be updated in the future year models.

Highway Generalised Cost Parameters

The highway trip costs are made up of time, distance and charge impacts. Changes in fuel costs, vehicle efficiency, values of time included in the WebTAG data book issued in November 2014 have been used to calculate the forecast year values of pence per minute (PPM) and pence per kilometre (PPK).

Table 3.8: 2014 and 2029 Highway Generalised Cost Parameters (2010 prices)

	AM		Inter Peak		PM	
	PPM	PPK	PPM	PPK	PPM	PPK
2014						
COM	13.52	7.54	13.42	7.54	13.23	7.54
EB	45.84	14.64	44.78	14.64	44.07	14.64
Other	17.25	7.54	17.93	7.54	18.45	7.54
LGV	20.64	14.51	20.64	14.51	20.64	14.51
HGV	48.07	52.14	48.07	52.14	48.07	52.14
2029						
COM	17.74	5.90	17.62	5.90	17.42	5.90
EB	60.27	13.12	59.05	13.12	57.97	13.12
Other	22.04	5.90	22.89	5.90	23.69	5.90
LGV	27.40	13.60	27.40	13.60	27.40	13.60
HGV	63.83	56.85	63.83	56.85	63.83	56.85

PT Generalised Cost Parameters

The generalised journey time (GJT) calculation in the public transport model includes fares, with appropriate values of time (VOT). As the PT assignment model operates in units of generalised time, the fare coefficient is the time equivalent (in minutes) of a £1 fare. The future year generalised times are calculated taking into account the assumed real growth in fares and future year values of time in line with WebTAG data book issued in November 2014.

Table 3.9: Value of Time for PT Assignment (2010 prices)

Purpose	2014	2029
Commute	11.80	15.67
EB	24.22	32.15
Other	10.48	13.91

Parking Charges and Fares

It is assumed that car park charges rise in line with GDP growth. However, for PT fares, we assume that there is no real terms growth applied to bus, P&R and rail fares.

Table 3.10: Average annual growth of Parking Charges and Fares

Type	
Car Park Charges	1.9%
Bus, P&R and Rail fare	0%

Vehicle Occupancy Changes

The car occupancy rates have also been updated to the forecasting year according to the WebTAG data book published in November 2014.

Table 3.11: 2014 and 2029 Car Occupancy Rates by Journey Purposes

	AM	IP	PM
2014			
Commute	1.15	1.14	1.12
EB	1.22	1.18	1.16
Other	1.65	1.71	1.76
2029			
Commute	1.12	1.11	1.09
EB	1.18	1.15	1.13
Other	1.60	1.67	1.72

4 P&R Analysis

4.1 Introduction

This section of the report sets out how the P&R demand has been calibrated in the base year so that the model represents observed demand at the three existing P&R sites in Bath. It then provides analysis for the 2029 forecasts with a potential A4 Eastern P&R site, showing the demand for a number of test scenarios, the distribution of trips and impacts on the highway network.

4.2 P&R Base Year Calibration

As stated in section 2.5, the P&R calibration was accomplished by inputting generalised times onto P&R links so that the modelled P&R demands in the base year model have a good fit with the observed. Table 4.1 shows the components of the calibrated generalised time on P&R links in the base model.

For the Odd Down RUH service, a total generalised time almost equivalent to in vehicle time has to be input on its pseudo link in order to attract enough demand across all time periods. This generates a negative calibrated time constant which is close to and offsets the waiting time.

For the Newbridge service, due to its recent (February 2015) expansion, the car park capacity was increased from 450 to 698 spaces. This has led to a significant increase in patronage, especially for the AM peak with the average hour AM peak demand being increased from 133 cars (October 2014) to 190 cars (March 2016). In order to reflect this increase, the P&R patronage on Newbridge has been recalibrated according to the March 2016 observation level.

Table 4.1: Components of Generalised Time (Seconds) for P&R links in the base model

Time Period	Total Generalised Time		In Vehicle Time		Waiting Time		Calibrated Time	
	OB	IB	OB	IB	OB	IB	OB	IB
AM								
Odd Down CC	-	1924	-	784	-	900	-	240
Odd Down RUH	-	1350	-	1376	-	1800	-	-1826
Newbridge	-	1940	-	661	-	900	-	379
Lansdown	-	1712	-	570	-	900	-	242
IP								
Odd Down CC	1480	1510	469	523	900	900	111	87
Odd Down RUH	1103	1075	1103	1075	1800	1800	-1800	-1800
Newbridge	1770	1635	459	535	900	900	411	200
Lansdown	1607	1462	402	344	900	900	305	218
PM								
Odd Down CC	1770	-	706	-	900	-	164	-
Odd Down RUH	1200	-	1417	-	900	-	-1117	-
Newbridge	1940	-	545	-	900	-	495	-
Lansdown	1605	-	504	-	900	-	201	-

Table 4.2 shows the modelled peak time period patronage against the observed in the base year, which indicates a good fit between the two.

Table 4.2: Base Year Observed and Predicted Peak hour P&R Patronage (unit: vehicle per hour)

	2014 Observed Demand			2014 Modelled Demand		
Site	**AM**	**IP**	**PM**	**AM**	**IP**	**PM**
Into P&R site						
Odd Down CC	190	49	13	190	57	-
Odd Down RUH	19	16	0	19	21	
Newbridge	190	38	2	190	37	-
Lansdown	173	43	22	172	37	-
Total	**572**	**146**	**37**	**571**	**152**	**-**
Out of P&R site						
Odd Down CC	8	59	183	-	66	188
Odd Down RUH	0	15	14		20	21
Newbridge	6	40	104	-	43	104
Lansdown	14	44	173	-	41	175
Total	**28**	**158**	**474**	**-**	**171**	**487**

*AM out of P&R site and PM into P&R site are not modelled; Newbridge patronage is based on March 2016 observation

4.3 Model Convergence

Whilst this section of the report focusses on the model outputs for P&R demand, it is important that the model convergence is checked to demonstrate that the results are robust insofar as not being affected by model 'noise' which occurs with either poorly converged demand or assignment modelling.

The G-BATH model employs an iterative method to achieve convergence between the assignment and demand models. The process passes costs from the assignment models to the demand model and then passes trips from the demand model to the assignment models with the process terminating when the convergence criterion has been met.

The demand model convergence 'gap' statistic is 0.1% for the forecast model scenario which is below the WebTAG target of 0.2% (values lower than this target means that the model is better converged). This shows that the demand model has converged acceptably well.

The assignment model convergence statistics are reported in Appendix B. For all time period models the assignment model convergence 'gap' is below the recommended WebTAG value of 0.1% by a substantial margin (similar to demand model convergence values lower than this target means that the assignment is better converged). The measurements of cost changes exceed the 98% target in all cases although the measurements of flow changes being slightly below the 98% target in some cases especially for the AM and PM peak (values above this target mean that the model is better converged). The result for flow

changes is an indication of the level of traffic demand being higher than the network capacity in some congested areas in the model.

4.4 Forecast P&R Demand

Future year 2029 peak hour demand forecasts for P&R services, for proposed sites and existing sites, are contained in Table 4.3. The estimated patronage on the A4 eastern site shows some 30% increase when extending the service to RUH and the result also indicates that competition exists between A4 Eastern and Lansdown which causes some redistribution of P&R trips.

Our future year analysis on the DM network also showed that there are some significant increases in delay on Wells Road/Bristol Road roundabout to the west of Bath with the average delay being 4-5 mins per vehicle approaching from both Bristol Road and Wells Road in the AM peak. This reduces travellers using the Newbridge P&R service with reduced patronage compared to the base. Further investigation has shown that this is due to lower values specified for the circulation capacity and saturation flows of the roundabout than is considered reasonable in the light of the forecasts produced. As a result, the circulation capacity and saturation flow specifications of the roundabout were modified for the future year so that a more reasonable patronage for Newbridge was obtained without excessive roundabout delays.

