DEVON COUNTY COUNCIL

A380 SOUTH DEVON LINK ROAD KINGSKERSWELL BYPASS

Report of Surveys and Local Model Validation Report

December 2007

Report No: TUE43444A/5/3

FINAL DRAFT

Prepared for
Devon County Council
County Hall
Topsham Road
Exeter
EX2 4QD

Prepared by
Parsons Brinckerhoff Ltd
The Forum
Barnfield Road
Exeter
Devon
EX1 1QR
Tel: +44 (0)1392 229700
Fax: +44 (0)1392 229701
E-mail: BlackD@pbworld.com
BeavisI@pbworld.com
MoodyK@pbworld.com

AUTHORISATION SHEET

Client: Devon County Council
Project: Kingskerswell Bypass Reappraisal
Address: County Hall, Topsham Road, Exeter, EX2 4QD

PREPARED BY

Name: Katherine Moody
Position: Assistant Engineer
Date: December 2007

AGREED BY

Name: Ian Beavis
Position: Principal Engineer
Date: December 2007

AUTHORISED FOR ISSUE

Name: David Black
Position: Technical Director
Date: December 2007

DISTRIBUTION

Copy No.	Company
1	Department for Transport
2	PB Office Copy (Exeter)

Copy Number 1

CONTENTS

FIGURES

TABLES

1 INTRODUCTION

1.1 Background

1.1.1 This report forms part of the Kingskerswell Bypass Reappraisal project. The proposed Kingskerswell Bypass improvement links Penn Inn roundabout near Newton Abbot to the A380 Hamelin Way near Kerswell Gardens, via a dual carriageway link aligned to the west of Kingskerswell.

1.2 Previous Work

1.2.1 The traffic modelling, forecasting and economics work to date has been based upon the previous traffic model developed by Halcrow Fox for the A380 Corridor Study. In order to progress the scheme to the Public Inquiry stage, it was considered necessary to update the traffic model using new traffic data and to provide a greater level of detail in the specific study area, as indicated in the Work Programme Report (Number TUE43444A/4/1).

1.3 Study Area

1.3.1 The existing A380 links to the A38 trunk road at Telegraph Hill and continues via Kingskerswell and Torquay to Paignton. The route is dual carriageway with the exception of the section from Penn Inn roundabout to Kerswell Gardens. The detailed and extended study areas are shown in Figure 1.1.

1.3.2 The study focuses specifically on the **detailed study area**, which consists of the A380 corridor, extending from Penn Inn roundabout near Newton Abbot in the north to Kerswell Gardens roundabout in the south. This area also includes other parallel roads which are used as rat-runs in the existing situation; these roads are the A381 Totnes Road, Kingskerswell Road, St. Marychurch Road and the A379 Teignmouth Road. These roads, along with the A380 through Kingskerswell, form a screenline across the study area that is used in subsequent analysis. These key locations and the screenline are illustrated on Figure 1.2.

1.3.3 In addition to the detailed study area, the traffic model covers a wider **extended study area**. This area extends from Exeter in the north, to Plymouth in the south and includes the Torbay, Newton Abbot, Totnes and Teignmouth urban areas. This area is included in the traffic model to allow analysis of traffic flows in these areas, although the level of modelling detail decreases as you move away from the detailed study area.

1.4 Layout of Report

1.4.1 This report firstly details the data used in the traffic modelling assessment in terms of both traffic survey and accident data. The following data has been collected for both the A380 and other important links within the study area.

- Manual Classified Link Counts
- Manual Classified Junction Counts
- Roadside Interview Data
- Automatic Traffic Counts
- Accident Data
- Journey Time and Speed Data
- Queue Length Data

1.4.2 This document subsequently provides a report of the methodology involved in the development of the traffic model. It aims to demonstrate that the model has been calibrated to DMRB standards, representing the current traffic situation to an acceptable level of accuracy thus allowing the model to be taken forward for use in the forecasting procedures.

2 MANUAL CLASSIFIED COUNT DATA

2.1 Location and Date of Collection

2.1.1 Link Counts

2.1.2 Manual Classified Link Count (MCC) data was collected by Parsons Brinckerhoff over 12 hours between 07:00 and 19:00 on key routes in the study area. The locations and dates of the link counts within the study area for this assessment are detailed in Table 2.1 below and are shown in Figure 2.1:

Table 2.1: Location of Manual Classified Link Counts

Location	Date
Manual Classified Link Counts	
A380 Torquay Road	*15th June 2005*
Kingskerswell Road	*16th June 2005*
A381 Totnes Road	*14th June 2005*
Gropers Lane	*4th July 2005*

2.1.3 Junction Counts

2.1.4 Manual Classified Junction Count data was collected by Parsons Brinckerhoff on St Marychurch Road and the A379 Teignmouth Road. Additional video classified turning count data was also collected by CTS Traffic and Transportation on behalf of Parsons Brinckerhoff, specifically for this study. Data was collected over 12 hours between 07:00 and 19:00. The locations of the junctions and survey dates are detailed in Table 2.2 below, and are illustrated on Figure 2.1.

Table 2.2: Location of Manual Classified Junction Counts

Location	Date
Manual Classified Junction Counts	
St Marychurch Road	*13th June 2005*
A379 Teignmouth Road	*14th June 2005*
Video Classified Turning Counts	
Penn Inn Roundabout	*7th June 2005*
Ware Barton Roundabout	*8th June 2005*
Jurys Corner	*7th June 2005*
Kerswell Gardens	*7th June 2005*

2.1.5 Using this junction count data it is possible to calculate the link count data for St Marychurch Road and Teignmouth Road. This information is illustrated in Table 2.3 below.

2.2 Results: Link Counts

2.2.1 The link count data is illustrated on Figure 2.2.

2.2.2 Table 2.3 shows the total 12 hour traffic flows, AM Peak (08:00 – 09:00) and PM Peak (17:00 – 18:00) hour flows, and the percentage of heavy goods vehicles (HGVs) across the screenline illustrated on Figure 1.2. The results are taken from counts carried out in June 2005.

Table 2.3: Link Count Data for the Screenline

Location	Direction	12 Hour Flow	% HGV	AM Peak Hour Flow (08:00–09:00)	% HGV	PM Peak Hour Flow (17:00–18:00)	% HGV
St. Marychurch Road	**Northbound**	4333	1.1	529	0.0	360	0.3
	Southbound	6211	1.2	598	0.3	911	0.2
A379	**Northbound**	5129	3.2	523	3.6	701	0.7
	Southbound	4895	2.7	568	3.9	580	1.0
A380	**Northbound**	12801	7.1	1067	6.3	1128	4.9
	Southbound	10450	8.0	1007	10.5	886	5.0
Kingskerswell Road	**Northbound**	1944	2.5	495	0.8	120	0.8
	Southbound	2811	1.4	189	3.2	619	0.3
Totnes Road	**Northbound**	5591	4.0	652	4.0	541	0.7
	Southbound	5970	3.1	517	3.7	700	1.0

2.2.3 The hourly flow profile for each of the five roads across the screenline, which consists of St Marychurch Road, A379 Teignmouth Road, A380 Torquay Road, Kingskerswell Road, and Totnes Road, is illustrated on Figure 2.3. Figure 2.4 shows the hourly flow combined across the screenline.

