



APPENDIX A

TfGM Validation Report for City Centre PARAMICS Model

Subject **Regional Centre S-Paramics Micro-Simulation Model**

Project **2017 Model Update and Local Validation**

This Note **HFAS_CityCentreModel_Validation_Report_v1.0.docx**

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Executive Summary

1. The Regional Centre Paramics Model was originally developed by HFAS in 2012. Subsequently JMP were commissioned to calibrate and validate an extended model to a 2014 base year. This model was subsequently updated and revalidated by HFAS to correct some errors found in the 2014 model and to update it to represent a 2017 base year. This report documents updates applied to the network and matrices as part of recent work, and the flow and journey time validation for the morning (08:00 – 09:00) and evening (17:00 – 18:00) peak hour models.
2. The morning peak hour model flows validate well with 72% of the link counts and 71% of the turn counts achieving a GEH of 5 or less. The model flows validate particularly well on Deansgate and at junctions on and around Chapel Street. The morning peak hour journey time validation is good with 20 of the 22 journey time routes achieving a modelled journey time within an acceptable range of observed journey times. The evening peak hour flow validation is reasonably good with 66% of both link counts and turn counts achieving a GEH of 5 or less. The evening peak hour journey time validation is reasonably good with 15 of the 22 journey time routes achieving a modelled journey time within an acceptable range of observed journey times.
3. A significant difficulty in trying to validate the model is the rate of change of the Regional Centre in terms of changes to traffic management, roadworks and new developments, all of which make it very difficult to obtain a consistent set of observed data. Overall, and bearing in mind the difficulty of obtaining a consistent set of traffic counts in the City Centre and the day-to-day variability of traffic, particularly in the evening peak hour, the Regional Centre 2017 base model validation is good. Albeit that we are aware that the flows in some areas of the model are an over-estimate compared to observed data that we have available (particularly in the evening peak).
4. This report demonstrates that the updated model continues to provide a reasonably robust and accurate representation of the observed operation of the Regional Centre highway network.

1. Introduction

- 1.1 In 2015, JMP were commissioned by TfGM to extend the Manchester City Centre S-Paramics model and calibrate / validate it to a 2014 base year. Details of the work undertaken by JMP in 2015 were documented in a model update and validation report “Manchester Regional Centre Paramics 2015 Model: Local Model Validation Report”.
- 1.2 The resulting model was subsequently updated and revalidated by HFAS to correct some errors found in the 2014 model and to update it to represent a 2017 base year. This report acts as an update to the original LMVR, and documents the changes made to the model along with the updated validation.
- 1.3 The structure of this report is as follows:
 - Section 2 – **Background** summarising previous model development
 - Section 3 – **Model Specification** details of the model features and parameters
 - Section 4 – **2017 Model Update** details of the network and matrix updates applied to the 2017 model
 - Section 5 – **Model Validation** details the 2017 model validation based on traffic flows and journey times
 - Section 6 – **Summary and Conclusions**

2. Background

- 2.1 The Regional Centre Paramics model was originally developed by HFAS in 2012 to assess the impact of the bus priority measures on Oxford Road and Portland Street, and its extent was restricted to the city centre network within the IRR and the Oxford Road and Upper Brook Street corridor to the south as shown in Figure 1 (blue line).
- 2.2 As part of the ongoing work to manage traffic both within the city centre and on the IRR as efficiently as possible, TfGM commissioned JMP to extend this model to include the Manchester and Salford Inner Relief Route and the Regent Road – A6 corridors (shown as a dashed black line in Figure 1) and calibrate it to a 2014 base year.
- 2.3 The final 2014 base year model enabled TfGM to test the operational impact of:
 - City centre traffic management strategies (including changing permitted turns at junctions and closing roads to general traffic);
 - Signal strategies to deal with incidents;
 - Use of Variable Message Signs to provide improved driver information.
- 2.4 Since the model extension, further refinements to the network and matrices have been made to ensure the model remains up to date and reflects the current highway network in the Regional Centre.

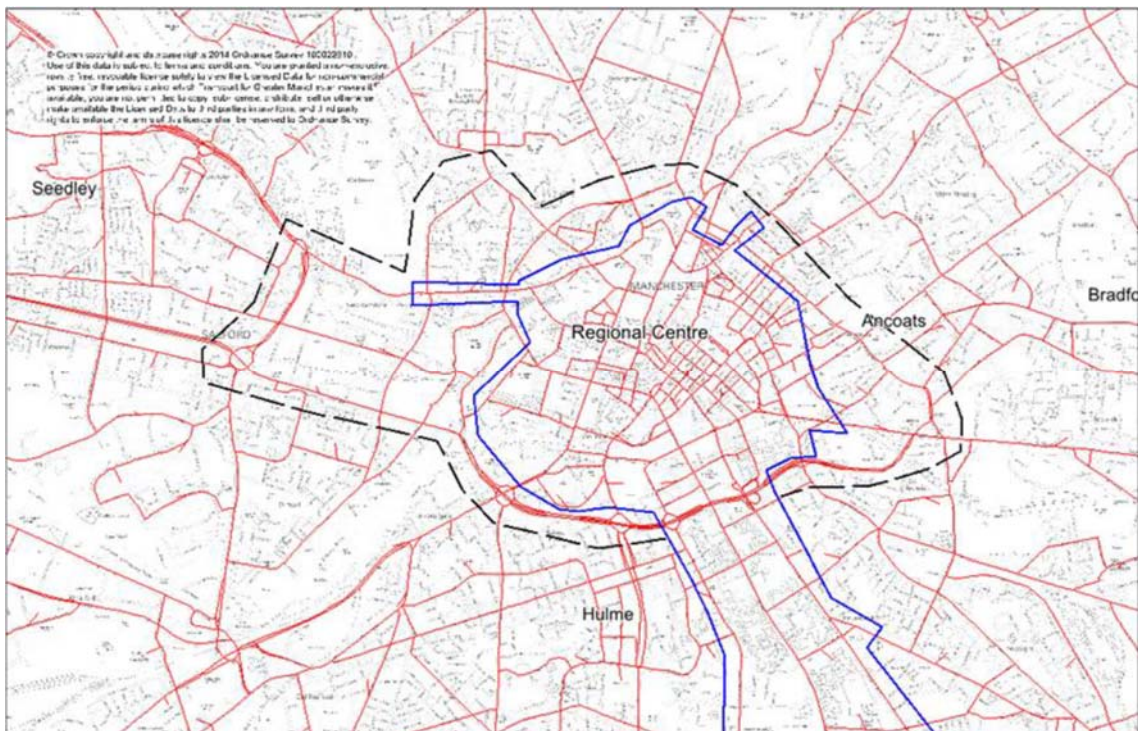


Figure 1: Extent of original and current Regional Centre Model

3. Model Specification

Software

- 3.1 The 2014 version of the model was built using S-Paramics version 2013.1, whilst the 2017 model has been updated to S-Paramics version 2014.1.

User Classes

- 3.2 The model includes separate matrices the following user classes:

- Cars;
- LGVs;
- HGVs.

- 3.3 Public transport including Metrolink and buses are included as fixed routes based on timetable information held by TfGM.

Time Periods

- 3.4 The model was developed to represent both the morning (07:00 to 10:00) and evening (16:00 to 19:00) peak time periods, which are represented using discrete hourly periods within each peak period. This allows the inclusion of suitable “warm-up” and “cool down” periods before and after the busiest peak hour in both peak periods. This is standard micro-simulation good practice to ensure that the busiest hour represented by the model includes a good representation of queuing and delay at the start of the busiest hour and to allow vehicles to complete journeys (if held in queues) at the end of the busiest hour.

- 3.5 This has resulted in the following periodic configuration within the model, each time period containing time period specific demand data:

- Period 1: 07:00 to 08:00
- Period 2: 08:00 to 09:00 (Morning peak hour)
- Period 3: 09:00 to 10:00
- Period 4: 10:00 to 16:00
- Period 5: 16:00 to 17:00
- Period 6: 17:00 to 18:00 (Evening peak hour)
- Period 7: 18:00 to 19:00
- Period 8: 19:00 to 07:00

- 3.6 Note that Periods 4 and 8 are empty periods with no demand assigned.

- 3.7 The release of the model demands within each hour is profiled to 15-minute intervals based on observed flow profiles from traffic counts.

Network extent

- 3.8 The original Regional Centre model covered the area within the Manchester Inner Relief Route, but not including it. However, JMP were commissioned to extend the coverage of the model to include the following:

- Albion Way,
- The A6 Crescent,
- Liverpool Street,
- The A57 Regent Road,
- A57 Hyde Road.
- A6 Stockport Road, and;
- Inner Relief Route (Trinity Way, Swan Street, Great Ancoats Street, Mancunian Way)

- 3.9 Figure 2 below shows the extent of the current network.

Model Parameters

- 3.10 The parameters within Paramics that govern routing and vehicle behaviour remain consistent with those used in the 2014 model.
- 3.11 Strategic route choice is available in the model which is controlled by the generalised cost equation as follows:

$$\text{Cost} = 1.0 \times \text{Time} + 0.5 \times \text{Distance}$$

- 3.12 The cost equation is used to calculate the generalised cost for all possible routes. If drivers had perfect knowledge of the costs of alternative routes, the route with the lowest cost would then be the route the vehicle takes. In other words, all-or-nothing assignment. However, the set-up of the model includes perturbation to represent imperfect knowledge of the cost of alternative routes. This uses the S-Paramics Percentage Algorithm, applying the default value of 5.0, which applies a +/- 5% variance to the true generalised cost, meaning that vehicles take a range of routes, not just the one with the lowest cost. "Feedback" is also applied to calculate when vehicles which are able to, change route during the simulation run, if their chosen route cost value increases. Feedback has been applied with an interval of **2 minutes**.
- 3.13 Each vehicle type has a maximum speed defined and parameters that influence route choice. These parameters have been kept at their default values.

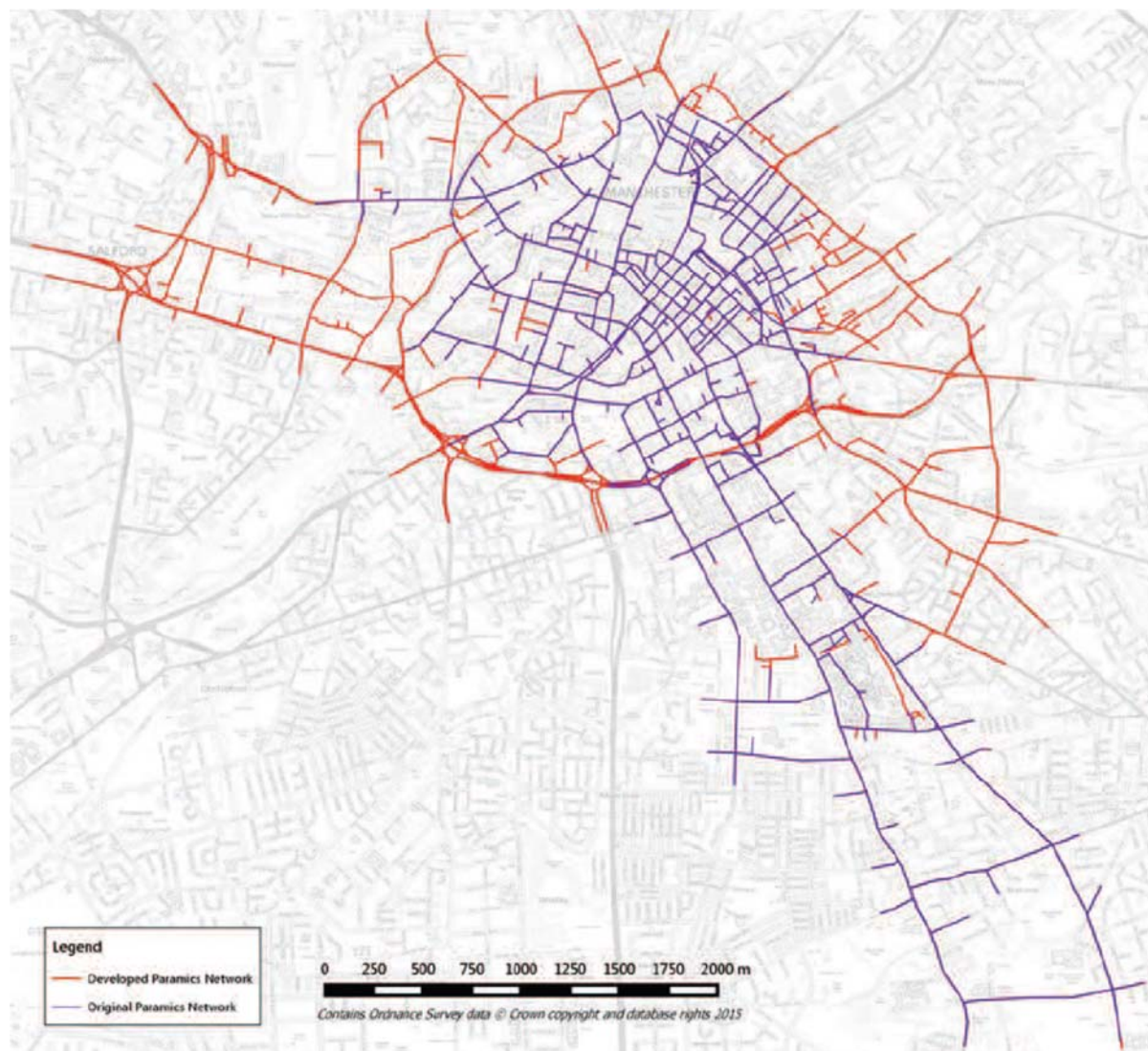


Figure 2: City Centre Paramics Model Network

4. 2017 Model Update

Network

4.1 As part of the most recent (2017) update to the model, the following changes have been made to the model network to represent key changes to the highway network in the Regional Centre:

- **Second City Crossing (2CC).** Figure 3 shows the new expanded tram stop at St Peter's Square and Figure 4 shows the new stop at Exchange Square. The Metrolink tram services operating on 2CC were coded as fixed bus routes with a frequency corresponding to the East Didsbury – Oldham/Rochdale service.
- **Bus priority package** on Oxford Road and Portland Street (associated signal timings updated). Figures 5 and 6 show the bus priority coding on Portland Street and Oxford Road.
- Update to **signal timings** in the Chapel Street, Deansgate, Albert Square and Mayfield areas of the city to represent current “street timings” and frequency of call of demand dependant stages.
- Other **ad-hoc junction** changes around the city centre that we are aware of, such as the introduction of the right turn movement at London Road / Fairfield Street.
- **Correction** of a number of coding errors found in the 2014 version of the model, specifically at key junctions on the northern and western side of the IRR.