Table 4.3: Future Year Peak Hour P&R Patronage (unit: vehicle per hour) –Demand Model Forecast

	2029 Do Minimum			2029 DSA* Scenario			2029 DSB* Scenario		
Site	**AM**	**IP**	**PM**	**AM**	**IP**	**PM**	**AM**	**IP**	**PM**
Into P&R site									
A4 Eastern CC	-	-	-	224	103	-	223	102	-
A4 Eastern RUH	-	-	-	-	-	-	76	56	-
Odd Down CC	248	96	-	236	92	-	236	93	-
Odd Down RUH	52	43		48	44		40	38	
Newbridge	194	48	-	174	43	-	174	43	-
Lansdown	268	114	-	173	81	-	174	82	-
Total	**762**	**301**	**-**	**856**	**362**	**-**	**923**	**414**	**-**
Out of P&R site									
A4 Eastern CC	-	-	-	-	66	124	-	66	124
A4 Eastern RUH	-	-	-	-	-	-	-	22	27
Odd Down CC	-	79	190	-	72	182	-	72	182
Odd Down RUH	-	12	20	-	12	19	-	12	19
Newbridge	-	31	129	-	27	117	-	27	117
Lansdown	-	71	213	-	58	169	-	58	171
Total	**-**	**192**	**551**	**-**	**235**	**611**	**-**	**257**	**640**

*DSA (A4 Eastern – Queen Square) & DSB (A4 Eastern – Queen Square – RUH)

Forecasting daily demand and profiles have been derived using peak hour model forecasts and base year observed profiles for both DM and DS scenarios. The base year observed profiles have been applied for the existing sites and the new site is assumed to be based on either the Odd Down or Lansdown profile. Table 4.4 provides the predicted total daily demand across all sites and Figure 4.1 to Figure 4.3 show the predicted occupancy during operation hours.

Table 4.4: Future Year Daily Traffic (unit: vehicle) –Demand Model Forecast

Site	DM	DSA		DSB	
		Based on Odd Down Profile	Based on Lansdown Profile	Based on Odd Down Profile	Based on Lansdown Profile
A4 Eastern	-	1,255	1,109	1,796	1,603
Odd Down	1,687	1,685	1,685	1,570	1,570
Newbridge	734	656	656	657	657
Lansdown	1,271	864	864	872	872
Total	**3,693**	**4,460**	**4,315**	**4,895**	**4,702**

Figure 4.1: Derived Site Occupancy, 2029DM

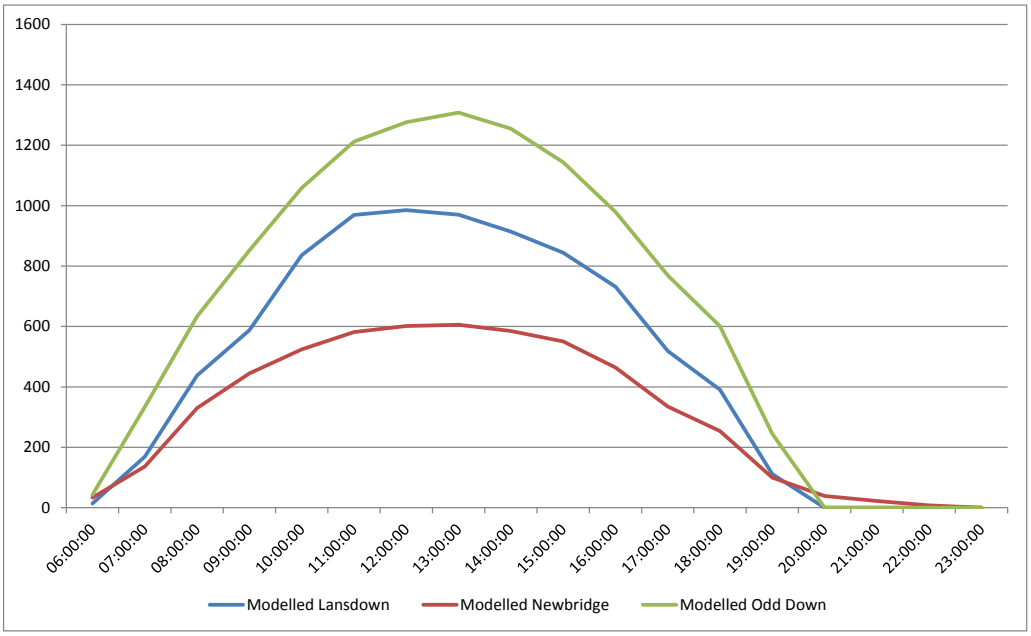


Figure 4.2: Derived Site Occupancy, 2029DSA

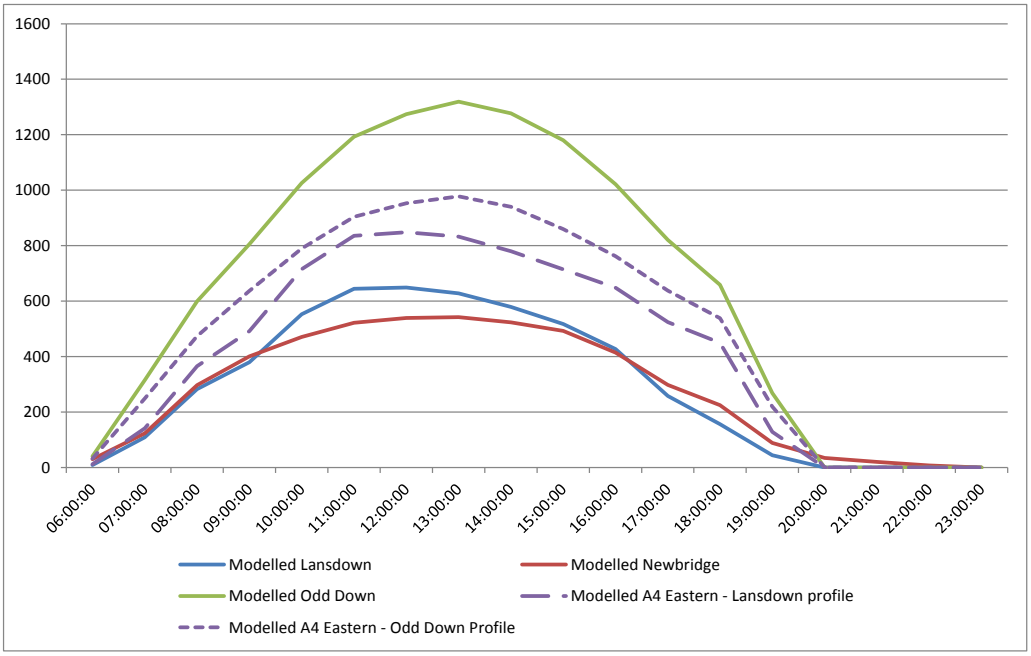
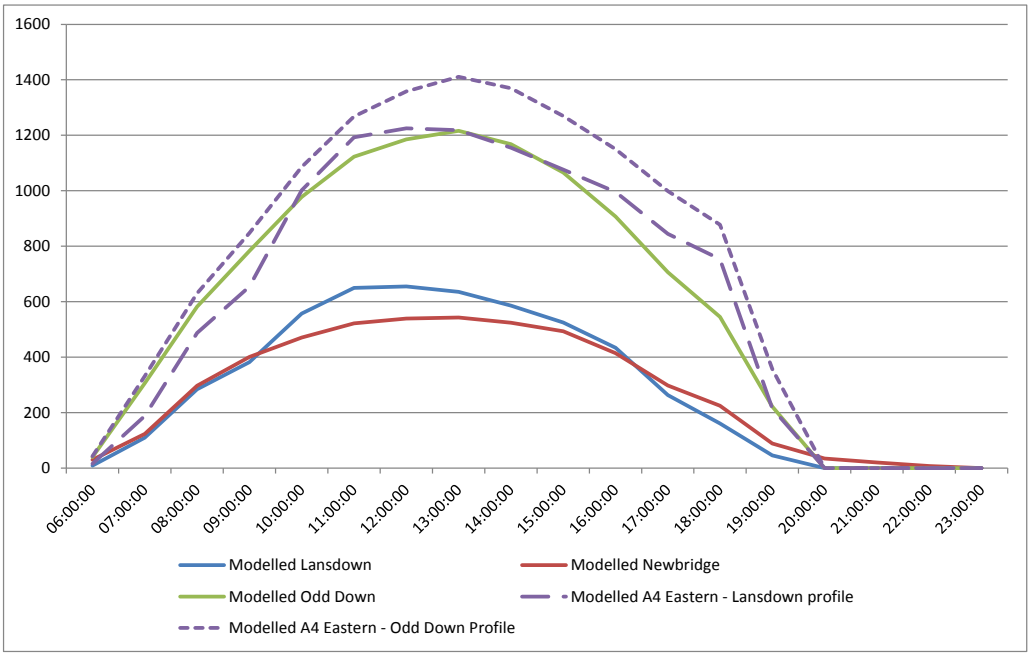


