GBATS4M Model Update

METROWEST Public Transport Local Model Validation Report

Prepared for

West of England Authorities

08 October 2015

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Document History

GBATS4M Model Update

METROWEST Public Transport LMVR

West of England Authorities

This document has been issued and amended as follows:

Version	Date	Description	Created by	Verified by	Approved by
1.0	22.4.15	Draft Report	Simon Guy / Gareth Walters / Esperança Corella Peris	Simon Guy	Chris Bushell
1.1	8.10.15	Final Report	Simon Guy / Gareth Walters / Esperança Corella Peris	Simon Guy	Chris Bushell

Contents

Section **Page**

Introduction 1-1
1.1 Background 1-1
1.2 This Report 1-2

Model Usage and Design Considerations 2-1
2.1 MetroWest 2-1
2.2 Potential Alternative Uses 2-1
2.3 Model Design Considerations 2-1

Model Standards, Criteria and Acceptability Guidelines 3-1
3.1 Overview 3-1
3.2 Trip Matrix Validation 3-1
3.3 Network and Service Validation 3-1
3.4 Assignment Validation Criteria 3-1
3.4.1 GEH Statistic 3-2
3.4.2 Bus Assignment Validation 3-2
3.4.3 Rail Assignment Validation 3-2

Key Features of the Model 4-1
4.1 Basic Model Setup 4-1
4.1.1 Source Models 4-1
4.1.2 Software 4-1
4.1.3 Base Year 4-1
4.1.4 Network Area 4-1
4.1.5 Time Periods 4-1
4.1.6 Zoning System 4-1
4.2 Transit Representation 4-4
4.2.1 Transit Modes 4-4
4.3 Transit Lines 4-4
4.4 Assignment Methodology 4-5
4.4.1 Generalised Cost Formulation 4-5
4.4.2 Transit Line Time 4-6
4.4.3 Effective Headways 4-7
4.4.4 Relationship with Highway Assignment Model and Demand Model 4-7

Trip Matrix Development 5-1
5.1 Introduction 5-1
5.2 Bus Matrices 5-1
5.2.1 Boarding and Alighting Counts 5-2
5.2.2 'At-Stop' Surveys 5-3
5.2.3 Boarding Expansion Factors 5-4
5.2.4 Transposition of Survey Records 5-4
5.2.5 Alighting Expansion Factors 5-5
5.2.6 Preliminary bus matrix calibration 5-5
5.2.7 Merging of X2 / X3 Matrices 5-9
5.2.8 Park and Ride Matrices 5-9
5.2.9 Inter-modal transfers 5-10
5.2.10 Non-city centre movements 5-10
5.2.11 Bus Matrix Totals 5-11
5.3 Rail Matrices 5-11
5.3.1 Data sources 5-11

5.3.2 Matrix development 5-13

Model Calibration and Validation 6-18
6.1 Introduction 6-18
6.2 Bus Mode Validation 6-18
6.2.1 Matrix Validation – Bus 6-18
6.2.2 Assignment Validation Results – Bus 6-19
6.2.3 Journey Time Validation – Bus 6-23
6.2.4 Check against ETM data 6-24
6.3 Rail Mode Validation 6-25
6.3.1 Journey Time Validation – Rail 6-25
6.3.2 Matrix assignment – Rail 6-25
6.3.3 Assignment Validation Results – Rail 6-25

Summary & Conclusions 7-1

Appendices

A PT Model Transit Lines
B Bus Journey Time Comparison

Tables

Table 4-1: Transit Modes in GBATS4M PT model 4-4
Table 4-2: Auxiliary Transit Modes in GBATS4M PT model 4-4
Table 4-3: Transit Line Summary – by time period 4-4
Table 4-4: Generalised Cost Parameters 4-6
Table 4-5: Average bus speeds by time periods 4-6
Table 5-1: Sample rate by expansion group 5-3
Table 5-2: Boarding expansion factors by time period 5-4
Table 5-3: Transpose factors by time period 5-5
Table 5-4: Alighting expansion factors by time period 5-5
Table 5-5: GBATS4M preliminary matrix totals 5-9
Table 5-6: X2/X3 Demand Matrices 5-9
Table 5-7: Park and Ride Demand Matrices 5-10
Table 5-8: Bus/ Rail intermodal transfers 5-10
Table 5-9: Non City Centre Matrix 5-11
Table 5-10: Components of Final Assignment Matrices 5-11
Table 5-11: Station entries and exits – calculated from WoE survey & ORR figures (2013) 5-12
Table 5-12: WoE survey initial matrix totals 5-14
Table 5-13: NRTS survey initial matrix totals 5-14
Table 5-14: Merging rail matrices – 2013 trips 5-15
Table 5-15: Final Base Year rail matrix totals – 2013 trips 5-16
Table 6-1: Matrix totals and bus boardings by time period 6-18
Table 6-2: Matrix totals and bus boardings by time period 6-19
Table 6-3: Comparison of annualised model boardings and operator data 6-19
Table 6-4: AM Peak Screenline Flows 6-20
Table 6-5: Inter Peak Screenline Flows 6-21
Table 6-6: PM Peak Screenline Flows 6-22
Table 6-7: Central area validation of bus boarding and alighting 6-23
Table 6-8: Validation of bus journey times 6-23
Table 6-9: Check against ETM data 6-24
Table 6-10: Rail journey time comparison – total times all lines (minutes) 6-25
Table 6-11: Assigned rail trips – 2013 trips 6-25

Table 6-12: Rail assignment validation– AM peak 6-26
Table 6-13: Rail assignment validation – inter peak.....6-27
Table 6-14: Rail assignment validation – PM peak.....6-28

Figures

Figure 1.1: GBATS3 Localised Core Areas.....1-1
Figure 1.2: GBATS4M Modelling Suite.....1-2
Figure 2.1: MetroWest Corridors 2-2
Figure 4.1: GBATS4M Highway model Central Modelled Area 4-2
Figure 4.2: GBATS4M Highway model Fully Modelled Area 4-2
Figure 4.3: GBATS4M Central Model Area Zones.....4-3
Figure 4.4: GBATS4M Wider Model Area Zones.....4-3
Figure 4.5: Extent of AM Peak public transport network.....4-5
Figure 5.1: Bus matrix development process 5-2
Figure 5.2: Bus Stop expansion groups 5-3
Figure 5.3: GBATS4M AM peak preliminary bus matrix.....5-6
Figure 5.4: GBATS4M Inter peak preliminary bus matrix.....5-7
Figure 5.5: GBATS4M PM peak preliminary bus matrix 5-8
Figure 5.6: Trip length distribution of Final Assignment Matrices 5-11
Figure 5.7: Base year rail matrix totals – AM peak.....5-16

SECTION 1

Introduction

1.1 Background

This report has been prepared by CH2M Hill as part of their commission to update the Greater Bristol Area Transport Study (GBATS) modelling suite for Bristol City Council (BCC), on behalf of the West of England authorities.

The updated GBATS model has been specified to be suitable for assessing the MetroWest major scheme Phases 1 and 2. The Bristol Area Traffic Study (BATS) model was originally built and validated to a base year of 2001. Since then it has been updated to BATS2 as a part of the Greater Bristol Bus Network study in 2004 and further updated to the GBATS3 strategic model with a base year of 2006. The GBATS3 model was used as the starting point for four localised studies. In each case the model was updated, recalibrated and revalidated with the local study area core as its focus. Figure 1.1 shows the core areas of the localised models. The four studies are below:

- Ashton Vale to Temple Meads Rapid Transit (AVTM, 2006 Base year, 580 active zones);
- Northern Fringe to Hengrove Package (NFHP, 2009, 584);
- South Bristol Link (SBL, 2009 & 2012, 616); and
- South Gloucestershire Core Strategy (SGCS, 2011, 591).

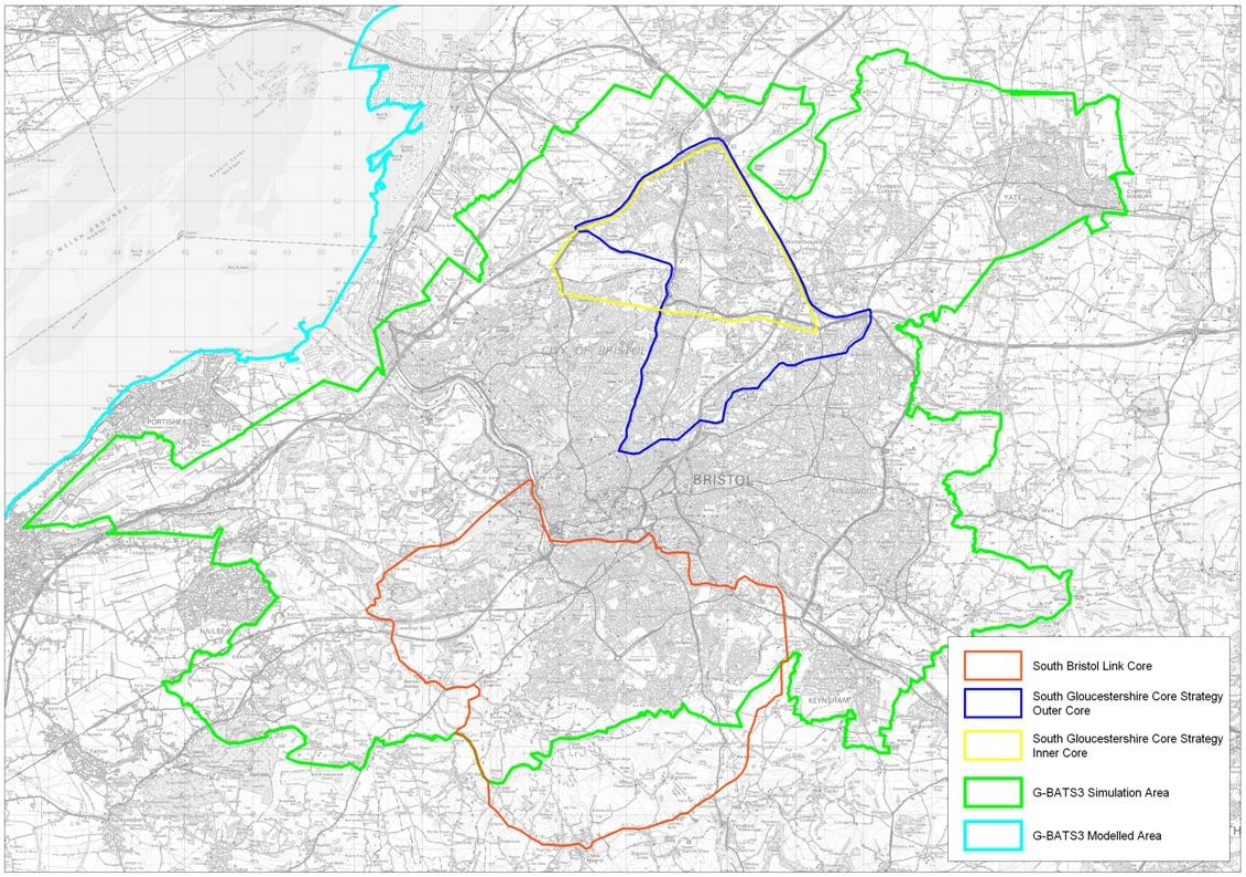

Figure 1.1: GBATS3 Localised Core Areas

The updated model is called the GBATS4 Metro Model (GBATS4M). The GBATS4M model consists of:

- A Highway Assignment Model representing vehicle based movements across the Greater Bristol area for a 2013 autumn weekday morning peak hour (08:00-09:00), an average inter-peak hour (10:00-16:00) and an evening peak hour (17:00-18:00);
- A Public Transport (PT) Assignment Model representing bus and rail based movements across the same area and time periods; and

- A five-stage multi-modal incremental Variable Demand Model (VDM) that forecasts changes in trip frequency and choice of main mode, time period of travel, destination, and sub-mode choice, in response to changes in generalised costs across the 12-hour period (07:00 – 19:00).

The GBATS4M PT model is closely integrated with the GBATS4M Highway model. The two models use different software packages (EMME and SATURN, respectively) but are identical in terms of road network structure, and zone system. The bus routes and frequencies in the PT model are used in the Highway model.

The GBATS4M PT model is fully integrated within the GBATS4M VDM. The GBATS4M PT model provides public transport costs to the GBATS4M VDM which, in turn, provides trip matrices for the GBATS4M PT model. The relationship between the elements of the modelling system is shown in Figure 1.2.

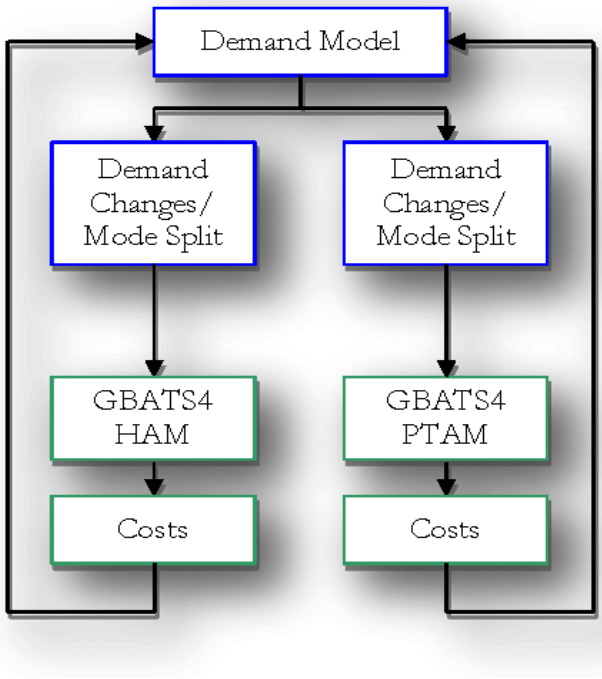

Figure 1.2: GBATS4M Modelling Suite

1.2 This Report

The remainder of this report consists of the following sections:

- Section 2 – Model Usage and Design Considerations;
- Section 3 – Model Standards, Criteria and Acceptability Guidelines;
- Section 4 – Key Features of the model;
- Section 5 – Trip Matrix Development;
- Section 6 – Model Calibration and Validation;
- Section 7 – Conclusions.

SECTION 2

Model Usage and Design Considerations

2.1 MetroWest

The GBATS4M modelling suite provides a tool with which to test the ability of future transport proposals to support forecast travel demand. At a general level this includes:

- Investigation of new development proposals; and
- Longer-term strategic planning of the transport network.

The specific purpose of the model is for assessing the MetroWest major scheme Phases 1 and 2. Figure 2.1 shows schematics of the MetroWest scheme. The primary focus of GBATS4M highway model is the MetroWest scheme corridors.

2.2 Potential Alternative Uses

The GBATS4M modelling suite could (with further validation if necessary) also be used to forecast and assess a range of alternative potential interventions. While not a definitive list, the following future year schemes could potentially be assessed:

- Bristol Arena
- Temple Circus Roundabout / Redcliffe Way;
- Temple Quarter Enterprise Zone;
- Central Area Action Plan;
- Changes to bus operations;
- Park and Ride schemes;
- M4 Link;
- North Fringe VISSIM interface;
- Strategic wider area schemes; and
- Major development proposals in the wider urban area.

2.3 Model Design Considerations

The principal objective of the GBATS4M PT model is to represent PT demand and travel times for the appraisal of the MetroWest scheme and should therefore provide:

- changes in the travel cost between the base year and forecast years for input to the GBATS4M VDM;
- changes in passenger flows along the MetroWest corridors for input to the appraisal; and
- changes in wider area PT travel costs for input to the economic appraisal.

The GBATS4M PT model is an EMME model that covers the whole of the Bristol urban area in detail, and is suitable for testing a wide range of transport interventions. The PT model covers bus, rail, and park and ride modes in the base year, with the ability to include BRT in the future reference cases. The focus of data collection for creating demand matrices has been the city centre, Park and Ride, and MetroWest scheme corridors.

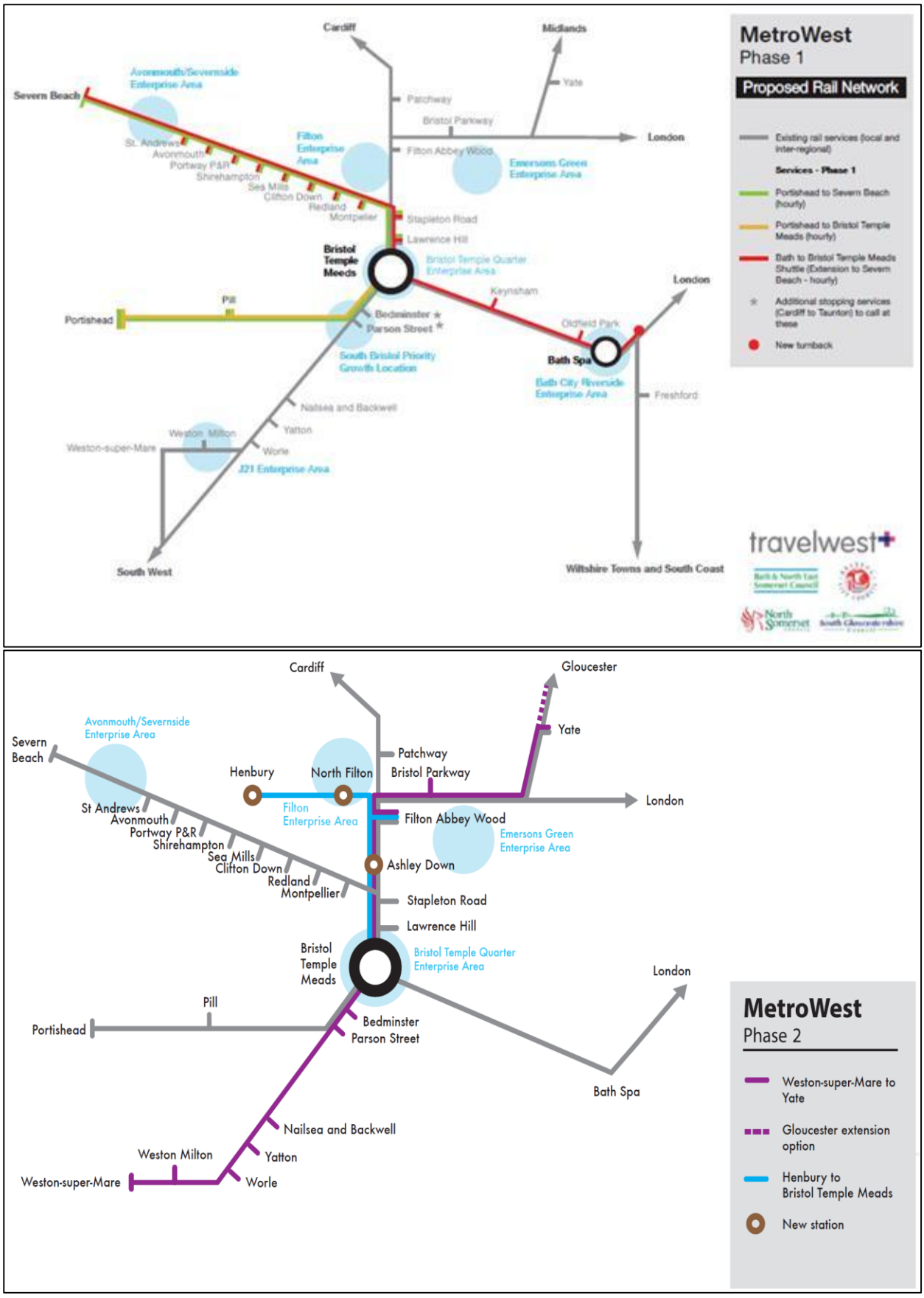

Figure 2.1: MetroWest Corridors

SECTION 3

Model Standards, Criteria and Acceptability Guidelines

3.1 Overview

The GBATS4M model has been designed and developed using the UK Department for Transport (DfT) Transport Analysis Guidance (TAG). The current, relevant guidance is: DfT TAG UNIT M3.2 Public Transport Assignment, January 2014. Referenced throughout this report as: 'TAG M3.2'.

The aim for the GBATS4M PT model was to achieve the validation acceptability guidelines specified in TAG M3.2. As indicated in the public transport calibration guidelines in TAG M3.2, the PT model validation includes:

- Validation of the trip matrices;
- Network and service validation; and
- Assignment validation.

3.2 Trip Matrix Validation

TAG Unit M3.2 states that "Wherever possible, a check should be made between the annual patronage derived from the model and annual patronage derived by the operator". No specific targets are defined for what is considered acceptable.

3.3 Network and Service Validation

The PT model bus network is identical in structure to the validated highway network. Checks on the accuracy of the coded network geometry are covered in the Highway Model LMVR. The coding of bus services was verified by checking the modelled flows of buses by route against the roadside bus count data.

Modelled bus journey times were compared against published timetables. TAG M3.2 does not contain a specific target for the accuracy of modelled journey times. However for the model validation an acceptability target of +/-15% was used, which is consistent with highway model journey time validation criteria.

The rail network was coded using industry accepted network diagrams to ensure distances between stations are accurate. Rail service station to station run times were explicitly included in the transit lines coding and therefore do not require validation.

3.4 Assignment Validation Criteria

TAG M3.2, paragraph 7.1.5 states that the validation of the assignment should involve comparing modelled and observed:

- Passenger flows across screenlines and cordons
- Passengers boarding and alighting in urban centres

The criteria in TAG M3.2 states that "across modelled screenlines, modelled flows should, in total, be within 15% of the observed values. On individual links in the network, modelled flows should be within 25% of the counts, except where the observed flows are particularly low (less than 150)."

In order to give a measure of the fit of the model to counts less than 150, we have used the GEH statistic. A GEH of less than 5 indicates a good fit of the modelled link flow to the observed count on low volume links, as specified in highway model validation criteria.

3.4.1 GEH Statistic

The GEH statistic has been included as an indicator of 'goodness of fit', i.e. the extent to which the modelled flows match the corresponding observed flows. This is recommended in the guidelines contained in TAG M3.1 and is defined as:

$$GEH = \sqrt{\frac{(M-C)^2}{0.5(M+C)}}$$

Where:
M = modelled flow; and
C = observed flow.

3.4.2 Bus Assignment Validation

For the bus assignment validation, bus occupancy counts were collected on 12 key corridors around Bristol City Centre. The counts were aggregated by corridor and time period and compared against the modelled flows along these corridors. Modelled flows on individual links were expected to be within +/-25% of observed links flows (or GEH < 5 for observed flow under 150 per hour). Total screenline flows were to be within +/-15% of the total observed flow.

Observed bus stop boardings and alightings totals (collected in the November 2013 surveys) were compared against the modelled passenger movements at surveyed bus stops. Modelled B&A were to be within +/-15% of observed passenger movements.

Checks were also undertaken of modelled bus passenger flows against First bus operator data on a corridor basis.

3.4.3 Rail Assignment Validation

For the rail assignment validation, (single day) boarding and alighting counts were available from the West of England Rail Survey, with cross-checks against NRTS and ORR data. As with the link flow validation for the bus matrices, we adopted the criterion that modelled boardings and alightings should be within 25% of the counts (or GEH < 5 where observed flows are less than 150 per hour).

SECTION 4

Key Features of the Model

4.1 Basic Model Setup

4.1.1 Source Models

The GBATS4M PT Model is a completely new model. The highway network definition is based on the GBATS4M Highway model, and this is supplemented by additional coding for the rail network.

The definition of transit lines (the public transport services included in the model) have been recoded to represent the service timetable in place in autumn 2013.

Bus demand matrices have been rebuilt using the data collected in November 2013 together with demand matrices included in the 2012 SBL version of GBATS3 covering bus movements with both their origin and destination outside Bristol city centre. The bus matrices used in the 2012 SBL GBATS3 model include all the OD data that were used in the development of the various other GBATS3 models, such as North-Fringe Hengrove (NFH) model and South Gloucestershire Core Strategy Model (CSM). Rail demand matrices have largely been rebuilt from new data sources, with only external to external trips sourced from the SBL GBATS3 model.