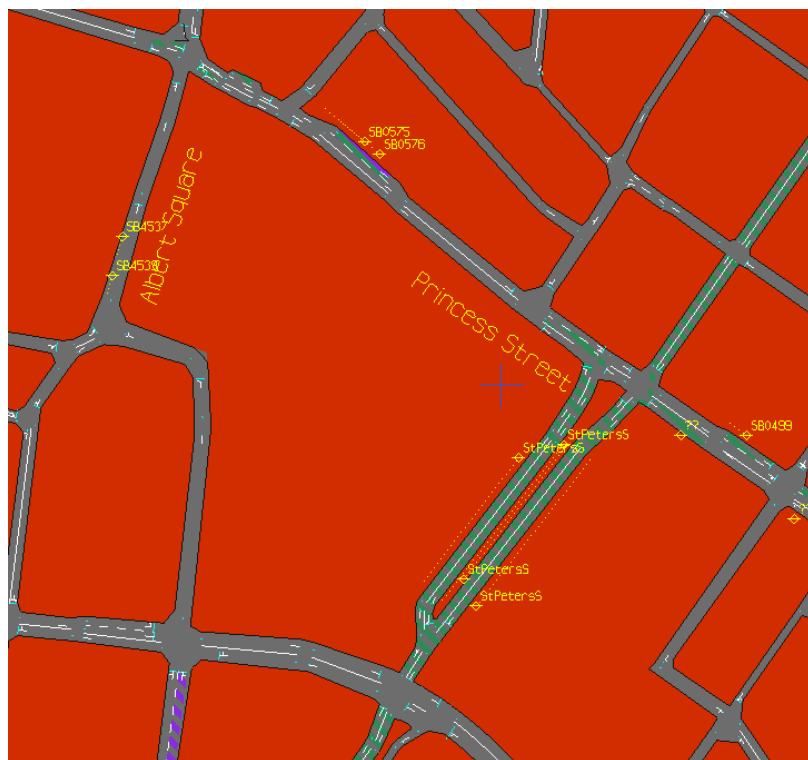


Figure 3: 2CC at St Peter's Square

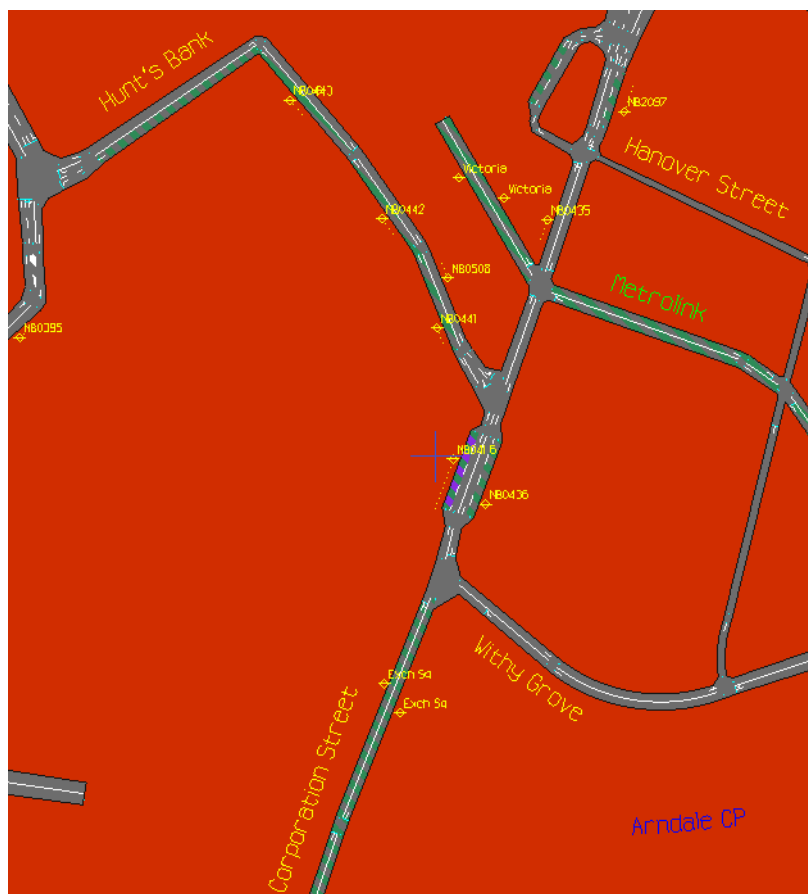


Figure 4: 2CC at Exchange Square

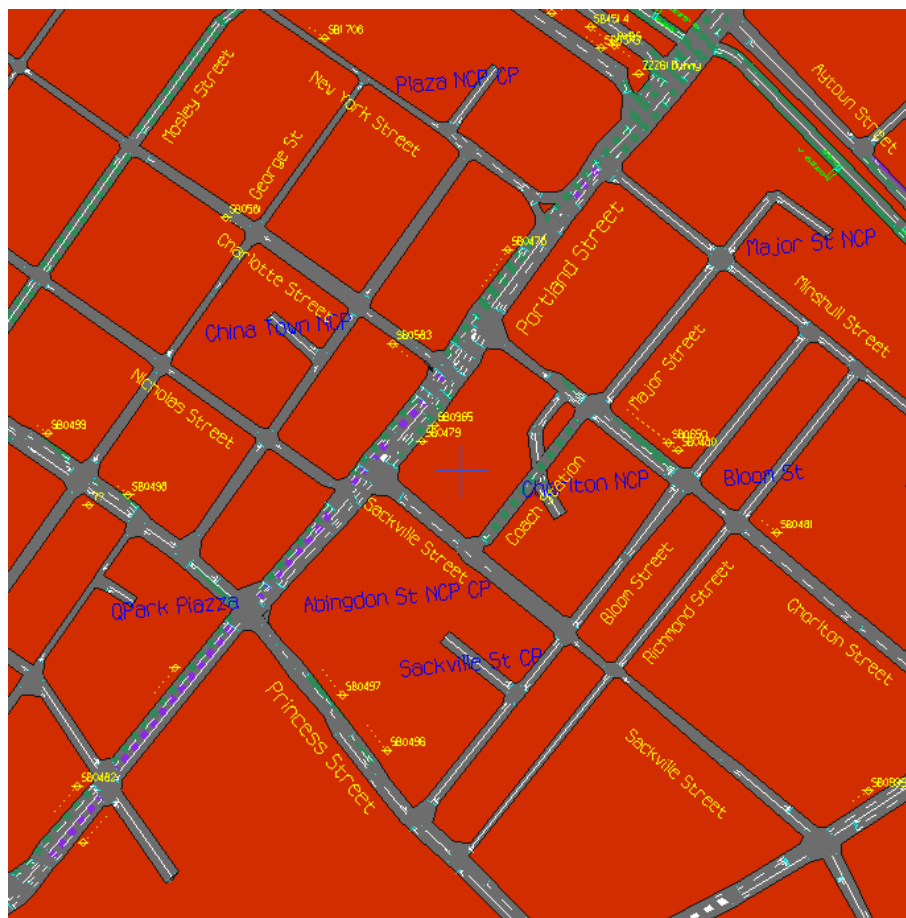


Figure 5: Bus priority coding on Portland Street

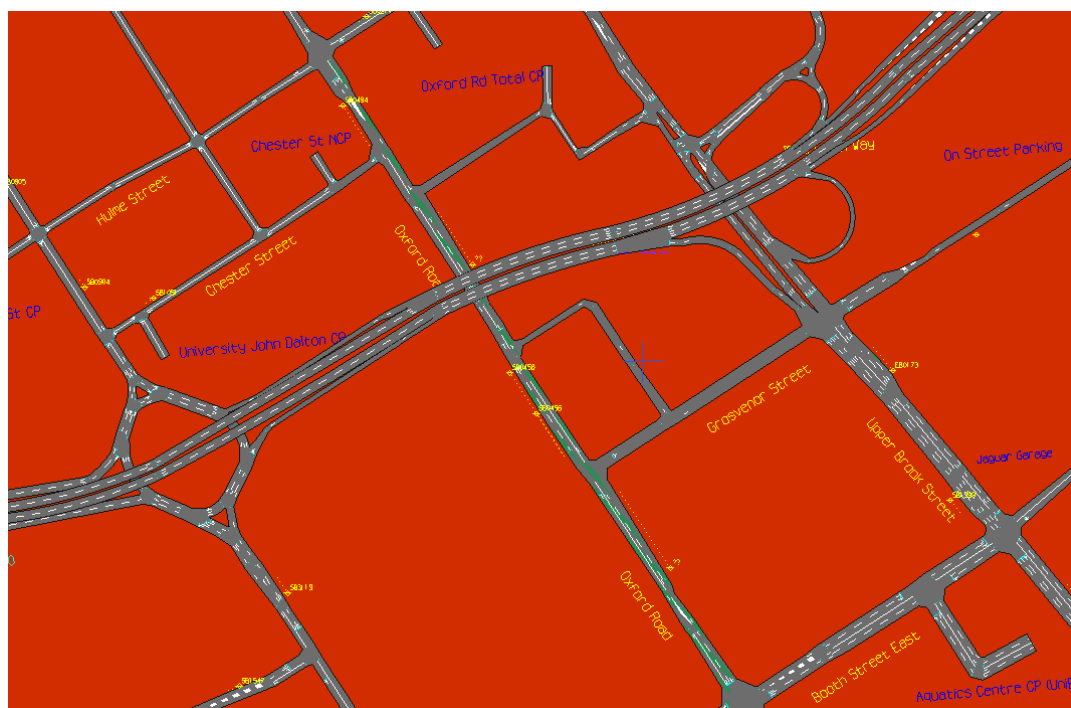


Figure 6: Bus priority coding on Oxford Road (between Hulme Street and Booth Street)

Matrix

- 4.2 As already discussed, the model represents the extended morning and evening peak periods, to include suitable “warm-up” and “cool-down” periods before and after the busiest peak hour. The demand matrices are also disaggregated into three user classes (i.e. Car, LGVs and HGVs).
- 4.3 The work undertaken by JMP in 2015 to extend the model also included building new Base matrices for the morning and evening peak periods for the extended area covered by the model. The zoning system used in the model is more detailed than that of the GM Saturn Highway Model (GMSM), with zones representing individual car parks and areas of on-street parking. However, to maintain links to the GMSM, all micro-simulation model zones are sub-divisions of the GMSM zones and they “nest” within them.
- 4.4 Briefly, the initial matrices for the Regional Centre model were created by disaggregating the base year GMSM time period matrices, with zones split by an approximate percentage, before being furnished against observed car parking data and link counts on entry links to the modelled area. Further details of the JMP matrix building process are contained within the 2014 Model LMVR.
- 4.5 The most recent refinements to the matrices were subsequently made using count data collected for the Manchester Town Hall Square Public Realm and Chapel Street East studies. This also included removing traffic from a small number of car parking zones that were taken out of operation between 2014 and 2017. This was almost exclusively commuter surface parking on cleared land that was no longer available due to construction on the land.
- 4.6 Overall, these changes resulted in a slight increase in car trip making in the morning and evening peak hour 2017 matrices compared to the validated 2014 totals as shown in Table 1.