Figure 4.3: Derived Site Occupancy, 2029DSB



The modelling shows that both Odd Down and Lansdown are forecast to exceed their current capacities in the DM, but that Lansdown would be significantly relieved with either the DSA or DSB scenario. There is also some relief to Newbridge but it is not as much as Lansdown. By adopting the Odd Down profile, the A4 Eastern site occupancy reaches 977 (DSA) and 1,411 (DSB) respectively. Table 4.5 summarizes the forecast maximum occupancy for the P&R sites for both DM and DS scenarios.

Table 4.5: Predicted max occupancy during operation Hours, 2029 –Demand Model Forecast

P&R Site	Car Park Capacity	DM	DSA	DSB
A4 Eastern	-	-	**977** **848**	**1,411** **1,225**
Odd Down	1,230	1,308	1,319	1,216
Newbridge	698	606	542	543
Lansdown	878	985	649	655

*numbers in red and blue are derived based on Odd Down and Lansdown profiles respectively

Previous analysis reported in *Bath Transportation Package Transport Assessment A4 Eastern Bath Park and Ride* (Mott MacDonald, 2009) supported a proposed 1400 space P&R site. However the 2008/9 modelling assumed a BRT connection between the P&R site and the city centre. The increased attractiveness of BRT was represented by a lower cost link which would account for higher P&R demand and it provided a through route to Newbridge serving a larger area and more attractions. There will be other differences between the previous and the latest analysis such as times of the year for the surveys and updated modelling. However the latest analysis shows that by extending the A4 Eastern service to RUH more demand would be attracted requiring 1,225 – 1,411 spaces.

It is also important to note that these latest estimations and those provided by CH2MHILL in their *Bath Enterprise Area/Transport Strategy S-Paramics Modelling* (CH2MHILL, 2014) cannot be directly compared. In the CH2M report, they have assumed certain increases in spaces at Odd Down and Lansdown P&R sites and 1600 spaces for new A4 Eastern P&R site. They have used entry / exit profiles which have been uplifted and assumed routes to the city centre to estimate the changes on traffic flows. Therefore the number of spaces at P&R sites and their distribution were input assumptions rather than outputs from modelling work. It should also be noted that for the latest modelling we have not capped demand at any of the P&R sites and have allowed the model to allocate demand to P&R sites through the assignment process which will also account for possible 'backfilling' of routes relieved by P&R.

4.5 Distribution of the new P&R demand

The origins of P&R trips that are forecast to use the proposed A4 Eastern site have also been examined in the model. The catchment areas are shown in Figure 4.4 and Figure 4.5.The distributions of trips by directions in relation to the location of the new site in the AM Peak are presented in Figure 4.6 and Figure 4.7, which indicates that the new site is attractive for traffic from A4 east that makes up 69% of the demand, with the rest being traffic approaching from A46 (24%) and the rest of the areas (7%) when

serving both city centre and RUH. The inclusion of the RUH attracts more trips particularly from the A4 Eastern corridor.

Figure 4.4: Origins of P&R trips using A4 Eastern, 2029DSA

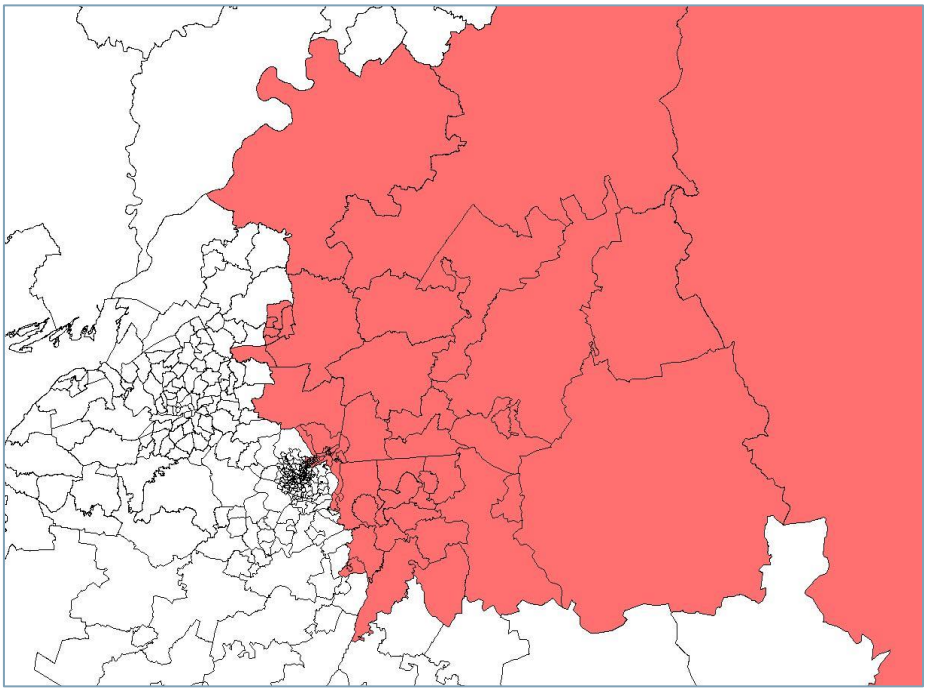


Figure 4.5: Origins of P&R trips using A4 Eastern, 2029DSB

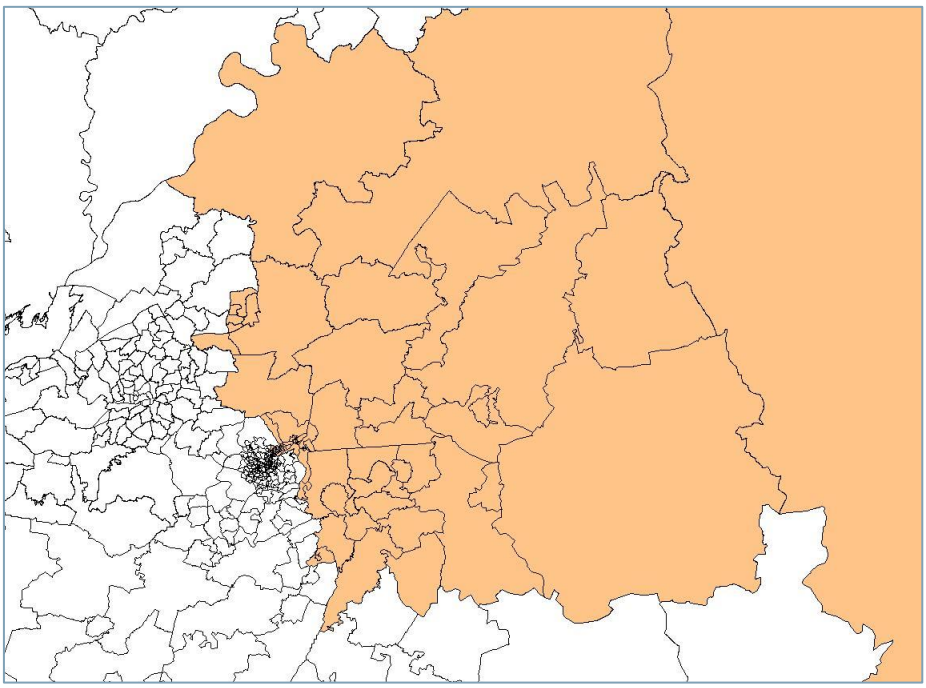


Figure 4.6: Distribution (unit: PCU) of P&R trips using A4 Eastern, 2029DSA, AM Peak