4.1.2 Software

The GBATS4M PT model uses EMME 4. The software is a well-established and robust transport planning package that has been used for previous versions of the GBATS model. The software is used also for the VDM that is developed as part of the GBATS model suite.

4.1.3 Base Year

The GBATS4M modelling system has a 2013 base year and represents the travel conditions for a typical autumn weekday.

4.1.4 Network Area

The GBATS4M PT model area retains the same geographical coverage as the GBATS3 model. The focus of the improvements for the GBATS4M was primarily the corridors most likely to be impacted by MetroWest, the central area and key radial routes. This included a review / update of all bus routes and bus priority measures in the central area and radial routes approaching the city centre. Figure 4.1 shows the central area. Figure 4.2 shows the wider model area, including the extents of both the simulation and buffer network in the highway model.

4.1.5 Time Periods

The GBATS4M PT model is based on trip making patterns on a typical autumn weekday in 2013. The three time periods modelled have been defined as:

- AM peak, representing hourly traffic flow between 08:00 and 09:00;
- Inter peak, representing average hourly traffic flow between 10:00 and 16:00; and
- PM peak, representing hourly traffic flow between 17:00 and 18:00.

4.1.6 Zoning System

The GBATS4M PT model zone system exactly matches that of the GBATS4M Highway model.

The GBATS4M zoning system comprises 650 zones covering the whole of Great Britain. A detailed zoning system was developed to represent the Greater Bristol Urban area and its surroundings. This is shown in Figure 4.3 and 4.4.

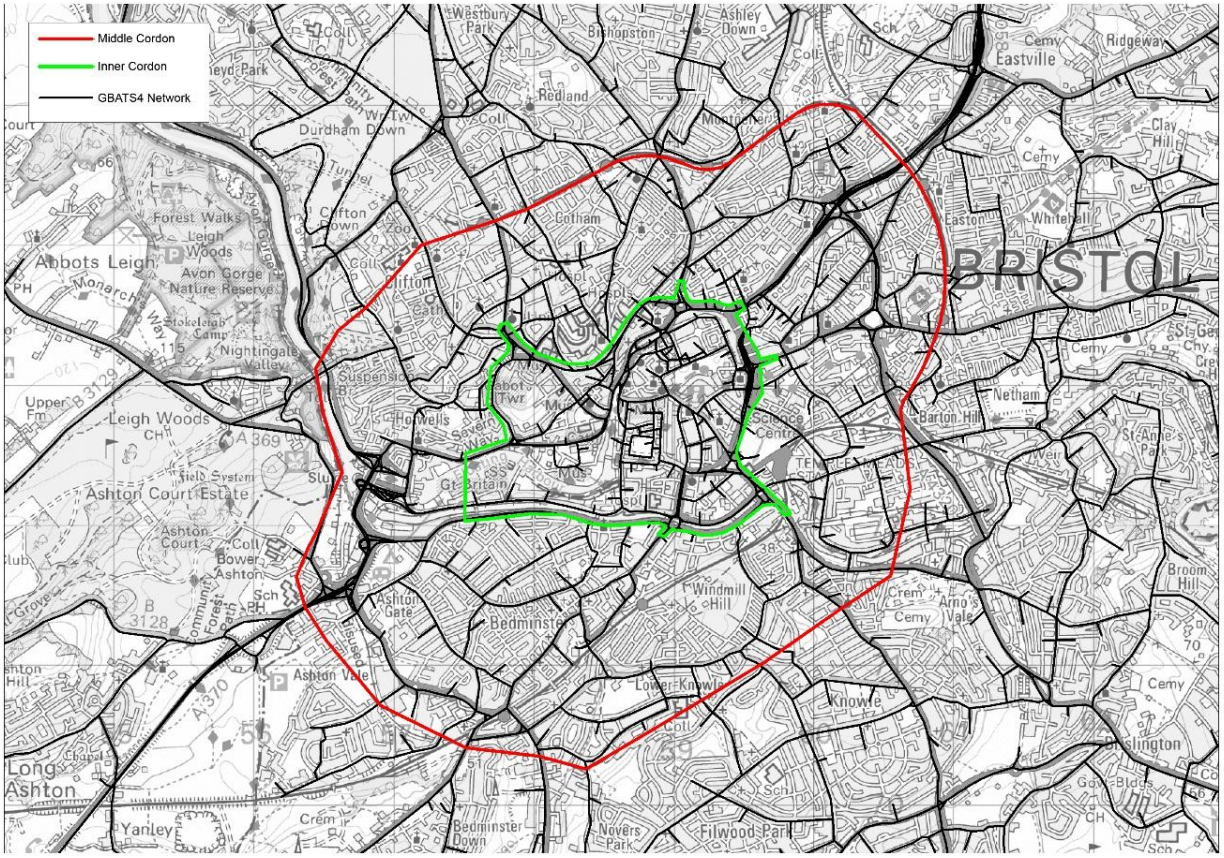

Figure 4.1: GBATS4M Highway model Central Modelled Area

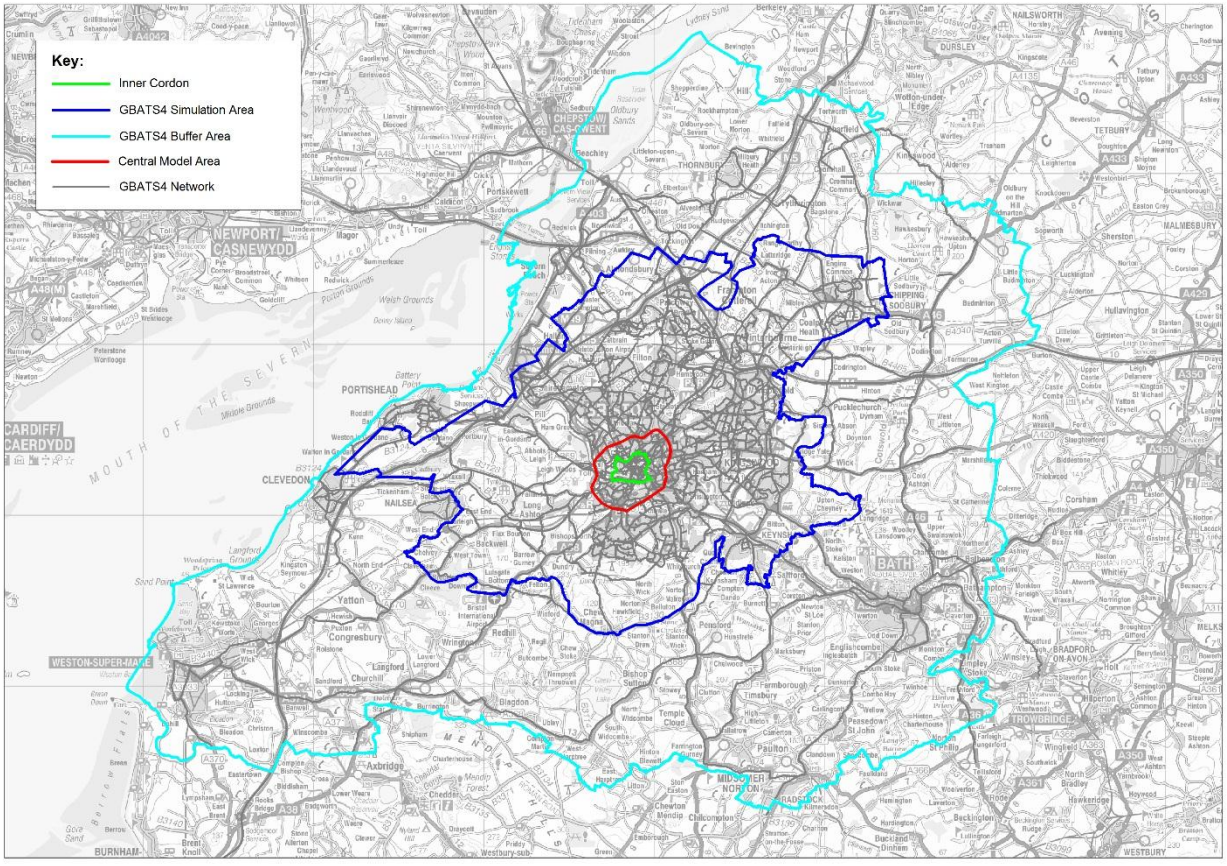

Figure 4.2: GBATS4M Highway model Fully Modelled Area

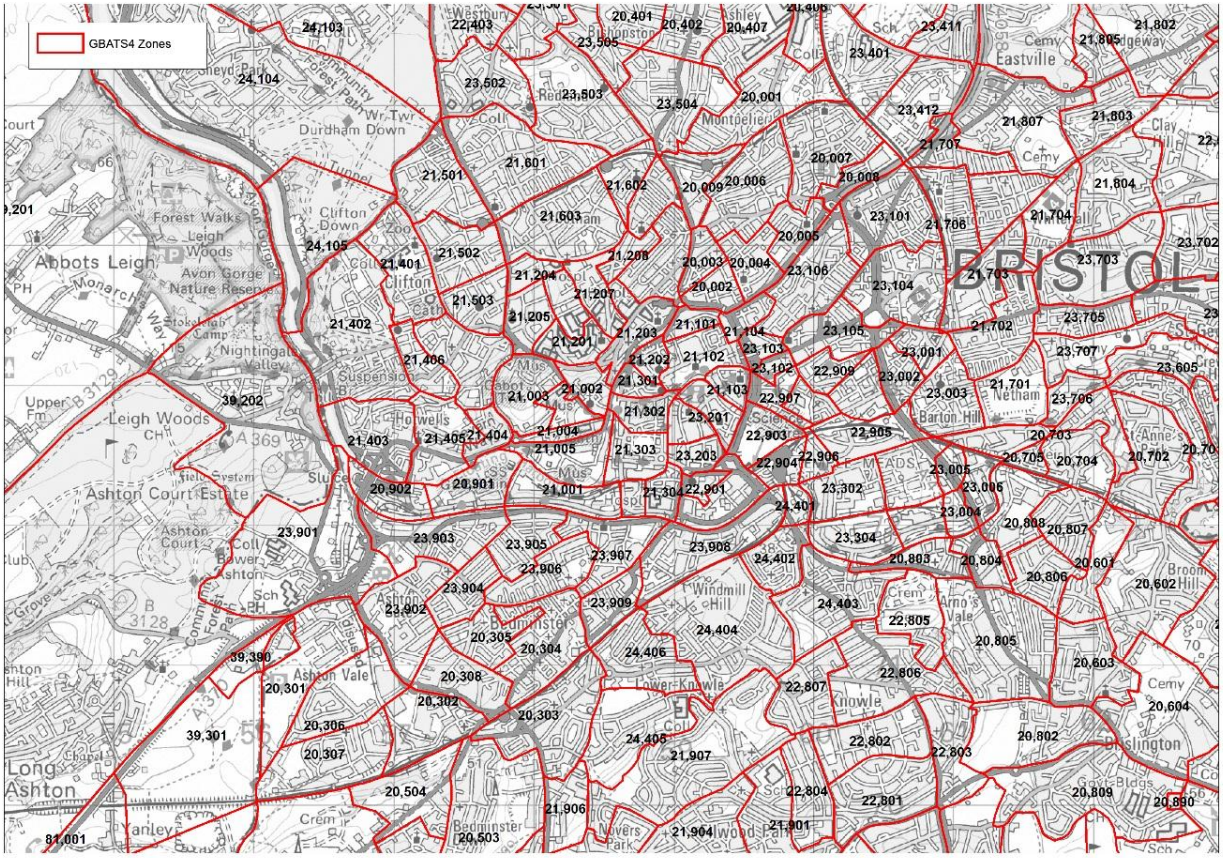

Figure 4.3: GBATS4M Central Model Area Zones

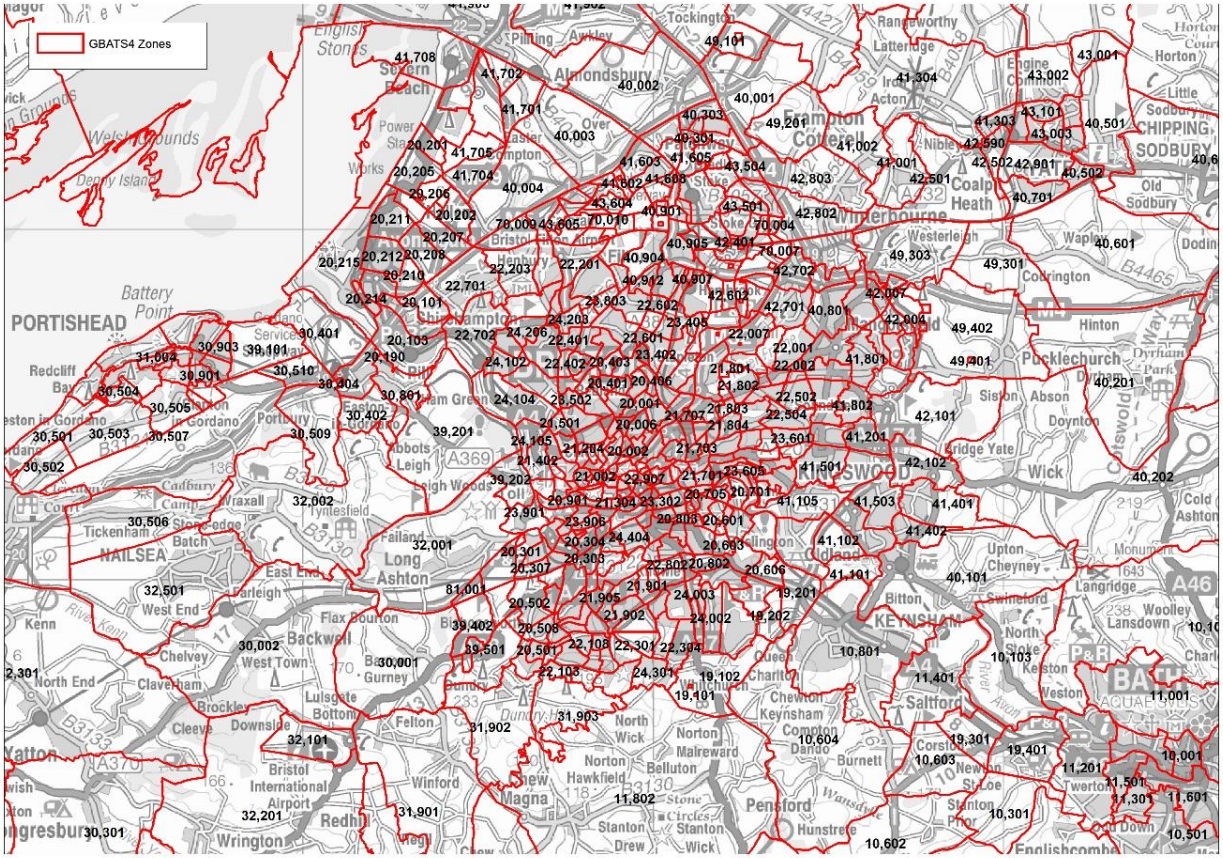

Figure 4.4: GBATS4M Wider Model Area Zones

4.2 Transit Representation

4.2.1 Transit Modes

Within EMME two categories of mode are required for public transport modelling; transit modes and auxiliary transit modes. The transit mode is used to define the modes that provide passenger services. The base year PT model includes the two currently available public transport modes:

- Bus; and
- Rail

Five individual transit modes have been defined in EMME. Four of these refer to bus services; the fifth refers to rail services. With regard to the bus modes, the differentiation between operators does not affect the assignment.

Table 4-1: Transit Modes in GBATS4M PT model

Mode	ID
Bus – First Group	B
Bus – Wessex	G
Bus – Other Operator	O
Bus – Park and Ride	P
Rail	R

The auxiliary transit mode is used to define the access/egress from transit services. Four auxiliary transit modes are defined. Mode D is used only in the rail assignment, and allows for the modelling of kiss & ride/ P&R at rail stations.

Table 4-2: Auxiliary Transit Modes in GBATS4M PT model

Mode	ID	Default speed (kph)
Walk	Q	5 kph
Slow Walk	E	3 kph
'Unmodelled' PT Access mode	X	35 kph
Rail Station Access – Car mode	D	70 kph

4.3 Transit Lines

The development of the PT model involved the complete recoding of the transit lines to represent the service pattern and timetable as of autumn 2013. Service routings were initially extracted from ATCO cif files[1] and matched to the model network link / node structure. Particular attention was paid in the city centre to ensure that bus stopping pattern was accurately reflected. Table 4.3 details the number of transit lines included in the three time periods.

Table 4-3: Transit Line Summary – by time period

Time Period	No. Bus Transit Lines	No. Rail Transit Lines	Total
AM	165	27	192
IP	189	41	230
PM	174	24	196

[1] ATCO cif files were obtained that contain bus services as represented in Traveline

The majority of services are provided by First Bus, with other operators including Wessex, and ABUS also providing services. Figure 4.5 shows the extent of the coded public transport network for the AM peak. The red lines represent links with at least one public transport service. The inter-peak and PM peak networks provide similar coverage.

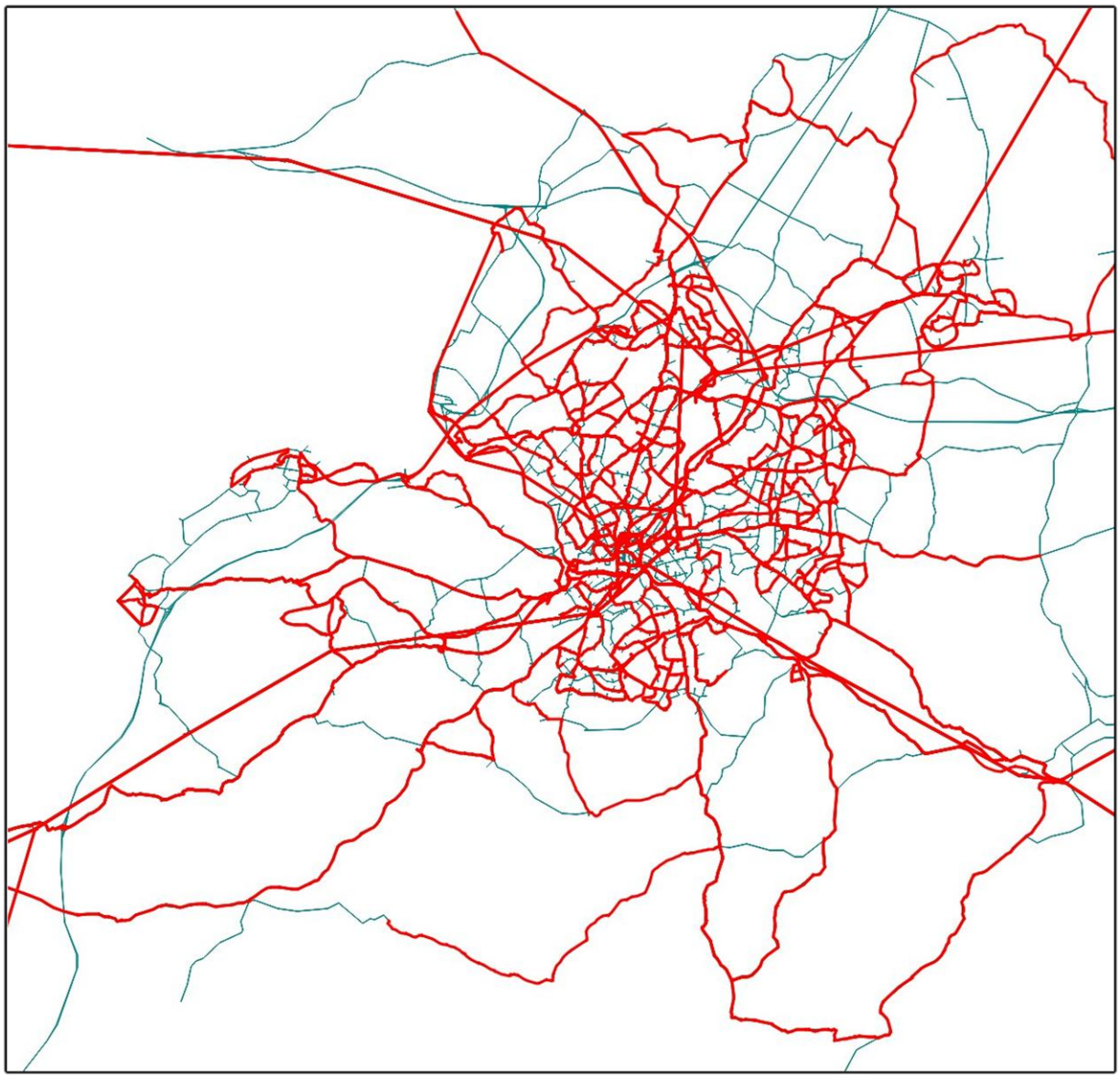

Figure 4.5: Extent of AM Peak public transport network

Appendix A details the services included in the base model and the modelled service frequency.

4.4 Assignment Methodology

The PT model uses EMME's Extended Transit Assignment algorithm. This offers an improved assignment methodology over the standard EMME transit assignment algorithm, by taking better account of service headways and journey times in the allocation of trips to PT services. This is particularly useful in representing more accurate route choice between potentially competing services, including bus and rail.

4.4.1 Generalised Cost Formulation

The generalised time utilised in EMME consists of the following formula:

GTime = (Access + Egress Time) * Aux Transit Weight +
(Average Wait Time * Wait Time Weight) +
Board Penalty + In-Vehicle Time

The parameters values used for the generalised cost calculation in the PT model are set out in Table 4.4. All values fall within thresholds described in TAG M3.2

Table 4-4: Generalised Cost Parameters

Parameter	Value
Wait Time Factor	0.5
Wait Time Weight	2
Auxiliary Transit Time Weight	2
Boarding Penalty (Bus)	10 mins
Boarding Penalty (Rail)	5 mins

The 'wait time factor' is applied to the service headway (or effective headway) to determine the average wait time. A factor of 0.5 indicates that the average wait time is equal to 50% of the service headway (i.e. an hourly service would be modelled as having an average wait time of 30mins). The "wait time weight" is applied to this average wait time.

The auxiliary transit time weight is applied to access, egress and any inter-service transfer from one node to another (e.g. walking). Access time is defined as the time required to move from an origin zone to the node at which the first PT service is boarded. Conversely egress time is the time required after disembarking from the last PT service to reach the destination zone.

Boarding penalties of 5 and 10 minutes are defined for rail and bus services respectively. These are penalties that are incurred every time a service is boarded. Therefore a trip from Portishead to Filton Abbey Wood utilising the X2/X3 service and a stopping train service from Bristol Temple Meads would incur a total boarding penalty of 15 minutes. If an additional bus service was used to access Temple Meads (e.g. 8 or 9) then total boarding penalty would increase to 25minutes.

4.4.2 Transit Line Time

An important attribute in the generalised cost formulation is the 'In- vehicle Time' – the time spent travelling on a service between stops. Travel time on a service is set utilising the travel time functions (TTF) in EMME. Two travel time functions are defined in the PT model for bus (TTF1) and rail (TTF2) as follows:

- TTF1 = (Length / Link Speed) * 60
- TTF2 = (Length / Service Specific Link Speed) * 60

As the rail model contains relatively few services, together with a relatively simple network, it was possible to code each rail service with a transit line specific link speed directly derived from the service timetable. Rail timetables in place in autumn 2013 were used for this process.

This approach was not possible for the bus mode and an alternative approach was adopted. The approach adopted involved deriving an average bus speed for links in the model, weighted according to service frequency, for the majority of modelled bus services. The data source were bus timetables valid during autumn 2013.