Table 1 Peak-hour Demand Matrix Totals						
User Class	AM peak hour (08:00 – 09:00)			PM peak hour (17:00 – 18:00)		
	2014	2017	Difference	2014	2017	Difference
Car	32,929	34,023	1,094	34,204	36,586	2,382
LGV	3,392	3,376	-16	3,548	3,548	0
HGV	852	852	0	284	284	0
Total	37,173	38,251	1,078	38,036	40,418	2,382

5. Model Validation

Introduction

- 5.1 Model validation is the process of comparing modelled and observed data to assess the accuracy of the calibrated network. TAG (Unit M3.1) states that:

“Validation consists of an independent check of the calibrated model”

- 5.2 As a result, any data used to inform the model validation process should not have been used at any stage of model calibration and any count comparisons should be undertaken using counts which have not been used within the Matrix Estimation or subsequent calibration process.
- 5.3 The modelled flows were checked against observed flows for each modelled time period and the goodness of fit measured using the GEH statistic specified in TAG:

$$GEH = \sqrt{\frac{(O - E)^2}{0.5(O + E)}}$$

Where: O = Observed flow

 E = Modelled assigned flow

- 5.4 The GEH is a measure that includes both the absolute and the relative difference. The modelled flows are typically considered to be an acceptable representation of observed flows where the GEH statistic is less than 5 in 85% of cases TAG (Unit M3.1).
- 5.5 It is important to note that all validation comparisons (both flows and journey times) are based on results averaged from 10 random seed model runs per time period.
- 5.6 Based on advice provided by the S-Paramics software developers, SIAS (now Systra), we calculated that statistically significant results could be obtained from this model based on 5 model runs. JMP based the calibration and validation of the 2014 model on an average of 5 random seed runs per time period. However, given advances in computing power and faster model run times, we took the decision to base all results for the 2017 version of the model on outputs averaged from 10 model runs.

Validation Data

- 5.7 Following the model update, link and turn counts (manual classified counts and ATC) from the GMCounts and C2 databases were used to check how well the model represented observed flows. Given that there have been many changes in the city centre in recent years, older traffic counts were not used. We normally only use traffic count data that is no more than 3 years old, but in less critical areas of the model, we do sometimes use count data up to 5 years old. However, in this case, and bearing in mind the amount of change that has happened in the City Centre in recent years, we did not use any older count data and used only post 2016 counts carried out between February 2016 to March 2019. This was a suitable compromise to ensure that the dataset was robust, but that it also provided good coverage of the modelled area. All manual traffic counts were classified by vehicle type and recorded at 15-minute intervals for standard split shift hours, 0730-0930, 1000-1200 and 1600-1800 hours for the most part.
- 5.1 Data from a total of 43 link counts (at 27 sites) and 107 turn counts (derived from 9 junction counts) were used to examine the operation of the 2017 model update. The count locations were spread across the Regional Centre, as shown in Figure 6, and provided a good coverage, in particular around the Deansgate and Chapel Street areas. Due to the range of time over which data had been collected, there were understandably some inconsistencies between the available counts. As such, the count data was refined to remove incidences of double counting as well as to resolve as many conflicts as possible, where two adjacent counts did not balance with each other.
- 5.2 Journey time information for a selection of key routes through the city centre was extracted from the TrafficMaster database for the period of October 2017 (weekdays only).

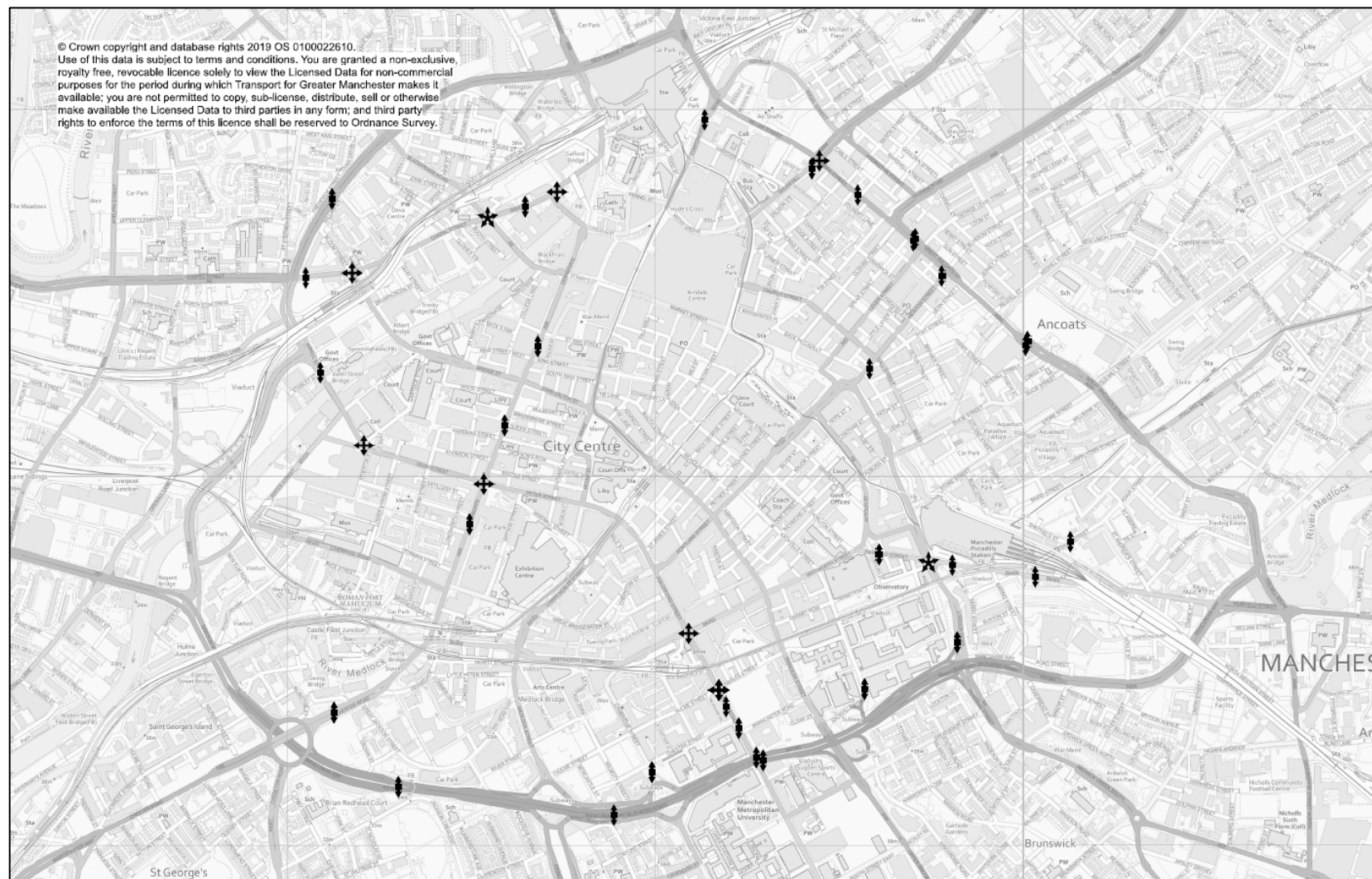


Figure 7: Regional Centre Model - Validation Count locations

Link Count Validation

- 5.3 The validation at the link count sites is shown in Tables 2 and 3 for the morning and evening peak hours respectively. The table compares the observed and model flows for all vehicles along with the GEH value for each count. Modelled flows with a GEH compared to the observed flow of less than 5 are highlighted in green and demonstrate where the model represents observed traffic flows accurately.
- 5.4 Sites where the modelled flow has a GEH of between 5 and 7.5 are highlighted in yellow. Whilst these sites do not meet normal validation acceptability criteria, they can be considered as sites where the model represents observed flows less well than desired, but where the validation is still reasonably accurate.
- 5.5 Finally, sites where the modelled flow has a GEH of greater than 7.5 are highlighted in red. These are sites where the model represents observed flows poorly.
- 5.6 The morning peak hour link count validation is reasonably good with 72% of the sites achieving a GEH of less than 5, while a further 14% of the count sites achieve a GEH between 5 and 7.5. This is consistent with the 2014 validation and shows that the model flows provide a robust level of validation, bearing in mind the difficulty of obtaining a consistent set of traffic counts in Manchester City Centre, given the level of change that has taken place in recent years.
- 5.7 The morning peak hour link count validation is particularly good on Deansgate and most routes inbound into the City Centre such as Chester Road northbound (GEH 1.2), Chapel Street eastbound (GEH 1.3), Fairfield Street westbound (GEH 0.1) and Corporation Street (GEH 4.6). The model flow is slightly too light northbound on London Road, which appears to be a routing issue given that the northbound model flow on Cambridge Street (to the west of London Road) is too high by a similar magnitude.
- 5.8 The evening peak hour link count validation shows that 66% of the sites achieve a GEH of less than 5, while a further 7% of the count sites achieve a GEH between 5 and 7.5. The evening peak hour validation on links outbound from the City Centre is generally good, examples being Fairfield Street westbound (GEH 3.0), Cambridge Street southbound (GEH 1.6), and Chapel Street westbound (GEH 3.9).
- 5.9 There are several locations in the evening peak where the model overestimates the traffic flow compared to observed flows, particularly on the IRR on Great Ancoats Street, Trinity Way, Mancunian Way, and also southbound on Deansgate. Generally, there is greater variability in traffic flows in the regional centre during the evening peak, making it harder to validate in the evening peak, and while overall the model slightly overestimates traffic levels during this time period, the model can be considered an acceptable representation of 2017 traffic conditions.

Table 2: Link Count Validation – AM Peak hour (vehs/hr)

Link location	Direction	Observed (vehs/hr)	Modelled (vehs/hr)	Diff (Mod – Obs)	GEH
B6469 Fairfield Street (east of London Road)	Westbound	467	469	2	0.1
	Eastbound	342	345	3	0.2
A56 Deansgate (between St Mary's St and King St West)	Southbound	335	417	82	4.2
	Northbound	225	298	73	4.5
A56 Deansgate (between John Dalton St and Lloyd St)	Southbound	512	411	-102	4.7
	Northbound	332	409	77	4.0
A56 Deansgate (between St John St and Camp St)	Southbound	660	523	-138	5.7
	Northbound	385	443	58	2.9
A34 Oxford Rd (between Chester St and Brancaster Rd)	Southbound	109	91	-18	1.8
	Northbound	220	231	11	0.8
Cambridge St (between Chester St and Mancunian Way)	Southbound	222	246	24	1.6
	Northbound	528	797	269	10.5
A56 Chester Rd (north of Mancunian Way)	Northbound	1,152	1,195	43	1.2
B6469 Fairfield St (east of Travis St)	Westbound	345	367	22	1.2
U Travis St (north of Sheffield St)	Southbound	508	466	-42	1.9
A62 Newton St (south of Ancoats St)	Southbound	333	416	83	4.3
A34 New Quay St (south of Trinity Way)	Northbound	717	792	75	2.7
A34 Oxford Rd (between Hulme St and Chester St)	Southbound	118	91	-27	2.6
	Northbound	261	233	-28	1.8
A62 Newton St (north of Piccadilly)	Southbound	130	307	177	12.0
	Northbound	29	98	69	8.7
A57(M) Mancunian Way (between Princess Rd and H Cambridge St)	Eastbound	2,318	2,093	-225	4.8
	Westbound	2,171	1,938	-233	5.1
A665 Gt Ancoats St (between Ducie St and Lomax St)	Eastbound	1,046	1,072	26	0.8
	Westbound	1,409	1,309	-100	2.7
A6042 Trinity Way (north of Chapel St)	Southbound	1,468	1,355	-113	3.0
	Northbound	1,092	1,227	135	4.0
A665 Swan St (between Rochdale Rd and Oldham Rd)	Westbound	1,306	1,536	230	6.1
A57(M) Mancunian Way (between Higher Cambridge St and Upper Brook St)	Eastbound	3,262	3,225	-37	0.6
	Westbound	3,333	3,232	-101	1.8
A6041 Chapel St (between Blackfriars's St and Victoria Bridge St)	Eastbound	98	97	-1	0.1
	Westbound	88	211	123	10.1
Sackville St (One-Way) (south of Charles St)	Northbound	501	590	88	3.8
A6 London Rd (north of Fairfield St)	Northbound	800	560	-240	9.2
B6469 Fairfield St (west of London Rd)	Eastbound	848	709	-139	5.0
	Westbound	262	353	91	5.2
A57(M) Mancunian Way (between Chester Rd and Princess Rd)	Eastbound	2,989	2,666	-323	6.1
	Westbound	2,519	2,535	16	0.3
A62 Gt Ancoats St (between Oldham St and Lever St)	Eastbound	1,442	1,091	-351	9.9
	Westbound	1,445	1,259	-186	5.0
A6 Chapel St (between trinity Way and New Bailey St)	Eastbound	602	571	-31	1.3
A664 Shudehill (south of Swan St)	Southbound	590	631	41	1.6
A6042 Corporation St (between Miller St and Hanover St)	Southbound	177	244	67	4.6
Total		37,696	37,150	-546	2.8

Table 3: Link Count Validation – PM Peak hour (vehs/hr)