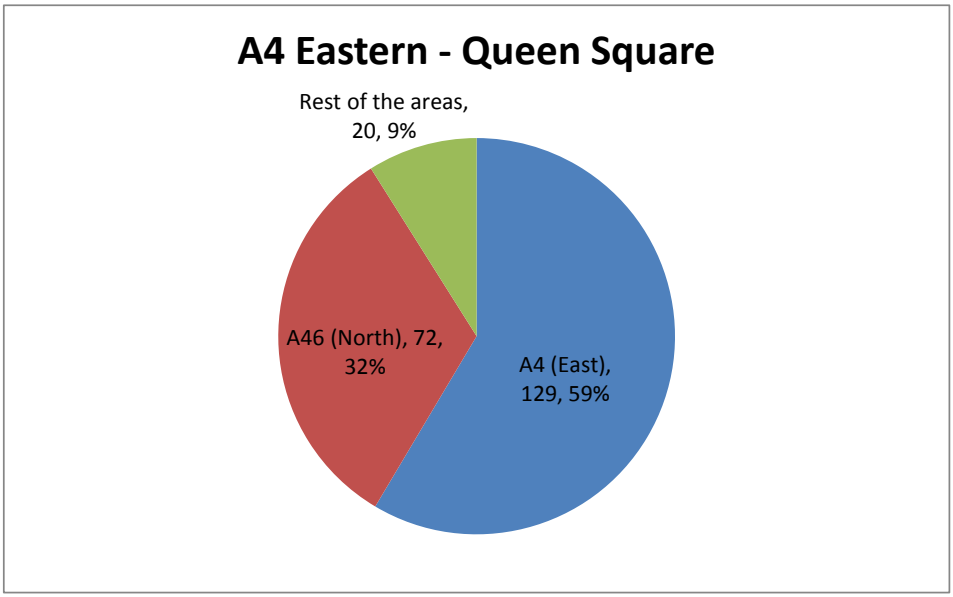
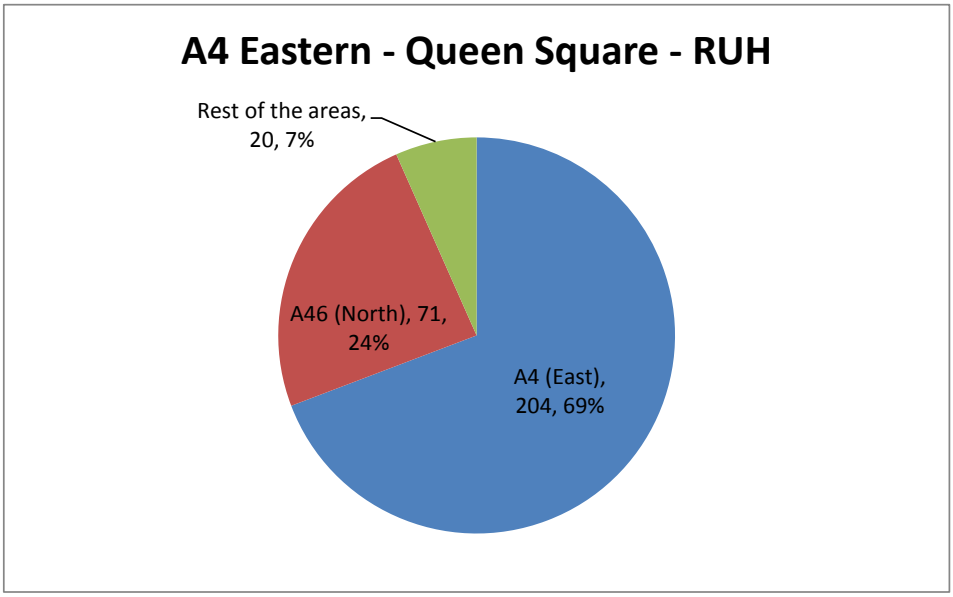


Figure 4.7: Distribution (unit: PCU) of P&R trips using A4 Eastern, 2029DSB, AM Peak



4.6 Highway Impact

Flow changes between DM and DS scenarios have also been analysed in particular with respect to London Road west. As seen from Table 4.6 below, the addition of the A4 Eastern P&R in the DS scenarios results in some significant reductions in traffic on London Road compared with the forecast DM. This is more pronounced in the DSB scenario which includes the new P&R service to access the RUH and in the AM peak.

Table 4.6: Predicted Actual Flows on London Road West between DM and DS Scenarios, 2029

	Demand Model Forecast (PCUs)		
Time Period	DM	DSA	DSB
AM			
Inbound	880	839 (-4.7%)	794 (-9.8%)
IP			
Inbound	1,045	999 (-4.4%)	952 (-8.9%)
Outbound	961	924 (-3.9%)	909 (-5.4%)
PM			
Outbound	1,152	1,115	1,109

	Demand Model Forecast (PCUs)		
Time Period	DM	DSA	DSB
		(-3.2%)	(-3.7%)

*Numbers in Parentheses show the % change from DM

5 Summary and conclusions

This report describes how the newly updated Bath transport model has been used to produce forecasts of travel demand for a proposed A4 Eastern P&R site east of Bath, the model having been updated to a 2014 base year. The forecasting has been carried out on a PA basis according to current WebTAG guidance and using data for forecasting from the TRICS database, National Trip End Model (NTEM) and Road Traffic Forecasts (RTF). The forecast networks were developed on the basis of WebTAG uncertainty log principles.

The modelling shows that both Odd Down and Lansdown are forecast to exceed their current capacity in the DM, but Lansdown would be relieved with the addition of an A4 Eastern P&R site due to redistribution of the P&R trips. The A4 Eastern site is predicted to reach maximum occupancy of 977 and 1,411 respectively, depending on whether the route serves the city centre only or both the city centre and RUH.

The distributions of P&R trips show that the A4 Eastern site is attractive for traffic from A4 east which makes up 69% of the demand, with the rest being traffic approaching from A46 (24%) and the rest of the areas (7%) when the route is connected with both city centre and RUH..

Both DS scenarios are also predicted to have some significant impact in reducing traffic on London Road west, the reduction ranges between 5% and 10% across different time periods.