The resultant link speeds were input into EMME as link attributes. Separate values were calculated for each time period (@spdam, @spdip and @spdpm). All other links (i.e. links for which no bus service currently operate or those used by bus services that were not sampled were set to the time period average bus speed. These are listed in Table 4.5.

Table 4-5: Average bus speeds by time periods

Time Period	Average Bus Speed (kph)
AM	18.85
IP	22.18

Table 4-5: Average bus speeds by time periods

Time Period	Average Bus Speed (kph)
PM	20.73

4.4.3 Effective Headways

EMME allows several approaches for how wait time is calculated, as follows:

- Using actual service headway. This approach looks at the service frequency and applies a common factor for all services to derive the average wait time. Typically a factor of 0.5 is assumed; therefore an hourly service would be modelled with a wait time of 30 minutes, while a 4 per hour service would have a modelled wait time of 7.5 minutes. This approach has the benefit of reflecting differences between all services with different headways, but can overestimate passenger response to improvements in low frequency services, as in practice people will tend to arrive at a stop soon before the scheduled departure time to avoid long wait times.
- Setting a ceiling for the maximum weight time allowed. This approach is based on the previous example, but sets an upper limit for the wait time. Whilst this approach prevents unrealistically long wait time from being derived, it means that the assignment procedure is not always able to reflect changes in service frequencies for infrequent services.
- Defining an "effective" service headway from which service wait time is derived. This approach enables a more sophisticated treatment of wait time to be modelled, for example a non-linear relationship between service frequency and wait time.

The third approach was judged to be most appropriate as it would enable more realistic modelling of responses to service frequency changes, without generating excessive time saving benefits for improvements to infrequent services.

A non-linear effective headway curve has been developed for the PT model, adopting values proposed by the Passenger Demand Forecasting Handbook. This yields effective headways close to actual service headway for high frequency services. However, as the service headway increases (and the frequency decreases), effective headway also increases but the differences between actual and effective headways become greater.

4.4.4 Relationship with Highway Assignment Model and Demand Model

In the base model the highway and PT assignment models operate independently of each other. Travel time skims are produced by the Highway and PT models and then used as an input to the demand model.

Forecast year runs of the models necessitate an interaction between highway and PT models to allow changes in highway delay (both positive and negative) to be reflected in the bus journey times (i.e. in mixed traffic conditions increased delay suggested by the Highway model should be reflected in the bus runtime). An automated procedure has been developed that allows changes in SATURN link speeds to be reflected in the EMME link speeds, whilst also taking account of operational changes to the network (i.e. addition/removal of bus lanes). This methodology will be described in detail in later Reports.

SECTION 5

Trip Matrix Development

5.1 Introduction

New demand matrices were developed for the bus and rail sub-models of the PT model. The starting point for the development of the bus matrices was the surveys undertaken in November 2013. Details of these surveys can be found in the 'GBATS4 Model Update - Report of Surveys and Existing Data Review'. In summary these surveys consisted of:

- Boarding and Alighting Counts;
- At Stop Passenger Origin – Destination (OD) surveys;
- On-board OD surveys completed on Park and Ride services;
- Cordon Counts.

In addition, data was made available by BCC regarding boarding & alightings on Park and Ride services during a one week period in October 2013, and by NSC regarding the X2/X3 Bristol – Portishead services for May 2014.

Rail matrices were developed using West of England Rail survey data, together with data from LENNON and ORR datasets.

The remainder of this section describes the methodology adopted to derive 2013 assignment matrices.

5.2 Bus Matrices

The process for developing the bus matrices is illustrated in Figure 5.1.

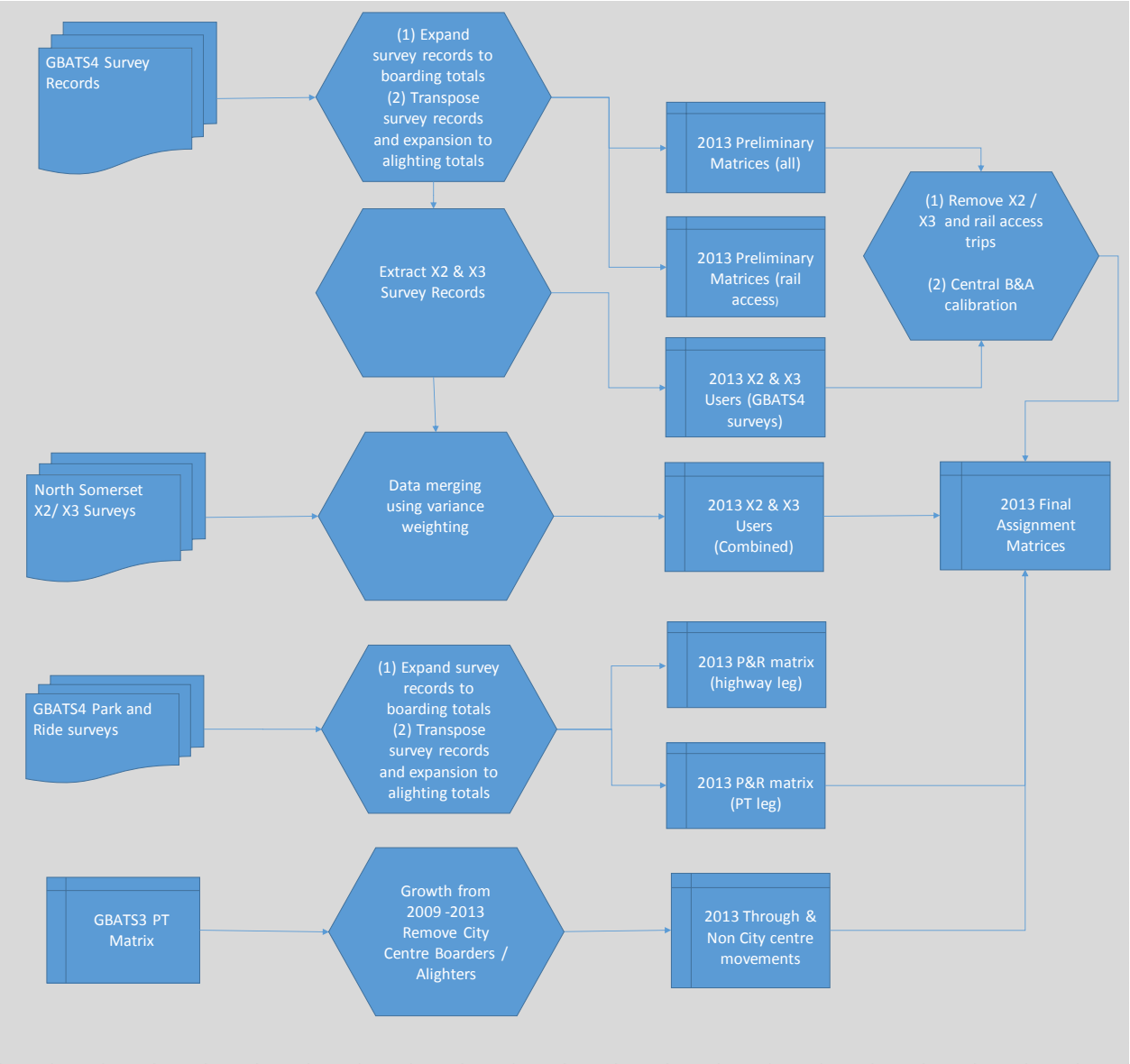

Figure 5.1: Bus matrix development process

5.2.1 Boarding and Alighting Counts

Boarding and alighting counts were matched to stops and time periods (AM, IP and PM). The total number of observations for each service number, stop and time period was derived. This was then compared to the total number of services expected at the stop per time period. This allowed a sample rate factor to be derived, and a correction factor used to uplift /reduce the observed number of boardings/alightings at the stop.

To aid the matrix building process and avoid potentially spurious expansion factors, stops were grouped into expansion clusters. This process also corrected for some misallocation of survey records to adjacent bus stops. Table 5.1 details the B&A sample rate per group and Figure 5.2 illustrates the expansion groupings utilised.

As detailed in the report of surveys, at-stop counts and passenger interview surveys did not include all bus stops, but included the busiest city centre stops.

Table 5-1: Sample rate by expansion group

Expansion Group	AM	IP	PM
1	79%	81%	70%
2	103%	103%	83%
3	84%	92%	85%
4	65%	85%	85%
5	59%	72%	70%
6	100%	99%	97%
7	71%	52%	64%
8	102%	68%	72%
9	99%	101%	63%

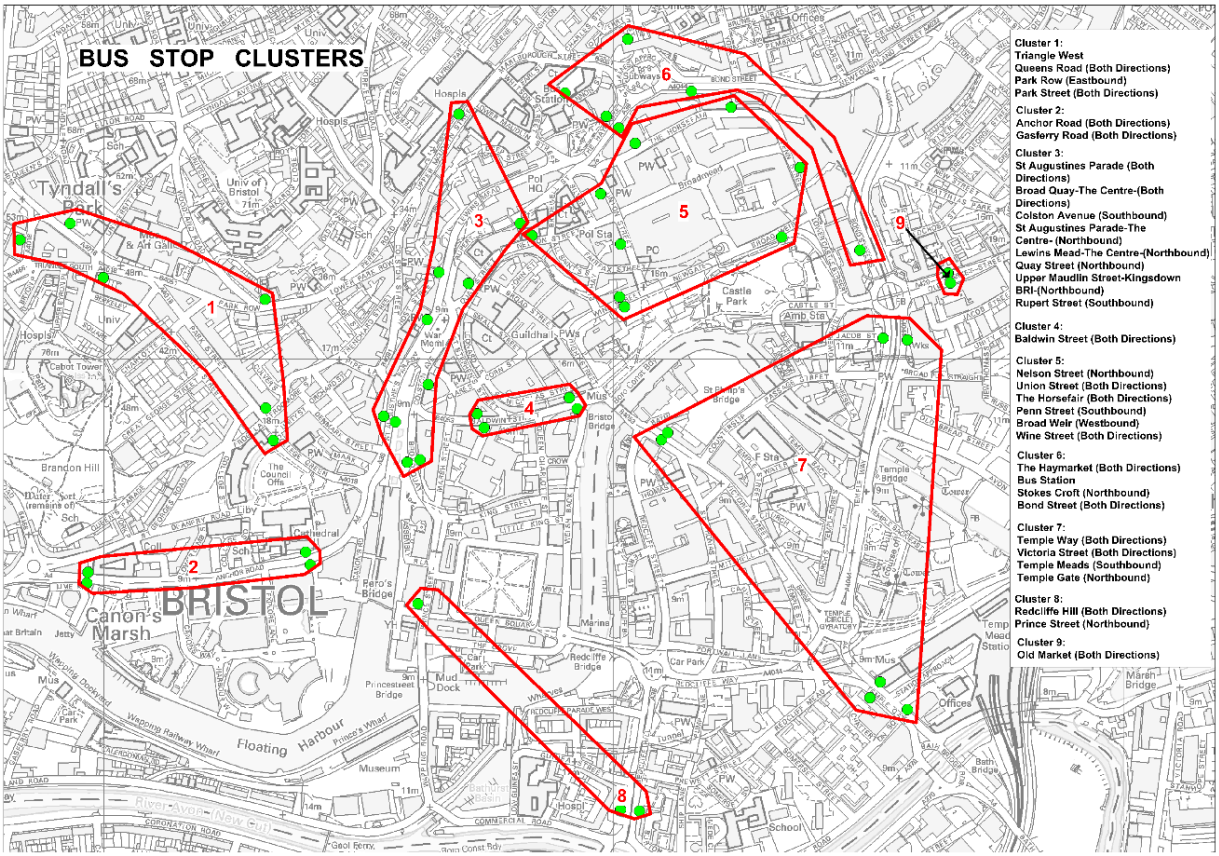

Figure 5.2: Bus Stop expansion groups

5.2.2 'At-Stop' Surveys

The 'at-stop' passenger surveys recorded trip origin and destination, trip purpose, time of return trip, access & egress mode from respondents and the number of passengers travelling together with the interviewee.

This data was comprehensively checked to ensure that data was reliable, referred to the correct stop, and had OD recorded in the correct direction. Suspect records were investigated and corrective action taken where possible (i.e. trip record reversed, reallocated to another stop, access mode adjusted). If no corrective action could be taken the survey record was removed from the dataset.

5.2.3 Boarding Expansion Factors

Boarding expansion factors to expand the survey records were determined using the expansion area groups. This technique was adopted to help avoid "lumpiness" that can occur when calculating expansion factors at the individual stop level. The expansion factor for a given survey response is calculated by:

$$BoardingExpansionFactor = \frac{N_{S,mTH}}{n_{S,sTP}}$$

Where:

- $N_{S,mTH}$ is the total number of boarders at expansion area group S during the modelled time hour mTH.
- $n_{R,S,sTP}$ is the total number of passenger OD surveys at expansion area group S during the surveyed time period sTP.

Table 5.2 details the boarding expansion factor per expansion group.

Table 5-2: Boarding expansion factors by time period

Expansion Group	AM	IP	PM
1	1.73	1.25	4.49
2	0.92	1.09	7.41
3	4.57	2.54	10.59
4	1.59	0.70	4.89
5	2.65	2.47	9.55
6	3.57	2.67	8.12
7	2.82	1.89	9.44
8	2.25	3.26	2.77
9	1.75	0.78	5.12

These expansion factors were applied to the number of passengers associated with each survey record, to produce an expanded total number of trips between origin and destination zone.

5.2.4 Transposition of Survey Records

The 'at stop' surveys only obtained OD information for boarders. As the stops surveyed were all located in the city centre, this generally meant that passengers leaving the city centre were interviewed. To generate the "city-centre bound" leg of the trip required the transposing of trips records and allocation to the three model time periods. The allocation of trip record to time period was based on a cross-tabulation of trip purpose and return timing of trip based on an analysis of survey records.

Table 5.3 summarises the transposition of trips records to the "non-observed" direction. For example, of the surveys completed in the AM Peak, 7% were transposed and allocated to the AM peak, 23% to the Inter peak and 64% to the PM peak. 7% were not transposed as the "un-surveyed" leg of the journey was outside of the modelled period, or the trip was "single".

Table 5-3: Transpose factors by time period

Interview Time	Number of Surveys completed in time period	Un-surveyed trip time			
		AM	IP	PM	Single Trip or Outside model period
AM (07:00 – 10:00)	832	7%	23%	64%	6%
IP (10:00 – 16:00)	1452	24%	45%	21%	10%
PM (16:00 -19:00)	790	56%	24%	8%	12%

5.2.5 Alighting Expansion Factors

Alighting Expansion Factors were derived for the transposed data in a similar fashion to the boarding expansion factor. The expansion factor for a given survey response is calculated by:

$$AlightingExpansionFactor = \frac{N_{S,mTH}}{n_{S,sTP}}$$

Where:

- $N_{S,mTH}$ is the total number of alighters at expansion area group S during the modelled time hour mTH.
- $n_{S,sTP}$ is the total number of passenger OD surveys at expansion area group S during the surveyed time period sTP.

Table 5-4: Alighting expansion factors by time period

Expansion Group	AM	IP	PM
1	9.46	1.54	2.67
2	6.56	1.34	1.58
3	9.35	2.69	3.15
4	12.14	1.33	1.46
5	3.78	2.28	2.26
6	9.54	4.52	3.87
7	11.24	2.67	2.00
8	11.60	2.35	2.22
9	5.15	1.17	1.75

The alighting expansion factors were applied to each transposed survey record to produce the total number of trips alighting at the node. Table 5.4 details the alighting expansion factors by expansion group.

To avoid double counting in the transpose and expansion process, a weight of 0.5 was applied to records for users who stated they had travelled by bus to reach the stop where they were surveyed, waiting for another bus service.

5.2.6 Preliminary bus matrix calibration

Following initial assignment, the production of preliminary matrices included some adjustment to calibrate the matrices to the central area boarding and alighting data. Figures 5.3- 5.5 illustrate the pattern of demand in the GBATS4M preliminary matrices. The resulting matrices show a pattern of trips

consistent with what would be expected. In the AM peak it can be seen that there is a predominance of trip destinations in and around the city centre. The UWE Frenchay campus also appears as a major destination – reflecting its size and importance. The inter-peak preliminary matrix is generally more balanced with the number of trips originating from any zone of a similar magnitude to the number of trips travelling to the zone. In the PM peak it can be seen that the trips primarily originate from zones in and around the city centre.