Link location	Direction	Observed (vehs/hr)	Modelled (vehs/hr)	Diff (Mod – Obs)	GEH
B6469 Fairfield Street (east of London Road)	Westbound	432	496	64	3.0
	Eastbound	505	574	69	3.0
A56 Deansgate (between St Mary's St and King St West)	Southbound	238	467	229	12.2
	Northbound	318	410	92	4.8
A56 Deansgate (between John Dalton St and Lloyd St)	Southbound	386	770	384	16.0
	Northbound	356	438	82	4.1
A56 Deansgate (between St John St and Camp St)	Southbound	439	748	309	12.7
	Northbound	309	324	15	0.8
A34 Oxford Rd (between Chester St and Brancaster Rd)	Southbound	126	117	-9	0.8
	Northbound	234	181	-53	3.7
Cambridge St (between Chester St and Mancunian Way)	Southbound	373	419	46	2.3
	Northbound	344	406	62	3.2
A56 Chester Rd (north of Mancunian Way)	Northbound	557	526	-31	1.3
B6469 Fairfield St (east of Travis St)	Westbound	288	216	-72	4.5
U Travis St (north of Sheffield St)	Southbound	340	261	-79	4.6
A62 Newton St (south of Ancoats St)	Southbound	191	194	3	0.2
A34 New Quay St (south of Trinity Way)	Northbound	394	174	-221	13.1
A34 Oxford Rd (between Hulme St and Chester St)	Southbound	150	117	-33	2.9
	Northbound	271	222	-49	3.1
A62 Newton St (north of Piccadilly)	Southbound	121	235	114	8.5
	Northbound	78	123	45	4.5
A57(M) Mancunian Way (between Princess Rd and H Cambridge St)	Eastbound	924	1,201	277	8.5
	Westbound	2,143	2,055	-88	1.9
A665 Gt Ancoats St (between Ducie St and Lomax St)	Eastbound	916	1,343	427	12.7
	Westbound	1,382	1,686	304	7.8
A6042 Trinity Way (north of Chapel St)	Southbound	1,061	1,325	264	7.6
	Northbound	1,257	1,653	396	10.4
A665 Swan St (between Rochdale Rd and Oldham Rd)	Westbound	1,357	1,226	-131	3.7
A57(M) Mancunian Way (between Higher Cambridge St and Upper Brook St)	Eastbound	2,266	2,405	139	2.9
	Westbound	3,623	2,814	-809	14.3
A6041 Chapel St (between Blackfriars's St and Victoria Bridge St)	Eastbound	140	232	92	6.8
	Westbound	232	296	64	3.9
Sackville St (One-Way) (south of Charles St)	Northbound	208	325	117	7.1
A6 London Rd (north of Fairfield St)	Northbound	477	368	-109	5.3
B6469 Fairfield St (west of London Rd)	Eastbound	503	599	96	4.1
	Westbound	474	702	228	9.4
A57(M) Mancunian Way (between Chester Rd and Princess Rd)	Eastbound	2,418	1,618	-800	17.8
	Westbound	2,787	2,756	-31	0.6
A62 Gt Ancoats St (between Oldham St and Lever St)	Eastbound	1,410	1,251	-159	4.4
	Westbound	1,955	1,882	-73	1.7
A6 Chapel St (between trinity Way and New Bailey St)	Westbound	382	341	-41	2.1
A664 Shudehill (south of Swan St)	Southbound	339	364	25	1.3
A6042 Corporation St (between Miller St and Hanover St)	Southbound	82	69	-13	1.5
	Total	32,786	33,926	1,140	6.2

Junction Count Validation

- 5.10 A further validation exercise was carried out to ensure the model reflects individual turning movements at key junctions in the network including:
- Deansgate / Peter St / Quay St (Thurs 07/03/2019)
 - London Rd / Fairfield St / Granby Row (Thurs 07/03/2019)
 - New Quay St / New Gartside St / Quay St (Tues 30/10/2018)
 - Blackfriars Rd / Salford Approach / Chapel St / Blackfriars St (Thurs 30/11/2017)
 - Greengate / Chapel St / Victoria Bridge St (Thurs 30/11/2017)
 - Rochdale Rd / Swan St / Shudehill / Miller St (Thurs 24/11/2016)
 - Bloom St / Chapel St / New Bailey St (Tues 09/02/2016)
 - Oxford St / Whitworth St / Whitworth Street West (Fri 03/05/2019)
 - Oxford Rd / Charles St / Hulme St (Fri 03/05/2019)
- 5.11 The overall validation for the turning counts is consistent with the link count validation with 71% (morning peak hour) and 66% (evening peak hour) of the turns achieving a GEH of less than 5, while a further 21% (morning peak hour) and 15% (evening peak hour) of the count sites achieve a GEH between 5 and 7.5. Generally, in cases where the validation is poor (i.e. GEH greater than 7.5) the modelled flow exceeds the observed flow, therefore, the model could be regarded as a worst case scenario at these locations.
- 5.12 The model validates particularly well at the junctions of Deansgate / Peter Street / Quay Street, Blackfriars's Road / Chapel Street and Chapel Street / New Bailey Street; a key area of the network. The validation is less good at some of the junctions on the IRR (particularly during the evening peak hour), though as with the link counts, generally the model flows are overestimated and could be considered a worst case scenario.

Table 4: Turn Count Validation – AM Peak hour (vehs/hr)

Junction	Arm / movement	Observed (vehs/hr)	Modelled (vehs/hr)	Diff (Mod – Obs)	GEH
Deansgate / Peter St / Quay St	A56 Deansgate LT	41	26	-15	2.5
	A56 Deansgate SO	407	357	-50	2.6
	A56 Deansgate RT	28	44	16	2.6
	A34 Peter St LT	70	57	-13	1.6
	A34 Peter St SO	145	95	-50	4.6
	A34 Peter St RT	129	84	-45	4.3
	A56 Deansgate LT	100	138	38	3.5
	A56 Deansgate SO	244	262	18	1.1
	A56 Deansgate RT	18	47	29	5.1
	A34 Quay St LT	42	83	41	5.2
	A34 Quay St SO	127	183	56	4.5
	A34 Quay St RT	161	111	-50	4.3
London Rd / Fairfield St	A6 London Rd LT	82	49	-33	4.0
	A6 London Rd SO	314	272	-42	2.4
	A6 London Rd RT	123	140	17	1.5
	B6469 Fairfield St LT	21	61	40	6.3
	B6469 Fairfield St SO	312	337	25	1.4
	B6469 Fairfield St RT	141	70	-71	6.9
	A6 London Rd LT	176	232	56	3.9
	A6 London Rd SO	494	456	-38	1.8
	A6 London Rd RT	2	0	-2	2.0
	B6469 Fairfield St LT	19	36	17	3.2
	B6469 Fairfield St SO	259	296	37	2.2
	B6469 Fairfield St RT	66	22	-44	6.7
New Quay St / New Gartside St / Quay St	A34 New Quay St LT	27	36	9	1.6
	A34 New Quay St SO	575	549	-26	1.1
	A34 New Quay St RT	15	0	-15	5.5
	New Gartside St LT	98	47	-51	6.0
	New Gartside St SO	7	0	-7	3.7
	New Gartside St RT	57	25	-33	5.1
	A34 Quay St LT	21	0	-21	6.5
	A34 Quay St SO	384	499	115	5.5
	A34 Quay St RT	120	0	-120	15.5
	B5225 Quay St LT	12	1	-11	4.3
	B5225 Quay St SO	2	0	-2	1.9
	B5225 Quay St RT	19	4	-15	4.5

Table 4 (cont): Turn Count Validation – AM Peak hour (vehs/hr)

Junction	Arm / movement	Observed (vehs/hr)	Modelled (vehs/hr)	Diff (Mod – Obs)	GEH
Blackfriars Rd / Salford Approach / Chapel St / Blackfriars St	A6041 Blackfriars Rd to Salford Approach	9	2	-8	3.3
	A6041 Blackfriars Rd LT	27	37	10	1.7
	A6041 Blackfriars Rd SO	236	48	-188	15.8
	A6041 Blackfriars Rd RT	163	157	-6	0.5
	Salford Approach to Chapel St E	1	0	-1	1.4
	Salford Approach to Blackfriars St S	2	0	-2	2.0
	Salford Approach to Chapel St W	0	0	0	0.0
	Salford Approach to Blackfriars St N	0	0	0	0.0
	A6041 Chapel St LT	18	0	-18	6.0
	A6041 Chapel St SO	101	96	-5	0.5
	A6041 Chapel St RT	26	1	-26	7.0
	A6041 Chapel St to Salford Approach	0	1	1	0.0
	A6 Blackfriars St LT	56	77	21	2.6
	A6 Blackfriars St SO	118	59	-59	6.3
	A6 Blackfriars St to Salford Approach	5	2	-3	1.8
	A6 Blackfriars St RT	37	52	15	2.2
	A6 Chapel St LT	70	39	-31	4.2
	A6 Chapel St to Salford Approach	2	9	7	3.0
	A6 Chapel St SO	81	123	42	4.1
	A6 Chapel St RT	44	78	34	4.4
Greengate / Chapel St / Victoria Bridge St	A56 Chapel St LT	360	436	76	3.8
	A56 Chapel St SO	113	107	-6	0.6
	A6 Victoria Bridge St LT	28	3	-25	6.4
	A6 Victoria Bridge St RT	116	177	61	5.0
	A6041 Chapel St SO	124	94	-30	2.9
	A6041 Chapel St RT	18	50	32	5.5
Rochdale Rd / Swan St / Shudehill / Miller St	A664 Rochdale Rd LT	0	0	0	0.0
	A664 Rochdale Rd SO	312	470	158	8.0
	A664 Rochdale Rd RT	385	255	-130	7.3
	A665 Swan St LT	175	168	-8	0.6
	A665 Swan St SO	808	1218	410	12.9
	A665 Swan St RT	121	155	34	2.9
	A664 Shudehill LT	24	124	100	11.6
	A664 Shudehill SO	111	81	-30	3.1
	A664 Shudehill RT	0	0	0	0.0

Table 4 (cont): Turn Count Validation – AM Peak hour (vehs/hr)

Junction	Arm / movement	Observed (vehs/hr)	Modelled (vehs/hr)	Diff (Mod – Obs)	GEH
Bloom St / Chapel St / New Bailey St	Bloom St LT	4	0	-4	2.8
	Bloom St SO	12	0	-12	4.9
	Bloom St RT	40	0	-40	8.9
	A6 Chapel St LT	116	41	-75	8.4
	A6 Chapel St SO	124	217	93	7.1
	A6 Chapel St RT	4	8	4	1.6
	A34 New Bailey St LT	119	174	55	4.6
	A34 New Bailey St SO	6	11	5	1.6
	A34 New Bailey St RT	46	32	-14	2.2
	A6 Chapel St LT	36	24	-12	2.2
	A6 Chapel St SO	274	301	27	1.6
	A6 Chapel St RT	281	247	-34	2.1
Oxford St / Whitworth St / Whitworth Street West	A34 Oxford St LT	46	80	34	4.2
	A34 Oxford St SO	36	47	11	1.7
	A34 Oxford St RT	1	0	-1	1.4
	B6469 Whitworth St LT	88	83	-5	0.5
	B6469 Whitworth St SO	335	440	105	5.3
	B6469 Whitworth St RT	17	0	-17	5.8
	A34 Oxford St LT	78	149	71	6.7
	A34 Oxford St SO	126	116	-11	1.0
	A34 Oxford St RT	1	0	-1	1.4
	B6469 Whitworth Street We LT	27	12	-15	3.5
	B6469 Whitworth Street We SO	223	538	315	16.1
	B6469 Whitworth Street We RT	0	0	0	0.0
Oxford Rd / Charles St / Hulme St	A34 Oxford Rd LT	19	26	7	1.4
	A34 Oxford Rd SO	103	87	-16	1.7
	A34 Oxford Rd RT	1	19	18	5.7
	Charles St LT	6	5	-1	0.6
	Charles St SO	126	93	-33	3.2
	Charles St RT	16	38	22	4.3
	A34 Oxford Rd LT	5	0	-5	3.2
	A34 Oxford Rd SO	186	228	42	2.9
	A34 Oxford Rd RT	43	5	-38	7.8
	Hulme St LT	7	0	-7	3.6
	Hulme St SO	35	23	-12	2.1
	Hulme St RT	0	0	0	0.0

Table 4: Turn Count Validation – PM Peak hour (vehs/hr)