Appendices

Appendix A. NTEM6 2 Growth Factors

Table A.1: NTEM62 Growth Factors – Highway

Highway	HB Work		HB EB		HB Other		NHB EB AM		NHB OTHER AM		NHB EB IP		NHB OTHER IP		NHB EB PM		NHB OTHER PM	
Region	P	A	P	A	P	A	O	D	O	D	O	D	O	D	O	D	O	D
GB	1.079	1.079	1.091	1.091	1.144	1.144	1.113	1.113	1.087	1.087	1.114	1.114	1.113	1.113	1.087	1.087	1.116	1.116
EAST	1.073	1.095	1.079	1.105	1.181	1.203	1.149	1.142	1.106	1.103	1.158	1.162	1.150	1.143	1.105	1.103	1.159	1.163
EM	1.065	1.065	1.073	1.073	1.162	1.162	1.114	1.114	1.074	1.074	1.121	1.121	1.115	1.115	1.074	1.074	1.123	1.123
LON	1.112	1.080	1.130	1.092	1.167	1.146	1.114	1.125	1.089	1.088	1.116	1.107	1.114	1.126	1.089	1.088	1.118	1.110
NE	1.060	1.060	1.067	1.067	1.126	1.126	1.092	1.092	1.065	1.065	1.093	1.093	1.092	1.092	1.065	1.065	1.096	1.096
NW	1.058	1.058	1.072	1.072	1.099	1.099	1.081	1.081	1.065	1.065	1.079	1.079	1.082	1.082	1.065	1.065	1.081	1.081
SE	1.065	1.071	1.071	1.083	1.134	1.135	1.104	1.098	1.078	1.081	1.104	1.106	1.104	1.098	1.079	1.082	1.106	1.107
SW	1.055	1.055	1.062	1.062	1.161	1.161	1.108	1.108	1.064	1.064	1.116	1.116	1.108	1.108	1.064	1.064	1.118	1.118
Avon	1.106	1.138	1.116	1.144	1.150	1.177	1.162	1.171	1.142	1.140	1.163	1.159	1.160	1.169	1.142	1.140	1.164	1.160
Bath & NE Somerset	1.074	1.125	1.087	1.142	1.118	1.154	1.147	1.157	1.133	1.150	1.144	1.135	1.147	1.155	1.133	1.149	1.147	1.137
Rural (Bath & NE Somerset)	1.078	1.126	1.082	1.142	1.113	1.160	1.150	1.158	1.134	1.151	1.143	1.143	1.150	1.156	1.134	1.150	1.150	1.143
Bristol(part of)	1.100	1.127	1.110	1.144	1.138	1.171	1.156	1.159	1.136	1.152	1.083	1.250	1.156	1.157	1.136	1.151	1.175	1.156
Bath	1.073	1.126	1.091	1.142	1.121	1.152	1.146	1.157	1.133	1.151	1.144	1.134	1.146	1.156	1.133	1.150	1.145	1.135
Norton-Radstock	1.066	1.122	1.075	1.136	1.105	1.155	1.145	1.154	1.129	1.142	1.147	1.140	1.145	1.152	1.129	1.141	1.146	1.138
Keynsham	1.079	1.125	1.092	1.142	1.127	1.154	1.147	1.157	1.133	1.151	1.150	1.135	1.147	1.155	1.133	1.150	1.149	1.136
Peasedown St John	1.086	1.127	1.092	1.145	1.122	1.162	1.154	1.159	1.137	1.155	1.100	1.143	1.154	1.157	1.137	1.154	1.160	1.144
Paulton	1.064	1.124	1.068	1.141	1.101	1.155	1.147	1.156	1.132	1.149	1.172	1.111	1.147	1.154	1.132	1.148	1.143	1.136
Saltford	1.091	1.125	1.099	1.141	1.131	1.157	1.150	1.157	1.133	1.148	1.091	1.174	1.150	1.155	1.133	1.147	1.154	1.132
City of Bristol	1.142	1.183	1.155	1.182	1.163	1.179	1.184	1.217	1.181	1.168	1.184	1.173	1.184	1.215	1.181	1.168	1.186	1.174
North Somerset	1.090	1.141	1.095	1.158	1.165	1.203	1.184	1.173	1.152	1.165	1.183	1.183	1.184	1.172	1.152	1.164	1.185	1.183

Highway	HB Work		HB EB		HB Other		NHB EB AM		NHB OTHER AM		NHB EB IP		NHB OTHER IP		NHB EB PM		NHB OTHER PM	
South Gloucestershire	1.084	1.095	1.093	1.101	1.140	1.170	1.132	1.129	1.100	1.096	1.136	1.142	1.132	1.127	1.100	1.095	1.138	1.144
Cornwall	1.038	1.051	1.043	1.057	1.148	1.159	1.106	1.103	1.060	1.061	1.114	1.116	1.106	1.103	1.060	1.061	1.116	1.117
Devon	1.071	1.065	1.082	1.075	1.175	1.170	1.116	1.118	1.075	1.074	1.123	1.123	1.118	1.119	1.075	1.075	1.126	1.125
Dorset	0.990	0.983	0.993	0.987	1.130	1.125	1.053	1.050	0.995	0.995	1.067	1.068	1.055	1.052	0.995	0.996	1.071	1.072
Gloucestershire	1.000	1.000	1.003	1.003	1.119	1.117	1.058	1.058	1.009	1.010	1.069	1.069	1.058	1.058	1.009	1.010	1.071	1.071
Somerset	1.037	1.035	1.042	1.042	1.231	1.230	1.132	1.130	1.052	1.053	1.150	1.151	1.132	1.130	1.052	1.053	1.152	1.152
Wiltshire	1.086	1.041	1.093	1.052	1.184	1.147	1.088	1.079	1.050	1.055	1.093	1.097	1.088	1.078	1.050	1.054	1.094	1.098
Kennet	0.986	1.013	0.987	1.032	1.099	1.084	1.054	1.047	1.024	1.042	1.050	1.049	1.054	1.046	1.024	1.041	1.053	1.048
North Wiltshire	1.062	1.030	1.066	1.044	1.159	1.142	1.082	1.060	1.041	1.045	1.088	1.103	1.082	1.058	1.041	1.044	1.089	1.103
Salisbury	0.993	1.034	0.999	1.037	1.129	1.153	1.094	1.104	1.043	1.045	1.102	1.093	1.094	1.106	1.043	1.046	1.105	1.096
Swindon	1.208	1.057	1.222	1.064	1.292	1.172	1.092	1.087	1.062	1.059	1.097	1.102	1.092	1.085	1.062	1.058	1.098	1.101
West Wiltshire	1.048	1.050	1.057	1.069	1.145	1.152	1.106	1.079	1.063	1.075	1.109	1.120	1.106	1.077	1.063	1.074	1.112	1.122
WALES	1.138	1.138	1.157	1.157	1.127	1.127	1.137	1.137	1.142	1.142	1.126	1.126	1.136	1.136	1.141	1.141	1.128	1.128
WM	1.081	1.081	1.088	1.088	1.124	1.124	1.103	1.103	1.086	1.086	1.103	1.103	1.102	1.102	1.085	1.085	1.104	1.104
YH	1.107	1.107	1.122	1.122	1.178	1.178	1.145	1.145	1.116	1.116	1.145	1.145	1.146	1.146	1.116	1.116	1.147	1.147
Devon & Cornwall	1.054	1.058	1.063	1.066	1.162	1.164	1.111	1.110	1.067	1.067	1.119	1.119	1.112	1.111	1.067	1.068	1.121	1.121
North	1.075	1.075	1.087	1.087	1.134	1.134	1.106	1.106	1.082	1.082	1.106	1.106	1.106	1.106	1.082	1.082	1.108	1.108
Scotland	1.059	1.059	1.069	1.069	1.113	1.113	1.087	1.087	1.065	1.065	1.086	1.086	1.087	1.087	1.065	1.065	1.088	1.088

Table A.2: NTEM62 Growth Factors – Bus

Bus	HB Work		HB EB		HB Other		NHB EB AM		NHB OTHER AM		NHB EB IP		NHB OTHER IP		NHB EB PM		NHB OTHER PM	
Region	P	A	P	A	P	A	O	D	O	D	O	D	O	D	O	D	O	D
GB	0.979	0.979	1.033	1.033	1.055	1.055	1.080	1.080	1.052	1.052	1.066	1.066	1.081	1.081	1.053	1.053	1.068	1.068
EAST	1.005	1.028	1.071	1.089	1.140	1.170	1.157	1.144	1.094	1.089	1.154	1.154	1.157	1.143	1.093	1.088	1.153	1.153
EM	0.987	0.987	1.047	1.047	1.096	1.096	1.101	1.101	1.052	1.052	1.096	1.096	1.102	1.102	1.054	1.054	1.096	1.096
LON	1.030	1.015	1.053	1.049	1.139	1.121	1.105	1.109	1.058	1.059	1.092	1.110	1.105	1.108	1.058	1.059	1.094	1.105
NE	0.937	0.937	0.988	0.988	0.994	0.994	1.031	1.031	1.016	1.016	1.020	1.020	1.033	1.033	1.016	1.016	1.020	1.020