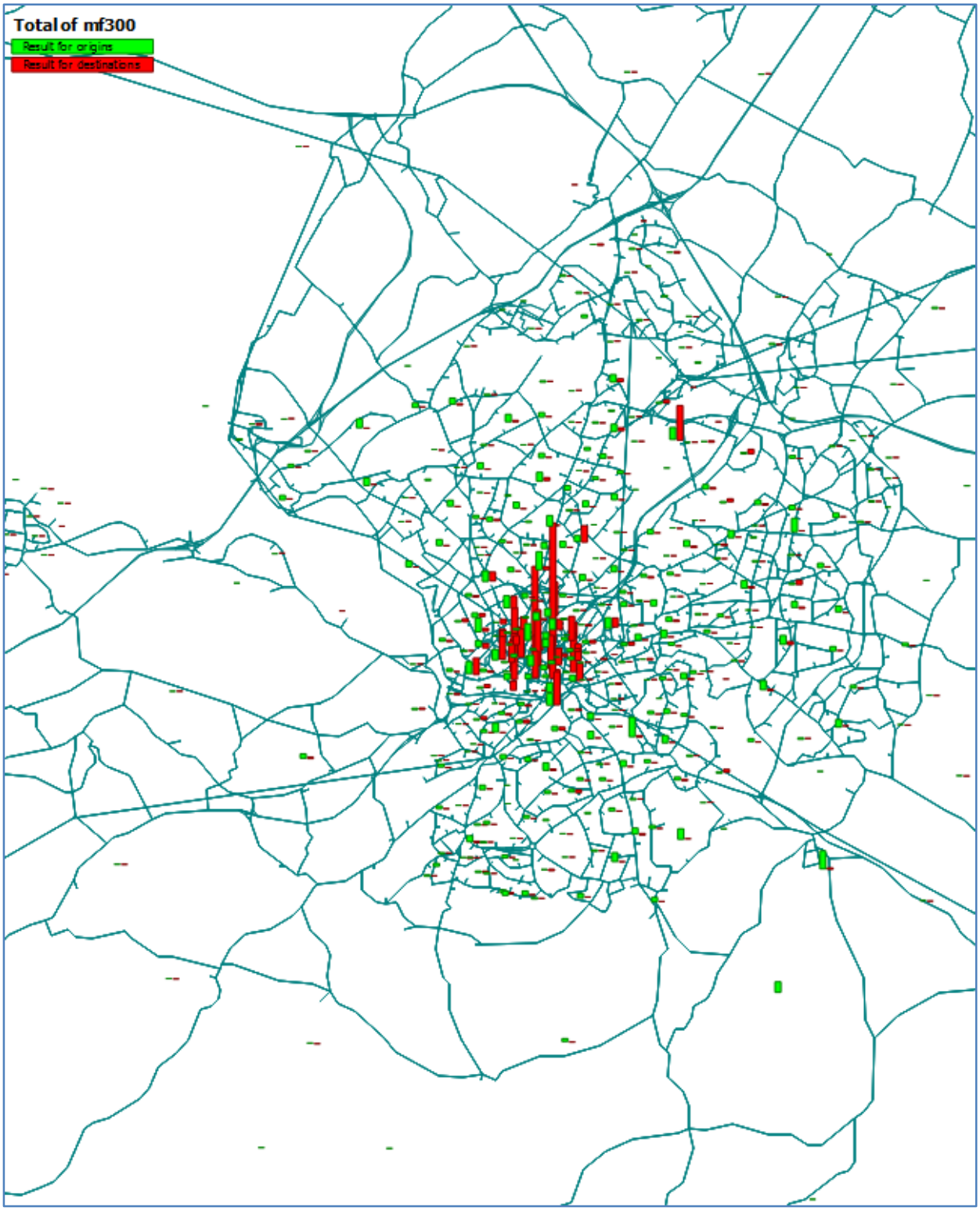

Figure 5.3: GBATS4M AM peak preliminary bus matrix

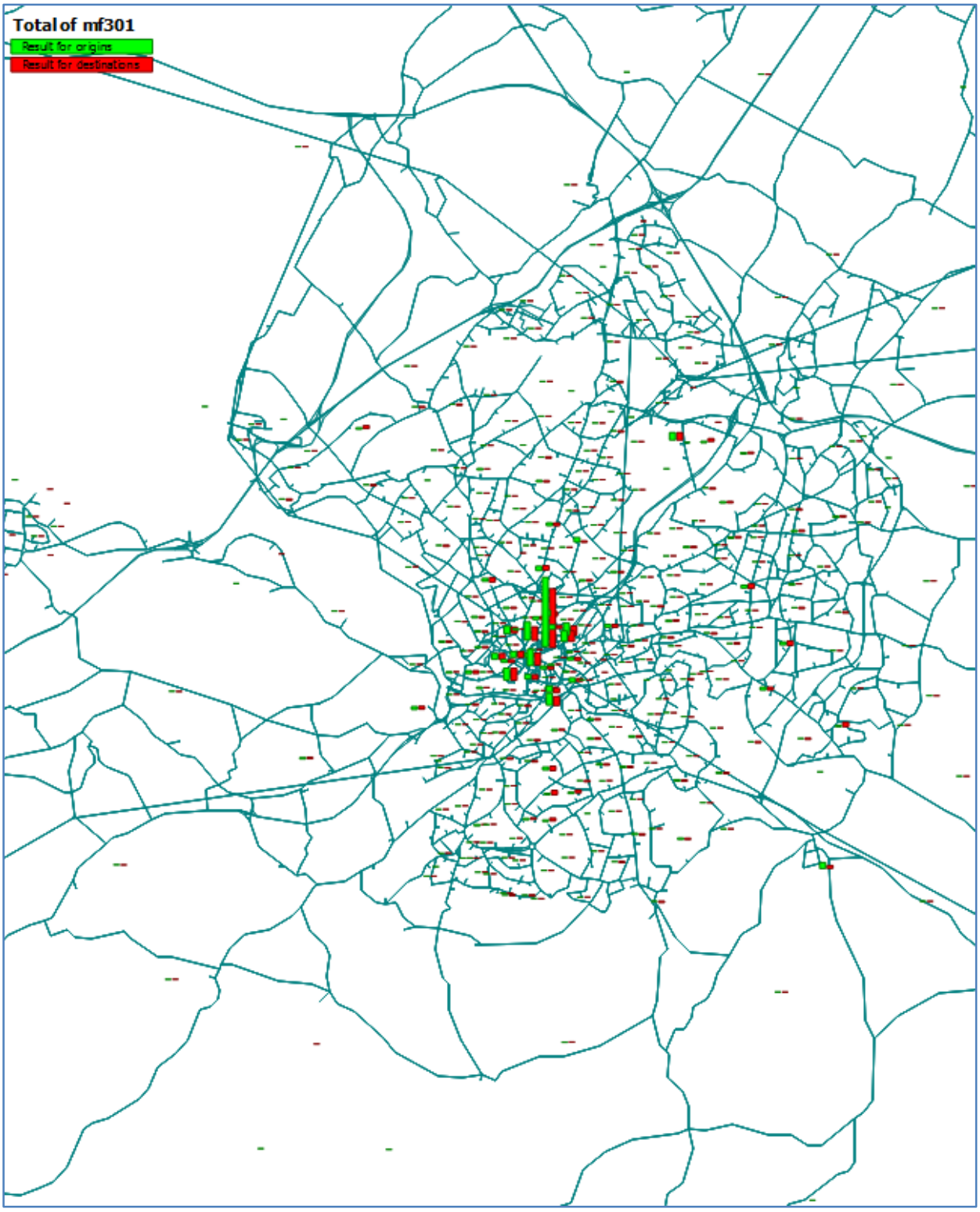

Figure 5.4: GBATS4M Inter peak preliminary bus matrix

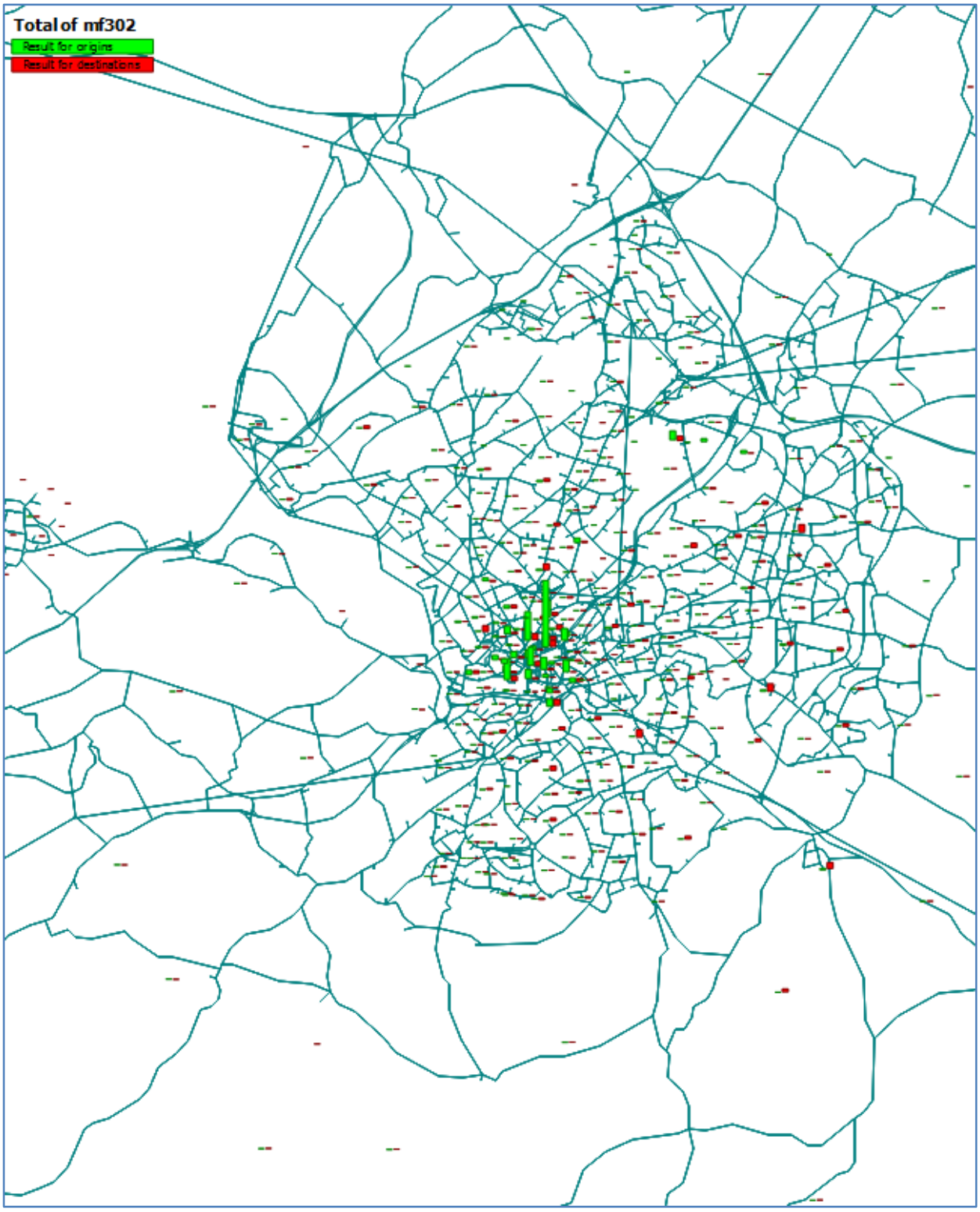

Figure 5.5: GBATS4M PM peak preliminary bus matrix

Table 5.5 summarises the matrix totals for the three time periods. These are the core building blocks of the final 2013 assignment matrices.

Table 5-5: GBATS4M preliminary matrix totals

Period	AM	IP	PM
GBATS4M preliminary matrix	8172	5584	8037

5.2.7 Merging of X2 / X3 Matrices

Two sources of demand data were available for the X2/X3 bus service; the main GBATS4M 'At Stop' surveys conducted in November 2013 and the "on-board" surveys conducted by North Somerset Council (NSC) in May 2014.

The North Somerset survey data was analysed to create two separate datasets. The first covered 'local' movements – essentially those trips between Portishead / Pill / Clanage Road. These trips were not surveyed in the GBATS4M surveys and therefore the NSC data is the only recent source of data. The second dataset covered the inter-urban movement (i.e. trips between Portishead and Bristol). This dataset potentially covers some of the movements that the November 2013 surveys included.

A weighted merge was applied to make best use of the most reliable estimate of demand for each OD pair. Firstly all trips in the preliminary GBATS4M matrices relating to the X2/X3 service were identified and removed from the GBATS4M preliminary matrices. These were then combined with the NSC dataset for inter-urban trips to form a sub-matrix of X2/X3 users using a weighted merge based on indices of dispersion. More precisely, from two matrices containing $\dot{X}_1$ and $\dot{X}_2$ for the same ij pair a merged estimate of $\dot{X}$ is:

$$\dot{X}_m = \frac{I_2\dot{X}_1 + I_1\dot{X}_2}{I_1 + I_2}$$

where:

- I= Var ($\dot{X}$) / $\dot{X}$
- $\dot{X} = \sum e$
- e = N/n, the expansion factor

Table 5.6 details the various sub-components of the X2/X3 demand included in the final assignment matrices.

Table 5-6: X2/X3 Demand Matrices

Source	AM	IP	PM
NSC "Local" X2/X3 Matrix	32	60	29
X2/X3 users from preliminary matrix	148	113	110
Merged X2/X3 Matrix (combined NSC and GBATS4M surveys)	165	128	190

5.2.8 Park and Ride Matrices

New Park and Ride matrices have been developed using the OD surveys conducted in November 2013. Survey records were expanded to the weekday average B&A counts provided by BCC. Trip records were analysed and two sets of matrices derived – one covering the "car-leg" part of the trip (i.e. the trip from the home end to the Park and Ride site), the other the PT based part of the trip (the trip from the P&R site to the ultimate destination). The car-leg portions of the trips were included in the highway model assignment.

Processing of survey records from the Portway P&R service took account of the fact that the 902 service also collects passengers from Sea Mills and Shirehampton. These trips were included in the survey

records. However it would be incorrect to create a "car-leg" matrix for these trips as access to the service does not involve driving to the P&R site.

Table 5.7 details the different segments of matrices to be added included in the main assignment matrices.

Table 5-7: Park and Ride Demand Matrices

Source	AM	IP	PM
Portway 'non car' users	32	60	29
P&R Users (all sites)	665	280	554

5.2.9 Inter-modal transfers

Trip records where 'rail' was used as access mode to the bus stop or subsequent onwards mode to their final destination were separated out and stored in separate time period matrices. These trips are already theoretically included in the rail matrix and therefore including them in the bus matrix would constitute double counting. These trips are therefore removed from the final assignment matrices.

Table 5-8: Bus/ Rail intermodal transfers

Source	AM	IP	PM
Bus/Rail Intermodal matrix	284	196	266

5.2.10 Non-city centre movements

The emphasis of the GBATS4M survey programme was on city centre boardings/alightings. As a consequence any matrices built purely from these survey records would almost entirely be city centre focussed. Movements from/ to areas outside the city centre would be excluded, unless an inter-bus city centre transfer was involved. Passengers on "cross-city" services such as the Service 75 (Hengrove – Cribbs) would not be surveyed or represented in the matrix.

The SBL version of GBATS3 PT model incorporated bus matrices based upon on-board bus OD surveys collected in July/ November 2009 together with Wayfarer data. The use of these data sources mean that the GBATS3 matrices theoretically cover not only movements to/from the city centre, but also movements to and from areas outside the city centre.

In order to capture these "non-city centre" movements and incorporate them in the GBATS4M PT model matrices, a process was developed to remove the OD movements from the SBL matrices that used any of the city centre bus stops that had been surveyed in November 2013. Any local trips between Portishead, Pill and Clanage Road were also removed as these were covered by the more recent North Somerset on-board surveys. As stated in section 4.1, the SBL model bus matrices include all OD data contained in the North Fringe Hengrove (NFH) model and South Gloucestershire Core Strategy Model (CSM). This included a number of count and interview surveys across Bristol, including the North Fringe area, as documented in the data collection report relevant to those models[2].

The resulting matrix of trips not observed by the GBATS4M PT surveys, was then added to the November 2013 bus user matrix before the Final Assignment matrices were produced. This included adjustment of demand outside the central modelled area to provide a good fit to available bus operator corridor demand data. Table 5.10 details the matrix totals of the source matrix and the resultant estimate for non-observed trips.

[2] South Bristol Link North Fringe Hengrove Package Data Collection Report, Atkins August 2011

Table 5-9: Non City Centre Matrix

Source	AM	IP	PM
SBL Matrix (all trips)	13467	9930	11826
2013 non city-centre Matrix	5047	4930	4660

5.2.11 Bus Matrix Totals

Table 5.10 summarises the main component parts of the GBATS4M Public transport matrices. The Final Assignment Matrices were filtered to remove any "walk" only trips (i.e. trips that were completed in their entirety without utilising a bus service).

Table 5-10: Components of Final Assignment Matrices

Source	AM	IP	PM
GBATS4M preliminary matrix	8172	5584	8037
2013 Non city centre matrix	5047	4930	3486
Combined Matrix (inc adjustments for P&R, X2/X3 etc)	13743	10662	13124
Final Assignment Matrix (walk only trips removed)	12506	9590	11852

Figure 5.6 details the trip length distribution of the final bus assignment matrices. The average trip length suggested by these matrices is 8.1km in the AM peak, 8.8 km in the inter-peak and 8.7km in the PM peak.

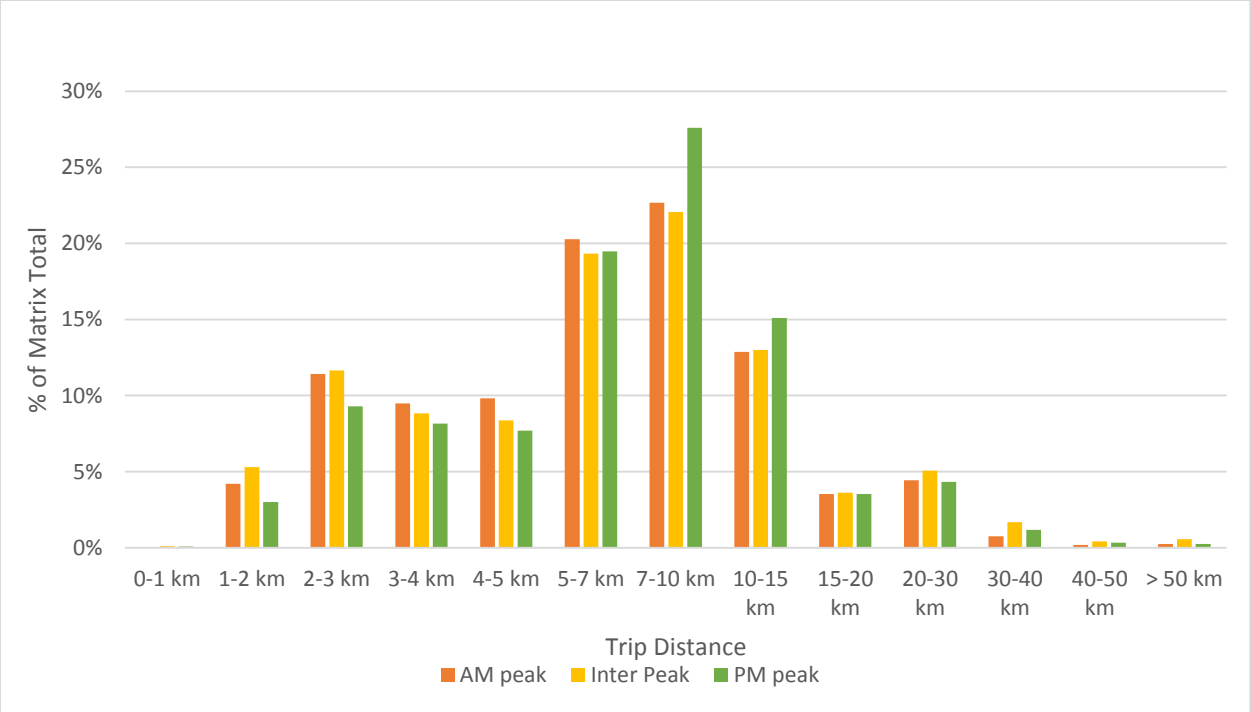

Figure 5.6: Trip length distribution of Final Assignment Matrices

5.3 Rail Matrices

5.3.1 Data sources

New rail matrices were developed for GBATS4M, making use of a number of available datasets. Note that while this included use of local survey data, no specific surveys of rail usage were carried out for model development. The principal sources of OD data used in the matrices were:

- West of England Rail Survey (WoE survey) – used for OD information and station entries and exits (where available);
- National Rail Travel Survey (NRTS) – used for OD information and station entries and exits (where WoE data was not available);
- Office of Rail Regulation (ORR) station usage estimates – used to update WoE survey information to 2013 values and adjust station entries and exits accordingly;
- MOIRA (rail industry model) – extracts from MOIRA have been used to assist in developing the rail matrices, including annual-to-daily and daily-to-period usage profiles and station-to-station movement calibration; and
- GBATS3 rail matrices – used for external-to-external rail movements, updated to 2013 figures using relationships derived from ORR station usage.

WoE Survey & NRTS data

The WoE surveys consist of an annual boarding and alighting count supplemented on a biannual basis by more detailed questionnaires. The development of rail matrices in the GBATS PT model makes use of station boarding and alighting counts carried out in November 2013, with questionnaire details from November 2012. Further surveys in the series took place in November 2014, but these were too late for inclusion in base year model. Surveys take place at all stations in the WoE area, but are limited to Severn Beach Line services only at Bristol Temple Meads, and coverage at other larger stations can be variable at busier times (such as Bristol Parkway and Bath Spa).

Comparison of WoE survey results with ORR station usage estimates has tended to yield differences that can be significant. This is partly as a result of differing methodologies, where the WoE survey is a one day snapshot in November and ORR usage estimates are based on ticket receipts. Both the WoE survey and NRTS provide an important element of OD information in that the trips included are 'true' origin to 'true' destination whereas MOIRA and LENNON ticketing data are station-to-station only.

Station entries and exits

Note that station entries and exits are used in the derivation and validation of the rail model rather than specific train boarding and alighting counts. Typically, larger station entry and exit values will be lower than counts of passengers actually boarding and alighting trains, as there is some element of train-to-train interchange, where the passengers concerned do not enter or leave the station. This distinction is related to the data available. Most of the stations in the WoE surveys (and indeed in the GBATS modelled area) are local stations at which there is no interchange, so entry and exit are the same as boarding and alighting respectively. The most significant interchange station in the modelled area, by far, is Bristol Temple Meads, but as this is not covered fully by the WoE surveys there is no record of interchange movements. However, NRTS and ORR provide station entries and exits on a consistent basis for all stations.

As such, while the primary source of station entries and exits is the WoE survey boarding and alighting counts, cross-reference has been made to NRTS derived information and ORR station entries and exits to identify the most appropriate values to use in matrix building and validation.

Table 5.11 shows station entries and exits derived for use in validating the rail elements of the model. These are compared with assigned rail mode trips later in this report.

Table 5-11: Station entries and exits – calculated from WoE survey & ORR figures (2013)

Station	AM peak		Inter Peak		PM peak	
	Entries	Exits	Entries	Exits	Entries	Exits
Bristol Temple Meads	892	2688	533	583	3395	870
Bedminster	54	26	6	6	17	43
Parson Street	68	15	6	4	22	48
Lawrence Hill	97	48	15	19	56	106
Avonmouth	20	33	8	9	38	22

Table 5-11: Station entries and exits – calculated from WoE survey & ORR figures (2013)

Station	AM peak		Inter Peak		PM peak	
	Entries	Exits	Entries	Exits	Entries	Exits
Shirehampton	28	10	6	8	10	41
Clifton Down	70	151	37	38	137	85
Montpelier	153	64	20	13	63	80
Stapleton Road	133	32	29	25	53	148
Redland	84	54	15	11	40	49
Sea Mills	42	4	6	7	8	51
Severn Beach	27	6	3	6	6	15
St Andrews Road	1	2	2	0	6	2
Bristol Parkway	427	412	160	125	251	764
Filton Abbeywood	117	554	88	47	503	106
Patchway	20	52	4	3	60	22
Yate	138	13	16	15	24	150
Bath Spa	993	1240	361	390	1238	1098
Keynsham	226	72	21	20	43	152
Oldfield Park	157	46	16	16	48	141
Nailsea & Backwell	171	105	40	72	90	250
Yatton	226	9	16	20	26	256
Weston Milton	41	13	6	7	8	37
Weston-super-Mare	304	113	77	69	155	337
Worle	128	26	22	23	34	175

5.3.2 Matrix development

The methodology for developing the base year rail matrices went through the following steps:

- Initial OD matrix developed from WoE survey data;
- Initial OD matrix developed from NRTS data;
- WoE and NRTS data merged;
- External-external movements added;
- Matrix smoothing; and
- Matrix calibration.

Initial OD matrix developed from WoE survey data

True origins and destinations are recorded in the WoE questionnaire surveys as postcodes. Around 90% are full postcodes, with others being partial, which can readily be allocated to GBATS zones.

The surveys record the time of departure, enabling direct allocation of movements to AM peak, Inter Peak and PM peak periods. Initially, in order to include the most comprehensive pattern the matrices included a 3-hour morning peak (07:00-10:00) and 3- hour PM peak (16:00-19:00), as well as including all movements in the inter peak period (between 10:00 and 16:00). However, closer examination of the data identified a significant drop-off in completed questionnaires through the day and especially in the PM peak, with de facto sample rates around 1% in the afternoon and evening, where up to 10% samples were recorded in the morning. This is not especially surprising, as a significant proportion of rail users at the WoE local stations are making return journeys, and moreover many are to Bristol Temple Meads (which was not surveyed).

As such, while boarding and alighting information is used from the whole day, origin and destination information from the WoE surveys is only taken from questionnaires undertaken prior to 13:00. This pattern is transposed to provide a combined direction Inter Peak and a PM peak pattern. Expansion factors derived from the boarding and alighting counts that accompanied the questionnaire surveys were used to convert the OD patterns to AM peak period (3-hour), Inter Peak (6-hour) and PM peak period (3-hour) matrices. Subsequently, hourly values were calculated for each period using a combination of the initial survey results and profiles from MOIRA.

Table 5.12 shows matrix totals derived from the WoE survey data.

Table 5-12: WoE survey initial matrix totals

2013 trips	AM	IP	PM
Total trips	5807	1342	5077

Initial OD matrix developed from NRTS data

True origins and destinations of rail trips are also recorded in the NRTS as postcodes, but unlike the WoE surveys, the most detailed postcode level included is postcode sector (for example, 'BS1 1'). This cannot always be allocated directly to a GBATS zone, particularly in urban areas, where postcode sectors can be much bigger than zones. As such, an origin and destination 'smoothing' process is subsequently required (described briefly below).

Like the WoE surveys, it is possible to identify time periods of movements directly from NRTS data. A key difference between the NRTS dataset and WoE survey data though, is that the NRTS dataset as issued to end users has been normalised and expanded to match ticketing data. As such, it is possible to directly collate information from the NRTS dataset into OD matrices that requires no further manipulation. However, to recognise that rail journeys are driven by the timetable and that patterns may slip just inside or outside arbitrary defined peak hours, a similar process was followed as with the WoE survey data to collate patterns from multi-hour periods initially, prior to final output as 1-hour values. Hourly values were calculated for each period using profiles from MOIRA.

ORR station entry and exit information is used to re-base NRTS trips to 2013 for the base year model. Table 5.13 shows matrix totals derived from NRTS data

Table 5-13: NRTS survey initial matrix totals

2013 trips	AM	IP	PM
Total trips	9587	3279	10083

WoE and NRTS data merged

With two sets of source matrices that essentially 'overlap' to a reasonable extent, it is not appropriate to simply add or average these datasets to produce combined matrices. As such, a weighted merge was applied to make best use of the most reliable estimate of demand for each OD pair from the respective matrices. The process followed is the same as that set out in the earlier section of this section that described bus matrix development, used to merge X2/X3 service matrices into the main preliminary bus matrices.

External-external movements added

While not specifically impacting on assignment, as there are currently no capacity based procedures involved, in order to better reflect all movements in the modelled area, external (to the detailed model area) trips are required. This cannot be determined from local surveys, and to do so from NRTS would be prohibitively complex, as this would require obtaining NRTS data for virtually all of the UK rail network (data was obtained for stations in the West of England area in order to derive the base year matrices). As such, it was determined that the best approach would be to capture external movements from the previous GBATS model – specifically the 2009 base year rail matrices from the predecessor SBL model.

ORR station entry and exit information has been used to re-base the external-external trips from 2009 to 2013, operating on pairs of stations using the average change (growth) over the ensuing period to 2013.

External-external trips were the added to the merged WoE survey and NRTS matrices to give a set of total initial rail matrices. Table 5.14 shows component parts and merged matrix totals.

Table 5-14: Merging rail matrices – 2013 trips

Source	AM	IP	PM
WoE Survey	5807	1342	5077
NRTS [1]	9358	3122	9790
External-external	936	312	506
Merged [2]	**9081**	**2841**	**9310**

(1) Note that the initial NRTS matrices included some trips that were external zone to external zone. These were removed prior to the merging process

(2) Merged totals exclude a small amount of intra-zonal trips, also eliminated in the process

Matrix smoothing

Once the initial matrices were developed it became apparent that some areas exhibited a coarse distribution of trips between adjacent zones. This was particularly an issue in the denser urban areas, and follows from the situation outlined earlier that postcode data used to reference true origin and destination could not always be allocated to concurrent zones. As such, all trips within a postcode sector would be allocated to a particular zone, leaving other adjacent zones empty.

Hence, a matrix smoothing process was employed that re-distributed trips within these areas. Matrix smoothing did not adjust trip totals, but rather re-distributed trips among groups of zones where particularly coarse distribution was observed, including:

- Central Bristol;
- North Fringe (two separate sections);
- Around Montpelier and Redland stations
- Around Clifton Down station
- Around Bedminster and Parson Street stations;
- Easton; and
- Bath

Smoothing was accomplished using a combination of population and employment figures derived from the 2011 Census. Population data was applied to origin zones in the AM peak and destination zones in the PM peak. Employment data was applied to destination zones in the AM peak and origin zones in the PM peak. An aggregate of population and employment was used for both origin and destination in the Inter Peak.

Matrix calibration

Trial assignment of the smoothed matrices indicated that whilst there was a good fit with entry and exit data at some locations, there were significant differences in others. This was to be expected as a result of the dominance of Bristol Temple Meads in the rail market in the area, but a comparative lack of local data to explain its usage. While the national datasets cover stations across the whole of the rail network in a consistent way, they do not always interact well with local data, as witnessed by previous discussions about differences between WoE survey and ORR figures.

Hence, the rail matrices were calibrated using the ‘demadjt’ process within EMME. This takes movements on key links and adjust trip matrices to match (as well as possible) assigned flows to values derived from counts.