2.2.4 Figure 2.4 shows that a tidal flow pattern is evident across the screenline as a whole, although the flows are only slightly higher in a northbound direction in the AM Peak period, compared with the southbound flow levels. The plot shows higher levels of traffic in the morning and evening peaks in comparison to the Interpeak period, representing work journeys to both Exeter and Newton Abbot in the north and Torbay in the south. When consideration is made of the A380 only, the flows are fairly constant throughout the day, suggesting that the road is currently congested all day, showing little decrease in traffic during the Interpeak period.

2.3 Results: Junction Counts

2.3.1 The junction count locations within the study area are illustrated on Figures 2.5, 2.6 and 2.7. This data includes that collected by CTS Traffic and Transportation at Penn Inn, Ware Barton, Jurys Corner and Kerswell Gardens, and the data collected by Parsons Brinckerhoff on St Marychurch Road and the A379 Teignmouth Road.

2.3.2 These flow diagrams illustrate traffic flows for the AM Peak (08:00-09:00), PM Peak (17:00-18:00) and the Average Interpeak Flow between 10:00 and 16:00. In addition to this the 12 hour flow has been included.

3 AUTOMATIC TRAFFIC COUNT DATA

3.1 Location and Date of Collection

3.1.1 Automatic Traffic Count (ATC) data was collected at four sites within the study area, as illustrated in Figure 2.1 and in Table 3.1. The automatic traffic counters on St Marychurch Road, Kingskerswell Road and the A379 Teignmouth Road were temporarily installed by Devon County Council for the whole of June 2005. The site on the A380 Torquay Road is a permanent counter and data for the whole of 2005 has therefore been collected from this site.

Table 3.1: Location of ATCs

Location	Date
Automatic Traffic Counts (ATCs)	
St Marychurch Road	*June 2005*
A380 Torquay Road	*2005*
Kingskerswell Road	*June 2005*
A379 Teignmouth Road	*June 2005*

3.1.2 This ATC data can be analysed to assess the hourly and daily flow profiles across the screenline and monthly flow profile and traffic growth on the A380 through Kingskerswell.

3.2 Hourly Flow Profile

<u>Side Roads</u>

3.2.1 Figure 3.1 (Graphs 1-3) illustrates the hourly profile at the ATC locations on each of the side roads for an average day in June 2005. The flows on these side roads are low throughout the day, however there are marked increases in flows in the AM and PM Peak periods, thus providing evidence of rat-running on these side roads. The interpeak flows drop to 57% of the peak values for St Marychurch Road, 49% of the peak values for Kingskerswell Road, and 74% of the peak values on the A379 Teignmouth Road. Before 07:00 and after 19:00 the flows decrease to very low levels.

<u>A380 Torquay Road through Kingskerswell</u>

3.2.2 Figure 3.1 (Graph 4) illustrates the hourly profile at the ATC site on the A380 Torquay Road for an average day in June 2005. The flows on this road are higher than those on the side roads as would be expected as a result of this being the main route through the area. A fairly flat profile is however evident at this location suggesting that the road is approaching capacity throughout the day. Before 07:00 and after 19:00 the flow does however decrease to very low levels.

3.3 Daily Flow Profile

Side Roads

3.3.1 Figure 3.2 (Graphs 1-3) illustrates the daily flow profile at each of the ATC locations on the side roads. It is evident in each case that the weekday flows are fairly similar; the only obvious increase in flows is evident on Kingskerswell Road on a Friday. As expected, flows drop significantly during the weekend. This shows that any day from Monday to Thursday can be assumed to be an average weekday in the analysis.

A380 Torquay Road through Kingskerswell

3.3.2 Figure 3.2 (Graph 4) illustrates the daily flow profile at the ATC location on the A380 Torquay Road. The daily flow is fairly constant throughout the week. The weekend flows on the A380 Torquay Road remain fairly high, with 12 hour flows reaching levels close to those for a weekday.

3.4 Monthly Flow Profile

3.4.1 Based on data from the Automatic Traffic Counter site on the A380 Torquay Road, a monthly flow profile for the A380 through Kingskerswell can be determined in order to ensure that June is a neutral month in terms of traffic flow. This is necessary in order to show that we are justified in using flows from June as being representative of the flow along the A380 link.

3.4.2 Figure 3.3 shows the monthly flow profile on the A380 Torquay Road in 2005. The graph shows a fairly flat profile throughout the year, with the exceptions of April and August where the increase in flow can likely be attributed to holiday traffic, and a fall in monthly flow in December. The average 2-way 12-hour weekday traffic flow for June is 27663 vehicles, which is similar to the average 2-way 12 hour average weekday flow for 2005. Therefore, it can be considered that June is a neutral month.

3.5 Traffic Growth

3.5.1 As a result of data from the ATC site on the A380 Torquay Road close to Kerswell Gardens only covering the period from 2003 to the present, data for the ATC site at Ideford has been used to identify the traffic growth in the area. This site is located 8.2 km north of Penn Inn.

3.5.2 Figure 3.4 illustrates the traffic growth over the period 2001 to 2006. The average neutral month 12 hour flow has increased over this period from 23771 in 2001 to 26422 vehicles in 2006, an increase of 11.2%. TEMPRO 5.0[1] suggests a growth factor of 12% for Devon over the period 2001-2006, compared with the 11.2% given above. This suggests that traffic growth on the A380 is increasing at a similar rate to the county average.

3.5.3 Although data from the A380 Torquay Road ATC site only covers more recent years, a comparison of the AADT between 1999 and 2005 has been made using data from a location on the A380 at Aller in order to identify whether there has been any growth on the A380 through Kingskerswell. In 1999, the AADT was 35924 vehicles and in 2005 the AADT was 36173 vehicles. This shows a growth of 1.02% over the six year

[1] Trip End Model Presentation Program produced by the ITEA division of the Department for Transport.

period. This minimal amount of growth suggests that the A380 through Kingskerswell is at capacity and any considerable growth in traffic is not possible.

3.6 Seasonal Variation

3.6.1 The monthly flow profile on the A380 Torquay Road shows an increase in 12-hour traffic flows in August. This is to be expected due to the increase in flows caused by holiday traffic. The COBA Manual states that for a Non-Built-up Principal Road, a Seasonality Index between 1.0 and 1.4 would be expected, with a typical value of 1.10[2]. The Seasonality Index has been calculated and is shown below:

$$\text{Seasonality Index} = \frac{\text{Average August Weekday 24-Hour Flow}}{\text{Average Neutral Month Weekday 24-Hour Flow}}$$

$$= \frac{36536}{35180}$$

$$= 1.039$$

3.6.2 The Seasonality Index for the A380 Torquay Road falls just above the lower boundary of the expected values for a non built-up principal road, indicating that the road exhibits minimal seasonal variation in traffic flows. The Seasonality Index has however been calculated for the A380 Torquay Road close to Kerswell Gardens, which exhibits fairly consistent levels of traffic throughout the year with a considerable amount of congestion. Therefore to identify whether there is seasonal variation in the study area as a whole, data from the ATC site at Ideford has been used to calculate the Seasonality Index.

3.6.3 As data is available for a 5-year period at this location, the Seasonality Indices have been calculated and are shown in Table 3.2 below:

[2] Design Manual for Roads and Bridges (Highways Agency) Volume 13, Section 1, Part 4, Table 6/1.