Bus	HB Work		HB EB		HB Other		NHB EB AM		NHB OTHER AM		NHB EB IP		NHB OTHER IP		NHB EB PM		NHB OTHER PM	
NW	0.940	0.940	0.990	0.990	0.995	0.995	1.031	1.031	1.020	1.020	1.017	1.017	1.032	1.032	1.020	1.020	1.017	1.017
SE	0.991	0.998	1.046	1.046	1.079	1.084	1.094	1.090	1.060	1.063	1.088	1.076	1.095	1.091	1.062	1.065	1.087	1.077
SW	0.989	0.989	1.051	1.051	1.122	1.122	1.110	1.110	1.051	1.051	1.106	1.106	1.110	1.110	1.050	1.050	1.106	1.106
Avon	1.003	1.031	1.056	1.086	1.052	1.086	1.129	1.127	1.108	1.099	1.111	1.108	1.128	1.126	1.105	1.094	1.115	1.110
Bath & NE Somerset	0.964	1.000	1.021	1.063	1.029	1.064	1.108	1.092	1.091	1.090	1.089	1.075	1.108	1.090	1.091	1.085	1.096	1.084
Rural (Bath & NE Somerset)	1.027	1.001	1.067	1.064	1.029	1.064	1.119	1.092	1.109	1.090	1.089	1.075	1.119	1.090	1.109	1.085	1.096	1.084
Bristol(part of)	1.006	1.002	1.057	1.065	1.029	1.064	1.123	1.093	1.105	1.091	1.089	1.075	1.123	1.092	1.105	1.086	1.096	1.084
Bath	0.939	1.000	1.000	1.064	1.029	1.064	1.103	1.092	1.084	1.090	1.089	1.075	1.103	1.090	1.084	1.085	1.096	1.084
Norton-Radstock	0.990	0.997	1.031	1.058	1.029	1.064	1.119	1.088	1.110	1.081	1.089	1.075	1.119	1.087	1.110	1.076	1.096	1.084
Keynsham	0.977	1.000	1.032	1.063	1.029	1.064	1.114	1.091	1.104	1.090	1.089	1.075	1.114	1.090	1.104	1.085	1.096	1.084
Peasedown St John	1.031	1.002	1.065	1.066	1.029	1.064	1.125	1.094	1.115	1.094	1.089	1.075	1.125	1.092	1.115	1.089	1.096	1.084
Paulton	1.007	0.999	1.045	1.062	1.029	1.064	1.122	1.090	1.117	1.088	1.089	1.075	1.122	1.089	1.117	1.083	1.096	1.084
Saltford	1.004	1.000	1.062	1.062	1.029	1.064	1.120	1.091	1.109	1.087	1.089	1.075	1.120	1.089	1.109	1.082	1.096	1.084
City of Bristol	1.003	1.052	1.052	1.102	1.026	1.090	1.138	1.148	1.124	1.108	1.117	1.120	1.138	1.147	1.124	1.103	1.118	1.119
North Somerset	1.021	1.016	1.083	1.081	1.098	1.109	1.154	1.109	1.124	1.107	1.139	1.127	1.154	1.107	1.124	1.102	1.142	1.125
South Gloucestershire	1.017	0.978	1.067	1.031	1.102	1.083	1.111	1.070	1.075	1.041	1.100	1.097	1.111	1.069	1.075	1.037	1.104	1.098
Cornwall	0.978	0.987	1.036	1.045	1.120	1.131	1.112	1.106	1.049	1.046	1.112	1.106	1.112	1.106	1.049	1.046	1.111	1.107
Devon	0.990	0.986	1.055	1.051	1.137	1.132	1.115	1.117	1.054	1.055	1.113	1.115	1.117	1.119	1.057	1.058	1.112	1.113
Dorset	0.954	0.943	1.019	1.007	1.132	1.128	1.079	1.073	0.993	0.991	1.087	1.084	1.081	1.075	0.996	0.994	1.085	1.083
Gloucestershire	0.955	0.957	1.018	1.020	1.100	1.100	1.074	1.075	1.007	1.009	1.075	1.074	1.074	1.075	1.007	1.009	1.075	1.076
Somerset	1.001	1.000	1.086	1.089	1.258	1.264	1.176	1.185	1.058	1.060	1.187	1.191	1.176	1.185	1.058	1.060	1.183	1.190
Wiltshire	1.026	0.954	1.085	1.015	1.141	1.079	1.077	1.061	1.031	1.020	1.073	1.070	1.077	1.061	1.031	1.018	1.070	1.068
Kennet	0.956	0.915	1.018	0.979	1.066	1.015	1.036	1.010	1.008	0.996	1.018	1.000	1.036	1.009	1.008	0.993	1.026	1.004
North Wiltshire	1.020	0.916	1.079	0.973	1.112	1.053	1.067	1.001	1.022	0.990	1.072	1.050	1.067	1.000	1.022	0.986	1.060	1.047
Salisbury	0.950	1.003	1.015	1.071	1.141	1.159	1.117	1.141	1.044	1.055	1.110	1.129	1.117	1.144	1.044	1.058	1.113	1.128
Swindon	1.106	0.939	1.165	0.991	1.219	1.061	1.061	1.025	1.026	1.002	1.057	1.045	1.061	1.023	1.026	0.998	1.053	1.046
West Wiltshire	0.989	0.934	1.053	0.996	1.090	1.063	1.090	1.019	1.046	1.020	1.071	1.067	1.090	1.017	1.046	1.015	1.084	1.072

Bus	HB Work		HB EB		HB Other		NHB EB AM		NHB OTHER AM		NHB EB IP		NHB OTHER IP		NHB EB PM		NHB OTHER PM	
WALES	0.987	0.987	1.042	1.042	0.964	0.964	1.048	1.048	1.079	1.079	1.023	1.023	1.048	1.048	1.077	1.077	1.025	1.025
WM	0.974	0.974	1.026	1.026	1.013	1.013	1.053	1.053	1.048	1.048	1.042	1.042	1.054	1.054	1.047	1.047	1.043	1.043
YH	0.978	0.978	1.043	1.043	1.070	1.070	1.094	1.094	1.067	1.067	1.085	1.085	1.097	1.097	1.071	1.071	1.083	1.083
Devon & Cornwall	0.984	0.987	1.046	1.048	1.128	1.132	1.113	1.112	1.051	1.050	1.113	1.111	1.114	1.112	1.053	1.052	1.111	1.110
North	0.952	0.952	1.007	1.007	1.020	1.020	1.052	1.052	1.034	1.034	1.040	1.040	1.054	1.054	1.035	1.035	1.040	1.040
Scotland	0.939	0.939	0.989	0.989	0.995	0.995	1.031	1.031	1.018	1.018	1.018	1.018	1.032	1.032	1.018	1.018	1.019	1.019

Table A.3: NTEM62 Growth Factors – Rail

Rail	HB Work		HB EB		HB Other		NHB EB AM		NHB OTHER AM		NHB EB IP		NHB OTHER IP		NHB EB PM		NHB OTHER PM	
Region	P	A	P	A	P	A	O	D	O	D	O	D	O	D	O	D	O	D
GB	1.030	1.030	1.061	1.061	1.080	1.080	1.090	1.090	1.067	1.067	1.075	1.075	1.094	1.094	1.066	1.066	1.075	1.075
EAST	1.013	1.042	1.063	1.080	1.150	1.177	1.155	1.144	1.099	1.094	1.151	1.150	1.154	1.142	1.098	1.092	1.149	1.147
EM	1.015	1.015	1.052	1.052	1.105	1.105	1.098	1.098	1.062	1.062	1.100	1.100	1.101	1.101	1.061	1.061	1.096	1.096
LON	1.043	1.037	1.090	1.071	1.127	1.122	1.106	1.112	1.060	1.066	1.074	1.096	1.106	1.110	1.060	1.063	1.081	1.089
NE	0.981	0.981	1.026	1.026	1.005	1.005	1.045	1.045	1.038	1.038	1.040	1.040	1.048	1.048	1.037	1.037	1.033	1.033
NW	0.990	0.990	1.036	1.036	0.997	0.997	1.046	1.046	1.042	1.042	1.032	1.032	1.046	1.046	1.042	1.042	1.030	1.030
SE	1.028	1.043	1.054	1.061	1.091	1.093	1.096	1.087	1.070	1.071	1.088	1.079	1.099	1.087	1.071	1.070	1.087	1.079
SW	1.016	1.016	1.046	1.046	1.137	1.137	1.104	1.104	1.055	1.055	1.105	1.105	1.105	1.105	1.057	1.057	1.103	1.103
Avon	1.046	1.075	1.091	1.113	1.048	1.086	1.138	1.140	1.118	1.109	1.119	1.116	1.136	1.136	1.124	1.118	1.125	1.120
Bath & NE Somerset	1.015	1.053	1.059	1.100	1.024	1.063	1.116	1.115	1.105	1.109	1.161	1.116	1.116	1.111	1.105	1.117	1.107	1.098
Rural (Bath & NE Somerset)	1.054	1.053	1.074	1.100	1.024	1.063	1.126	1.116	1.117	1.109	1.161	1.116	1.126	1.112	1.117	1.117	1.107	1.098
Bristol(part of)	1.057	1.057	1.089	1.089	1.024	1.063	1.147	1.147	1.131	1.131	1.161	1.116	1.147	1.147	1.131	1.131	1.107	1.098
Bath	0.995	1.053	1.050	1.100	1.024	1.063	1.112	1.115	1.100	1.109	1.161	1.116	1.112	1.111	1.100	1.117	1.107	1.098
Norton-Radstock	1.028	1.049	1.056	1.094	1.024	1.063	1.130	1.112	1.123	1.100	1.161	1.116	1.130	1.108	1.123	1.108	1.107	1.098
Keynsham	1.028	1.052	1.065	1.100	1.024	1.063	1.123	1.115	1.117	1.109	1.161	1.116	1.123	1.111	1.117	1.117	1.107	1.098
Peasedown St John	1.059	1.054	1.081	1.103	1.024	1.063	1.134	1.117	1.125	1.113	1.161	1.116	1.134	1.113	1.125	1.121	1.107	1.098