Table 5.15 shows matrix totals before and after adjustment. As an indication of modelled demand patterns, Figure 5.7 shows the origin and destination totals of rail matrices on a network plot for the AM peak.

Table 5-15: Final Base Year rail matrix totals – 2013 trips

Source	AM	IP	PM
Initial matrices (merged)	9081	2841	9310
Final matrices (post adjustment)	9138	3219	10360

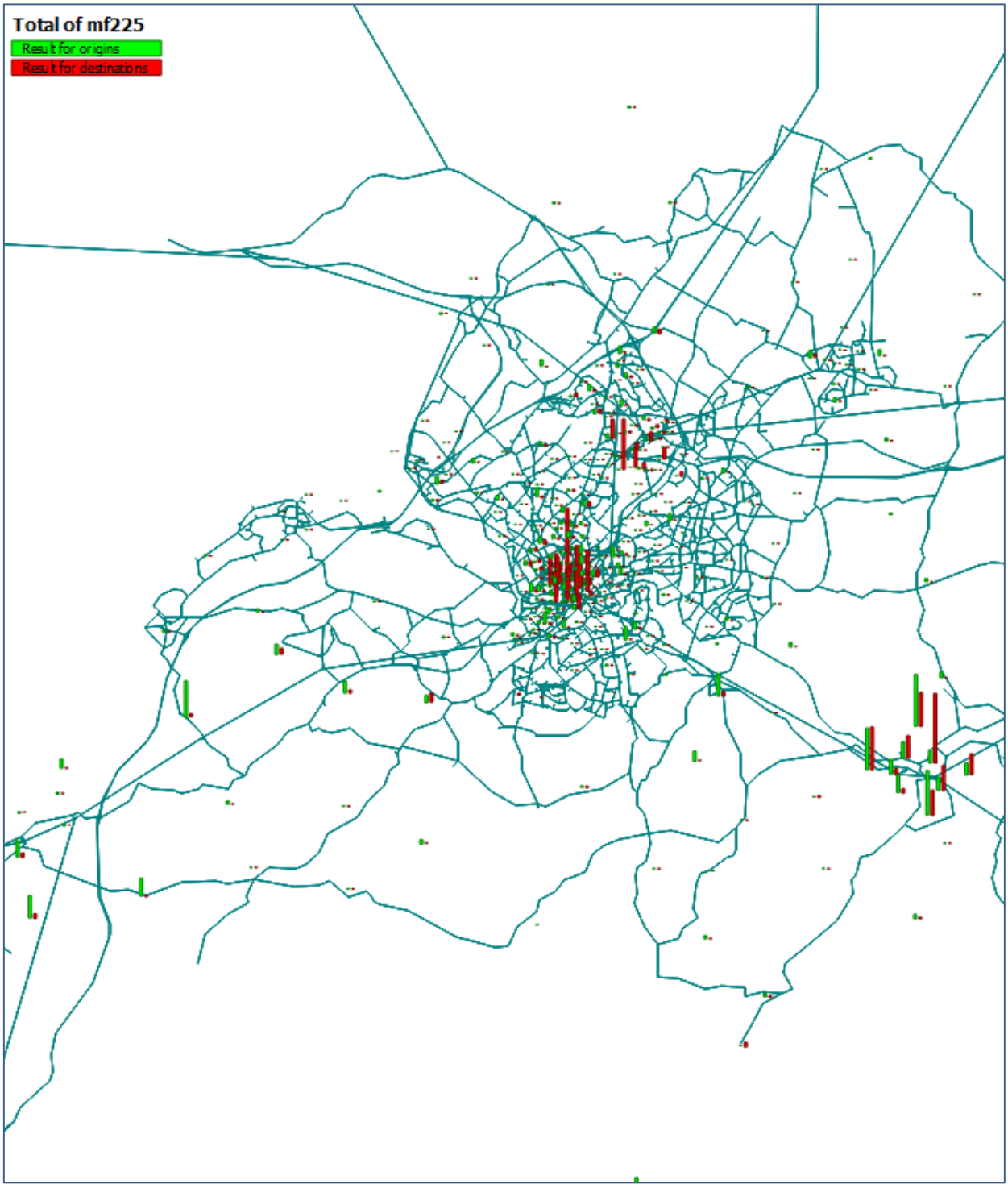

Figure 5.7: Base year rail matrix totals – AM peak

Model Calibration and Validation

6.1 Introduction

Following the construction of the public transport network and services (Section 4) and the accompanying public transport demand matrices (Section 5), a calibration and validation exercise was undertaken to assess the robustness of the resulting model.

The validation process has been carried out in-line with current guidelines as set-out in the TAG M3.2. This states that validation should involve checks of:

- Validation of the trip matrix;
- Network and service validation; and
- Assignment validation.

The validation of the public transport network was an on-going iterative process during the model construction. A number of assignments were undertaken to achieve a validated model. The results of the final assignment are outlined in the following paragraphs.

The steps in the validation and calibration process were:

- Bus and rail demand matrices were assigned onto the network for each time period;
- Passenger demand flows and boarding flows in the modelled assignment were analysed and compared with the public transport passenger count dataset obtained from the surveys and or other datasets.

6.2 Bus Mode Validation

6.2.1 Matrix Validation – Bus

TAG Unit M3.2 states that "Wherever possible, a check should be made between the annual patronage derived from the model and annual patronage derived by the operator". No specific targets are defined for what is considered acceptable. However for the purpose of this exercise a target of +/- 15% was set.

Table 6.1 details the bus user matrix totals, together with the total number of bus boardings suggested by the PT model final assignment. It can be seen that the average trip involves the use of approximately 1.22 trips in the AM peak; similar levels are suggested for the inter-peak and PM peak.

Table 6-1: Matrix totals and bus boardings by time period

Time Period	Matrix Total	Bus Boardings	Average Bus Boardings / Trip
AM	12505	15332	1.22
IP	9590	11451	1.19
PM	11852	14624	1.23

Expansion factors derived from survey data and ETM data supplied by First have been used to enable the assignment results to be expanded to annual patronage. Table 6.2 details the expansion values and the patronage totals (49.5m).

Table 6-2: Matrix totals and bus boardings by time period

Expansion Factor	Expansion Value	Source	Total
Modelled AM peak Hour Boardings-> 3 hour total	2.22	Survey Data	34,071
Modelled Inter-peak boardings –> 6 hour total	6.0	Average	68,706
Modelled PM Peak boardings– >3 hour total	2.78	Survey Data	40,622
12 Hour Total –>24 hour total	1.12	ETM data	160,607
Weekend Estimate (applied to IP Total)	1.38	ETM data	94,814
Annual Weekday	253	Number of weekdays	40,633,635
Annual Weekend	112	Number of weekend days	10,619,199
Seasonal Adjustment (Autumn –> Average Monthly)	0.966	ETM Data	49,519,646

The estimated annual patronage has been compared against patronage data provided by the Department for Transport (Annual Bus Statistics 2013/2014: Table Bus 0109a). This data is presented in Table 6.3. Data for three local authorities has been adjusted downwards to take account for the fact that not all services operating in this regions are modelled in the MetroWest PT model. This shows a reasonably close fit to the operator data.

Table 6-3: Comparison of annualised model boardings and operator data

Authority	2013/2014	Estimate for Modelled Area
Bath and North East Somerset	12	4.8
Bristol	29.8	29.8
North Somerset	5.0	4.3
South Gloucestershire	6.9	5.9
All	53.7	44.8
Estimate of Annual Patronage Metrowest PT model		49.5
% Difference between actual and model		+10.5%

6.2.2 Assignment Validation Results – Bus

TAG Unit M3.2 states that validation of model assignment should involve comparing modelled and observed patronage flows across screenlines and passengers boarding and alighting in urban centres.

The TAG recommendation is that across modelled screenlines, modelled flows should, in total, be within 15% of the observed values. On individuals links modelled flows should be within 25% of the counts for observed flows exceeding 150. For links with observed flows under 150, GEH < 5 has been used as validation criteria. Tables 6.4-6.6 detail the screenline flows during the three modelled time periods.

Based on the data in Tables 6.4-6.6 the model can be considered to be successfully validated against individual cordon flows (+/- 25% or GEH<5) and screenline (+/-15%) totals.

Table 6-4: AM Peak Screenline Flows

Cordon Site	Count	Model	% Difference	Abs Diff	GEH	Pass / Fail
			INBOUND			
Newfoundland Street	326	339	4%	12	0.7	Pass
Old Market Street	1773	1520	-14%	-252	6.2	Pass
Bath Road/ Wells Road	1612	1824	13%	212	5.1	Pass
Bedminster Parade	663	744	12%	81	3	Pass
St John's Road	119	124	5%	6	0.5	Pass
Coronation Road	6	23	290%	17	4.5	Pass
Cumberland Road	10	9	-11%	-1	0.3	Pass
Hotwells Road	825	693	-16%	-132	4.8	Pass
Queens Road	1046	882	-16%	-164	5.3	Pass
Horfield Road	14	28	100%	14	3.1	Pass
Cheltenham Road	1121	1021	-9%	-100	3.1	Pass
City Road	145	123	-15%	-22	1.9	Pass
Total	**7659**	**7330**	**-4%**	**-330**	**3.8**	**Pass**
			OUTBOUND			
Newfoundland Street	172	193	12%	21	1.6	Pass
Old Market Street	438	442	1%	5	0.2	Pass
Bath Road/ Wells Road	201	228	13%	27	1.8	Pass
Bedminster Parade	166	200	20%	33	2.5	Pass
St John's Road	77	54	-30%	-23	2.9	Pass
Coronation Road	38	23	-39%	-15	2.7	Pass
Cumberland Road	6	10	66%	4	1.4	Pass
Hotwells Road	164	136	-17%	-28	2.3	Pass
Queens Road	1006	814	-19%	-191	6.3	Pass
Horfield Road	4	10	174%	6	2.4	Pass
Cheltenham Road	723	549	-24%	-174	6.9	Pass
City Road	32	47	48%	15	2.4	Pass
Total	**3026**	**2706**	**-11%**	**-319**	**6**	**Pass**

Table 6-5: Inter Peak Screenline Flows

Cordon Site	Count	Model	% Difference	Abs Diff	GEH	Pass / Fail
			INBOUND			
Newfoundland Street	139	162	17%	23	1.9	Pass
Old Market Street	823	691	-16%	-132	4.8	Pass
Bath Road/ Wells Road	563	655	16%	92	3.7	Pass
Bedminster Parade	391	367	-6%	-24	1.2	Pass
St John's Road	78	62	-21%	-16	2	Pass
Coronation Road	35	31	-11%	-4	0.7	Pass
Cumberland Road	4	17	273%	12	3.7	Pass
Hotwells Road	247	258	4%	10	0.7	Pass
Queens Road	453	502	11%	49	2.2	Pass
Horfield Road	12	11	-9%	-1	0.3	Pass
Cheltenham Road	481	484	1%	3	0.1	Pass
City Road	79	54	-32%	-26	3.1	Pass
Total	**3307**	**3294**	**0%**	**-13**	**0.2**	**Pass**
			OUTBOUND			
Newfoundland Street	167	160	-4%	-6	0.5	Pass
Old Market Street	891	788	-11%	-102	3.5	Pass
Bath Road/ Wells Road	590	711	20%	121	4.7	Pass
Bedminster Parade	400	450	13%	50	2.4	Pass
St John's Road	91	63	-31%	-28	3.2	Pass
Coronation Road	37	58	55%	21	3	Pass
Cumberland Road	3	7	155%	4	1.9	Pass
Hotwells Road	298	339	14%	40	2.3	Pass
Queens Road	605	502	-17%	-104	4.4	Pass
Horfield Road	11	33	205%	22	4.7	Pass
Cheltenham Road	490	504	3%	14	0.6	Pass
City Road	52	84	61%	32	3.9	Pass
Total	**3635**	**3700**	**2%**	**65**	**1.1**	**Pass**

Table 6-6: PM Peak Screenline Flows

Cordon Site	Count	Model	% Difference	Abs Diff	GEH	Pass / Fail
			INBOUND			
Newfoundland Street	145	208	44%	64	4.8	Pass
Old Market Street	695	533	-23%	-162	6.5	Pass
Bath Road/ Wells Road	421	486	15%	65	3.1	Pass
Bedminster Parade	309	276	-11%	-32	1.9	Pass
St John's Road	78	71	-9%	-7	0.8	Pass
Coronation Road	58	26	-54%	-32	4.9	Pass
Cumberland Road	8	14	72%	6	1.7	Pass
Hotwells Road	220	184	-17%	-37	2.6	Pass
Queens Road	612	674	10%	62	2.4	Pass
Horfield Road	8	9	9%	1	0.3	Pass
Cheltenham Road	523	397	-24%	-126	5.9	Pass
City Road	53	48	-9%	-5	0.6	Pass
Total	**3129**	**2926**	**-6%**	**-203**	**3.7**	**Pass**
			OUTBOUND			
Newfoundland Street	387	403	4%	16	0.8	Pass
Old Market Street	2016	1831	-9%	-185	4.2	Pass
Bath Road/ Wells Road	1543	1646	7%	104	2.6	Pass
Bedminster Parade	792	754	-5%	-38	1.4	Pass
St John's Road	142	119	-16%	-22	2	Pass
Coronation Road	8	7	-9%	-1	0.3	Pass
Cumberland Road	11	30	170%	19	4.1	Pass
Hotwells Road	644	584	-9%	-60	2.4	Pass
Queens Road	1028	824	-20%	-203	6.7	Pass
Horfield Road	24	41	70%	17	2.9	Pass
Cheltenham Road	896	844	-6%	-52	1.8	Pass
City Road	93	117	26%	24	2.4	Pass
Total	**7582**	**7201**	**-5%**	**-382**	**4.4**	**Pass**

Table 6.7 compares the modelled boardings and alighting with the observed data. Across all three time periods it can be seen that modelled figures are within the TAG acceptability criteria.

Table 6-7: Central area validation of bus boarding and alighting

Time period	Count	Model	% Difference	Pass / Fail
		BOARDING		
AM	2774	2809	1%	35
IP	3555	3498	-2%	-57
PM	6832	6558	-4%	-274
		ALIGHTING		
AM	7262	7291	0%	30
IP	3276	3327	2%	51
PM	2708	3015	11%	307

It should be noted that central area boardings and alightings have been included in the matrix calibration process. The check against cordon counts by corridor provide validation of the bus model assignment using an independent data source.

6.2.3 Journey Time Validation – Bus

Modelled journey times were compared to bus timetables. Primary emphasis was placed on the six MetroWest corridors. In addition, checks were made of the most frequent bus services in the model (defined as the top 40% of services in terms of frequency). Table 6.8 and Appendix C have of this validation exercise and the services included in the comparison.

TAG M3.2 does not detail a specific target for the validation of journey times. However for the purpose of this exercise a target of +/-15% was set, which is consistent with highway model journey time validation criteria.

Based on the data in Table 6.8 the model journey times can be considered to be successfully validated against published bus journey times.

Table 6-8: Validation of bus journey times

Corridor	Total Number of Services	Number of Services within JT threshold	% of Services
	AM PEAK		
Corridor 1 - Weston Super Mare	10	10	100%
Corridor 2 – Portishead	11	11	100%
Corridor 3 - Severn Beach	18	18	100%
Corridor 4 – Henbury	69	69	100%
Corridor 5 - Bristol Parkway/Yate	64	64	100%
Corridor 6 - Keynsham/Bath Spa	30	30	100%
Total Metrowest Corridors	**202**	**202**	**100%**
Top 40% of Services (ordered by frequency)	**155**	**155**	**100%**

Table 6-8: Validation of bus journey times

Corridor	Total Number of Services	Number of Services within JT threshold	% of Services
	INTER PEAK		
Corridor 1 - Weston Super Mare	9	9	100%
Corridor 2 – Portishead	12	11	92%
Corridor 3 - Severn Beach	17	17	100%
Corridor 4 – Henbury	85	85	100%
Corridor 5 - Bristol Parkway/Yate	78	78	100%
Corridor 6 - Keynsham/Bath Spa	20	20	100%
Total Metrowest Corridors	**221**	**220**	**99.5%**
Top 40% of Services (ordered by frequency)	**174**	**174**	**100%**
	PM PEAK		
Corridor 1 - Weston Super Mare	8	8	100%
Corridor 2 – Portishead	12	12	100%
Corridor 3 - Severn Beach	17	17	100%
Corridor 4 – Henbury	73	73	100%
Corridor 5 - Bristol Parkway/Yate	70	70	100%
Corridor 6 - Keynsham/Bath Spa	30	28	93%
Total Metrowest Corridors	**210**	**208**	**99.0%**
Top 40% of Services (ordered by frequency)	**152**	**152**	**100%**

6.2.4 Check against ETM data

Individual service boardings were checked against ETM data provided by FIRST Bristol for 20 bus services operating along the MetroWest corridors. Data from other operators was not available. The ETM was processed to derive an estimate of service loadings by modelled hour and then assigned to a MetroWest corridor. Some services fell in more than one corridor. The ETM data was then compared against modelled service loadings. TAG M3.2 does not contain a specific target for checks against operator data. Table 6-9 shows a good fit against operator data in most cases. It should be noted that other services also operate on these corridors and hence a precise match would not always be expected in this type of model, but this nevertheless provides further assurance that the model provides a good representation of patronage on these corridors.

Table 6-9: Check against ETM data

Corridor	Operator ETM Patronage Data	Model Patronage Data	Model / ETM data
	AM PEAK		
Corridor 1 - Weston Super Mare	160	220	1.38
Corridor 2 – Portishead	316	308	0.97
Corridor 3 - Severn Beach	623	673	1.08
Corridor 4 – Henbury	3722	4293	1.15
Corridor 5 - Bristol Parkway/Yate	1274	1602	1.26
Corridor 6 - Keynsham/Bath Spa	879	1083	1.23

Table 6-9: Check against ETM data

Corridor	Operator ETM Patronage Data	Model Patronage Data	Model / ETM data
	INTER PEAK		
Corridor 1 - Weston Super Mare	224	262	1.17
Corridor 2 – Portishead	210	199	0.95
Corridor 3 - Severn Beach	570	565	0.99
Corridor 4 – Henbury	3561	3272	0.92
Corridor 5 - Bristol Parkway/Yate	1327	1307	0.99
Corridor 6 - Keynsham/Bath Spa	856	877	1.02
	PM PEAK		
Corridor 1 - Weston Super Mare	200	255	1.28
Corridor 2 – Portishead	229	264	1.16
Corridor 3 - Severn Beach	555	560	1.01
Corridor 4 – Henbury	3540	4241	1.20
Corridor 5 - Bristol Parkway/Yate	1292	1567	1.21
Corridor 6 - Keynsham/Bath Spa	812	1014	1.25

6.3 Rail Mode Validation

6.3.1 Journey Time Validation – Rail

Rail journey times in the model are based directly on timetables, including travel and dwell time as advertised. Table 6.10 shows a comparison between modelled travel times and timetable times, indicating a very good fit.

Table 6-10: Rail journey time comparison – total times all lines (minutes)

	In vehicle travel	Dwell time	Total Time	Model time	Difference
AM peak	2118	252	2370	2360	-0.43%
Inter Peak	2847	278	3125	3133	0.25%
PM peak	1650	168	1818	1812	-0.34%

6.3.2 Matrix assignment – Rail

Table 6.11 shows the number of rail trips assigned to the network. This indicates that virtually all of the trips in the matrices are being assigned.

Table 6-11: Assigned rail trips – 2013 trips

Source	AM	IP	PM
Matrix totals (post adjustment)	9138	3219	10360
Trips assigned	9125	3193	10340
Not assigned	13 (0.14%)	26 (0.81%)	20 (0.19%)

6.3.3 Assignment Validation Results – Rail

TAG Unit M3.2 states that validation of model assignment should involve comparing modelled and observed patronage flows across screenlines and passengers boarding and alighting in urban centres.

However, screenline data is not available to assess rail assignment, so for rail elements of the PT model, validation has been undertaken for station entries and exits at rail stations in the model area.

The TAG recommendation on individual links modelled flows should be within 25% of the counts for observed flows over 150. Comparison with GEH statistic values has been used for flows under 150, where a GEH of less than 5 is considered a reasonable fit.

The validation results for rail entries and exits are shown in Tables 6.12-6.14. The boarding and alighting counts validate at all stations with differences less than 25% (or GEH < 5 for flows under 150), in all three time periods. Further, it can also be seen that the criteria of GEH < 5 is actually satisfied for all stations.