Table 3.2: Seasonality Index for the ATC site on the A380 Ideford

$$\text{Seasonality Index} = \frac{\text{Average August Weekday 24-Hour Flow}}{\text{Average Neutral Month Weekday 24-Hour Flow}}$$

Year	Average August Weekday 24-Hour Flow	Average Neutral Month Weekday 24-Hour Flow	Seasonality Index
2000	28923	25660	1.127
2001	29702	27334	1.087
2002	30288	27596	1.098
2003	31788	29374	1.082
2004	32021	30903	1.036
Average			**1.086**

3.6.4 The Seasonality Index for the A380 near Ideford is within the range expected for this class of road and is approximately the same as the typical value. This suggests that the A380 shows an average level of seasonal variation in traffic flow at this location. The Seasonality Index calculated using the ATC site on the A380 Ideford has been used in subsequent analysis, as the Seasonality Index calculated on the A380 through Kingskerswell cannot be considered to be representative of the study area as a whole due to the considerable levels of congestion on the A380 through Kingskerswell.

3.7 Conversion Factors

3.7.1 Conversion factors from 12-hour to 16-hour flows (E-factor) and 16-hour to Annual Average Daily Traffic (AADT) flows can be calculated using data from the A380 Torquay Road ATC site.

Conversion From 12-Hour Flows To 16-Hour Flows (E-Factor):

The E-factor is calculated in Table 3.3 below using 12-hour weekday neutral month flows:

Table 3.3: 12 Hour to 16 Hour Conversion 2005

Date	Average 12-Hour Weekday Flow (vehicles)	Average 16-Hour Weekday Flow (vehicles)	E-Factor
April 2005	28208	33249	1.179
May 2005	27866	33041	1.186
June 2005	27663	33073	1.196
September 2005	27523	32665	1.187
October 2005	27455	32356	1.179
Average	27743	32877	1.185

The COBA Manual suggests an E-factor of 1.15 for a non built-up principal road[3]. Therefore, the E-factor calculated above for the A380 Torquay Road is slightly above the national average.

E-Factor = 1.185

Conversion From 16 Hour Flow To AADT:

3.7.2 In order to calculate a conversion factor from 16 hour flows to AADT, the average 16 hour weekday flow for neutral months, shown in Table 3.3 is used. The AADT has been calculated using ATC data from the A380 Kerswell Gardens site for the whole of 2005. The conversion factor can then be calculated as illustrated below.

Average 16 Hour Weekday Flow (Neutral Months)	=	32877
Calculated AADT	=	33717
Conversion Factor	=	1.026

[3] Design Manual for Roads and Bridges (Highways Agency) Volume 13, Section 1, Part 4, Table 9/1.

Conversion From 12 Hour Flow To 18 Hour Flow:

In addition, a 12-hour to 18-hour conversion factor has been calculated for use in noise calculations and is shown in Table 3.4 below:

Table 3.4: 12 Hour to 18 Hour Conversion 2005

Date	Average 12-Hour Weekday Flow (vehicles)	Average 18-Hour Weekday Flow (vehicles)	18 Hour Flow as % of 12 Hour Flow
April 2005	28208	34450	1.221
May 2005	27866	34313	1.231
June 2005	27663	34429	1.245
September 2005	27523	33928	1.233
October 2005	27455	33546	1.222
Average	27743	34133	1.230

Average 12 Hour Weekday Flow (Neutral Months)	=	27743
Average 18 hour Weekday Flow (Neutral Months)	=	34133
Conversion Factor	=	1.230

4 JOURNEY TIMES AND SPEEDS

4.1.1 Journey time and journey speed data was collected by CTS Traffic and Transportation on behalf of Parsons Brinckerhoff on Tuesday 7th and Thursday 9th June 2005. This involved enumerators travelling in cars between Ware Barton Roundabout and Lowes Bridge, noting the time taken to travel the 8.72km route in both a northbound and southbound direction over a 12-hour period. Figure 4.1 details a plan of the route that was taken, whilst the raw journey time and speed data is illustrated in Figure 4.2. A summary of the journey time results and associated speeds for the AM Peak hour, average Interpeak hour and PM Peak hour is illustrated in Table 4.1. On Day 1, in total 33 measurements were taken in a southbound direction, and 35 measurements were taken in a northbound direction. On Day 2 a total of 34 measurements were taken in a southbound direction, and 35 measurements in a northbound direction.

Table 4.1: Journey Time [seconds] and (Journey Speed [kph]) Results

		AM Peak (08:00-09:00) Average	Average Interpeak Hour Average	PM Peak (17:00-18:00) Average
Day 1: Tuesday 7th June 2005	Northbound	1112 (29)	813 (39)	1596 (23)
	Southbound	1261 (25)	775 (41)	1333 (24)
Day 2: Thursday 9th June 2005	Northbound	1372 (23)	878 (37)	1030 (31)
	Southbound	1094 (29)	753 (43)	943 (35)
Average	Northbound	1242 (26)	845 (38)	1313 (27)
	Southbound	1177 (27)	764 (42)	1138 (29)

4.1.2 Validation of the journey time data has occurred and a graph has also been produced illustrating the confidence intervals. This is illustrated on Figure 4.3 which shows the observed mean journey time and the associated confidence intervals.

4.1.3 Journey time validation on the A380 illustrates that the data is more spread in the PM Peak period particularly in a northbound direction. The modelled journey times for all periods are close to the observed journey time data, with the exception of the PM Peak journey times in a southbound direction. The modelled journey time is higher than the observed journey time in this instance. Further examination indicates however that this is due to the delay that has been modelled at Penn Inn, which in reality is not unreasonable.

4.1.4 From the journey time data outlined in Table 4.1, it is clear that there is a marked difference between the peak hours and the average interpeak hour, with a reduction in the journey time in the interpeak period. Consideration of the traffic flows illustrated on Figures 2.5 and 2.7, indicates however that the flows in the interpeak period are fairly similar to those in the peak hours. Thus it would appear that even with considerable flows during the Interpeak, the journey time is greatly reduced. This apparent anomaly can be explained by the fact that only a slight difference in traffic flows is evident between the peak hours and the average interpeak hour. Any increase in flows, however slight, during the peak hours will result in capacity being reached and exceeded, thereby resulting in congestion and increasing journey times along the route.

4.2 Journey Time Results

4.2.1 The results of the journey time survey are also illustrated in Figure 4.4. The graph illustrates that the journey time is considerably higher during the peak periods with the maximum journey time witnessed in the PM Peak, with average journey times reaching 19 minutes in a southbound direction and 22 minutes in a northbound direction. The maximum journey time was recorded during the PM Peak in a northbound direction with a value of 36 minutes. This illustrates that there is considerable delay on the existing route. Even during the Interpeak period where journey times are markedly lower, the average journey time is 14 minutes in a southbound direction and 13 minutes in a northbound direction. The minimum speed recorded was during the Interpeak period and had a value of 9 minutes in a southbound direction.

4.2.2 The free flow journey time for the section of road has been calculated to be 8.2 minutes based on a speed limit of 40mph. The results of the surveys all show journey times greater than the free flow journey time even during the Interpeak period, and thereby suggest that there is congestion along the route.

4.2.3 In order to identify the location of any delay, distance time graphs have been produced. Actual data is not available relating to each junction along the route, therefore the graphs have been produced using data from the base year model. Figure 4.5 illustrates distance time graphs for the AM Peak, Interpeak and PM Peak periods and shows the link and junction delay for the base year. It is evident from Figure 4.5 that delay is apparent at Penn Inn roundabout in both a northbound and southbound direction. Further delay occurs where two lanes merge into one between Kerswell Gardens and Southey Lane in a northbound direction. There is also slight delay at the traffic lights at Scotts Bridge in a southbound direction.