Rail	HB Work		HB EB		HB Other		NHB EB AM		NHB OTHER AM		NHB EB IP		NHB OTHER IP		NHB EB PM		NHB OTHER PM	
Paulton	1.036	1.036	1.056	1.056	1.024	1.063	1.140	1.140	1.129	1.129	1.161	1.116	1.140	1.140	1.129	1.129	1.107	1.098
Saltford	1.049	1.052	1.082	1.098	1.024	1.063	1.127	1.115	1.118	1.106	1.161	1.116	1.127	1.111	1.118	1.114	1.107	1.098
City of Bristol	1.053	1.107	1.114	1.140	1.007	1.090	1.153	1.173	1.150	1.128	1.150	1.125	1.153	1.169	1.150	1.136	1.135	1.133
North Somerset	1.054	1.068	1.082	1.116	1.112	1.125	1.163	1.131	1.141	1.123	1.167	1.071	1.163	1.127	1.141	1.131	1.153	1.151
South Gloucestershire	1.050	1.024	1.079	1.058	1.106	1.086	1.112	1.085	1.084	1.053	1.105	1.115	1.112	1.082	1.084	1.060	1.108	1.109
Cornwall	1.001	1.014	1.028	1.043	1.147	1.153	1.105	1.102	1.053	1.055	1.083	1.110	1.105	1.103	1.053	1.055	1.104	1.111
Devon	1.029	1.023	1.060	1.054	1.148	1.145	1.109	1.111	1.067	1.067	1.116	1.118	1.113	1.114	1.064	1.064	1.111	1.106
Dorset	0.966	0.953	0.985	0.971	1.156	1.154	1.060	1.050	0.995	0.986	1.071	1.076	1.065	1.055	0.991	0.982	1.076	1.072
Gloucestershire	0.973	0.976	0.994	0.998	1.120	1.122	1.065	1.067	1.007	1.010	1.076	1.075	1.065	1.067	1.007	1.010	1.067	1.071
Somerset	1.009	1.008	1.035	1.034	1.300	1.311	1.153	1.160	1.052	1.053	1.167	1.190	1.153	1.160	1.052	1.053	1.163	1.167
Wiltshire	1.050	0.990	1.079	1.023	1.156	1.085	1.076	1.066	1.038	1.030	1.069	1.063	1.076	1.066	1.038	1.033	1.067	1.071
Kennet	0.964	0.960	0.984	0.988	1.075	1.035	1.040	1.042	1.013	0.993	1.091	1.111	1.040	1.044	1.013	0.993	1.015	1.026
North Wiltshire	1.036	0.964	1.060	1.006	1.122	1.063	1.069	1.021	1.031	1.009	1.000	1.000	1.069	1.018	1.031	1.016	1.070	1.062
Salisbury	0.967	1.010	0.989	1.031	1.171	1.175	1.102	1.113	1.041	1.051	1.053	1.143	1.102	1.118	1.041	1.046	1.099	1.106
Swindon	1.151	0.988	1.195	1.024	1.235	1.067	1.067	1.047	1.040	1.020	1.074	1.077	1.067	1.043	1.040	1.028	1.060	1.062
West Wiltshire	1.014	0.982	1.045	1.030	1.099	1.068	1.090	1.041	1.052	1.038	1.063	1.000	1.090	1.037	1.052	1.046	1.081	1.079
WALES	1.050	1.050	1.113	1.113	0.961	0.961	1.079	1.079	1.107	1.107	1.050	1.050	1.078	1.078	1.109	1.109	1.049	1.049
WM	1.018	1.018	1.060	1.060	1.021	1.021	1.068	1.068	1.064	1.064	1.058	1.058	1.069	1.069	1.066	1.066	1.056	1.056
YH	1.037	1.037	1.083	1.083	1.082	1.082	1.104	1.104	1.094	1.094	1.100	1.100	1.108	1.108	1.091	1.091	1.095	1.095
Devon & Cornwall	1.015	1.018	1.044	1.048	1.147	1.149	1.107	1.106	1.060	1.061	1.100	1.114	1.109	1.108	1.058	1.059	1.108	1.109
North	1.003	1.003	1.048	1.048	1.028	1.028	1.065	1.065	1.058	1.058	1.057	1.057	1.067	1.067	1.057	1.057	1.053	1.053
Scotland	0.985	0.985	1.031	1.031	1.001	1.001	1.046	1.046	1.040	1.040	1.036	1.036	1.047	1.047	1.040	1.040	1.032	1.032

Appendix B. Assignment Convergence Statistics

Table B.1: Assignment Convergence Statistics – DM, 2029

	DM Scenario		
	% Gap	% Flows	% Delays
AM	0.021	96.1	99.3
IP	0.0027	98.9	99.9
PM	0.0098	96.4	99.4

Table B.2: Assignment Convergence Statistics – DSA, 2029

	DSA Scenario		
	% Gap	% Flows	% Delays
AM	0.020	97.2	99.3
IP	0.0032	98.5	99.9
PM	0.016	99.4	99.7

Table B.3: Assignment Convergence Statistics – DSB, 2029

	DSB Scenario		
	% Gap	% Flows	% Delays
AM	0.013	97.2	99.4
IP	0.0086	97.2	99.7
PM	0.0092	96.6	99.5

Appendix C. Proposed Development in Bath

Table C.1: Proposed Development, 2015-2029

Site	GFA sqm	Dwellings Private*	Dwellings Non Private*	Planning Definition	Bath Strategy Definition	Level of Uncertainty
Manvers Street	1,456			A3	Restaurants and cafés	Hypothetical
Manvers Street	9,077			B1	Offices	Hypothetical
Manvers Street		48	26	C3(a)	Flats	Hypothetical
Manvers Street	6,480			C1	Hotels	Hypothetical
Cattlemarket site	1,745			A3	Restaurants and cafés	Reasonably foreseeable
Cattlemarket site	2,080			C1	Hotels	Reasonably foreseeable
Cattlemarket site		35	19	C3(a)	Flats	Reasonably foreseeable
Green Park Station West	9,471			B1	Offices	Hypothetical
Green Park Station West	31,786			A1	Shops	Hypothetical
Green Park Station West		290	156	C3(a)	Flats	Hypothetical
Green Park Station West	405			A3	Restaurants and cafés	Hypothetical
Green Park Station West	7,432			A1	Supermarket	Hypothetical
Green Park Station East	3,152			A1	Shops	Hypothetical
Green Park Station East		67	36	C3(a)	Flats	Hypothetical
Green Park Station East	12,160			B1	Offices	Hypothetical
Green Park Station East	596			A3	Restaurants and cafés	Hypothetical
North Quays	15,435			B1	Offices	More than likely
North Quays	2,036			A3	Restaurants and cafés	More than likely
North Quays		46	25	C3(a)	Flats	More than likely
North Quays	7,762			C1	Hotels	More than likely
North Quays	3,993			B1	Innovation / workspace	More than likely
South Quays	427			A3	Restaurants and cafés	More than likely
South Quays	11,025			B1	Offices	More than likely
South Quays	8,985			B1	Innovation / workspace	More than likely
South Bank		40	21	C3(a)	Flats	Hypothetical
South Bank	21,752			B1	Offices	Hypothetical