Junction	Arm / movement	Observed (vehs/hr)	Modelled (vehs/hr)	Diff (Mod – Obs)	GEH
Deansgate / Peter St / Quay St	A56 Deansgate LT	72	72	0	0.0
	A56 Deansgate SO	308	545	237	11.5
	A56 Deansgate RT	23	79	56	7.8
	A34 Peter St LT	73	113	40	4.1
	A34 Peter St SO	165	112	-53	4.5
	A34 Peter St RT	107	85	-22	2.3
	A56 Deansgate LT	84	81	-3	0.4
	A56 Deansgate SO	199	235	36	2.5
	A56 Deansgate RT	27	10	-17	3.9
	A34 Quay St LT	28	44	16	2.7
	A34 Quay St SO	143	144	1	0.1
	A34 Quay St RT	100	114	14	1.3
London Rd / Fairfield St	A6 London Rd LT	74	21	-53	7.7
	A6 London Rd SO	409	309	-100	5.3
	A6 London Rd RT	124	152	28	2.4
	B6469 Fairfield St LT	90	98	8	0.9
	B6469 Fairfield St SO	236	301	65	3.9
	B6469 Fairfield St RT	105	97	-8	0.8
	A6 London Rd LT	89	158	69	6.2
	A6 London Rd SO	275	277	2	0.1
	A6 London Rd RT	3	0	-3	2.4
	B6469 Fairfield St LT	11	2	-9	3.7
	B6469 Fairfield St SO	425	550	125	5.7
	B6469 Fairfield St RT	130	157	27	2.3
New Quay St / New Gartside St / Quay St	A34 New Quay St LT	13	18	5	1.4
	A34 New Quay St SO	460	323	-137	6.9
	A34 New Quay St RT	9	0	-9	4.2
	New Gartside St LT	133	87	-46	4.4
	New Gartside St SO	2	0	-2	2.0
	New Gartside St RT	80	61	-19	2.2
	A34 Quay St LT	7	0	-7	3.7
	A34 Quay St SO	463	403	-60	2.9
	A34 Quay St RT	42	6	-36	7.5
	B5225 Quay St LT	10	3	-7	2.8
	B5225 Quay St SO	3	0	-3	2.2
	B5225 Quay St RT	11	13	2	0.6

Table 4 (cont): Turn Count Validation – PM Peak hour (vehs/hr)

Junction	Arm / movement	Observed (vehs/hr)	Modelled (vehs/hr)	Diff (Mod – Obs)	GEH
Blackfriars Rd / Salford Approach / Chapel St / Blackfriars St	A6041 Blackfriars Rd to Salford Approach	1	1	0	0.1
	A6041 Blackfriars Rd LT	42	50	8	1.2
	A6041 Blackfriars Rd SO	162	68	-94	8.7
	A6041 Blackfriars Rd RT	94	23	-71	9.3
	Salford Approach to Chapel St E	5	15	10	3.0
	Salford Approach to Blackfriars St S	3	1	-2	1.7
	Salford Approach to Chapel St W	12	5	-7	2.6
	Salford Approach to Blackfriars St N	4	5	1	0.5
	A6041 Chapel St LT	12	0	-12	4.9
	A6041 Chapel St SO	82	153	71	6.5
	A6041 Chapel St RT	35	79	44	5.9
	A6041 Chapel St to Salford Approach	1	1	0	0.3
	A6 Blackfriars St LT	77	93	16	1.7
	A6 Blackfriars St SO	122	212	90	7.0
	A6 Blackfriars St to Salford Approach	2	8	6	2.7
	A6 Blackfriars St RT	59	64	5	0.6
	A6 Chapel St LT	69	102	33	3.5
	A6 Chapel St to Salford Approach	8	16	8	2.3
	A6 Chapel St SO	109	176	67	5.6
	A6 Chapel St RT	70	68	-2	0.3
Greengate / Chapel St / Victoria Bridge St	A56 Chapel St LT	241	401	160	8.9
	A56 Chapel St SO	73	124	51	5.1
	A6 Victoria Bridge St LT	42	49	7	1.0
	A6 Victoria Bridge St RT	270	305	35	2.1
	A6041 Chapel St SO	224	202	-22	1.5
	A6041 Chapel St RT	8	84	76	11.2
Rochdale Rd / Swan St / Shudehill / Miller St	A664 Rochdale Rd LT	0	0	0	0.0
	A664 Rochdale Rd SO	241	216	-25	1.6
	A664 Rochdale Rd RT	221	396	175	10.0
	A665 Swan St LT	99	148	49	4.4
	A665 Swan St SO	430	884	454	17.7
	A665 Swan St RT	132	203	71	5.5
	A664 Shudehill LT	17	136	119	13.6
	A664 Shudehill SO	246	324	78	4.6
	A664 Shudehill RT	0	0	0	0.0

Table 4 (cont): Turn Count Validation – PM Peak hour (vehs/hr)

Junction	Arm / movement	Observed (vehs/hr)	Modelled (vehs/hr)	Diff (Mod – Obs)	GEH
Bloom St / Chapel St / New Bailey St	Bloom St LT	11	1	-10	4.1
	Bloom St SO	13	0	-13	5.1
	Bloom St RT	19	33	14	2.8
	A6 Chapel St LT	65	6	-59	9.9
	A6 Chapel St SO	225	404	179	10.1
	A6 Chapel St RT	4	0	-4	2.8
	A34 New Bailey St LT	222	391	169	9.6
	A34 New Bailey St SO	13	0	-13	5.1
	A34 New Bailey St RT	124	48	-76	8.2
	A6 Chapel St LT	27	0	-27	7.2
	A6 Chapel St SO	108	225	117	9.1
	A6 Chapel St RT	134	118	-16	1.4
Oxford St / Whitworth St / Whitworth Street West	A34 Oxford St LT	64	163	99	9.3
	A34 Oxford St SO	50	62	12	1.6
	A34 Oxford St RT	0	0	0	0.0
	B6469 Whitworth St LT	84	82	-2	0.2
	B6469 Whitworth St SO	387	394	7	0.4
	B6469 Whitworth St RT	14	0	-14	5.3
	A34 Oxford St LT	119	177	58	4.7
	A34 Oxford St SO	131	105	-26	2.4
	A34 Oxford St RT	1	0	-1	1.4
	B6469 Whitworth Street We LT	56	10	-46	8.1
	B6469 Whitworth Street We SO	186	401	215	12.5
	B6469 Whitworth Street We RT	0	0	0	0.0
Oxford Rd / Charles St / Hulme St	A34 Oxford Rd LT	28	16	-12	2.5
	A34 Oxford Rd SO	107	111	4	0.4
	A34 Oxford Rd RT	3	17	14	4.4
	Charles St LT	10	6	-4	1.5
	Charles St SO	189	47	-142	13.1
	Charles St RT	25	63	38	5.7
	A34 Oxford Rd LT	10	0	-10	4.5
	A34 Oxford Rd SO	201	216	15	1.1
	A34 Oxford Rd RT	68	6	-62	10.2
	Hulme St LT	25	10	-15	3.6
	Hulme St SO	38	76	38	5.0
	Hulme St RT	3	0	-3	2.4

Journey time validation

- 5.13 In addition to traffic count validation, the ability of the model to replicate observed journey times along key city centre routes was examined. Journey times were extracted from TrafficMaster data for weekdays during October 2017, representative of typical traffic conditions. Journey times were extracted for the weekday morning peak (0800-0900) and evening Peak (1700-1800), to match the modelled peak hours. A total of 22 routes were defined as follows:
- Route 1 & 2 – (NB, SB) Bridge St, New Bailey St, Chapel St, Trinity Way
 - Route 3 – (NB only) – Bridge St, New Bailey St, Chapel St to Blackfriars Road
 - Route 4 – (NB) – Deansgate, Blackfriars St
 - Route 5 & 6 – (NB, SB) – Deansgate
 - Route 7 – (SB) – A6 London Road
 - Route 8 & 9 – (WB, EB) – Fairfield St, Whitworth St
 - Route 10 & 11 – (EB, WB) – Mancunian Way
 - Route 12 & 13 – (NB, SB) – A635 Ring Road, Great Ancoats St
 - Route 14 & 15 – (NB, SB) – Trinity Way
 - Route 16 – (NB) – Portland St, Oxford St, Peter St, Quay St, New Quay St
 - Route 17 & 18 – (EB, WB) – Regent Rd
 - Route 19 & 20 – (EB, WB) – A6 Chapel St
 - Route 21 & 22 – (NB, SB) – A34 Upper Brook St
- 5.14 The full routes are shown in Figure 8. TrafficMaster data provides the average journey times for the selected routes as well as the variance of the observed data. The variance was used to calculate the 95% confidence interval of the average observed journey times.
- 5.15 Journey time validation involved defining paths within the model and averaging the time it takes vehicles to traverse each route averaged over multiple model runs.
- 5.16 This was then compared to the observed journey time data for each of the routes. Although WebTAG guidance suggests journey time validation criteria, we are aware that there is considerable variation in observed journey times within the Regional Centre that far exceeds the WebTAG acceptability range. In this case, we compared modelled journey times against the range of observed times defined by the 95% confidence interval of the

mean observed journey time. Modelled journey times lying within this confidence interval were considered to be an acceptable representation of the observed data.

- 5.17 Figures 9 and 10 below compare the average journey time from the modelled runs with the average observed journey time and its associated 95% confidence interval for each of the 22 routes.
- 5.18 91% (20 out of 22) of the modelled journey times lie within the observed confidence intervals in the morning peak and 68% (15 out of 22) are within the intervals in the evening peak.
- 5.19 In both peak periods the modelled journey times are mostly lower than mean observed journey times, suggesting that the model struggles to fully represent congestion along city centre routes.
- 5.20 In the morning peak, observed journey times along Deansgate (Routes 5 & 6) are around 7 minutes, whereas modelled times on these routes are under 4 minutes. In the evening peak, the difference in journey times along Deansgate is more pronounced especially southbound. Journey times along Regent Road eastbound (Route 17) heading towards the city centre are also underestimated by the model by over 5 minutes. The modelled journey times for Regent Road eastbound fall outside the confidence interval of the observed data in both peak periods.
- 5.21 In other areas of the model, journey times are better represented, with differences between modelled and observed journey times of less than a minute along New Bailey Street/Chapel Street (Routes 1 & 2) and along the Mancunian Way eastbound (Route 10) during both the morning and evening peak periods.