4.2.4 In addition to considering the link and junction delay on the A380, it is also important to consider the side roads. No journey time surveys were carried out on these roads as it was considered that these routes do not experience problems with congestion. Distance time graphs have been produced for the side roads using the base year model for the AM Peak, Interpeak and PM Peak periods. These are illustrated on Figure 4.6. The graphs on Figure 4.6 support the rationale for not carrying out journey time surveys displaying minimal delay on all of the side roads.

4.3 Journey Speed Results

4.3.1 The average speed is illustrated in Figure 4.7. The graph illustrates that the average journey speed is low in the AM and PM Peak periods with an average speed of 26 kph in a northbound direction and 27 kph in a southbound direction during the AM Peak hour, and speeds of 27 kph in a northbound direction and 29 kph in a southbound direction during the PM Peak hour. During the Interpeak period, the average speed increases with speeds reaching a maximum of 44 kph in both a northbound and southbound direction. A speed of 44 kph is the equivalent of approximately 28 mph. This illustrates that even during the Interpeak periods the average speed is still considerably lower than the permitted speed on the road.

5 QUEUE LENGTH RESULTS

5.1.1 Queue length surveys were carried out by CTS Traffic and Transportation on behalf of Parsons Brinckerhoff on Tuesday 7th, Wednesday 8th and Thursday 9th June 2005. Surveys were conducted between 07:00 and 19:00 hours, recording the length of queue at 5 minute intervals on all arms of the junctions shown in Table 5.1 below.

Table 5.1: Location of Queue Length Surveys

Location	Date
Queue Length Surveys	
Penn Inn (Roundabout)	*7th June – 9th June 2005*
Jurys Corner (Signalised Junction)	*7th June – 9th June 2005*
Kerswell Gardens (Roundabout)	*7th June – 9th June 2005*

5.1.2 The length of the queue was taken to be the distance, in metres, from the stop line to the rear of the furthest stationary vehicle.

5.2 Queue Length Results

5.2.1 The results of the queue length surveys for Penn Inn are illustrated on Figure 5.1, with the results for Jurys Corner illustrated on Figure 5.2 and Kerswell Gardens illustrated on Figure 5.3. These figures illustrate both the maximum queue and the average queue on the arm.

<u>Penn Inn Roundabout</u>

5.2.2 Figure 5.1 illustrates that a queue is evident throughout the day on all arms of the junction as a result of the traffic signals on all arms. The queue length is greater on the A380 Besigheim Way, the A380 Torquay Road and Shaldon Road, with lower queue lengths evident on the A381 Torquay Road. The average queue length on Shaldon Road is however greater than the average queue on the main road, with average queues exceeding 80 metres on this arm.

<u>Jurys Corner</u>

5.2.3 Figure 5.2 illustrates that although queues are evident throughout the day on all arms of the junction, the queue length is greatest on the main road in both directions, with peaks in queue lengths in the AM and PM periods. The peaks in queue lengths do however cover a longer period of time than purely the peak hour, illustrating that congestion is evident on the main road for large periods of the day. The queues on the side roads are considerably lower, however again there are marked increases in the AM and PM Peak periods.

Kerswell Gardens

5.2.4 Figure 5.3 illustrates that there is a queue evident throughout the day on all arms of the junction. On the A380 Torquay Road arm, there is a marked increase in queue length during the AM Peak period where the maximum queues reach 100 metres as a result of vehicles travelling towards Torbay. Alternatively, when consideration is made of the A3022 Riviera Way, the average queue length is greatest during the PM Peak, when traffic is travelling out of Torbay. Figure 5.3 indicates three peaks in queue lengths on the A380 Hamelin Way during the AM Peak, Interpeak and PM Peak periods, with the maximum queue exceeding 200 metres in all three periods.

6 ACCIDENT ANALYSIS

6.1 General

6.1.1 Existing accident data for the detailed study area was collected from Devon County Council and Torbay Council for the period 1st January 2001 – 31st December 2005. The data covers the area on the A380 between Penn Inn roundabout and Kerswell Gardens.

6.1.2 Summary plans showing the details and locations of each accident within the study area can be seen in Figures 6.1, 6.2, and 6.3.

6.2 Accident Severity

6.2.1 During the 5 year period, a total of 160 personal injury accidents were recorded along the A380 between Penn Inn and Kerswell Gardens, of which 148 have been slight in severity, 11 serious and 1 fatal. The split by severity for each of the 5 years is illustrated in Table 6.1 below.

Table 6.1: Accident Severity Split

	2001	2002	2003	2004	2005	Total
Fatal Accidents	0	1	0	0	0	**1**
Serious Accidents	2	1	4	2	2	**11**
Slight Accidents	25	33	37	34	19	**148**
Total	**27**	**35**	**41**	**36**	**21**	**160**

6.2.2 Table 6.2 below compares the severity split for the A380 with figures from the Department for Transport (DfT) publication *‘Transport Statistics Great Britain: 2005’*. A comparison has been made for the period January 2001 to December 2004 as no national data is available for 2005.

Table 6.2: Comparison of Severity Split for the A380 with the National Average Severity Split

	A380 – Severity Split (Jan 2001 to Dec 2004)	National Average Severity Split (Jan 2001 to Dec 2004)
Fatal Accidents	0.6%	1.1%
Serious Accidents	6.9%	11.6%
Slight Accidents	92.5%	87.2%

6.2.3 The above table shows that the accident severity split along this section of the A380 is similar to the national average figures. There are deviations from this; the proportions of serious and fatal accidents are slightly lower than the national average, whereas the proportion of slight accidents is above average on this section of the A380. This is likely to be as a result of the slow speeds on the road.

6.3 Accident Rates

6.3.1 The annual accident rate can be calculated using AADT flows on the A380 near Aller Park. Table 6.3 below summarises all accidents recorded on this length of the A380 during the 5 year period between 2001 and 2005. The accident rate has been calculated using the average AADT illustrated in section 3.7.2:

Table 6.3: Accident Rates

Fatal Accidents	Serious Accidents	Slight Accidents	Road Length	AADT	Accident Rate (per mvkm)
1	11	148	4.74 km	33717	0.55

6.3.2 In comparison, the COBA Manual[4] suggests an expected link and junction combined accident rate of 0.844 personal injury accidents per million vehicle kilometres for a modern S2 A-road with a speed limit of 40 mph. Therefore the accident rate along this section of the A380 is lower than that suggested by the COBA Manual. The accident rate may be low due to the slow speeds evident on the route through the area.

6.3.3 This is further confirmed using data obtained from the Department for Transport[5] which states an accident rate of 0.77 personal injury accidents per million vehicle kilometres (2001-2004 average, as 2005 data is again unavailable) for an urban A road. Again, this demonstrates that the stretch of the A380 between Penn Inn roundabout and Kerswell Gardens roundabout shows an accident rate that is below average.