Table 6-12: Rail assignment validation– AM peak

Station	ENTRANCE						EXIT					
	count	model	diff	%	GEH	pass /fail	count	model	diff	%	GEH	pass /fail
Bristol TM	892	847	-45	-5%	1.51	PASS	2,688	2,538	-150	-6%	2.93	PASS
Bedminster	54	52	-2	-4%	0.27	PASS	26	57	31	119%	4.81	PASS
Parson Street	68	78	10	15%	1.17	PASS	15	37	22	151%	4.38	PASS
Lawrence Hill	97	100	3	3%	0.31	PASS	48	79	31	64%	3.85	PASS
Avonmouth	20	3	-17	-85%	4.99	PASS	33	23	-10	-31%	1.92	PASS
Shirehampton	28	45	17	61%	2.81	PASS	10	29	19	203%	4.42	PASS
Clifton Down	70	73	3	4%	0.31	PASS	151	114	-37	-25%	3.25	PASS
Montpelier	153	159	6	4%	0.48	PASS	64	55	-9	-14%	1.17	PASS
Stapleton Rd	133	162	29	22%	2.39	PASS	32	62	30	91%	4.30	PASS
Redland	84	100	16	19%	1.67	PASS	54	46	-8	-15%	1.15	PASS
Sea Mills	42	57	15	35%	2.08	PASS	4	7	3	58%	1.08	PASS
Severn Beach	27	10	-17	-62%	3.87	PASS	6	-	-6	-	3.54	PASS
StAndrews Rd	1	-	-1	-	1.21	PASS	2	-	-2	-	1.92	PASS
Bristol Prkwy	427	341	-86	-20%	4.38	PASS	412	346	-66	-16%	3.40	PASS
Filton AW	117	81	-36	-31%	3.60	PASS	554	514	-40	-7%	1.74	PASS
Patchway	20	25	5	28%	1.16	PASS	52	65	13	25%	1.70	PASS
Yate	138	164	26	19%	2.10	PASS	13	31	18	147%	3.96	PASS
Bath Spa	993	1,133	140	14%	4.30	PASS	1,240	1,174	-66	-5%	1.89	PASS
Keynsham	226	224	-2	-1%	0.13	PASS	72	41	-31	-43%	4.12	PASS
Oldfield Park	157	128	-29	-19%	2.45	PASS	46	78	32	71%	4.11	PASS
Nailsea & Bkwl	171	202	31	18%	2.25	PASS	105	104	-1	-1%	0.06	PASS
Yatton	226	219	-7	-3%	0.47	PASS	9	25	16	192%	4.02	PASS
Weston Mlton	41	18	-23	-56%	4.27	PASS	13	4	-9	-70%	3.15	PASS
Weston-s-M	304	354	50	17%	2.78	PASS	113	133	20	18%	1.80	PASS
Worle	128	144	16	13%	1.39	PASS	26	43	17	67%	2.93	PASS
Total	**4,616**	**4,719**	**103**	**2%**	**1.51**	**PASS**	**5,787**	**5,605**	**-182**	**-3%**	**2.41**	**PASS**

Table 6-13: Rail assignment validation – inter peak

Station	ENTRANCE						EXIT					
	count	model	diff	%	GEH	pass /fail	count	model	diff	%	GEH	pass /fail
Bristol TM	533	553	20	4%	0.84	PASS	583	622	39	7%	1.57	PASS
Bedminster	6	3	-3	-45%	1.21	PASS	6	8	2	30%	0.69	PASS
Parson Street	6	10	4	62%	1.35	PASS	4	15	11	246%	3.43	PASS
Lawrence Hill	15	15	-	-	-	PASS	19	28	9	46%	1.82	PASS
Avonmouth	8	1	-7	-87%	3.25	PASS	9	2	-7	-76%	2.84	PASS
Shirehampton	6	8	2	26%	0.62	PASS	8	19	11	148%	3.10	PASS
Clifton Down	37	28	-9	-24%	1.52	PASS	38	46	8	21%	1.21	PASS
Montpelier	20	37	17	87%	3.22	PASS	13	26	13	95%	2.86	PASS
Stapleton Rd	29	28	-1	-2%	0.13	PASS	25	48	23	91%	3.78	PASS
Redland	15	26	12	79%	2.56	PASS	11	19	8	70%	2.02	PASS
Sea Mills	6	10	4	58%	1.28	PASS	7	13	7	100%	2.08	PASS
Severn Beach	3	1	-2	-65%	1.32	PASS	6	2	-4	-67%	2.00	PASS
StAndrews Rd	2	-	-2	-	1.73	PASS	0	-	-0	-	0.82	PASS
Bristol Prkwy	160	141	-19	-12%	1.58	PASS	125	102	-23	-19%	2.17	PASS
Filton AW	88	66	-22	-25%	2.45	PASS	47	30	-17	-36%	2.76	PASS
Patchway	4	10	6	131%	2.12	PASS	3	6	3	125%	1.60	PASS
Yate	16	29	13	85%	2.82	PASS	15	26	11	71%	2.39	PASS
Bath Spa	361	362	1	0%	0.06	PASS	390	392	2	1%	0.11	PASS
Keynsham	21	14	-7	-33%	1.67	PASS	20	18	-2	-11%	0.50	PASS
Oldfield Park	16	11	-5	-31%	1.36	PASS	16	18	2	11%	0.44	PASS
Nailsea & Bkwl	40	40	0	0%	0.03	PASS	72	51	-21	-29%	2.64	PASS
Yatton	16	23	7	45%	1.61	PASS	20	21	1	5%	0.20	PASS
Weston Mlton	6	1	-5	-83%	2.61	PASS	7	3	-4	-56%	1.73	PASS
Weston-s-M	77	81	4	6%	0.49	PASS	69	72	3	5%	0.38	PASS
Worle	22	15	-7	-31%	1.59	PASS	23	27	4	19%	0.87	PASS
Total	**1,510**	**1,513**	**3**	**0%**	**0.07**	**PASS**	**1,536**	**1,614**	**78**	**5%**	**1.96**	**PASS**

Table 6-14: Rail assignment validation – PM peak

Station	ENTRANCE						EXIT					
	count	model	diff	%	GEH	pass /fail	count	model	diff	%	GEH	pass /fail
Bristol TM	3,395	3,380	-15	-0%	0.26	PASS	870	773	-97	-11%	3.38	PASS
Bedminster	17	35	18	104%	3.49	PASS	43	70	27	62%	3.55	PASS
Parson Street	22	42	20	92%	3.57	PASS	48	69	21	45%	2.81	PASS
Lawrence Hill	56	44	-12	-21%	1.66	PASS	106	106	0	0%	0.03	PASS
Avonmouth	38	13	-25	-66%	4.92	PASS	22	7	-15	-68%	3.91	PASS
Shirehampton	10	30	20	208%	4.54	PASS	41	45	4	10%	0.62	PASS
Clifton Down	137	106	-31	-23%	2.83	PASS	85	114	29	35%	2.95	PASS
Montpelier	63	72	9	15%	1.12	PASS	80	112	32	41%	3.32	PASS
Stapleton Rd	53	56	3	5%	0.35	PASS	148	183	35	24%	2.72	PASS
Redland	40	48	8	21%	1.24	PASS	49	86	37	76%	4.54	PASS
Sea Mills	8	11	3	34%	0.91	PASS	51	83	32	63%	3.90	PASS
Severn Beach	6	1	-5	-84%	2.75	PASS	15	18	3	18%	0.69	PASS
StAndrews Rd	6	-	-6	-	3.42	PASS	2	-	-2	-	1.77	PASS
Bristol Prkwy	251	281	30	12%	1.82	PASS	764	761	-3	-0%	0.10	PASS
Filton AW	503	447	-56	-11%	2.57	PASS	106	85	-21	-20%	2.12	PASS
Patchway	60	41	-19	-32%	2.67	PASS	22	50	28	127%	4.67	PASS
Yate	24	34	10	41%	1.82	PASS	150	187	37	25%	2.85	PASS
Bath Spa	1,238	1,282	44	4%	1.24	PASS	1,098	1,196	98	9%	2.90	PASS
Keynsham	43	36	-7	-17%	1.16	PASS	152	190	38	25%	2.87	PASS
Oldfield Park	48	23	-25	-52%	4.19	PASS	141	136	-5	-3%	0.40	PASS
Nailsea & Bkwl	90	81	-9	-10%	0.94	PASS	250	298	48	19%	2.91	PASS
Yatton	26	40	14	51%	2.36	PASS	256	208	-48	-19%	3.18	PASS
Weston Mlton	8	8	0	3%	0.07	PASS	37	14	-23	-62%	4.56	PASS
Weston-s-M	155	160	5	3%	0.41	PASS	337	363	26	8%	1.38	PASS
Worle	34	17	-17	-49%	3.29	PASS	175	216	41	23%	2.93	PASS
Total	**6,331**	**6,288**	**-43**	**-1%**	**0.54**	**PASS**	**5,046**	**5,370**	**324**	**6%**	**4.50**	**PASS**

SECTION 7

Summary & Conclusions

The GBATS4M model includes a detailed public transport model of the rail and bus networks and services in the West of England area. It has been developed utilising EMME modelling software.

The validation of the public transport model has been undertaken as a rigorous and comprehensive exercise adhering to relevant DfT guidance. Count data from a variety of sources has been compared to modelled flows in all represented time-periods. This has demonstrated that in the majority of cases the resulting validation has been good.

The public transport model provides a robust platform to test and evaluate strategic public transport initiatives within the West of England region.

Appendix A
PT Model Transit Lines

Appendix A1: GBATS4 Bus Services by time period

Time Period	Id	Route Description	Headway (mins)
AM	1&01	1BrmHill-Cribbs	12
AM	1&11	1Cribbs-BrmHill	12
AM	11&02	11BowerAshton-UWEFC	20
AM	11&11	11UWEFC-BowerAshton	20
AM	12&01	12Centre-UWEFC	30
AM	12&12	12UWEFC-Centre	30
AM	121&01	121BrisBS-WSM	60
AM	121&12	121WSM-BrisBS	60
AM	13&02	13Brdmead-WilowBrks	30
AM	13&11	13WilowBrks-Brdmead	30
AM	13&X02	13Brdmead-UWEFC	30
AM	13&X11	13UWEFC-Brdmead	60
AM	14&X11	14Centre-UWEFC	30
AM	14&X13	14UWEFC-Centre	60
AM	15&01	15Centre-UWEFC	30
AM	15&12	15UWEFC-Centre	20
AM	16&X02	16TyndPark-UoBBS	10
AM	16&X11	16UoBBS-TyndPark	6
AM	178&01	178BristolBS-BathBS	60
AM	178&11	178BathBS-BristolBS	60
AM	18&02	18SmeadHosp-EmGreen	30
AM	18&11	18EmGreen-SmeadHosp	30
AM	19&01	19Centre-UWEFC	15
AM	19&11	19UWEFC-Centre	15
AM	1W&01	1BrisBS-WSM	30
AM	1W&11	1WSM-BrisBS	60
AM	2&01	2Stockwood-Cribbs	12
AM	2&11	2Cribbs-Stockwood	12
AM	20&01	20Centre-Southmead	30
AM	20&11	20Southmead-Centre	30
AM	222&11	222ChpSod-LgwellGr	60
AM	222&X0	222Kngswood-ChpSod	60
AM	24&01	24AshtVale-Horfld	20
AM	24&11	24Horfld-AshVale	20
AM	25&01	25AshVale-Horfld	20
AM	25&11	25Horfld-AshVale	20
AM	310&01	310BrisBS-Thrnbry	30
AM	310&11	310Thrnbry-BrisBS	30
AM	312&12	312Thrnbry-Dwnend	60
AM	312&X1	312Thrnbry-Frenchay	60
AM	319&02	319Cribbs-BathBS	60
AM	319&11	319BathBS-Cribbs	30
AM	319&X0	319PrkwayS-BathBS	60
AM	327&02	327Yate-BrisBS	60
AM	327&11	327BrisBS-Yate	60
AM	332&01	332BrisBS-BathBS	60
AM	332&11	332BathBS-BristolBS	60
AM	338&01	338BristolBS-BathBS	30
AM	338&11	338BathBS-BristolBS	30
AM	342&02	342ChpSod-BrisBS	30
AM	342&11	342BrisBS-ChpSod	30
AM	349&11	349Kynshm-Horsefair	30
AM	36&01	BldwinSt-Withywod	20
AM	36&11	36Withywod-BldwinSt	20
AM	376&03	376Wells-BristolBS	30
AM	376&14	376BristolBS-Wells	30
AM	379&01	379Radstock-BrisBS	60
AM	379&12	379BrisBS-Radstock	60
AM	3A&01	3ACentre-AztecWest	30
AM	3A&11	3AAztecWest-Centre	15
AM	3C&01	3CClifton-AztecWest	60
AM	3X&01	3XCentre-AztecWest	60
AM	4&01	4RupertSt-Downend	30
AM	4&11	4Downend-RupertSt	30
AM	40&01	40UnionSt-Cribbs	20
AM	40&11	40Cribbs-UnionSt	20
AM	41&01	41UnionSt-Avonmouth	20
AM	41&11	41Avonmouth-UnionSt	20
AM	42&01	42Centre-Keysham	20
AM	42&11	42Keysham-Centre	20
AM	43&01	43Centre-CdburyHth	20
AM	43&11	43CdburyHth-Centre	20

Time Period	Id	Route Description	Headway (mins)
IP	1&01	1BrmHill-Cribbs	10
IP	1&11	1Cribbs-BrmHill	10
IP	11&02	11BowerAshton-UWEFC	21
IP	11&11	11UWEFC-BowerAshton	21
IP	12&01	12Centre-UWEFC	20
IP	12&12	12UWEFC-Centre	20
IP	121&01	121BrisBS-WSM	120
IP	121&12	121WSM-BrisBS	120
IP	13&02	13Brdmead-WilowBrks	24
IP	13&11	13WilowBrks-Brdmead	24
IP	13&X02	13Brdmead-UWEFC	24
IP	13&X11	13UWEFC-Brdmead	24
IP	14&11	14UWEFC-Centre	20
IP	15&01	15Centre-UWEFC	20
IP	15&12	15UWEFC-Centre	20
IP	16&02	16Centre-UoBBS	13
IP	16&11	16UoBBS-Centre	13
IP	178&01	178BristolBS-BathBS	60
IP	178&11	178BathBS-BristolBS	60
IP	18&02	18SmeadHosp-EmGreen	30
IP	18&11	18EmGreen-SmeadHosp	33
IP	19&01	19Centre-UWEFC	12
IP	19&11	19UWEFC-Centre	12
IP	1W&01	1BrisBS-WSM	60
IP	1W&11	1WSM-BrisBS	60
IP	2&01	2Stockwood-Cribbs	10
IP	2&11	2Cribbs-Stockwood	10
IP	20&01	20Centre-Southmead	30
IP	20&11	20Southmead-Centre	30
IP	222&X0	222Kngswood-ChpSod	60
IP	222&X1	222ChpSod-Kngswood	60
IP	24&01	24AshtVale-Horfld	20
IP	24&11	24Horfld-AshVale	20
IP	25&01	25AshVale-Horfld	20
IP	25&11	25Horfld-AshVale	20
IP	3&01	3Centre-Cribbs	16
IP	3&11	3Cribbs-Centre	15
IP	309&01	309BrisBS-Thrnbry	33
IP	309&11	30Thrnbry-BrisBS	30
IP	309&X0	309BrisBS-CribbsC	40
IP	309&X1	309CribbsC-BrisBS	40
IP	312&01	312Dwnend-Thrnbry	60
IP	312&12	312Thrnbry-Dwnend	60
IP	319&02	319Cribbs-BathBS	30
IP	319&11	319BathBS-Cribbs	30
IP	327&02	327Yate-BrisBS	60
IP	327&11	327BrisBS-Yate	60
IP	332&01	332BrisBS-BathBS	60
IP	332&11	332BathBS-BristolBS	60
IP	338&01	338BristolBS-BathBS	30
IP	338&11	338BathBS-BristolBS	30
IP	342&02	342ChpSod-BrisBS	30
IP	342&11	342BrisBS-ChpSod	33
IP	349&11	349Kynshm-Horsefair	30
IP	36&01	BldwinSt-Withywod	19
IP	36&11	36Withywod-BldwinSt	20
IP	376&03	376Wells-BristolBS	30
IP	376&14	376BristolBS-Wells	28
IP	379&01	379Radstock-BrisBS	60
IP	379&12	379BrisBS-Radstock	60
IP	3A&01	3ACentre-AztecWest	360
IP	3B&01	3bCentre-BradleyStok	180
IP	4&01	4RupertSt-Downend	30
IP	4&11	4Downend-RupertSt	30
IP	40&01	40UnionSt-Cribbs	20
IP	40&11	40Cribbs-UnionSt	20
IP	41&01	41UnionSt-Avonmouth	20
IP	41&11	41Avonmouth-UnionSt	20
IP	42&01	42Centre-Keysham	20
IP	42&11	42Keysham-Centre	20
IP	43&01	43Centre-CdburyHth	20
IP	43&11	43CdburyHth-Centre	20

Time Period	Id	Route Description	Headway (mins)
PM	1&01	1BrmHill-Cribbs	12
PM	1&11	1Cribbs-BrmHill	12
PM	11&02	11BowerAshton-UWEFC	20
PM	11&11	11UWEFC-BowerAshton	30
PM	12&01	12Centre-UWEFC	30
PM	12&12	12UWEFC-Centre	30
PM	121&01	121BrisBS-WSM	60
PM	121&12	121WSM-BrisBS	60
PM	13&02	13Brdmead-WilowBrks	30
PM	13&11	13WilowBrks-Brdmead	30
PM	13&X02	13Brdmead-UWEFC	30
PM	13&X11	13UWEFC-Brdmead	30
PM	14&X12	14UWEFC-Centre	30
PM	14&X13	14UWEFC-Centre	60
PM	15&01	15Centre-UWEFC	20
PM	15&12	15UWEFC-Centre	20
PM	16&X02	16TyndPark-UoBBS	8
PM	16&X11	16UoBBS-TyndPark	8
PM	178&01	178BristolBS-BathBS	60
PM	178&11	178BathBS-BristolBS	60
PM	18&02	18SmeadHosp-EmGreen	30
PM	18&11	18EmGreen-SmeadHosp	30
PM	19&01	19Centre-UWEFC	15
PM	19&11	19UWEFC-Centre	15
PM	1W&01	1BrisBS-WSM	60
PM	1W&11	1WSM-BrisBS	30
PM	2&01	2Stockwood-Cribbs	12
PM	2&11	2Cribbs-Stockwood	12
PM	20&01	20Centre-Southmead	30
PM	20&11	20Southmead-Centre	30
PM	222&05	222LgwellGr-ChpSod	60
PM	24&01	24AshtVale-Horfld	20
PM	24&11	24Horfld-AshVale	20
PM	25&01	25AshVale-Horfld	20
PM	25&11	25Horfld-AshVale	20
PM	309&01	309BrisBS-Thrnbry	60
PM	309&11	309Thrnbry-BrisBS	30
PM	310&01	310BrisBS-Thrnbry	60
PM	312&X1	312Thrnbry-Frenchay	60
PM	319&02	319Cribbs-BathBS	30
PM	319&11	319BathBS-Cribbs	30
PM	327&02	327Yate-BrisBS	60
PM	327&11	327BrisBS-Yate	60
PM	332&01	332BrisBS-BathBS	60
PM	332&11	332BathBS-BristolBS	60
PM	338&01	338BristolBS-BathBS	30
PM	338&11	338BathBS-BristolBS	30
PM	342&02	342ChpSod-BrisBS	30
PM	342&11	342BrisBS-ChpSod	30
PM	349&11	349Kynshm-Horsefair	30
PM	36&01	BldwinSt-Withywod	20
PM	36&11	36Withywod-BldwinSt	30
PM	376&03	376Wells-BristolBS	30
PM	376&14	376BristolBS-Wells	30
PM	379&01	379Radstock-BrisBS	60
PM	379&12	379BrisBS-Radstock	60
PM	3A&01	3ACentre-AztecWest	30
PM	3A&11	3AAztecWest-Centre	30
PM	3B&01	3ACentre-BradleyStok	60
PM	3C&11	3CAztecWest-Clifton	60
PM	4&01	4RupertSt-Downend	30
PM	4&11	4Downend-RupertSt	30
PM	40&01	40UnionSt-Cribbs	20
PM	40&11	40Cribbs-UnionSt	20
PM	41&01	41UnionSt-Avonmouth	20
PM	41&11	41Avonmouth-UnionSt	20
PM	42&01	42Centre-Keysham	20
PM	42&11	42Keysham-Centre	20
PM	43&01	43Centre-CdburyHth	20
PM	43&11	43CdburyHth-Centre	20
PM	44&01	44Centre-Kingswood	20
PM	44&11	44Kingswood-Centre	30

Appendix A1: GBATS4 Bus Services by time period

Time Period	Id	Route Description	Headway (mins)
AM	44&01	44Centre-Kingswood	30
AM	44&11	44Kingswood-Centre	20
AM	45&01	45Centre-LngwllGrn	30
AM	45&11	45LngllGrn-Centre	20
AM	462&14	462EmerGreen-BTM	30
AM	48&01	48RupertSt-EmGreen	15
AM	48&11	48EmGreen-RupertSt	15
AM	49&01	49RupertSt-EmGreen	15
AM	49&11	49EmGreen-RupertSt	15
AM	5&01	5RupertSt-Downend	30
AM	5&11	5Downend-RupertSt	30
AM	50&01	50Centre-HgrveDepot	20
AM	50&11	50HgrveDepot-Centre	20
AM	501&03	501Amouth-AbWood	60
AM	501&11	501AbWood-Amouth	60
AM	502&02	502Shirhmpton-UWEFC	60
AM	502&11	502UWEFC-Shirhmpton	60
AM	505&02	505SmeadHosp-BowAsh	30
AM	505&11	505BowAsh-SmeadHosp	30
AM	506&X0	506SmeadHosp-CREATE	30
AM	506&X1	506CREATE-SmeadHosp	30
AM	507&02	507SmeadHosp-Kynshm	60
AM	507&11	507Kynshm-SmeadHosp	60
AM	507&X0	507SmeadHosp-Kngswd	60
AM	507&X1	507Kngswd-SmeadHosp	60
AM	508&02	508SeaMills-Smead	60
AM	508&11	508Smead-SeaMills	60
AM	51&01	51Centre-HgrveDepot	20
AM	51&11	51HgrveDepot-Centre	20
AM	512&X1	Totterdown-Bedminst	60
AM	515&01	Stockwood-Hartcliffe	60
AM	515&11	Hartcliffe-Stockwood	60
AM	533&01	533Kynshm-Mngtsfld	60
AM	533&13	533Mngtsfld-Kynshm	60
AM	57&11	57Stockwood-Centre	60
AM	581&03	581ChpSod-Hnham	60
AM	581&11	581Hnham-ChpSod	60
AM	6&01	6BaldwinSt-Kingswod	20
AM	6&11	6Kingswod-BaldwinSt	20
AM	622&14	622ChippSod-Cribbs	60
AM	624&15	624SevBch-Centre	60
AM	635&03	635Centre-Chipham	60
AM	635&16	635Chipham-Centre	60
AM	672&13	672ChwVly-Broadmead	60
AM	672&X0	672Broadmead-ChwVly	60
AM	689&11	689Yate-Centre	60
AM	689&X0	689Mngtsfld-Yate	60
AM	7&01	7BldwnSt-StapleHill	20
AM	7&11	7StapleHill-BldwnSt	20
AM	70&01	70BTM-UWEFrenchay	15
AM	70&11	70UWEFrenchay-BTM	15
AM	73&01	73Centre-Cribbs	15
AM	73&11	73Cribbs-Centre	15
AM	75&01	75Cribbs-Hengrove	12
AM	75&11	75Hengrove-Cribbs	12
AM	76&01	76Cribbs-Hengrove	12
AM	76&11	76Hengrove-Cribbs	10
AM	8&11	8TempleMeads-Cotham	12
AM	86&01	86Yate-Wotton-Under-	60
AM	86&13	86Wotton-Under-Edge-	60
AM	86&15	86Yate-Kgwood	60
AM	9&11	9BTM-Redland	12
AM	90&01	90Broadmead-Hngrve	10
AM	90&11	90Hngrve-Broadmead	10
AM	902&11	902PortPR-Centre	12
AM	903&11	903LongAshPR-Centre	10
AM	904&11	904BrstonPR-Centre	12
AM	A1&04	A1BrisAir-Broadmead	10
AM	A1&13	A1Broadmead-BrisAir	10
AM	A4&04	A4BrisAir-BathCntre	60
AM	A4&13	A4BathCntre-BrisAir	60
AM	NHS&2	BTM-StMichaelsHospit	30

Time Period	Id	Route Description	Headway (mins)
IP	44&01	44Centre-Kingswood	20
IP	44&11	44Kingswood-Centre	20
IP	45&01	45Centre-LngwllGrn	20
IP	45&11	45LngllGrn-Centre	20
IP	48&01	48RupertSt-EmGreen	15
IP	48&11	48EmGreen-RupertSt	15
IP	482&01	482Cribbs-ChippSod	180
IP	482&11	482ChippSod-Cribbs	120
IP	49&01	49RupertSt-EmGreen	15
IP	49&11	49EmGreen-RupertSt	14
IP	5&01	5RupertSt-Downend	30
IP	5&11	5Downend-RupertSt	30
IP	50&01	50Centre-HgrveDepot	20
IP	50&11	50HgrveDepot-Centre	20
IP	501&03	501Amouth-AbWood	60
IP	501&11	501AbWood-Amouth	60
IP	502&02	502Shirhmpton-UWEFC	60
IP	502&11	502UWEFC-Shirhmpton	60
IP	505&02	505SmeadHosp-BowAsh	30
IP	505&11	505BowAsh-SmeadHosp	30
IP	506&04	506SmeadHosp-CREATE	30
IP	506&13	506CREATE-SmeadHosp	30
IP	507&02	507SmeadHosp-Kynshm	60
IP	507&11	507Kynshm-SmeadHosp	60
IP	507&X0	507SmeadHosp-Kngswd	60
IP	507&X1	507Kngswd-SmeadHosp	60
IP	508&02	508SeaMills-Smead	60
IP	508&11	508Smead-SeaMills	60
IP	51&01	51Centre-HgrveDepot	20
IP	51&11	51HgrveDepot-Centre	20
IP	511&01	511Hengrove-Bedminst	72
IP	511&12	511Bedminster-Hengro	72
IP	512&11	Bedminster-circular	360
IP	512&X1	Broadmd-Bedminster	360
IP	512&X2	Bedminster-circular	120
IP	513&01	Brisli-Knowle	72
IP	513&12	Knowle-Brisli	72
IP	514&01	514BrisliT-Knowle	90
IP	514&12	514Knowle-BrisliT	72
IP	515&01	Stockwood-Hartcliffe	60
IP	515&11	Hartcliffe-Stockwood	60
IP	52&01	52Broadmd-HgrvePark	72
IP	52&11	52HgrvePark-Broadmd	90
IP	52&X11	52HgrvePark-Highrdg	360
IP	533&01	533Kynshm-Mngtsfld	60
IP	533&13	533Mngtsfld-Kynshm	60
IP	55&03	55Bristol-Nailsea	120
IP	55&11	55Nailsea-Bristol	120
IP	57&01	57Centre-Stockwood	60
IP	57&11	57Stockwood-Centre	90
IP	581&03	581ChpSod-Hnham	60
IP	581&11	581Hnham-ChpSod	51
IP	6&01	6BaldwinSt-Kingswod	20
IP	6&11	6Kingswod-BaldwinSt	20
IP	622&01	622Cribbs-ChpSod	90
IP	622&14	622ChippSod-Cribbs	90
IP	625&04	625UWEFren-SevBch	60
IP	625&12	625SevBch-UWEFren	60
IP	634&03	634Kingswood-Tormart	180
IP	634&11	634Tormarton-Kingswo	180
IP	635&03	635Centre-Chipham	120
IP	635&12	635Chipham-Centre	90
IP	67&01	Bristol-WestH	360
IP	672&04	672Broadmead-ChwVly	360
IP	672&13	672ChwVly-Broadmead	360
IP	672&X0	672Broadmead-ChwVly	360
IP	672&X1	672ChwVly-Broadmead	360
IP	689&03	689Centre-Yate	60
IP	689&11	689Yate-Centre	60
IP	7&01	7BldwnSt-StapleHill	20
IP	7&11	7StapleHill-BldwnSt	20
IP	70&01	7070BTM-UWEFrenchay	12