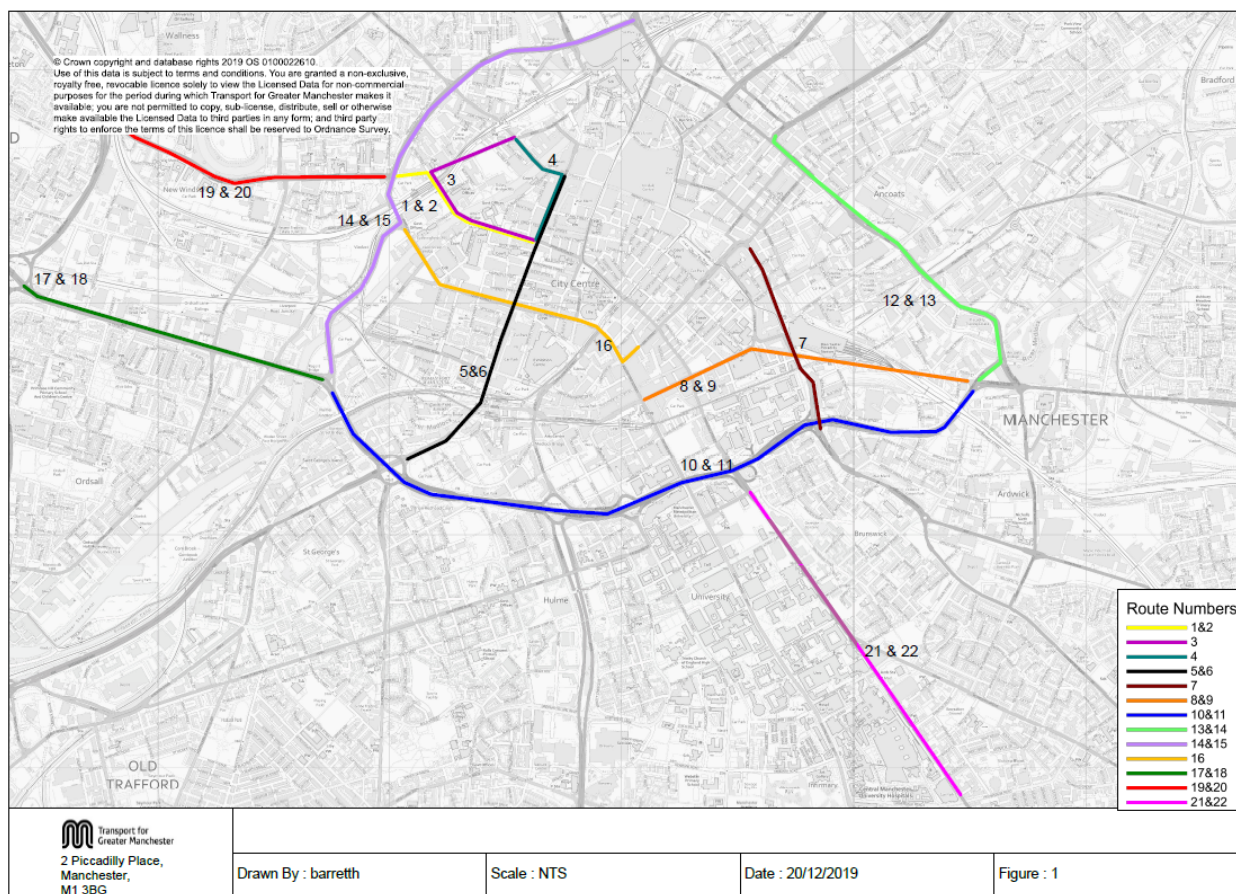


Figure 8: Journey time routes

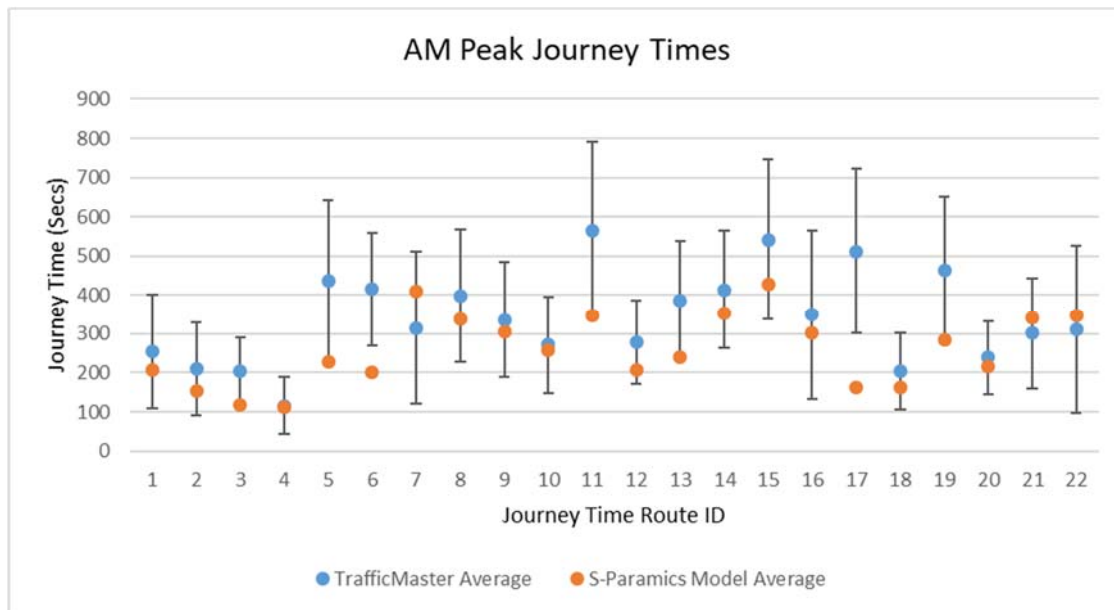


Figure 9: AM Peak hour journey time comparison

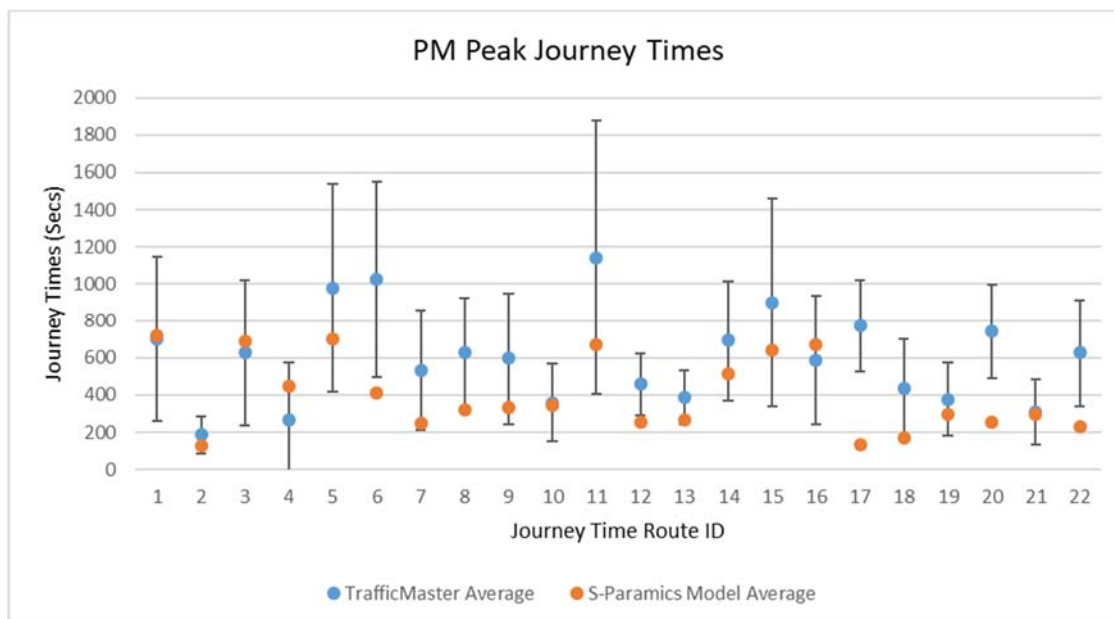


Figure 10: PM Peak hour journey time comparison

AM Journey Time Validation (Secs)

Routes	Observed Average	Observed + 2Std	Observed – 2std	Modelled Average	Within Confidence interval
Route 1 – Bridge St, New Bailey St, Chapel St, Trinity Way NB	255	402	108	208	Yes
Route 2 – Bridge St, New Bailey St, Chapel St, Trinity Way SB	209	328	90	154	Yes
Route 3 – Bridge St, New Bailey St, Chapel St to Blackfairs NB	204	291	117	118	Yes
Route 4 – Deansgate, Blackfriars St NB	116	188	45	113	Yes
Route 5 – Deansgate NB	436	643	229	229	Yes
Route 6 – Deansgate SB	415	560	271	202	No
Route 7 – A6 London Road SB	315	510	120	410	Yes
Route 8 – Fairfield St, Whitworth St WB	397	567	227	340	Yes
Route 9 – Fairfield St, Whitworth St EB	336	483	189	306	Yes
Route 10 – Mancunian Way EB	272	395	148	259	Yes
Route 11 – Mancunian Way WB	564	791	337	346	Yes
Route 12 – Ring Road, Great Ancoats St NB	279	386	172	209	Yes
Route 13 – Ring Road, Great Ancoats St SB	387	537	237	241	Yes
Route 14 – Trinity Way NB	414	564	264	353	Yes
Route 15 – Trinity Way SB	541	746	337	427	Yes
Route 16 – Portland St, Oxford St, Peter St, Quay St, New Quay St NB	349	565	134	304	Yes
Route 17 – Regent Rd EB	512	722	302	164	No
Route 18 – Regent Rd WB	204	301	107	164	Yes
Route 19 – A6 Chapel St EB	464	651	277	284	Yes
Route 20 – A6 Chapel St WB	239	332	146	217	Yes
Route 21 – A34 Upper Brook St NB	302	443	161	341	Yes
Route 22 – A34 Upper Brook St SB	310	525	96	348	Yes

PM Journey Time Validation (Secs)

Routes	Observed Average	Observed + 2Std	Observed - 2std	Modelled Average	Within Confidence interval
Route 1 – Bridge St, New Bailey St, Chapel St, Trinity Way NB	702	1145	259	719	Yes
Route 2 – Bridge St, New Bailey St, Chapel St, Trinity Way SB	185	283	87	126	Yes
Route 3 – Bridge St, New Bailey St, Chapel St to Blackfairs NB	627	1019	236	690	Yes
Route 4 – Deansgate, Blackfriars St NB	265	577	-46	450	Yes
Route 5 – Deansgate NB	979	1540	418	700	Yes
Route 6 – Deansgate SB	1025	1553	498	412	No
Route 7 – A6 London Road SB	534	856	212	250	Yes
Route 8 – Fairfield St, Whitworth St WB	626	925	327	321	No
Route 9 – Fairfield St, Whitworth St EB	596	947	245	331	Yes
Route 10 – Mancunian Way EB	360	567	153	345	Yes
Route 11 – Mancunian Way WB	1142	1877	407	671	Yes
Route 12 – Ring Road, Great Ancoats St NB	457	621	292	254	No
Route 13 – Ring Road, Great Ancoats St SB	387	533	240	268	Yes
Route 14 – Trinity Way NB	693	1015	371	513	Yes
Route 15 – Trinity Way SB	897	1458	337	643	Yes
Route 16 – Portland St, Oxford St, Peter St, Quay St, New Quay St NB	587	935	240	670	Yes
Route 17 – Regent Rd EB	771	1019	524	134	No
Route 18 – Regent Rd WB	438	699	177	168	No
Route 19 – A6 Chapel St EB	377	572	181	296	Yes
Route 20 – A6 Chapel St WB	743	998	487	253	No
Route 21 – A34 Upper Brook St NB	308	484	133	294	Yes
Route 22 – A34 Upper Brook St SB	627	914	340	231	No

6. Summary and Conclusions

5. The Regional Centre Paramics Model was originally developed by TfGM HFAS in 2012. In 2015, JMP were commissioned to calibrate and validate an extend model to a 2014 base year. This model was subsequently updated and revalidated by HFAS to correct some errors found in the 2014 model and to update it to represent a 2017 base year. This report documents the updates applied to the network and matrices, and the flow and journey time validation for the morning (08:00 – 09:00) and evening (17:00 – 18:00) peak hour models.

Morning Peak Hour

6. Generally, the morning peak hour model flows validate well with 72% of the link counts and 71% of the turn counts achieving a GEH of 5 or less. The model flows validate particularly well on Deansgate and at junctions on and around Chapel Street. There are a few locations where the model flows are slightly light (e.g. London Road northbound) due to routing issues but overall the flow validation is consistent with the 2014 model.
7. The morning peak hour journey time validation is good with 20 of the 22 journey time routes achieving a modelled journey time within an acceptable range of observed journey times.

Evening Peak Hour

8. The evening peak hour flow validation is reasonably good with 66% of both link counts and turn counts achieving a GEH of 5 or less. There are a few locations where the model flows are too high compared to observed flows, particularly on the IRR and Deansgate southbound. However, there is greater variability in traffic flows in the regional centre during the evening peak, making it harder to validate, and at locations where the model flow is overestimated the model could be consider robust in reflecting a worst-case scenario.
9. The evening peak hour journey time validation is reasonably good with 15 of the 22 journey time routes achieving a modelled journey time within an acceptable range of observed journey times. The evening peak observed journey times reflect the greater variability of traffic patterns during this period. During this period some of the model journey times are slightly too fast, mainly on arterial routes such as Regent Road, Oxford Road and Chapel Street, suggesting the model is not able to fully reflect the delays on these routes.
10. Overall, given the difficulty of obtaining a consistent set of traffic counts in the Regional Centre and the day-to-day observed variability of traffic, particularly during the evening peak hour, the Regional Centre 2017 base model validation is good while accepting that

the flows in some areas are on the high side (particularly in the evening peak). This report demonstrates that the updated model continues to provide a robust and accurate representation of the City Centre traffic movements.

11. The model is considered capable of assessing:
- Forecast traffic growth impacts;
 - Development impacts;
 - Infrastructure improvements impacts; and the
 - Identification of infrastructure deficiencies.



APPENDIX B

Linsig Junction Modelling Outputs

Basic Results Summary

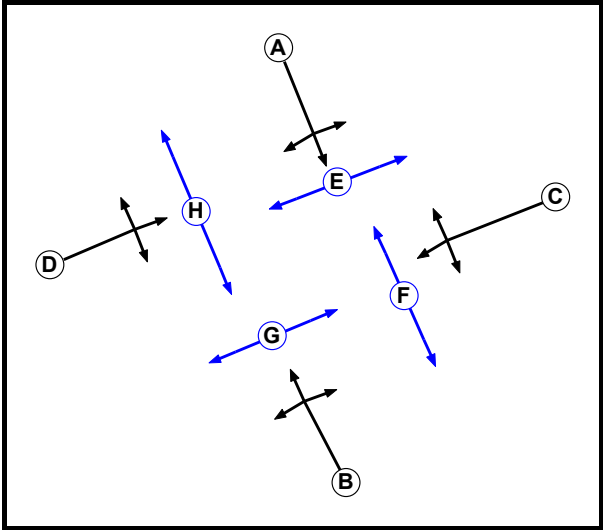
Basic Results Summary

User and Project Details

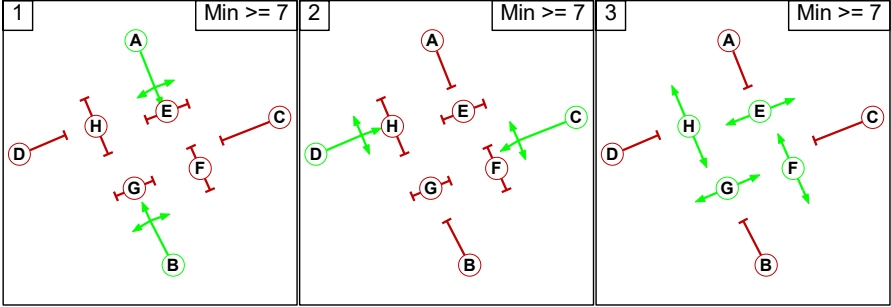
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Title:	Quay Street Corridor (Existing Layout)
Location:	
Additional detail:	
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Author:	
Company:	Vectos (North) Ltd
Address:	