7 ROADSIDE INTERVIEWS

7.1 Location and Date of Collection

7.1.1 Four Roadside Interview surveys were conducted specifically for this study over a 12-hour period between 07:00 and 19:00 hours, along the west-east screenline shown in Figure 7.1. The locations and dates of these surveys are detailed in Table 7.1 below. A roadside interview survey was not carried out on Totnes Road for a number of reasons. Firstly a safe site could not realistically be found. Secondly data had already been synthesised for the site for the Newton Abbot study as will be discussed later in this report, which could feasibly be used in this study. Finally, Totnes Road is a road towards Totnes and Plymouth, rather than Torbay, and the traffic using this road is unlikely to transfer to the bypass.

Table 7.1: Location of Roadside Interview Surveys

Location	Date
St. Marychurch Road (Northbound)	*13th June 2005*
A380 Torquay Road (Southbound)	*15th June 2005*
Kingskerswell Road (Southbound)	*16th June 2005*
A379 Teignmouth Road (Southbound)	*14th June 2005*

7.1.2 In addition to the above RSIs, a series of RSIs were carried out by Parsons Brinckerhoff on behalf of Devon County Council for use in the *Newton Abbot Network Modelling and Forward Design* Project. The data from these RSIs was also used in the development of the Kingskerswell traffic model. The locations and dates of these surveys are detailed in Table 7.2 below and are also indicated on Figure 7.1.

Table 7.2: Location of Previous Roadside Interview Surveys

Location	Date
B3193 Clay Lane – New Cross (Southbound)	*28th June 2004*
A383 Ware Cross (Eastbound)	*28th June 2004*
B3195 Lindridge Lane (Southbound)	*29th June 2004*
Old Exeter Road – West Golds Mine (Southbound)	*29th June 2004*
A383 Newton Road - Racecourse Layby (Southbound)	*30th June 2004*

[4] Design Manual for Roads and Bridges (Highways Agency) Volume 13, Section 1, Part 2, Table 4/1.
[5] Transport Statistics Great Britain: 2005 Edition (Department for Transport – 2005)

7.2 Information Collected

7.2.1 Roadside interviews were conducted using Huskey Hunter Data Loggers. Use of this equipment allows data to be collected quickly and efficiently and has been used in numerous similar studies. The information collected from each driver was kept to a minimum in order to minimise delays through the interview sites. The information collected is illustrated in Table 7.3.

Table 7.3: Information Collected

No	Question
1	Vehicle Type
2	Vehicle Occupancy
3	Origin of Trip
4	Origin Purpose
5	Destination of Trip
6	Destination Purpose
7	Frequency of journey

7.3 Interview Validation

7.3.1 All interview records were individually checked for illogical trips. The overall purpose of the trip was checked, as was the overall movement, to ensure that the driver interviewed had correctly understood exactly which origin / destination information was required. Any trips that could not be rationalised by purpose or did not demonstrate a logical journey were tagged and not used in the final analysis.

7.3.2 Table 7.4 shows the number of interviews that produced valid records. Also included is the total number of vehicles counted at the site over a 12 hour period, and the resultant sample rates.

Table 7.4: Roadside Interview Record Summary

	St Marychurch Road (Northbound)	A379 Teignmouth Road (Southbound)	A380 Torquay Road (Southbound)	Kingskerswell Road (Southbound)
Number of Valid Records	925	1034	1785	713
12 Hour Total Vehicle Count from MCC	4333	4895	11761	2811
12 Hour Sample Rate	21.3%	21.1%	15.2%	25.4%

7.3.3 The RSI site on the A380 was analysed to produce a series of desire line diagrams in order to understand the current vehicle movements in the area. Figure 7.2 is a desire line diagram for the AM Peak hour showing the origins and destinations of the trips on the A380 at the Roadside Interview Site in both a northbound and southbound direction. This information was obtained from the model using a select link analysis on the A380 in both directions. It is clear from the desire line diagram that all interviewees are travelling to and from either Torbay or Kingskerswell and could therefore have logically passed through the interview site. In addition to trips travelling to and from either Torbay or Kingskerswell, the south of England appears to be a large producer and attractor of trips. This could include some holiday traffic, however the south of England does include trips to and from local destinations such as Taunton and Bristol, in addition to destinations further away such as London.

7.3.4 Figure 7.3 and Figure 7.4 are desire line diagrams for the Average Interpeak hour and PM Peak hour showing the origin and destinations of the trips on the A380 at the Roadside Interview site in both a northbound and southbound direction. It is evident that the flows are higher in the AM and PM Peak periods when a comparison is made with the Average Interpeak hour.

7.4 Interview Expansion Factor

7.4.1 Manual Classified Counts were carried out at all sites, alongside the roadside interview surveys. The count data was used on the day to monitor sample rates.

7.4.2 The count data was also used to provide hourly expansion factors, which allowed the roadside interview survey records to be factored in order to represent a full 12-hour period. The hourly expansion factors for each of the roadside interview sites and the reverse directions (discussed later in the report) are detailed in Figure 7.5.

7.5 Interview Adjustment Factor

7.5.1 An adjustment factor was calculated to adjust the MCC to the ATC data to ensure that the data represented an average weekday in June. Adjusting the data to the ATC data is important to minimise any erroneous results that may have been obtained on the survey day. The value for the adjustment factor varied depending on the time of day and the location of the site. The adjustment factors for each of the roadside interview survey locations are illustrated in Figure 7.6.

8 SUMMARY OF REPORT OF SURVEYS

8.1.1 The data outlined in this report has been collected from all available sources. The most recent data available has been obtained in all cases to ensure that the data remains valid and still accurately represents the traffic situation within the study area.

8.1.2 The data contained within this report will be carried forward within the following sections of this document, which will assess the calibration and validation of the traffic model for the study area.

9 LOCAL AREA TRAFFIC MODEL

9.1 Model Requirements

9.1.1 For the traffic and economic assessment of the Kingskerswell Bypass scheme options, a strategic model of the study area, consisting of a detailed network and zone system to represent traffic behaviour within the study area was required. The detailed study area was required to be modelled to a high level of detail, in particular to address alternative routes and congestion on the existing A380. In addition, the extended study area was required to be included in the model in order to incorporate wider route choice through the network and the impact of the scheme across the regional area.

9.2 Previous Models

9.2.1 A traffic model was developed by Halcrow Fox as part of the *'A380 Newton Abbot to Torquay Corridor Study'* carried out in 2000. This model was produced using SATURN[6] highway modelling software and consists of a detailed network in the Kingskerswell, Paignton and Torquay areas, combined with broad detail of the remainder of the study area. The Halcrow Fox model was used as the basis for the local area traffic model used in this assessment, although considerable detail was added to this model in the Kingskerswell, Newton Abbot, Torbay and Exeter areas.

9.2.2 The traffic model developed in the Halcrow Fox study detailed above was enhanced by Parsons Brinckerhoff and recalibrated and revalidated in 2000. This model was used to predict future year traffic flows in order to provide information submitted as part of the Planning Application process.