Time Period	Id	Route Description	Headway (mins)
PM	45&01	45Centre-LngwllGrn	20
PM	45&11	45LngllGrn-Centre	30
PM	462&02	462BTM-EmerGreen	30
PM	48&01	48RupertSt-EmGreen	15
PM	48&11	48EmGreen-RupertSt	15
PM	482&11	482ChippSod-Cribbs	60
PM	483&01	483Cribbs-ChpSod	60
PM	49&01	49RupertSt-EmGreen	15
PM	49&11	49EmGreen-RupertSt	20
PM	5&01	5RupertSt-Downend	30
PM	5&11	5Downend-RupertSt	30
PM	50&01	50Centre-HgrveDepot	20
PM	50&11	50HgrveDepot-Centre	30
PM	501&03	501Amouth-AbWood	60
PM	501&11	501AbWood-Amouth	60
PM	502&02	502Shirhmpton-UWEFC	60
PM	502&11	502UWEFC-Shirhmpton	60
PM	505&02	505SmeadHosp-BowAsh	30
PM	505&11	505BowAsh-SmeadHosp	30
PM	506&X0	506SmeadHosp-CREATE	30
PM	506&X1	506CREATE-SmeadHosp	30
PM	507&02	507SmeadHosp-Kynshm	60
PM	507&11	507Kynshm-SmeadHosp	60
PM	507&X0	507SmeadHosp-Kngswd	60
PM	507&X1	507Kngswd-SmeadHosp	60
PM	508&02	508SeaMills-Smead	60
PM	508&11	508Smead-SeaMills	60
PM	51&01	51Centre-HgrveDepot	20
PM	51&11	51HgrveDepot-Centre	30
PM	515&01	Stockwood-Hartcliffe	60
PM	515&11	Hartcliffe-Stockwood	60
PM	52&X01	52Broadmd-Highridge	60
PM	533&02	533Kynshm-Mngtsfld	60
PM	533&13	533Mngtsfld-Kynshm	60
PM	57&01	57Centre-Stockwood	30
PM	57&11	57Stockwood-Centre	60
PM	581&02	581ChpSod-Hnham	60
PM	581&14	581Hnham-ChpSod	60
PM	6&01	6BaldwinSt-Kingswod	30
PM	6&11	6Kingswod-BaldwinSt	30
PM	622&01	622Cribbs-ChpSod	60
PM	622&14	622ChippSod-Cribbs	60
PM	624&02	624BondSt-SevBch	60
PM	625&04	625UWEFren-SevBch	60
PM	625&15	625SevBch-UWEFren	60
PM	626&02	626Centre-Wotton	60
PM	635&03	635Centre-Chipham	60
PM	635&12	635Chipham-Centre	60
PM	672&04	672Broadmead-ChwVly	60
PM	689&03	689Centre-Yate	60
PM	689&12	689Yate-Centre	60
PM	7&01	7BldwnSt-StapleHill	15
PM	7&11	7StapleHill-BldwnSt	20
PM	70&01	7070BTM-UWEFrenchay	15
PM	70&11	70UWEFrenchay-BTM	15
PM	73&01	73Centre-Cribbs	15
PM	73&11	73Cribbs-Centre	15
PM	75&01	75Cribbs-Hengrove	10
PM	75&11	75Hengrove-Cribbs	12
PM	76&01	76Cribbs-Hengrove	12
PM	76&11	76Hengrove-Cribbs	12
PM	8&11	8TempleMeads-Cotham	15
PM	86&01	86Kgwood-Wotton-Unde	30
PM	86&13'	86Wotton-Under-Edge-	60
PM	9&11	9BTM-Redland	15
PM	90&01	90Broadmead-Hngrve	10
PM	90&11	90Hngrve-Broadmead	10
PM	902&11	902PortPR-Centre	12
PM	903&11	903LongAshPR-Centre	12
PM	904&11	904BrstonPR-Centre	12
PM	A1&04	A1BrisAir-Broadmead	10
PM	A1&13	A1Broadmead-BrisAir	10

Appendix A1: GBATS4 Bus Services by time period

Time Period	Id	Route Description	Headway (mins)
AM	X1&01	X1BrisBS-WSM	30
AM	X1&11	X1WSM-BrisBS	20
AM	X18&03	X18AztWest-Kgwood	60
AM	X18&X1	X18Emersgrn-AztWest	60
AM	X2&11	X2BrisBS-Portis	30
AM	X27&01	X27Yate-AnchorRd	60
AM	X27&12	X27AnchorRd-Yate	60
AM	X3&11	X3Portis-BrisBS	30
AM	X39&01	X39BristoBS-BathBS	12
AM	X39&11	X39BathBS-BristolBS	15
AM	X42&02	X42ChpSod-BrisBS	60
AM	X6&01	X6Bristol-Clevedon	30
AM	X6&11	X6Clevedon-Bristol	30
AM	X7&02	X7Clevedon-BTM	60
AM	X7&11	X7BTM-Clevedon	60
AM	X7&c1	X7Centre-Chepstow	30
AM	X7&c2	X7Chepstow-Centre	60
AM	X73&11	X73Cribbs-Centre	30
AM	X8&01	X8Bristol-Clevedon	60
AM	X8&X01	X8Bristol-Portishead	60
AM	X9&01	X9Bristol-Nailsea	30

Time Period	Id	Route Description	Headway (mins)
IP	70&11	70UWEFrenchay-BTM	12
IP	73&01	73Centre-Cribbs	10
IP	73&11	73Cribbs-Centre	10
IP	75&01	75Cribbs-Hengrove	10
IP	75&11	75Hengrove-Cribbs	10
IP	76&01	76Cribbs-Hengrove	10
IP	76&11	76Hengrove-Cribbs	10
IP	8&11	8TempleMeads-Cotham	12
IP	86&01'	86Kgwood-Wotton-Unde	120
IP	86&13'	86Wotton-Under-Edge-	120
IP	9&11	9BTM-Redland	12
IP	90&01	90Broadmead-Hngrve	10
IP	90&11	90Hngrve-Broadmead	10
IP	902&11	902PortPR-Centre	15
IP	903&11	903LongAshPR-Centre	12
IP	904&11	904BrstonPR-Centre	15
IP	904&X1	904Centre-BrstonPR	360
IP	A1&04	A1BrisAir-Broadmead	10
IP	A1&13	A1Broadmead-BrisAir	10
IP	A4&04	A4BrisAir-BathCntre	60
IP	A4&13	A4BathCntre-BrisAir	60
IP	NHS&1	CabtCrcus-MchaelsHsp	30
IP	NHS&2	BTM-StMichaelsHospit	30
IP	X1&01	X1BrisBS-WSM	20
IP	X1&11	X1WSM-BrisBS	20
IP	X18&12	X18Kgwood-AztWest	180
IP	X18&X0	X18AztWest-Emersgrn	360
IP	X2&11	X2BrisBS-Portis	30
IP	X25&02	X25Cribbs-Portishead	60
IP	X25&11	X25Portishead-Cribbs	60
IP	X27&01	X27Yate-AnchorRd	60
IP	X27&12	X27AnchorRd-Yate	60
IP	X3&11	X3Portis-BrisBS	30
IP	X39&01	X39BristoBS-BathBS	12
IP	X39&11	X39BathBS-BristolBS	12
IP	X42&11	X42BrisBS-NSChpSod	360
IP	X6&01	X6Bristol-Clevedon	30
IP	X6&11	X6Clevedon-Bristol	30
IP	X7&02	X7Clevedon-BTM	60
IP	X7&11	X7BTM-Clevedon	60
IP	X7&c1	X7Centre-Chepstow	60
IP	X7&c2	X7Chepstow-Centre	60
IP	X8&01	X8Bristol-Clevedon	60
IP	X8&X01	X8Bristol-Portishead	60
IP	X9&01	X9Bristol-Nailsea	360

Time Period	Id	Route Description	Headway (mins)
PM	A4&04	A4BrisAir-BathCntre	60
PM	A4&13	A4BathCntre-BrisAir	60
PM	NHS&1	CabtCrcus-MchaelsHsp	30
PM	NHS&2	BTM-StMichaelsHospit	30
PM	X1&02	X1BrisBS-WSM	20
PM	X1&11	X1WSM-BrisBS	30
PM	X18&01	X18AztWest-Kgwood	60
PM	X18&X0	X18AztWest-Emersgrn	60
PM	X18&X1	X18Emersgrn-AztWest	60
PM	X2&11	X2BrisBS-Portis	30
PM	X25&02	X25Cribbs-Portishead	60
PM	X25&11	X25Portishead-Cribbs	60
PM	X27&01	X27Yate-AnchorRd	60
PM	X27&12	X27AnchorRd-Yate	60
PM	X3&11	X3Portis-BrisBS	30
PM	X39&01	X39BristoBS-BathBS	15
PM	X39&11	X39BathBS-BristolBS	15
PM	X42&11	X42BrisBS-NSChpSod	60
PM	X54&03	X54Bristol-Nailsea	60
PM	X54&13	X54Nailsea-Redclife	60
PM	X6&01	X6Bristol-Clevedon	30
PM	X6&11	X6Clevedon-Bristol	30
PM	X7&02	X7Clevedon-BTM	60
PM	X7&11	X7BTM-Clevedon	60
PM	X7&c1	X7Centre-Chepstow	60
PM	X7&c2	X7Chepstow-Centre	60
PM	X73&01	X73Centre-Cribbs	30
PM	X8&01	X8Bristol-Clevedon	60
PM	X8&X01	X8Bristol-Portishead	60
PM	X9&01	X9Bristol-Nailsea	30

Appendix A2: GBATS4 Rail Services by time period

Time Period	Id	Route Description	Headway (mins)
AM	051a2s	Drby-Plym Chlt-Taun	30
AM	051a4n	Plym-Glas Taun-Chlt	60
AM	051a5n	Pain-Manc Taun-Chlt	60
AM	123a1n	Warm-GtMv Trow-Chlt	60
AM	123a2n	Pmth-CdfC Trow-Newp	60
AM	123a3n	From-CdfC Trow-Newp	60
AM	123a4s	BTM-Sals BTM-Trow	180
AM	123a5s	WoSH-Weym Chlt-Trow	120
AM	123a6s	Chlt-West Chlt-Trow	120
AM	123a7s	CdfC-Pmth Newp-Trow	60
AM	125a1e	Swan-Padd Newp-Lond	30
AM	125a2w	Padd-BTM Lond-BTM	60
AM	125a4w	Padd-BTM Lond-BTM	60
AM	125a5w	Padd-Swan Lond-Newp	30
AM	125a6e	Taun-Padd Taun-Lond	60
AM	125a7e	Plym-Padd Taun-Lond	60
AM	133a1s	Avnm-BTM Avnm-BTM	80
AM	133a2n	BTM-Avnm BTM-Avnm	40
AM	133a3s	SevB-BTM Svrn-BTM	80
AM	134a1n	Weym-Prkw Trow-Prkw	60
AM	134a2s	BTM-WsM BTM-WsM	120
AM	134a3s	Prkw-Taun Prkw-Taun	60
AM	134a4s	Prkw-BTM Prkw-BTM	60
AM	134a5n	ExSD-Prkw Taun-Prkw	60
AM	134a6n	WsM-CdfC WsM-Newp	60
AM	134a7s	Glos-Swin Yate-Swin	120
AM	135a1s	CdfC-Pain Newp-Taun	120

Time Period	Id	Route Description	Headway (mins)
IP	051a1n	BTM-Manc BTM-Chlt	90
IP	051a2s	Manc-BTM Chlt-BTM	90
IP	051a3s	Newc-Plym Chlt-Taun	120
IP	051a4s	Manc-Pain Chlt-Taun	360
IP	051a5n	Penz-Glas Taun-Chlt	52
IP	051a6n	Pain-Manc Taun-Chlt	360
IP	123a1n	Weym-Glos Trow-Yate	180
IP	123a2n	Pmth-CdfC Trow-Newp	60
IP	123a3n	Sals-BTM Trow-BTM	180
IP	123a4n	Pmth-CdfC Trow-Newp	360
IP	123a5n	Weym-BTM Trow-BTM	180
IP	123a6n	Sotn-GtMv Trow-Chlt	90
IP	123a7s	BTM-Sals BTM-Trow	180
IP	123a8s	CdfC-Pmth Newp-Trow	72
IP	123a9s	CdfC-Pmth Newp-Trow	360
IP	123b1s	Glos-Weym Yate-Trow	120
IP	125a1e	BTM-Padd BTM-Lond	30
IP	125a2e	Swan-Padd Newp-Lond	30
IP	125a3w	Padd-BTM Lond-BTM	33
IP	125a5w	Padd-Pain Lond-Taun	360
IP	125a6w	Padd-Swan Lond-Newp	30
IP	125a7e	Penz-Padd Taun-Lond	180
IP	125a8e	Pain-Padd Taun-Lond	360
IP	133a1s	Avnm-BTM Avnm-BTM	60
IP	133a3n	BTM-Avnm BTM-Avnm	120
IP	133a4n	BTM-SevB BTM-Svrn	120
IP	133a5n	BTM-Avnm BTM-Avnm	120
IP	133a5s	SevB-BTM Svrn-BTM	120
IP	134a1n	West-Prkw Trow-Prkw	360
IP	134a2n	West-Glos Trow-Yate	360
IP	134a3n	BTM-Glos BTM-Yate	180
IP	134a4s	Prkw-WsM Prkw-WsM	60
IP	134a5s	Prkw-Bath Prkw-Bath	180
IP	134a6s	GtMv-Brtn Chlt-Trow	360
IP	134a7s	GtMv-West Chlt-Trow	180
IP	134a8s	CdfC-Taun Newp-Taun	360
IP	134a9s	CdfC-Plym Newp-Taun	60
IP	134b1n	Taun-Prkw Taun-Prkw	180
IP	134b2n	Penz-CdfC Taun-Newp	72
IP	134b3n	WsM-Prkw WsM-Prkw	60
IP	134b4n	WsM-CdfC WsM-Newp	360

Time Period	Id	Route Description	Headway (mins)
PM	051a1n	BTM-Manc BTM-Chlt	60
PM	051a3s	Abdn-Penz Chlt-Taun	30
PM	051a4n	Plym-Leds Taun-Chlt	60
PM	123a1n	Pmth-CdfC Trow-Newp	60
PM	123a2n	Weym-Glos Trow-Yate	60
PM	123a4s	FAW-West FAW-Trow	120
PM	123a5s	CdfC-Pmth Newp-Trow	60
PM	123a6s	Glos-Weym Yate-Trow	60
PM	125a1e	BTM-Padd BTM-Lond	60
PM	125a2e	Swan-Padd Newp-Lond	30
PM	125a3w	Padd-BTM Lond-BTM	60
PM	125a4w	Padd-WsM Lond-WsM	60
PM	125a6w	Padd-Swan Lond-Newp	30
PM	125a7e	WsM-Padd WsM-Lond	60
PM	133a1s	Avnm-BTM Avnm-BTM	80
PM	133a2n	BTM-Avnm BTM-Avnm	80
PM	133a3n	BTM-SevB BTM-Svrn	80
PM	133a4s	SevB-BTM Svrn-BTM	80
PM	134a1n	Bath-Prkw Bath-Prkw	120
PM	134a3s	Prkw-WsM Prkw-WsM	60
PM	134a4s	Prkw-Warm Prkw-Trow	60
PM	134a5s	CdfC-Taun Newp-Taun	60
PM	134a6n	Taun-CdfC Taun-Newp	60
PM	134a8n	WsM-Prkw WsM-Prkw	60

Appendix B
Bus Journey Time Comparison

Appendix B1: Modelled AM Peak Bus Journey Time vs Timetabled Time

	Route ID	From	To	Headway	Number of services	Difference (Model vs Timetable)	Pass/Fail
Weston-super-Mare	1W&11	Weston-Super-Mare	Bristol Bus Station	60	1	-1%	Pass
	1W&01	Bristol Bus Station	Weston-Super-Mare	30	2	3%	Pass
	X1&11	Weston-Super-Mare	Bristol Bus Station	20	3	9%	Pass
	X1&01	Bristol Bus Station	Weston-Super-Mare	30	2	8%	Pass
	121&12	Weston-Super-Mare	Bristol Bus Station	60	1	9%	Pass
	121&01	Bristol Bus Station	Weston-Super-Mare	60	1	-4%	Pass
Portished	X2&11	Bristol Bus Station	Portishead	30	2	6%	Pass
	X3&11	Bristol Bus Station	Portishead	30	2	4%	Pass
	X6&01	Bristol Bus Station	Clevedon	30	2	2%	Pass
	X6&11	Clevedon	Bristol Bus Station	30	2	7%	Pass
	X7&11	Temple Meads	Clevedon	60	1	14%	Pass
	X8&01	Bristol Bus Station	Clevedon	60	1	-1%	Pass
	X8&X01	Bristol Bus Station	Portishead	60	1	-1%	Pass
Severn Beach	40&11	Cribbs Causeway	Union Street (BCC)	20	3	-3%	Pass
	40&01	Union Street (BCC)	Cribbs Causeway	20	3	6%	Pass
	41&01	Union Street (BCC)	Avonmouth	20	3	15%	Pass
	41&11	Avonmouth	Union Street (BCC)	20	3	3%	Pass
	501&11	Abbey Wood	Avonmouth	60	1	0%	Pass
	501&03	Avonmouth	Abbey Wood	60	1	9%	Pass
	502&02	Shirehampton	UWE Frenchay Campus	60	1	-3%	Pass
	502&11	UWE Frenchay Campus	Shirehampton	60	1	5%	Pass
	508&02	Sea Mills	Southmead	60	1	-2%	Pass
	508&11	Southmead	Sea Mills	60	1	-6%	Pass
Henbury	1&01	Broom Hill	Cribbs Causeway	12	5	4%	Pass
	1&11	Cribbs Causeway	Broom Hill	12	5	2%	Pass
	2&01	Stockwood	Cribbs Causeway	12	5	3%	Pass
	2&11	Cribbs Causeway	Cribbs Causeway	12	5	3%	Pass
	3A&01	The Centre (BCC)	Aztec West	30	2	-3%	Pass
	3A&11	Aztec West	The Centre (BCC)	15	4	-1%	Pass
	3X&01	The Centre (BCC)	Aztec West	60	1	14%	Pass
	40&01	Union Street (BCC)	Cribbs Causeway	20	3	6%	Pass
	40&11	Cribbs Causeway	Union Street (BCC)	20	3	-3%	Pass
	73&01	The Centre (BCC)	Cribbs Causeway	15	4	8%	Pass
	73&11	Cribbs Causeway	The Centre (BCC)	15	4	-6%	Pass
	X73&11	Cribbs Causeway	The Centre (BCC)	30	2	14%	Pass
	75&11	Hengrove	Cribbs Causeway	12	5	3%	Pass
	75&01	Cribbs Causeway	Hengrove	12	5	14%	Pass
	76&01	Cribbs Causeway	Hengrove	12	5	7%	Pass
	76&11	Hengrove	Cribbs Causeway	10	6	0%	Pass
	319&02	Cribbs Causeway	Bath Bus Station	60	1	8%	Pass
	319&11	Bath Bus Station	Cribbs Causeway	30	2	4%	Pass
	319&X0	Bristol Parkway	Bath Bus Station	60	1	4%	Pass
	622&14	Chipping Sodbury	Cribbs Causeway	60	1	8%	Pass
Bristol Parkway / Yate	73&01	The Centre (BCC)	Cribbs Causeway	15	4	8%	Pass
	73&11	Cribbs Causeway	The Centre (BCC)	15	4	-6%	Pass
	24&11	Horfield Common	Ashton Vale	20	3	3%	Pass
	24&01	Ashton Vale	Horfield Common	20	3	5%	Pass
	25&01	Ashton Vale	Horfield Common	20	3	2%	Pass
	25&11	Horfield Common	Ashton Vale	20	3	0%	Pass
	11&11	UWE Frenchay Campus	Bower Ashton Campus	20	3	1%	Pass
	11&02	Bower Ashton Campus	UWE Frenchay Campus	20	3	-6%	Pass
	12&01	The Centre (BCC)	UWE Frenchay Campus	30	2	1%	Pass
	12&12	UWE Frenchay Campus	The Centre (BCC)	30	2	-2%	Pass
	15&12	UWE Frenchay Campus	The Centre (BCC)	20	3	-2%	Pass
	15&01	The Centre (BCC)	UWE Frenchay Campus	30	2	-1%	Pass
	19&01	The Centre (BCC)	UWE Frenchay Campus	15	4	-3%	Pass
	19&11	UWE Frenchay Campus	The Centre (BCC)	15	4	-2%	Pass
	70&01	Temple Meads	UWE Frenchay Campus	15	4	0%	Pass
	70&11	UWE Frenchay Campus	Temple Meads	15	4	-7%	Pass
	502&11	UWE Frenchay Campus	Shirehampton	60	1	-7%	Pass
	502&02	Shirehampton	UWE Frenchay Campus	60	1	9%	Pass
	319&02	Cribbs Causeway	Bath Bus Station	60	1	9%	Pass