C1 - Water Street

Phase Diagram

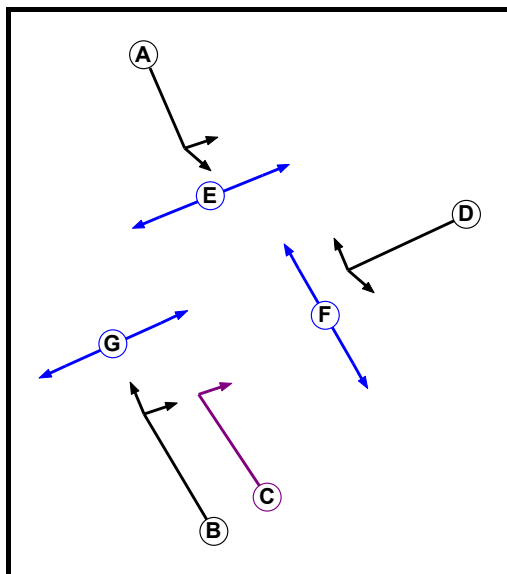


Stage Diagram

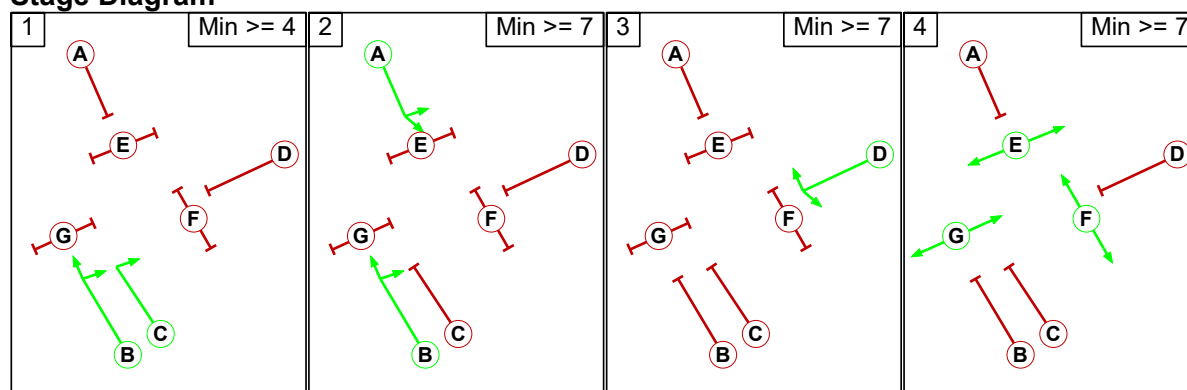


Basic Results Summary

C2 - New Quay St / Gartside St Phase Diagram



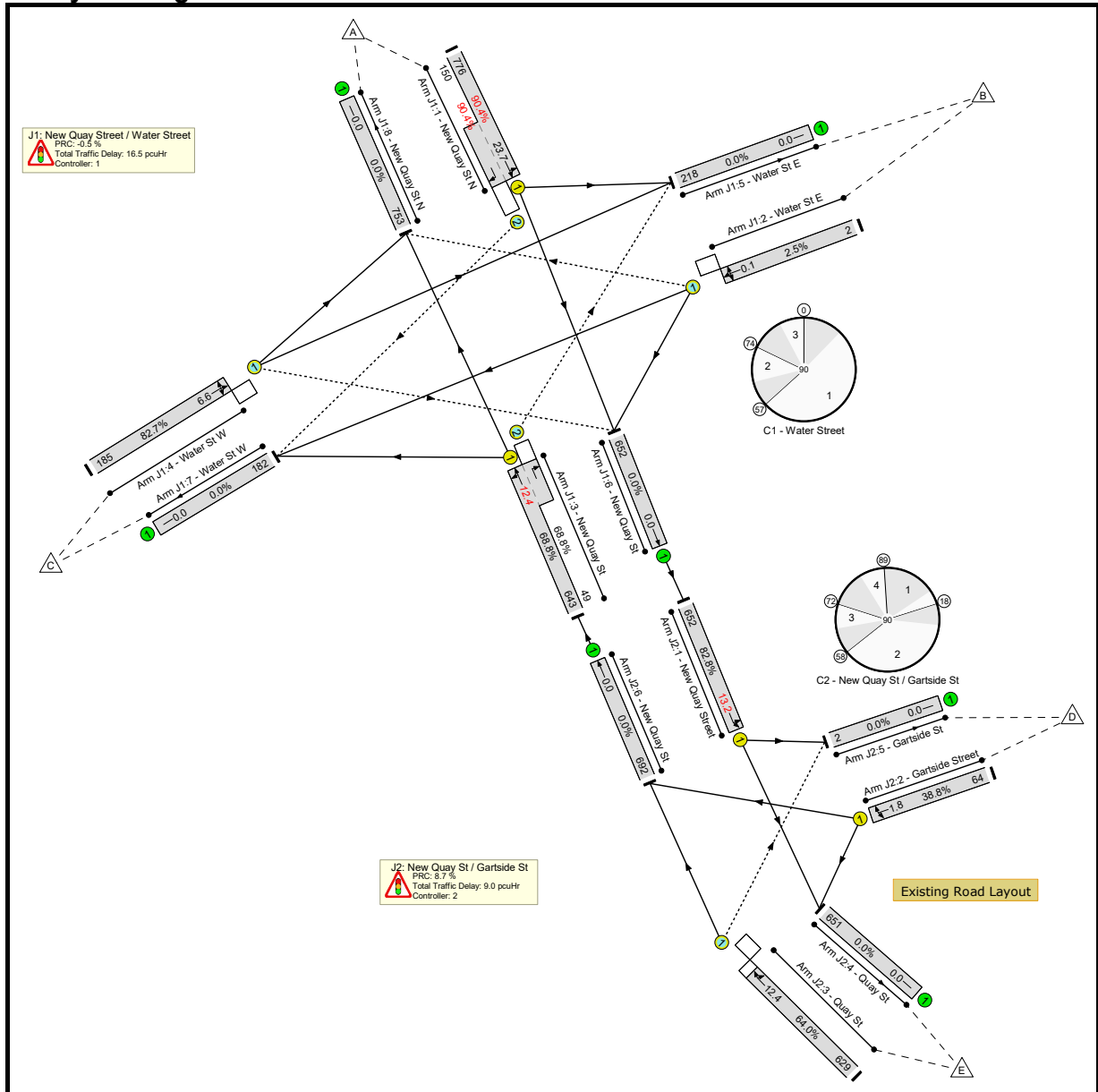
Stage Diagram



Basic Results Summary

Scenario 1: 'DS Water St Open AM' (FG1: 'With Dev Water St Open (Existing) AM', Plan 1: 'Network Control Plan 1')

Network Layout Diagram



Basic Results Summary

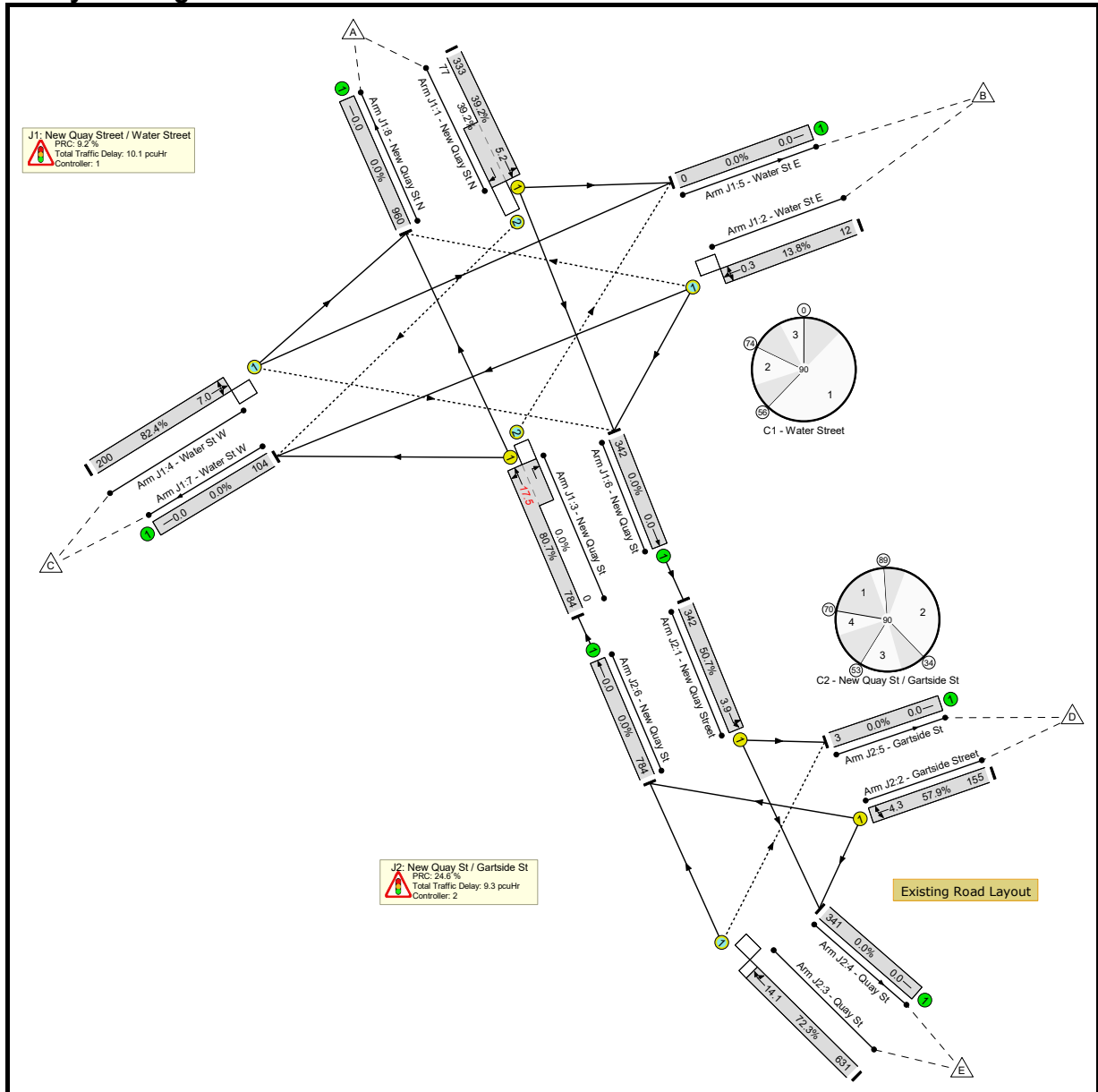
Network Results

Item	Lane Description	Lane Type	Full Phase	Arrow Phase	Num Greens	Total Green (s)	Arrow Green (s)	Demand Flow (pcu)	Sat Flow (pcu/Hr)	Capacity (pcu)	Deg Sat (%)	Turners In Gaps (pcu)	Turners When Unopposed (pcu)	Turners In Intergreen (pcu)	Total Delay (pcuHr)	Av. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)
Network: Quay Street Corridor (Existing Layout)	-	-	-		-	-	-	-	-	-	90.4%	158	0	79	25.5	-	-
J1: New Quay Street / Water Street	-	-	-		-	-	-	-	-	-	90.4%	158	0	79	16.5	-	-
1/1+1/2	New Quay St N Left Ahead Right	U+O	C1:A		1	46	-	926	1876:1868	858+166	90.4 : 90.4%	112	0	38	9.5	37.1	23.7
2/1	Water St E Left Ahead Right	O	C1:C		1	10	-	2	1807	80	2.5%	2	0	0	0.0	66.6	0.1
3/1+3/2	New Quay St Right Left Ahead	U+O	C1:B		1	46	-	692	1906:1912	934+71	68.8 : 68.8%	8	0	41	2.8	14.6	12.4
4/1	Water St W Ahead Right Left	O	C1:D		1	10	-	185	1830	224	82.7%	36	0	0	4.1	80.5	6.6
J2: New Quay St / Gartside St	-	-	-		-	-	-	-	-	-	82.8%	1	0	0	9.0	-	-
1/1	New Quay Street Ahead Left	U	C2:A		1	34	-	652	2025	788	82.8%	-	-	-	4.2	23.1	13.2
2/1	Gartside Street Left Right	U	C2:D		1	7	-	64	1854	165	38.8%	-	-	-	1.0	56.4	1.8
3/1	Quay St Right Ahead	O	C2:B	C2:C	1	44	4	629	1965	983	64.0%	1	0	0	3.8	21.6	12.4
C1 - Water Street				PRC for Signalled Lanes (%):		-0.5		Total Delay for Signalled Lanes (pcuHr):				16.52		Cycle Time (s):		90	
C2 - New Quay St / Gartside St				PRC for Signalled Lanes (%):		8.7		Total Delay for Signalled Lanes (pcuHr):				8.96		Cycle Time (s):		90	
				PRC Over All Lanes (%):		-0.5		Total Delay Over All Lanes(pcuHr):				25.48					

Basic Results Summary

Scenario 2: 'DS Water St Open PM' (FG2: 'With Dev Water St Open (Existing) PM', Plan 1: 'Network Control Plan 1')