9.3 Modelled Network

9.3.1 The modelled network was based on the network developed by Halcrow Fox for the A380 Corridor Study. However, this model required considerable detail to be added in several areas, which included information such as speed flow data, and alterations to capacities:

- ***Kingskerswell*** – the modelled network was enhanced in the Kingskerswell area to include all minor junctions and the side roads;
- ***Newton Abbot*** – the network within Newton Abbot town centre, the Newton Abbot sub-region and Penn Inn roundabout was added to the network from the Newton Abbot Network Modelling and Forward Design project, carried out by Parsons Brinckerhoff for Devon County Council from 2002 – 2006. The Newton Abbot model for this project contained a high level of detail in the Newton Abbot area and was accurately calibrated;
- ***Torbay*** – the Torbay network was updated in the Kingskerswell model using the calibrated model from the Torbay SATURN Model project, carried out by Parsons Brinckerhoff for Torbay Council in 2005. This calibrated model contains a detailed network of the Torquay, Paignton and Brixham areas;
- ***Exeter*** – additional detail was added to the Exeter area from the Exeter Sub-Regional traffic model, produced for the Exeter Sub-Regional Study carried

[6] Simulation and Assignment of Traffic in Urban Road Networks

out by Parsons Brinckerhoff for Devon County Council in 2004 – 2006. A broad level of detail was added in order to incorporate the impact of development in the Exeter Sub-Regional area;

9.3.2 A summary of the traffic models used to construct the modelled network for the Kingskerswell Bypass study is shown in Figure 9.1 while the modelled network for the detailed study area is illustrated on Figure 9.2.

9.4 Zone System

9.4.1 The traffic model zone system includes a detailed zone system within the Kingskerswell, Newton Abbot and Torbay areas. Outside of these areas, most towns and villages within the extended study area are represented by individual zones.

9.4.2 A detailed zone system was added to the model in the Exeter sub-region. This was done in order to ensure that proposed future development in Exeter and particularly to the East of Exeter was incorporated into the modelling work. Hence, individual areas of Exeter (e.g. Sowton, Marsh Barton, Exeter Airport) are represented by individual zones.

9.4.3 In addition, the zone system includes zones for wider areas (e.g. Cornwall, South England and Rest of the Country). This zone structure was put in place to ensure that accurate trip length distributions could be obtained from the traffic model, and analysis of trip origins and destinations could be performed if required.

9.4.4 A plan of the zone system is illustrated on Figure 9.3.

9.5 Data Manipulation

9.5.1 Since the roadside interviews were only carried out in one direction, it was necessary to create an analogous series of records for the reverse direction. In order to achieve this, the origin and destination zones were switched for all records.

9.5.2 For certain specific trips, the time of the journey was adjusted to reflect the likely time of the journey in the opposite direction. The time of the reverse trip was treated differently according to trip purpose. In most cases, times were reflected about 1300 hours, meaning, for example, that 0730 hours becomes 1830 hours and 1200 becomes 1400. The point at which the data was reflected was chosen to be 1300 hours, as consideration of the flow profile has indicated that the peak is at 08:30 and 17:30. 1300 hours lies half way between these peaks, and thus allows for the average journeys to be reversed. For education trips, the trip *from* school was assumed to take place 30 minutes from after the trip *to* school.

9.5.3 Any trips that could not easily be assigned reverse trip times were simply reversed according to their origin and destination.

9.5.4 In addition to synthesising data for the reverse direction, a series of proxy sites were created in locations where it was not possible to carry out a Roadside Interview Survey. The locations of these are illustrated on Figure 9.4. These sites were created by copying the distribution of trips collected from the Roadside Interview survey at a nearby site displaying similar characteristics to the proxy site. A common sense test was adopted, removing trips that were considered to be unreasonable at the proxy site (for example to destinations that would not use this particular route). The data was then matched to the latest count data at the location of the proxy site.

9.6 Trip Matrix Formation

9.6.1 Base year trip matrices were formed for each of the modelled time periods using a combination of data collected specifically for this study, and trip matrices from existing traffic models. The modelled base year is 2005.

ERICA[7]

9.6.2 The ERICA modelling programme is a trip database system, which builds trip matrices for county or regional models. The program is capable of carrying out the following functions:

- producing a complete set of interleaved matrices;
- building matrices from individual roadside interview sites;
- using site specific conversion factors and associated variances;
- removing double counting using statistical averaging routines.

9.6.3 Initially, trip matrices were constructed from the Roadside Interview (RSI) data using the ERICA modelling programme. The RSI locations and proxy sites were used to sector the study area in order to build matrices of traffic movements between these sectors. A plan of the sectors is illustrated in Figure 9.5. These trip matrices contained all trips between the sectors defined in the ERICA input.

9.6.4 The software takes origin-destination (O-D) trip records from roadside interviews and maintains them as a database. The database then allows the trips from individual stations to be combined so as to eliminate (or to compensate for the) double counting of trips. This is achieved by selecting screenline segments, which are used to build each sector-to-sector movement in the trip matrices. ERICA will also build trip matrices from the database using statistical relationships, as outlined in the Traffic Appraisal Manual.

9.6.5 A major benefit of the software is that it facilitates a method of data storage, which is consistent and easily manageable. In short there is an allocated storage space for all data relating to a project, thus removing any ambiguity.

9.6.6 ERICA also allows new data sources to be incorporated and existing data to be updated quickly and easily, so avoiding the need for extensive matrix building. The software is authorised by the DfT.

9.6.7 Before entering records into the ERICA database, all records were individually checked for illogical trips. The overall purpose of the trip was checked, as was the overall movement, to ensure that the driver interviewed had correctly understood exactly which origin / destination information was required. Any trips that could not be rationalised by purpose or did not demonstrate a logical journey were tagged and not used in the final analysis. The rejection rates for each interview site are detailed in Table 9.1. From Table 9.1 it is evident that the rejection rates for all of the interview sites are low.

[7] ERICA v8.3 Trip Record Database and Matrix Building Suite (Peter Davidson Consultancy)

Table 9.1: Rejection Rate Summary

	St Marychurch Road (Northbound)	**A379 Teignmouth Road (Southbound)**	**A380 Torquay Road (Southbound)**	**Kingskerswell Road (Southbound)**
Number of Surveyed responses	967	1089	1911	738
Number of Valid Records with illogical trips removed	925	1034	1785	713
Rejection Rate (%)	4.3	5.1	6.6	3.4

<u>Trip Matrices Produced Using ERICA</u>

9.6.8 Trip matrices were produced for the AM, average Interpeak hour and PM Peak hours using the ERICA modelling programme. The total number of trips in each of the matrices is detailed in Table 9.2 below:

Table 9.2: Number of trips in the AM, average Interpeak hour, and PM Peak hour matrices produced using the ERICA modelling programme

	AM Peak (0800 – 0900)	**Average Interpeak hour between 1000 and 1600**	**PM Peak (1700 – 1800)**
Total Number of Trips in the matrix produced using the ERICA programme	*10791*	*9470*	*11343*

Additional Trips

9.6.9 The trip matrices produced from ERICA only contained trips between the sectors defined in the ERICA input. Hence, internal trips within these sectors and trips across sectors where no RSI site was present were not included in the ERICA matrices. In order to incorporate these trips into the trip matrices, additional trips were added into the trip matrices from existing traffic models, as detailed below. All of these traffic models were calibrated to DMRB standards.

- ***Kingskerswell to / from Torbay*** – trips from Kingskerswell to Torbay that did not cross the RSI screenline were added into the trip matrices from the existing Halcrow Kingskerswell model developed in 2000;

- ***Newton Abbot Town Centre*** – internal trips within Newton Abbot town centre and trips to Newton Abbot from the North (via Penn Inn) were added to the trip matrices from the existing Newton Abbot traffic model, developed for the *Newton Abbot Network Modelling and Forward Design* study, carried out by Parsons Brinckerhoff for Devon County Council from 2002 - 2006;

- ***Torbay*** – trips within Torquay, Paignton and Brixham were added to the trip matrices from the existing Torbay model, constructed for the *Torbay SATURN Model* project carried out by Parsons Brinckerhoff for Torbay Council in 2005;

- ***Exeter*** – trips within the Exeter area were added to the trip matrices from the Exeter Sub-Regional traffic model, produced for the Exeter Sub-Regional Study carried out by Parsons Brinckerhoff for Devon County Council in 2004 – 2006.