Site	GFA sqm	Dwellings Private*	Dwellings Non Private*	Planning Definition	Bath Strategy Definition	Level of Uncertainty
South Bank	964			A3	Restaurants and cafés	Hypothetical
Bath Press		57	31	C3(a)	Flats	More than likely
Bath Press	23,659			B1	Innovation / workspace	More than likely
Roseberry Place	681			A3	Restaurants and cafés	More than likely
Roseberry Place	4,207			A1	Shops	More than likely
Roseberry Place		265	143	C3(a)	Flats	More than likely
BWR: B1 & B2 (Crest)		26		C3(a)	Flats	More than Likely
BWR: B6, B12 (Crest)		38		C3(a)	Flats	More than Likely
BWR: B11, B13,B15a, B15b (Crest)		197	62	C3(a)	Flats	More than Likely
BWR: B10c (Crest)		11		C3(a)	Flats	More than Likely
BWR:B5 (Crest)		45		C3(a)	Flats	More than Likely
BWR:B16 (Crest)		52		C3(a)	Flats	More than Likely
BWR OPA.1 (Crest)		911	304	C3(a)	Flats	More than Likely
BWR OPA.1 Fmr part of green land for school		57	18	C3(a)	Flats	Reasonably foreseeable
Southbourne Gardens		7	4	C3(a)	Flats	Near certain
43 Upper Oldfield Park (Landmark Developments)		9	5	C3(a)	Flats	Near certain
5 - 13 Somerset Place		15	8	C3(a)	Flats	Near certain
Newark House		9	5	C3(a)	Flats	Near certain
90 Frome Road (Crossman)		9	5	C3(a)	Flats	Near certain
BWR Argos River Frontage (Midland Road LLP)		10	4	C3(a)	Flats	Reasonably foreseeable
Former Lambridge Harvester (Mcarthy & Stone)		50		C3(a)	Flats	Near certain
Hope House, Lansdown Road		38	20	C3(a)	Flats	Near certain

Site	GFA sqm	Dwellings Private*	Dwellings Non Private*	Planning Definition	Bath Strategy Definition	Level of Uncertainty
(Square Bay)						
MoD Ensleigh - Granville Rd (Kersfield)		24	16	C3(a)	Flats	Near certain
MoD Ensleigh - Core Area (Linden)		73	13	C3(a)	Flats	Near certain
MoD Ensleigh - Core Area (Bloor)		80	15	C3(a)	Flats	Near certain
MoD Ensleigh CCRC (IM Properties)		72		C3(a)	Flats	Near certain
MoD Warminster Road (Square Bay. Developer TBC)		122	82	C3(a)	Flats	Near certain
MoD Foxhill (Curo)		193	83	C3(a)	Flats	Near certain
MoD Foxhill (Curo)		296	127	C3(a)	Flats	Near certain
BWR Hinton Garage (Pegasus Life)		74		C3(a)	Flats	More than Likely
MoD Ensleigh - Royal High (IM Properties)		60	40	C3(a)	Flats	More than Likely
R/O 89-123 Englishcombe Lane (BANES & Redcliffe)		28	12	C3(a)	Flats	Reasonably foreseeable
King Georges Road, Twerton (Curo)			21	C3(a)	Flats	More than Likely
St Mary's Church, Julian Road (Clifton Dicocese)		10	5	C3(a)	Flats	More than Likely
Hartwells Garage		56	24	C3(a)	Flats	More than Likely
Land at Royal United Hospital (North Site)		35	15	C3(a)	Flats	Reasonably foreseeable
Twerton Park		105	45	C3(a)	Flats	Reasonably foreseeable
BWR Windsor Bridge Road (Westmark)		84	36	C3(a)	Flats	More than Likely
BWR Onega Centre		25	11	C3(a)	Flats	Reasonably foreseeable
BWR		42	18	C3(a)	Flats	Reasonably

Site	GFA sqm	Dwellings Private*	Dwellings Non Private*	Planning Definition	Bath Strategy Definition	Level of Uncertainty
Comfortable Place						foreseeable
BWR East Minimum		180	120	C3(a)	Flats	Reasonably foreseeable
Land at Odd Down (Bloor)		180	120	C3(a)	Flats	Reasonably foreseeable

*All dwellings are assumed to be flats. Where the split between private and non-private is unknown, a 65% (private) and 35% (non-private) split is applied

Appendix D. Trip Rates

Table D.1: Peak time period trip rates* by land use types with AM (0700-1000), IP (1000-1600) and PM (1600-1900)

Land use Type	Car - Arrival			Car - Departure		
	AM	IP	PM	AM	IP	PM
A1-Supermarket	0.047	0.290	0.116	0.031	0.285	0.123
A1-Shops	0.107	0.202	0.142	0.092	0.199	0.141
A3 - Restaurants and cafés	0.000	0.170	0.128	0.000	0.143	0.113
B1 – Office	0.035	0.026	0.004	0.005	0.026	0.032
B1- Innovation / workspace	0.033	0.025	0.006	0.007	0.028	0.029
C1 – Hotels	0.010	0.024	0.011	0.011	0.022	0.010
C3 – Private	0.112	0.573	0.655	0.591	0.597	0.374
C3 – Non private	0.249	0.690	0.728	0.512	0.721	0.512
C3 – Private, BWR	0.037	0.317	0.494	0.345	0.277	0.107
C3 – Non private, BWR	0.083	0.382	0.549	0.299	0.335	0.147
Land use Type	**Bus- Arrival**			**Bus- Departure**		
	AM	IP	PM	AM	IP	PM
A1-Supermarket	0.002	0.012	0.002	0.000	0.012	0.004
A1-Shops	0.005	0.013	0.003	0.003	0.010	0.006
A3 - Restaurants and cafés	0.000	0.034	0.023	0.000	0.033	0.029
B1 – Office	0.009	0.002	0.000	0.000	0.003	0.008
B1- Innovation / workspace	0.001	0.001	0.000	0.000	0.001	0.001
C1 – Hotels	0.001	0.003	0.001	0.000	0.003	0.001
C3 – Private	0.000	0.036	0.024	0.053	0.012	0.000
C3 – Non private	0.039	0.078	0.046	0.116	0.094	0.031
C3 – Private, BWR	0.000	0.199	0.058	0.046	0.089	0.000
C3 – Non private, BWR	0.025	0.431	0.111	0.100	0.696	0.161
Land use Type	**Rail- Arrival**			**Rail - Departure**		
	AM	IP	PM	AM	IP	PM
A1-Supermarket	0.000	0.000	0.000	0.000	0.000	0.000
A1-Shops	0.000	0.000	0.000	0.000	0.000	0.000
A3 - Restaurants and cafés	0.000	0.045	0.018	0.000	0.033	0.009
B1 – Office	0.005	0.001	0.000	0.000	0.002	0.005
B1- Innovation / workspace	0.001	0.000	0.000	0.000	0.001	0.001
C1 – Hotels	0.001	0.001	0.001	0.000	0.002	0.000
C3 – Private	0.006	0.000	0.076	0.076	0.006	0.000
C3 – Non private	0.000	0.000	0.000	0.000	0.000	0.000
C3 – Private, BWR	0.004	0.000	0.184	0.065	0.044	0.000
C3 – Non private, BWR	0.000	0.000	0.000	0.000	0.000	0.000

*Trip rates reported above are in per sqm for non-residential land use types and per unit for residential land use types