Network Layout Diagram



Basic Results Summary

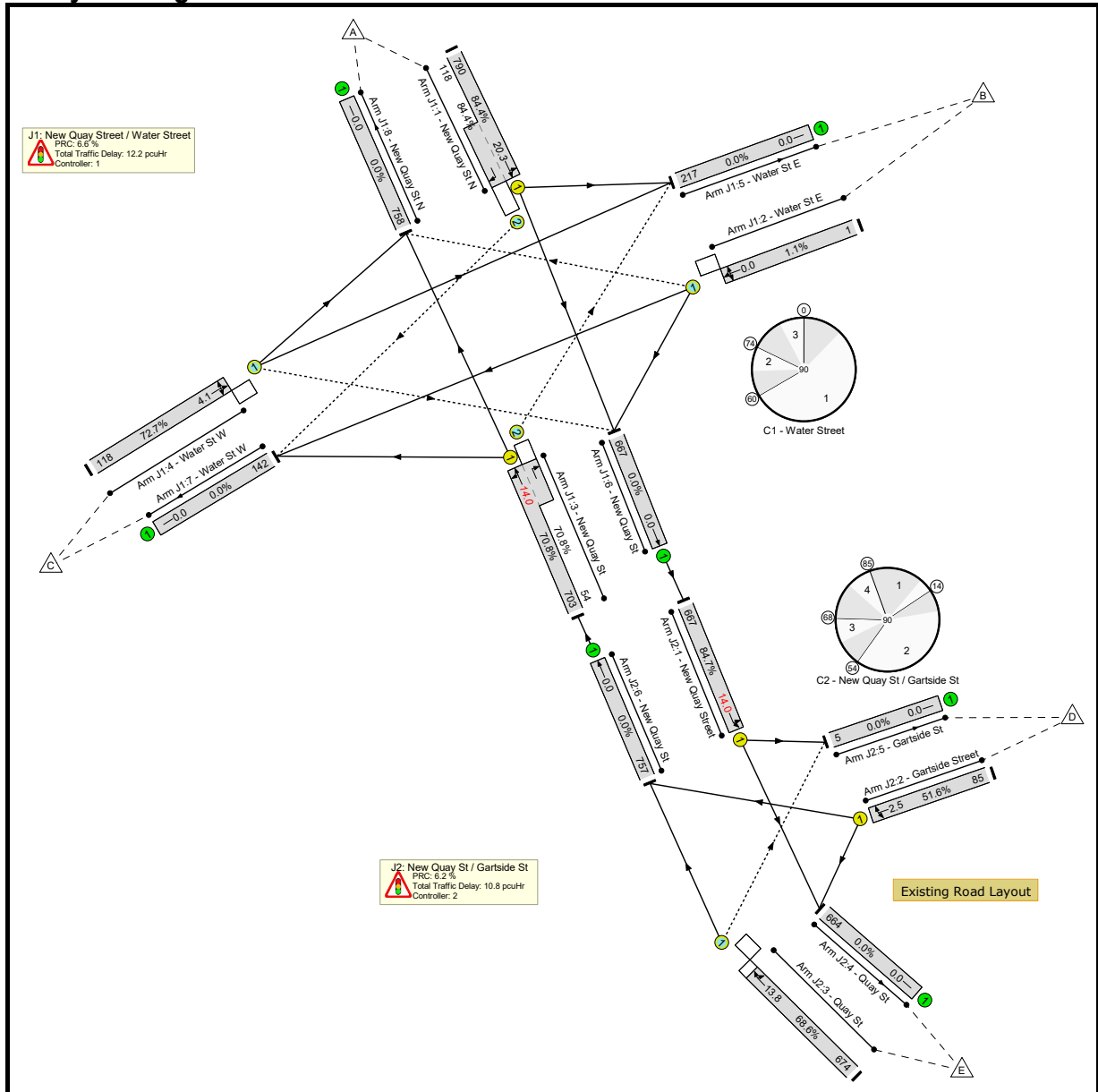
Network Results

Item	Lane Description	Lane Type	Full Phase	Arrow Phase	Num Greens	Total Green (s)	Arrow Green (s)	Demand Flow (pcu)	Sat Flow (pcu/Hr)	Capacity (pcu)	Deg Sat (%)	Turners In Gaps (pcu)	Turners When Unopposed (pcu)	Turners In Intergreen (pcu)	Total Delay (pcuHr)	Av. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)	
Network: Quay Street Corridor (Existing Layout)	-	-	-		-	-	-	-	-	-	82.4%	92	0	5	19.3	-	-	
J1: New Quay Street / Water Street	-	-	-		-	-	-	-	-	-	82.4%	91	0	5	10.1	-	-	
1/1+1/2	New Quay St N Left Ahead Right	U+O	C1:A		1	45	-	410	1915:1868	850+196	39.2 : 39.2%	72	0	5	2.2	19.5	5.2	
2/1	Water St E Left Ahead Right	O	C1:C		1	11	-	12	1801	87	13.8%	11	0	0	0.2	66.5	0.3	
3/1+3/2	New Quay St Right Left Ahead	U+O	C1:B		1	45	-	784	1908:2055	971+0	80.7 : 0.0%	0	0	0	3.4	15.5	17.5	
4/1	Water St W Ahead Right Left	O	C1:D		1	11	-	200	1820	243	82.4%	8	0	0	4.2	76.3	7.0	
J2: New Quay St / Gartside St	-	-	-		-	-	-	-	-	-	72.3%	2	0	0	9.3	-	-	
1/1	New Quay Street Ahead Left	U	C2:A		1	29	-	342	2025	675	50.7%	-	-	-	2.2	23.0	3.9	
2/1	Gartside Street Left Right	U	C2:D		1	12	-	155	1854	268	57.9%	-	-	-	2.2	51.7	4.3	
3/1	Quay St Right Ahead	O	C2:B	C2:C	1	39	4	631	1965	873	72.3%	2	0	0	4.9	27.8	14.1	
C1 - Water Street				PRC for Signalled Lanes (%):			9.2	Total Delay for Signalled Lanes (pcuHr):				10.06	Cycle Time (s):		90			
C2 - New Quay St / Gartside St				PRC for Signalled Lanes (%):			24.6	Total Delay for Signalled Lanes (pcuHr):				9.29	Cycle Time (s):		90			
				PRC Over All Lanes (%):			9.2	Total Delay Over All Lanes(pcuHr):				19.35						

Basic Results Summary

Scenario 3: 'DS Water St Closed AM' (FG3: 'With Dev Water St Closed AM', Plan 1: 'Network Control Plan 1')

Network Layout Diagram

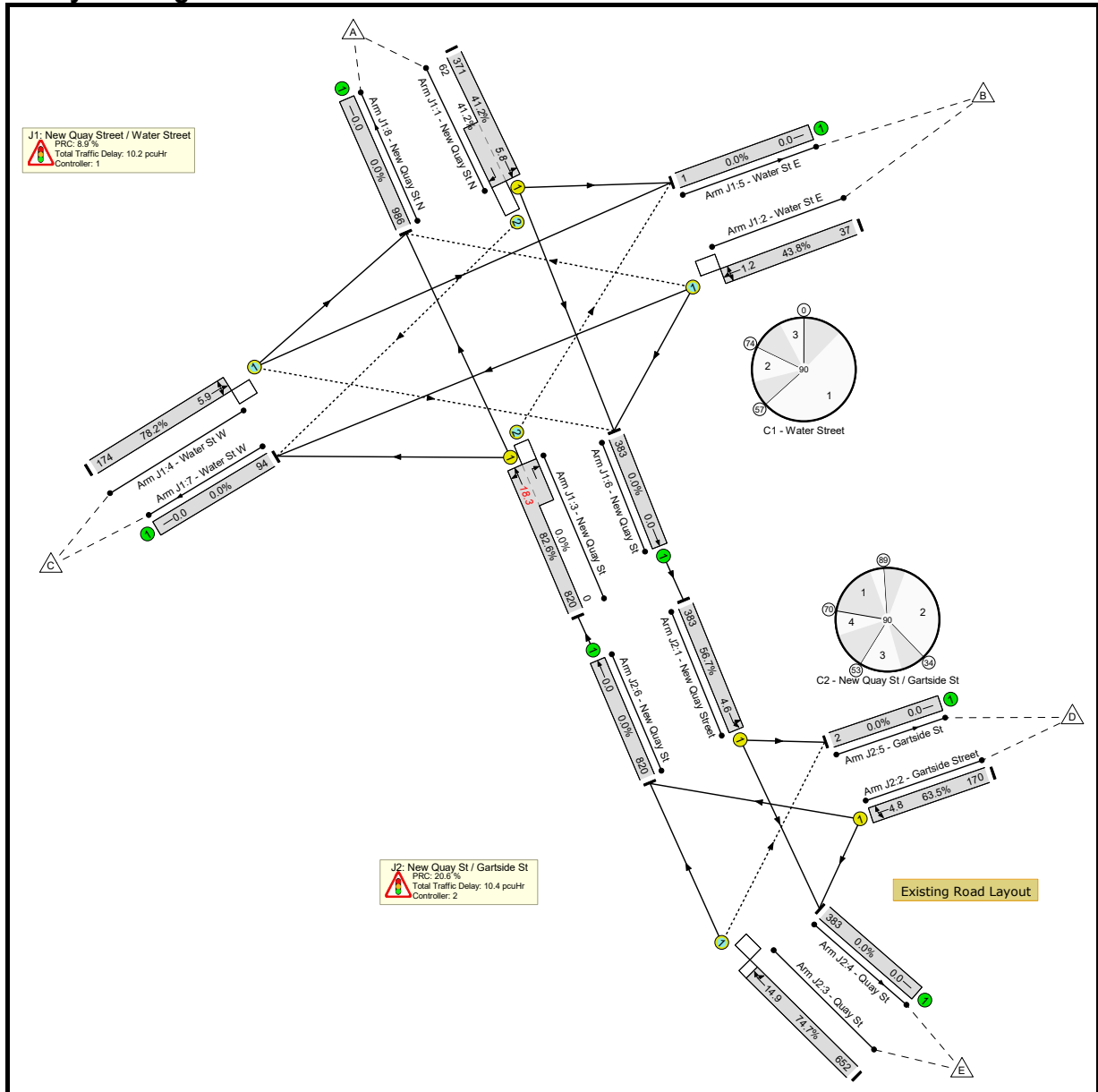


Network Results

Basic Results Summary

Scenario 4: 'DS Water St Closed PM' (FG4: 'With Dev Water St Closed PM', Plan 1: 'Network Control Plan 1')

Network Layout Diagram



Basic Results Summary

Network Results

Item	Lane Description	Lane Type	Full Phase	Arrow Phase	Num Greens	Total Green (s)	Arrow Green (s)	Demand Flow (pcu)	Sat Flow (pcu/Hr)	Capacity (pcu)	Deg Sat (%)	Turners In Gaps (pcu)	Turners When Unopposed (pcu)	Turners In Intergreen (pcu)	Total Delay (pcuHr)	Av. Delay Per PCU (s/pcu)	Mean Max Queue (pcu)
Network: Quay Street Corridor (Existing Layout)	-	-	-		-	-	-	-	-	-	82.6%	106	0	4	20.6	-	-
J1: New Quay Street / Water Street	-	-	-		-	-	-	-	-	-	82.6%	104	0	4	10.2	-	-
1/1+1/2	New Quay St N Left Ahead Right	U+O	C1:A		1	46	-	433	1914:1868	901+151	41.2 : 41.2%	58	0	4	2.2	18.4	5.8
2/1	Water St E Left Ahead Right	O	C1:C		1	10	-	37	1803	85	43.8%	35	0	0	0.8	80.5	1.2
3/1+3/2	New Quay St Right Left Ahead	U+O	C1:B		1	46	-	820	1908:2055	992+0	82.6 : 0.0%	0	0	0	3.6	15.9	18.3
4/1	Water St W Ahead Right Left	O	C1:D		1	10	-	174	1820	222	78.2%	11	0	0	3.5	73.1	5.9
J2: New Quay St / Gartside St	-	-	-		-	-	-	-	-	-	74.7%	2	0	0	10.4	-	-
1/1	New Quay Street Ahead Left	U	C2:A		1	29	-	383	2025	675	56.7%	-	-	-	2.6	24.6	4.6
2/1	Gartside Street Left Right	U	C2:D		1	12	-	170	1854	268	63.5%	-	-	-	2.6	54.4	4.8
3/1	Quay St Right Ahead	O	C2:B	C2:C	1	39	4	652	1965	873	74.7%	2	0	0	5.2	28.8	14.9
C1 - Water Street				PRC for Signalled Lanes (%):		8.9		Total Delay for Signalled Lanes (pcuHr):				10.21		Cycle Time (s):		90	
C2 - New Quay St / Gartside St				PRC for Signalled Lanes (%):		20.6		Total Delay for Signalled Lanes (pcuHr):				10.40		Cycle Time (s):		90	
				PRC Over All Lanes (%):		8.9		Total Delay Over All Lanes(pcuHr):				20.61					