9.6.10 Although additional trips were added from the aforementioned studies, growth has been added to the data to ensure that all the data is provided for the same base year, which in this study is 2005. The number of trips in the matrix in this study added from each of the above models is detailed in Table 9.3.

Table 9.3: Number of trips in the matrix added from previous models

	AM Peak (0800 – 0900)	Average Interpeak hour between 1000 and 1600	PM Peak (1700 – 1800)
Trips from Kingskerswell to Torbay	*191*	*43*	*120*
Trips from Torbay to Kingskerswell	*120*	*43*	*190*
Internal Trips in Newton Abbot	*12705*	*3758*	*12705*
Trips to Newton Abbot from the north	*202*	*47*	*118*
Trips from Newton Abbot to the north	*118*	*47*	*202*
Internal Trips in Torbay	*15909*	*4791*	*15909*
Internal Trips in Exeter	*37019*	*38807*	*37019*

10 MODEL CALIBRATION

10.1 Model Calibration Methodology

10.1.1 The model was built and calibrated using data from the Roadside Interview Surveys and thus the model was calibrated across the screenline. Model validation instead involved the use of junction count data on the A380 corridor as will be discussed in section 11.

10.1.2 Model calibration involved a comparison of the observed and modelled link flows for the AM Peak hour (08:00 – 09:00), Interpeak (average hour between 10:00 and 16:00) and PM Peak hour (17:00-18:00) across the screenline. The link flows were analysed by direct comparison with the survey data. Where necessary network modifications were made and / or factors applied to sections of the trip matrix.

10.1.3 In order to ensure that the model is accurately representing the existing traffic situation within the study area, an analysis of the routes used in the model was carried out. This was necessary to ensure that routes selected for journeys appear logical. This analysis was carried out using the *Forest* and *Select Link Analysis* functions in the SATURN programme P1X.

10.2 Route Analysis

<u>Forests</u>

10.2.1 The *Forest* function in the SATURN programme P1X plots all the routes used within the network for trips between two zones. By using the Forest function for many zone pairs throughout the study area, routes used by traffic were examined to ensure they were reasonable and resemble probable routes used by vehicles in the current traffic situation. The routes used in each situation are the lowest cost routes available between the two zones. It also displays the percentage of traffic using each different route, thus highlighting the most common path taken.

10.2.2 Examples of AM Peak hour Forests for a variety of zone pairs are shown in Figure 10.1. Plot 1 shows routes from Exeter to Paignton. In this situation, as would be expected, the majority of the traffic uses the A380, with a small proportion of trips using minor roads. Plot 2 shows trips from Torquay to Exeter. Again, this plot shows how alternative routes are used as 'rat-runs' to avoid the A380 congestion. Plot 3 shows trips from Newton Abbot to Torquay. This plot shows that due to the congestion on the A380, some trips use alternative routes such as St. Marychurch Road. Plots 4 and 5 show trips from Teignmouth to Paignton and Torquay respectively. These plots indicate that the majority of traffic uses the A379 Teignmouth Road as would be expected for trips between these areas. Plots 6 to 8 show trips from Totnes to Exeter, Newton Abbot and Teignmouth respectively. The traffic travelling between these areas uses Totnes Road and the A38. As has been discussed previously, this is the route that would be expected for those travelling between Totnes and other areas.

10.2.3 Examples of Interpeak hour Forests for the same zone pairs are shown in Figure 10.2. The plots show a similar situation in the Interpeak as in the AM Peak period as the traffic uses both the main road and the rat runs. The continued use of the rat runs during the Interpeak period suggests that the main road remains congested during this period, encouraging drivers to find alternative routes through the study area.

10.2.4 Examples of PM Peak hour Forests for the same zone pairs are shown in Figure 10.3. During the PM Peak the plots indicate that traffic uses a larger number of minor roads to reach its destination. This is likely to be a result of increased congestion on the network, forcing traffic to find an alternative route.

<u>Select Link Analysis</u>

10.2.5 The *Select Link Analysis* function in SATURN shows the links used by all vehicles travelling on the selected link. This function allows an analysis of the distribution of trips using the selected link and whether this is reasonable.

10.2.6 Figure 10.4 shows select link analysis plots of the A380 in the AM Peak hour. Plot 1 shows routes using the northbound A380 at Aller. The plot shows that the main routes using this link originate from the A380 Hamelin Way and A3022 Riviera Way south of Kerswell Gardens. The main destinations are the A380 and M5 to Exeter and Newton Abbot. This corresponds with the desire line diagram illustrated in Figure 7.2 which shows a large number of trips travelling from Torbay to Newton Abbot, Exeter and destinations beyond. Plot 2 shows a similar diagram for the southbound A380 at Aller. The main trip origins are the A380 and M5 from Exeter and Newton Abbot, with the main destinations being Paignton and Torquay. The southbound results of the select link analysis also correspond to the desire line diagram illustrated in Figure 7.2 for the southbound direction with the majority of trips travelling between Newton Abbot, Exeter and South England.

10.2.7 Figures 10.5 and 10.6 show similar plots for the Interpeak and PM Peak periods. The plots for both the northbound and southbound carriageways show similar results to those found in the AM Peak.

10.2.8 All plots show sensible results with the main origins and destinations of trips using the A380 as would be expected.

10.3 The Assignment Model

10.3.1 The assignment methodology used within SATURN in this assessment is based on Wardrop's Principle of traffic equilibrium. This method of assignment has been chosen because there is congestion evident on the network and it is therefore essential to account for the effects of capacity restraint on route choice. Wardrop's Principle states that 'traffic arranges itself on congested networks such that the cost of travel on all routes used between each O-D pair is equal to the minimum cost of travel and all unused routes have equal or greater cost'[8].

10.3.2 All assignment techniques within SATURN assume that individual drivers seek to minimise their travel cost. The travel cost has been defined as a generalised cost, which is a linear combination of time and distance defined by:

$$c = at + bd$$

where c = cost, t = time, d = distance

[8] SATURN Manual (Atkins) Section 7

10.3.3 The generalised cost parameters used to assign traffic in the base year situation were *a* = 1.0 pence/min and *b* = 0.4 pence/km. These generalised cost parameters were used for all trip purposes.