Appendix B1: Modelled AM Peak Bus Journey Time vs Timetabled Time

	Route ID	From	To	Headway	Number of services	Difference (Model vs Timetable)	Pass/Fail
	319&11	Bath Bus Station	Cribbs Causeway	30	2	10%	Pass
	319&X0	Bristol Parkway	Bath Bus Station	60	1	4%	Pass
	X27&12	Anchor Road (BCC)	Yate	60	1	5%	Pass
	327&11	Bristol Bus Station	Yate	60	1	-2%	Pass
	327&02	Yate	Bristol Bus Station	60	1	-2%	Pass
	342&02	Chipping Sodbury	Bristol Bus Station	30	2	2%	Pass
	342&11	Bristol Bus Station	Chipping Sodbury	30	2	10%	Pass
	178&11	Bath Bus Station	Bristol Bus Station	60	1	4%	Pass
	178&01	Bristol Bus Station	Bath Bus Station	60	1	4%	Pass
	349&11	Keynsham	The Horsefair (BCC)	30	2	13%	Pass
	338&11	Bath Bus Station	Bristol Bus Station	30	2	-5%	Pass
	338&01	Bristol Bus Station	Bath Bus Station	30	2	-2%	Pass
	A4&13	Bath City Centre	Bristol Airport	60	1	8%	Pass
	A4&04	Bristol Airport	Bath City Centre	60	1	6%	Pass
Keynsham / Bath Spa	X39&01	Bristol Bus Station	Bath Bus Station	12	5	9%	Pass
	X39&11	Bath Bus Station	Bristol Bus Station	15	4	8%	Pass
	319&11	Bath Bus Station	Cribbs Causeway	30	2	10%	Pass
	319&X0	Bristol Parkway	Bath Bus Station	60	1	4%	Pass
	332&01	Bristol Bus Station	Bath Bus Station	60	1	13%	Pass
	332&11	Bath Bus Station	Bristol Bus Station	60	1	9%	Pass
	42&11	Keynsham	The Centre (BCC)	20	3	-6%	Pass
	42&01	The Centre (BCC)	Keynsham	20	3	0%	Pass
	16&X11	16UoBBS-TyndPark		6	10	-2%	Pass
	16&X02	16TyndPark-UoBBS		10	6	-2%	Pass
	76&11	76Hengrove-Cribbs		10	6	0%	Pass
	90&01	90Broadmead-Hngrve		10	6	-2%	Pass
	90&11	90Hngrve-Broadmead		10	6	-4%	Pass
	903&11	903LongAshPR-Centre		10	6	1%	Pass
	A1&04	A1BrisAir-Broadmead		10	6	9%	Pass
	A1&13	A1Broadmead-BrisAir		10	6	15%	Pass
	1&01	1BrmHill-Cribbs		12	5	4%	Pass
	1&11	1Cribbs-BrmHill		12	5	2%	Pass
	2&01	2Stockwood-Cribbs		12	5	3%	Pass
	2&11	2Cribbs-Stockwood		12	5	3%	Pass
	75&01	75Cribbs-Hengrove		12	5	14%	Pass
	75&11	75Hengrove-Cribbs		12	5	3%	Pass
	76&01	76Cribbs-Hengrove		12	5	7%	Pass
Top 40% of services	8&11	8TempleMeads-Cotham		12	5	3%	Pass
	9&11	9BTM-Redland		12	5	-1%	Pass
	902&11	902PortPR-Centre		12	5	7%	Pass
	904&11	904BrstonPR-Centre		12	5	4%	Pass
	X39&01	X39BristoBS-BathBS		12	5	13%	Pass
	19&11	19UWEFC-Centre		15	4	-2%	Pass
	48&01	48RupertSt-EmGreen		15	4	3%	Pass
	48&11	48EmGreen-RupertSt		15	4	-4%	Pass
	49&01	49RupertSt-EmGreen		15	4	0%	Pass
	49&11	49EmGreen-RupertSt		15	4	-3%	Pass
	70&01	70BTM-UWEFrenchay		15	4	0%	Pass
	70&11	70UWEFrenchay-BTM		15	4	-7%	Pass
	73&01	73Centre-Cribbs		15	4	8%	Pass
	73&11	73Cribbs-Centre		15	4	-6%	Pass
	X39&11	X39BathBS-BristolBS		15	4	8%	Pass
	11&02	11BowerAshton-UWEFC		20	3	-6%	Pass

Appendix B2: Modelled IP Bus Journey Time vs Timetabled Time

	Route ID	From	To	Headway	Number of services	Difference (Model vs Timetable)	Pass/Fail
Weston-super-Mare	1W&11	Weston-Super-Mare	Bristol Bus Station	60	1	-4%	Pass
	1W&01	Bristol Bus Station	Weston-Super-Mare	60	1	0%	Pass
	X1&11	Weston-Super-Mare	Bristol Bus Station	20	3	8%	Pass
	X1&01	Bristol Bus Station	Weston-Super-Mare	20	3	9%	Pass
	121&12	Weston-Super-Mare	Bristol Bus Station	120	1	1%	Pass
	121&01	Bristol Bus Station	Weston-Super-Mare	120	1	-6%	Pass
Portishead	X2&11	Bristol Bus Station	Portishead	30	2	4%	Pass
	X3&11	Bristol Bus Station	Portishead	30	2	6%	Pass
	X6&01	Bristol Bus Station	Clevedon	30	2	2%	Pass
	X6&11	Clevedon	Bristol Bus Station	30	2	9%	Pass
	X7&11	Temple Meads	Clevedon	60	1	20%	Fail
	X7&02	Clevedon	Temple Meads	60	1	-1%	Pass
	X8&01	Bristol Bus Station	Clevedon	60	1	-3%	Pass
	X8&X01	Bristol Bus Station	Portishead	60	1	-4%	Pass
Severn Beach	40&11	Cribbs Causeway	Union Street (BCC)	20	3	-2%	Pass
	40&01	Union Street (BCC)	Cribbs Causeway	20	3	6%	Pass
	41&01	Union Street (BCC)	Avonmouth	20	3	9%	Pass
	41&11	Avonmouth	Union Street (BCC)	20	3	8%	Pass
	501&11	Abbey Wood	Avonmouth	60	1	1%	Pass
	502&02	Shirehampton	UWE Frenchay Campus	60	1	-4%	Pass
	502&11	UWE Frenchay Campus	Shirehampton	60	1	3%	Pass
	508&02	Sea Mills	Southmead	60	1	-5%	Pass
	508&11	Southmead	Sea Mills	60	1	-4%	Pass
Henbury	1&01	Broom Hill	Cribbs Causeway	10	6	-6%	Pass
	1&11	Cribbs Causeway	Broom Hill	10	6	1%	Pass
	2&01	Stockwood	Cribbs Causeway	10	6	-3%	Pass
	2&11	Cribbs Causeway	Cribbs Causeway	10	6	-5%	Pass
	3&01	The Centre (BCC)	Cribbs Causeway	16	4	7%	Pass
	3&11	Cribbs Causeway	The Centre (BCC)	15	4	2%	Pass
	3A&01	The Centre (BCC)	Aztec West	360	0	-3%	Pass
	40&01	Union Street (BCC)	Cribbs Causeway	20	3	6%	Pass
	40&11	Cribbs Causeway	Union Street (BCC)	20	3	-2%	Pass
	73&01	The Centre (BCC)	Cribbs Causeway	10	6	-4%	Pass
	73&11	Cribbs Causeway	The Centre (BCC)	10	6	-6%	Pass
	75&11	Hengrove	Cribbs Causeway	10	6	10%	Pass
	75&01	Cribbs Causeway	Hengrove	10	6	1%	Pass
	76&01	Cribbs Causeway	Hengrove	10	6	6%	Pass
	76&11	Hengrove	Cribbs Causeway	10	6	-3%	Pass
	319&02	Cribbs Causeway	Bath Bus Station	30	2	5%	Pass
	319&11	Bath Bus Station	Cribbs Causeway	30	2	2%	Pass
	622&14	Chipping Sodbury	Cribbs Causeway	90	1	6%	Pass
	X25&02	Cribbs Causeway	Portishead	60	1	2%	Pass
	309&01	Bristol Bus Station	Thornbury	33	2	-7%	Pass
	309&11	Thornbury	Bristol Bus Station	30	2	-1%	Pass
	625&04	UWE Frenchay Campus	Severn Beach	60	1	6%	Pass
	625&12	Severn Beach	UWE Frenchay Campus	60	1	1%	Pass
Bristol Parkway / Yate	73&01	The Centre (BCC)	Cribbs Causeway	10	6	-4%	Pass
	73&11	Cribbs Causeway	The Centre (BCC)	10	6	-6%	Pass
	24&11	Horfield Common	Ashton Vale	20	3	3%	Pass
	24&01	Ashton Vale	Horfield Common	20	3	-2%	Pass
	25&01	Ashton Vale	Horfield Common	20	3	-2%	Pass
	25&11	Horfield Common	Ashton Vale	20	3	6%	Pass
	11&11	UWE Frenchay Campus	Bower Ashton Campus	21	3	1%	Pass
	11&02	Bower Ashton Campus	UWE Frenchay Campus	21	3	-1%	Pass
	12&01	The Centre (BCC)	UWE Frenchay Campus	20	3	7%	Pass
	12&12	UWE Frenchay Campus	The Centre (BCC)	20	3	1%	Pass
	15&12	UWE Frenchay Campus	The Centre (BCC)	20	3	0%	Pass
	15&01	The Centre (BCC)	UWE Frenchay Campus	20	3	3%	Pass
	19&01	The Centre (BCC)	UWE Frenchay Campus	12	5	7%	Pass
	19&11	UWE Frenchay Campus	The Centre (BCC)	12	5	4%	Pass
	70&01	Temple Meads	UWE Frenchay Campus	12	5	1%	Pass
	70&11	UWE Frenchay Campus	Temple Meads	12	5	-3%	Pass
	501&11	Abbey Wood	Avonmouth	60	1	1%	Pass
	502&11	UWE Frenchay Campus	Shirehampton	60	1	3%	Pass
	502&02	Shirehampton	UWE Frenchay Campus	60	1	3%	Pass
	625&04	UWE Frenchay Campus	Severn Beach	60	1	6%	Pass

Appendix B2: Modelled IP Bus Journey Time vs Timetabled Time

	Route ID	From	To	Headway	Number of services	Difference (Model vs Timetable)	Pass/Fail
	625&12	Severn Beach	UWE Frenchay Campus	60	1	1%	Pass
	319&02	Cribbs Causeway	Bath Bus Station	30	2	6%	Pass
	319&11	Bath Bus Station	Cribbs Causeway	30	2	2%	Pass
	X27&12	Anchor Road (BCC)	Yate	60	1	9%	Pass
	327&11	Bristol Bus Station	Yate	60	1	10%	Pass
	327&02	Yate	Bristol Bus Station	60	1	-1%	Pass
	342&02	Chipping Sodbury	Bristol Bus Station	30	2	7%	Pass
	342&11	Bristol Bus Station	Chipping Sodbury	33	2	15%	Pass
	178&11	Bath Bus Station	Bristol Bus Station	60	1	-1%	Pass
	178&01	Bristol Bus Station	Bath Bus Station	60	1	6%	Pass
	349&11	Keynsham	The Horsefair (BCC)	30	2	0%	Pass
	338&11	Bath Bus Station	Bristol Bus Station	30	2	-5%	Pass
	338&01	Bristol Bus Station	Bath Bus Station	30	2	-8%	Pass
	A4&13	Bath City Centre	Bristol Airport	60	1	-1%	Pass
Keynsham / Bath Spa	A4&04	Bristol Airport	Bath City Centre	60	1	-4%	Pass
	X39&01	Bristol Bus Station	Bath Bus Station	12	5	2%	Pass
	X39&11	Bath Bus Station	Bristol Bus Station	12	5	10%	Pass
	319&11	Bath Bus Station	Cribbs Causeway	30	2	2%	Pass
	332&01	Bristol Bus Station	Bath Bus Station	60	1	13%	Pass
	332&11	Bath Bus Station	Bristol Bus Station	60	1	5%	Pass
	42&11	Keynsham	The Centre (BCC)	20	3	-2%	Pass
	42&01	The Centre (BCC)	Keynsham	20	3	-1%	Pass
	1&01	1BrmHill-Cribbs		10	6	-6%	Pass
	1&11	1Cribbs-BrmHill		10	6	1%	Pass
	2&01	2Stockwood-Cribbs		10	6	-3%	Pass
	2&11	2Cribbs-Stockwood		10	6	-5%	Pass
	73&01	73Centre-Cribbs		10	6	-4%	Pass
	73&11	73Cribbs-Centre		10	6	-6%	Pass
	75&01	75Cribbs-Hengrove		10	6	1%	Pass
	75&11	75Hengrove-Cribbs		10	6	10%	Pass
	76&01	76Cribbs-Hengrove		10	6	6%	Pass
	76&11	76Hengrove-Cribbs		10	6	-3%	Pass
	90&01	90Broadmead-Hngrve		10	6	-2%	Pass
	90&11	90Hngrve-Broadmead		10	6	-1%	Pass
	A1&04	A1BrisAir-Broadmead		10	6	7%	Pass
	A1&13	A1Broadmead-BrisAir		10	6	5%	Pass
	19&01	19Centre-UWEFC		12	5	7%	Pass
	19&11	19UWEFC-Centre		12	5	4%	Pass
	70&01	7070BTM-UWEFrenchay		12	5	1%	Pass
Top 40% of services	70&11	70UWEFrenchay-BTM		12	5	-3%	Pass
	8&11	8TempleMeads-Cotham		12	5	1%	Pass
	9&11	9BTM-Redland		12	5	1%	Pass
	903&11	903LongAshPR-Centre		12	5	7%	Pass
	X39&01	X39BristoBS-BathBS		12	5	2%	Pass
	X39&11	X39BathBS-BristolBS		12	5	10%	Pass
	16&02	16Centre-UoBBS		13	5	6%	Pass
	49&11	49EmGreen-RupertSt		14	4	0%	Pass
	16&11	16UoBBS-Centre		13	5	4%	Pass
	3&11	3Cribbs-Centre		15	4	2%	Pass
	48&01	48RupertSt-EmGreen		15	4	5%	Pass
	48&11	48EmGreen-RupertSt		15	4	0%	Pass
	49&01	49RupertSt-EmGreen		15	4	-3%	Pass
	902&11	902PortPR-Centre		15	4	12%	Pass
	904&11	904BrstonPR-Centre		15	4	10%	Pass
	3&01	3Centre-Cribbs		16	4	7%	Pass
	3&11	3Centre-Cribbs		15	4	0%	Pass

Appendix B3: Modelled PM Peak Bus Journey Time vs Timetabled Time

	Route ID	From	To	Headway	Number of services	Difference (Model vs Timetable)	Pass/Fail
Weston-super-Mare	1W&11	Weston-Super-Mare	Bristol Bus Station	30	2	-1%	Pass
	1W&01	Bristol Bus Station	Weston-Super-Mare	60	1	14%	Pass
	X1&11	Weston-Super-Mare	Bristol Bus Station	30	2	6%	Pass
	X1&02	Bristol Bus Station	Weston-Super-Mare	20	3	4%	Pass
Portishead	X2&11	Bristol Bus Station	Portishead	30	2	6%	Pass
	X3&11	Bristol Bus Station	Portishead	30	2	4%	Pass
	X6&01	Bristol Bus Station	Clevedon	30	2	7%	Pass
	X6&11	Clevedon	Bristol Bus Station	30	2	10%	Pass
	X7&11	Temple Meads	Clevedon	60	1	15%	Pass
	X7&02	Clevedon	Temple Meads	60	1	0%	Pass
	X8&01	Bristol Bus Station	Clevedon	60	1	2%	Pass
	X8&X01	Bristol Bus Station	Portishead	60	1	1%	Pass
Severn Beach	40&11	Cribbs Causeway	Union Street (BCC)	20	3	3%	Pass
	40&01	Union Street (BCC)	Cribbs Causeway	20	3	2%	Pass
	41&01	Union Street (BCC)	Avonmouth	20	3	6%	Pass
	41&11	Avonmouth	Union Street (BCC)	20	3	8%	Pass
	501&11	Abbey Wood	Avonmouth	60	1	4%	Pass
	501&03	Avonmouth	Abbey Wood	60	1	-3%	Pass
	502&02	Shirehampton	UWE Frenchay Campus	60	1	-2%	Pass
	502&11	UWE Frenchay Campus	Shirehampton	60	1	-1%	Pass
Henbury	1&01	Broom Hill	Cribbs Causeway	12	5	3%	Pass
	1&11	Cribbs Causeway	Broom Hill	12	5	-7%	Pass
	2&01	Stockwood	Cribbs Causeway	12	5	0%	Pass
	2&11	Cribbs Causeway	Cribbs Causeway	12	5	7%	Pass
	3A&01	The Centre (BCC)	Aztec West	30	2	0%	Pass
	3A&11	Aztec West	The Centre (BCC)	30	2	5%	Pass
	3B&01	The Centre (BCC)	Bradley Stoke	60	1	0%	Pass
	3C&11	Aztec West	Clifton	60	1	1%	Pass
	40&01	Union Street (BCC)	Cribbs Causeway	20	3	2%	Pass
	40&11	Cribbs Causeway	Union Street (BCC)	20	3	3%	Pass
	73&01	The Centre (BCC)	Cribbs Causeway	15	4	0%	Pass
	73&11	Cribbs Causeway	The Centre (BCC)	15	4	-3%	Pass
	X73&01	The Centre (BCC)	Cribbs Causeway	30	2	-1%	Pass
	75&11	Hengrove	Cribbs Causeway	12	5	-3%	Pass
	75&01	Cribbs Causeway	Hengrove	10	6	-5%	Pass
	76&01	Cribbs Causeway	Hengrove	12	5	9%	Pass
	76&11	Hengrove	Cribbs Causeway	12	5	1%	Pass
	319&02	Cribbs Causeway	Bath Bus Station	30	2	10%	Pass
	319&11	Bath Bus Station	Cribbs Causeway	30	2	3%	Pass
	X25&02	Cribbs Causeway	Portishead	60	1	9%	Pass
	309&01	Bristol Bus Station	Thornbury	60	1	14%	Pass
	309&11	Thornbury	Bristol Bus Station	30	2	-3%	Pass
	625&15	Severn Beach	UWE Frenchay Campus	60	1	7%	Pass
	625&04	UWE Frenchay Campus	Severn Beach	60	1	-3%	Pass
Bristol Parkway / Yate	73&01	The Centre (BCC)	Cribbs Causeway	15	4	0%	Pass
	73&11	Cribbs Causeway	The Centre (BCC)	15	4	-3%	Pass
	X73&01	The Centre (BCC)	Cribbs Causeway	30	2	-1%	Pass
	24&11	Horfield Common	Ashton Vale	20	3	2%	Pass
	24&01	Ashton Vale	Horfield Common	20	3	8%	Pass
	25&01	Ashton Vale	Horfield Common	20	3	1%	Pass
	25&11	Horfield Common	Ashton Vale	20	3	-8%	Pass
	11&11	UWE Frenchay Campus	Bower Ashton Campus	30	2	6%	Pass
	11&02	Bower Ashton Campus	UWE Frenchay Campus	20	3	-2%	Pass
	12&01	The Centre (BCC)	UWE Frenchay Campus	30	2	2%	Pass
	12&12	UWE Frenchay Campus	The Centre (BCC)	30	2	-1%	Pass
	15&12	UWE Frenchay Campus	The Centre (BCC)	20	3	-3%	Pass
	15&01	The Centre (BCC)	UWE Frenchay Campus	20	3	-1%	Pass
	19&01	The Centre (BCC)	UWE Frenchay Campus	15	4	9%	Pass
	19&11	UWE Frenchay Campus	The Centre (BCC)	15	4	-2%	Pass
	70&01	Temple Meads	UWE Frenchay Campus	15	4	-2%	Pass
	70&11	UWE Frenchay Campus	Temple Meads	15	4	-8%	Pass
	501&11	Abbey Wood	Avonmouth	60	1	4%	Pass
	501&03	Avonmouth	Abbey Wood	60	1	-3%	Pass
	502&11	UWE Frenchay Campus	Shirehampton	60	1	-1%	Pass

Appendix B3: Modelled PM Peak Bus Journey Time vs Timetabled Time

	Route ID	From	To	Headway	Number of services	Difference (Model vs Timetable)	Pass/Fail
	502&02	Shirehampton	UWE Frenchay Campus	60	1	-2%	Pass
	625&15	Severn Beach	UWE Frenchay Campus	60	1	7%	Pass
	625&04	UWE Frenchay Campus	Severn Beach	60	1	-3%	Pass
	319&02	Cribbs Causeway	Bath Bus Station	30	2	10%	Pass
	319&11	Bath Bus Station	Cribbs Causeway	30	2	3%	Pass
	X27&12	Anchor Road (BCC)	Yate	60	1	-8%	Pass
	327&11	Bristol Bus Station	Yate	60	1	6%	Pass
	327&02	Yate	Bristol Bus Station	60	1	-9%	Pass
	342&02	Chipping Sodbury	Bristol Bus Station	30	2	7%	Pass
	342&11	Bristol Bus Station	Chipping Sodbury	30	2	0%	Pass
	178&11	Bath Bus Station	Bristol Bus Station	60	1	5%	Pass
	178&01	Bristol Bus Station	Bath Bus Station	60	1	6%	Pass
	349&11	Keynsham	The Horsefair (BCC)	30	2	18%	Fail
	338&11	Bath Bus Station	Bristol Bus Station	30	2	-7%	Pass
	338&01	Bristol Bus Station	Bath Bus Station	30	2	-3%	Pass
	A4&13	Bath City Centre	Bristol Airport	60	1	6%	Pass
	A4&04	Bristol Airport	Bath City Centre	60	1	4%	Pass
Keynsham / Bath Spa	X39&01	Bristol Bus Station	Bath Bus Station	15	4	13%	Pass
	X39&11	Bath Bus Station	Bristol Bus Station	15	4	-5%	Pass
	319&11	Bath Bus Station	Cribbs Causeway	30	2	3%	Pass
	319&02	Bristol Parkway	Bath Bus Station	30	2	7%	Pass
	332&01	Bristol Bus Station	Bath Bus Station	60	1	14%	Pass
	332&11	Bath Bus Station	Bristol Bus Station	60	1	7%	Pass
	42&11	Keynsham	The Centre (BCC)	20	3	1%	Pass
	42&01	The Centre (BCC)	Keynsham	20	3	-2%	Pass
	16&X02	16TyndPark-UoBBS		8	7.5	11%	Pass
	16&X11	16UoBBS-TyndPark		8	7.5	-2%	Pass
	75&01	75Cribbs-Hengrove		10	6	-5%	Pass
	90&01	90Broadmead-Hngrve		10	6	-3%	Pass
	90&11	90Hngrve-Broadmead		10	6	-9%	Pass
	A1&04	A1BrisAir-Broadmead		10	6	3%	Pass
	A1&13	A1Broadmead-BrisAir		10	6	4%	Pass
	1&01	1BrmHill-Cribbs		12	5	3%	Pass
	1&11	1Cribbs-BrmHill		12	5	-7%	Pass
	2&01	2Stockwood-Cribbs		12	5	0%	Pass
	2&11	2Cribbs-Stockwood		12	5	7%	Pass
	75&11	75Hengrove-Cribbs		12	5	-3%	Pass
	76&01	76Cribbs-Hengrove		12	5	9%	Pass
	76&11	76Hengrove-Cribbs		12	5	1%	Pass
	902&11	902PortPR-Centre		12	5	8%	Pass
Top 40% of services	903&11	903LongAshPR-Centre		12	5	-1%	Pass
	904&11	904BrstonPR-Centre		12	5	0%	Pass
	19&01	19Centre-UWEFC		15	4	9%	Pass
	19&11	19UWEFC-Centre		15	4	-2%	Pass
	48&01	48RupertSt-EmGreen		15	4	8%	Pass
	49&01	49RupertSt-EmGreen		15	4	1%	Pass
	7&01	7BldwnSt-StapleHill		15	4	-5%	Pass
	70&01	7070BTM-UWEFrenchay		15	4	-2%	Pass
	73&01	73Centre-Cribbs		15	4	0%	Pass
	73&11	73Cribbs-Centre		15	4	-3%	Pass
	8&11	8TempleMeads-Cotham		15	4	6%	Pass
	9&11	9BTM-Redland		15	4	2%	Pass
	X39&01	X39BristoBS-BathBS		15	4	13%	Pass
	X39&11	X39BathBS-BristolBS		15	4	-5%	Pass
	11&02	11BowerAshton-UWEFC		20	3	-2%	Pass
	15&01	15Centre-UWEFC		20	3	-1%	Pass
	15&12	15UWEFC-Centre		20	3	-3%	Pass