10.4 Convergence

10.4.1 When running the traffic model it was important to observe the level of convergence. Convergence is required in order to provide stable, consistent and robust model results and to differentiate between real changes and those associated with differing degrees of convergence. The Design Manual for Roads and Bridges (DMRB) Volume 12 outlines the convergence criteria for a traffic model. To assess the level of convergence, the criteria uses *'the percentage of links on which flows change by less than 5% between successive iterations'* (sometimes known as P) and *'the difference between the costs along the chosen routes and those along the minimum cost routes, summed across the whole network, and expressed as a percentage of the minimum costs'* (sometimes known as δ)[9]. Table 10.1 below shows the criteria and the convergence results from the model:

Table 10.1: Convergence Results

Measure of Convergence	Acceptable Value(s)	Model Results	Acceptability
% of Links with Flow Change (P) < 5%	4 Consecutive Iterations > 90%	AM Peak Final 4 iterations: 92.5% 94.3% 95.9% 99.5%	**PASS**
		Interpeak Final 4 iterations: 89.0% 99.4% 92.0% 99.6%	**PASS**
		PM Peak Final 4 iterations: 89.2% 95.1% 97.6% 99.7%	**PASS**
Delta (δ)	< 1%	AM Peak – 0.17%	**PASS**
		Interpeak – 0.10%	**PASS**
		PM Peak – 0.18%	**PASS**

10.4.2 The results produced by the model clearly show that a high level of convergence has been achieved in the AM Peak model, with four successive iterations occurring with P

[9] Design Manual For Roads and Bridges (Highways Agency) Volume 12, Section 2, Chapter 4.4.20

> 90% and δ < 1%. For the Interpeak and PM Peak models it is considered that the last four iterations are sufficiently close or above 90% to pass the convergence criteria, and the value for delta is below 1% in both cases.

11 MODEL VALIDATION

11.1 Model Validation Criteria

11.1.1 Following the construction of the modelled network, zone system and trip matrices, the traffic model was validated in accordance with DMRB procedures, for each of the modelled time periods. This validation involved a direct comparison of observed and modelled link flows against DMRB validation criteria.

11.1.2 The modelled and observed link flows were directly compared and assessed against DMRB validation criteria. DMRB Volume 12 states the criteria for acceptability guidelines with respect to link flows as indicated in Table 11.1:

Table 11.1: DMRB Validation Criteria

Criteria	% Of Cases	Acceptability Guideline	GEH[10] Statistic
Individual Link Flows < 700 vph	> 85% of cases	± 100 vehicles	< 5
Individual Link Flows 700 – 2700 vph		± 15%	< 5
Individual Link Flows > 2700 vph		± 400 vehicles	< 5
Cordon	All	± 5%	< 4

Source: DMRB Volume 12, Section 2, Chapter 4, Table 4.2

11.2 Junction Flows

11.2.1 The DMRB criteria have been used to assess the accuracy and validity of the model using counts along the A380 through Kingskerswell and on the side roads, collected in June 2005. Figure 11.1 illustrates the observed and modelled flows on links in the study area. Figures 11.2 to 11.4 show link validation tables for the AM, Interpeak and PM Peak periods. Due to the size of the model, it is more difficult to calibrate to turning movements, and thus the calibration has concentrated on link flows. The observed and modelled turning movements have however been included for the AM, Interpeak and PM Peak hours in Figures 11.5 to 11.7.

11.2.2 The screenline provides a very good measure of the performance and accuracy of the model in the specific area of interest as it ensures that traffic across the screenline is of the correct volume. Figure 11.2 to 11.4 show a 100% pass rate for the screenline links in all three modelled periods. These results clearly show that the model is very accurately calibrated across the screenline.

11.2.3 The overall pass rate for the links in all three time periods is illustrated in Table 11.2.

[10] GEH = $\sqrt{\frac{(M-C)^2}{\frac{1}{2}(M+C)}}$ where M = Modelled Flow and C = Observed Flow. The GEH value is a form of Chi-squared statistic and incorporates both relative and absolute errors, giving an overall measure of the accuracy of the modelled flow.

Table 11.2: Model Validation Results

	AM Peak	Interpeak	PM Peak
Overall	91%	88%	85%

11.2.4 Overall the pass rate in all three time periods is above the level acceptable in Table 11.1. The results therefore demonstrate that for each of the modelled time periods, the model accurately represents the existing traffic situation within the detailed study area and passes the criteria when all links are considered together.

11.2.5 It is clear that there are a number of discrepancies between the observed and modelled flows on certain links in the network. It is considered that these discrepancies will not have a major impact on the appraisal of the scheme.

11.2.6 With regards to the flow on the side roads at Jurys Corner, these will have little impact on the appraisal of the scheme as Coffinswell Lane is a dead end road, and Barnhill Road leads into the village with narrow lanes.

11.2.7 There are also discrepancies in the flows on the A380 Besigheim Way northbound and on Riviera Way southbound. Data for an alternative day was assessed for each of these locations to identify whether the surveyed day was representative of the flow on the link.

11.2.8 An assessment of the flows on the A380 Besigheim Way northbound in November 1999 was initially considered. Growth has been added to this data using TEMPRO in order to provide a flow that represents a weekday in November 2005. This analysis has illustrated that the flow during the AM Peak for November is 1765 vehicles, during the Interpeak is 1163 vehicles, and during the PM Peak is 1598 vehicles. Comparing these flows with the count data illustrated on Figure 11.1, it is evident that the flows are slightly lower for November. Despite these flows being lower, it is only the Interpeak flow that has an effect on the link validation. The Interpeak passes having previously failed with the surveyed data for June, although the AM and PM Peak flows do not pass the validation criteria using the November flows. Thus it would appear that the flow on the A380 Besigheim Way is representative of a neutral month weekday and consideration of the flow at this location on a different day will not provide an explanation for the discrepancy between observed and modelled flows.

11.2.9 The discrepancy in the flows on Besigheim Way northbound could be explained by the fact that the left turn on the A381 Torquay Road is slightly low in all three time periods as illustrated on Figures 11.5 to 11.7. An increase in the flows travelling from Newton Abbot to the north could have a positive effect on the validation of the link on the A380 Besigheim Way northbound. It is however considered that although this discrepancy in flows exists, the A380 Besigheim Way northbound flows away from the study area and Torbay, and therefore will have very little impact on scheme appraisal.

11.2.10 An assessment has also been carried out with respect to the flows on Riviera Way southbound at the Kerswell Gardens roundabout. Consideration has been made of the flows on this link in November 1999. Again growth has been added to this link using TEMPRO in order to provide a flow that represents a weekday in November 2005. This analysis has indicated that the flow during the AM Peak for November is

1231 vehicles, for the Interpeak is 1201 vehicles, and for the PM Peak is 1211 vehicles. Comparing these flows with the count data illustrated on Figure 11.1, it is evident that the flows are similar, although the flows during the Interpeak are slightly higher for November, than for June. This suggests that the count in June was not carried out on an unusual day.

11.2.11 Kerswell Gardens is also on the edge of the study area with traffic on the link travelling away from the study area. In addition to this, the flow on the link is only considerably different for the PM Peak. With respect to this discrepancy it is evident that there will not be a major impact on the scheme appraisal and manual adjustments can be made when carrying out detailed junction modelling in order to account for this.

11.2.12 The base year traffic model has therefore been demonstrated to be accurately validated and can be taken forward for use in the forecasting procedures.

12 CONCLUSIONS

12.1 Summary

12.1.1 The traffic model for this assessment was developed based on Roadside Interview Data collected in June 2005. The validation statistics demonstrate that the traffic model accurately represents the existing traffic situation within the study area and produces robust and consistent traffic flows.

12.1.2 The traffic model produces accurate flows across the screenline which covers the specific area of interest for this assessment. All modelled time periods pass the DMRB validation criteria.

12.1.3 The model achieved an acceptable level of convergence, satisfying the DMRB criteria in all cases.

12.2 Model Suitability

12.2.1 It is recommended that the calibrated model be carried forward for use in the forecasting procedures. The model accurately represents the current traffic situation and produces stable and robust traffic flows making it suitable for use as the basis for the traffic and economics work required for the Major Scheme Bid application.