Base Model Development Report

for RMS Review

60-80 Southern Cross Avenue & 45-65 Hall Circuit – Middleton Grange

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1. Introduction

1.1 Background

TRAFFIX has been commissioned by Manta Group Pty Ltd to undertake an Aimsun micro-simulation assessment in response to both RMS and Liverpool City Council's Requirements dated 27 February 2017. The application relates to the subdivision of the site for a Town Centre comprising of 912 residential units, 20,240m^2 GLA of retail and 2,533m^2 GFA of commercial.

The requirements of the modelling were set out in an inception meeting held between the Roads and Maritime Services (RMS), Liverpool City Council and TRAFFIX on 29 March 2017.

The purpose of this report is to provide the calibration and validation data for the purpose of obtaining approval for the base case models prior to the commencement of the future option assessment.

In this regard the base case model has been assessed taking due account of the RMS Modelling Guidelines to Microsimulation Modelling and other relevant documentation.

1.2 Site and Study Area

Site:

The site is situated approximately 500 metres west of the M7 Motorway Interchange with Cowpasture Road, seven (7) kilometres west of the Liverpool CBD and 40 kilometres south-west of Sydney CBD. The site comprises eight (8) lots.

It is irregular in shape and is bounded by Southern Cross Avenue to the north, Flynn Avenue to the south, Middleton Grange Public School (and vacant land) to the east and residential developments to the west. It is noted that Kingsford Smith Avenue and Flynn Avenue provide access to the site with respect to the wider road network.

A Location and Site Plan for the development are presented in **Figure 1** and **Figure 2**, respectively. The road hierarchy in the vicinity of the precinct is also shown in **Figure 3.**

Study Area:

The study area for the Aimsun model will generally be confined within Middleton Grange with the following roads / streets to be included the assessment:

- Cowpasture Road: an RMS Main Road (MR 648) that runs in a north-south direction between The Horsley Drive in the north and Camden Valley Way in the south. Cowpasture Road carries approximately 27,000 vehicles per day within the vicinity of the site with 'No Stopping' restrictions applying along its length at all times. It is subject to a 70km/h speed zoning in the vicinity of the site and generally carries two lanes of traffic in either direction within a separated carriageway of width 30 metres.

- Fifteenth Avenue: a collector road that runs in an east-west direction between Cowpasture Road in the east and Ramsay Road in the west. It is subject to a 60km/h speed zoning. Fifteenth Avenue carries a single lane of traffic in each direction.

- Kingsford Smith Avenue: a local road that traverses north-south between Mclver Ave in north and Fifteenth Avenue in the south. It is subject to a 50km/h speed zoning however, is also subject to a 40km/h speed zoning during the hours of 7:30am to 9:30am and 2:30pm to 4:00pm during school days. Kingsford Smith Avenue carries a single lane of traffic and kerb side parking in each direction with a carriageway of width 13 metres.

- Southern Cross Avenue: a local road that runs in an east-west direction between Hall Circuit in the east and De Garis Avenue in the west. It is subject to a 50km/h speed zoning however, is also subject to a 40km/h speed zoning during the hours of 8:00am to 9:30am and 2:30pm to 4:00pm during school days. Southern Cross Avenue carries a single lane of traffic in each direction.

- Flynn Avenue: a local road that runs parallel to Southern Cross Avenue between Cowpasture Road in the east and De Garis Avenue in the west. It is subject to a 50km/h speed zoning however, is also subject to a 40km/h speed zoning during the hours of 7:30am to 9:30am and 2:30pm to 4:00pm during school days (located near Kingsford Smith Avenue). This road is identified in the DCP as a neighbourhood centre street with a 26.7 metre reserve and 12.7 metre carriageway. Flynn Avenue carries a single lane of traffic and kerbside parking in either direction.

- Bird Walton Avenue: a local road that runs parallel to Southern Cross Avenue between Bravo Avenue in the east and Kingsford Smith Avenue in the west. It carries a single lane of traffic and kerbside parking in either direction.

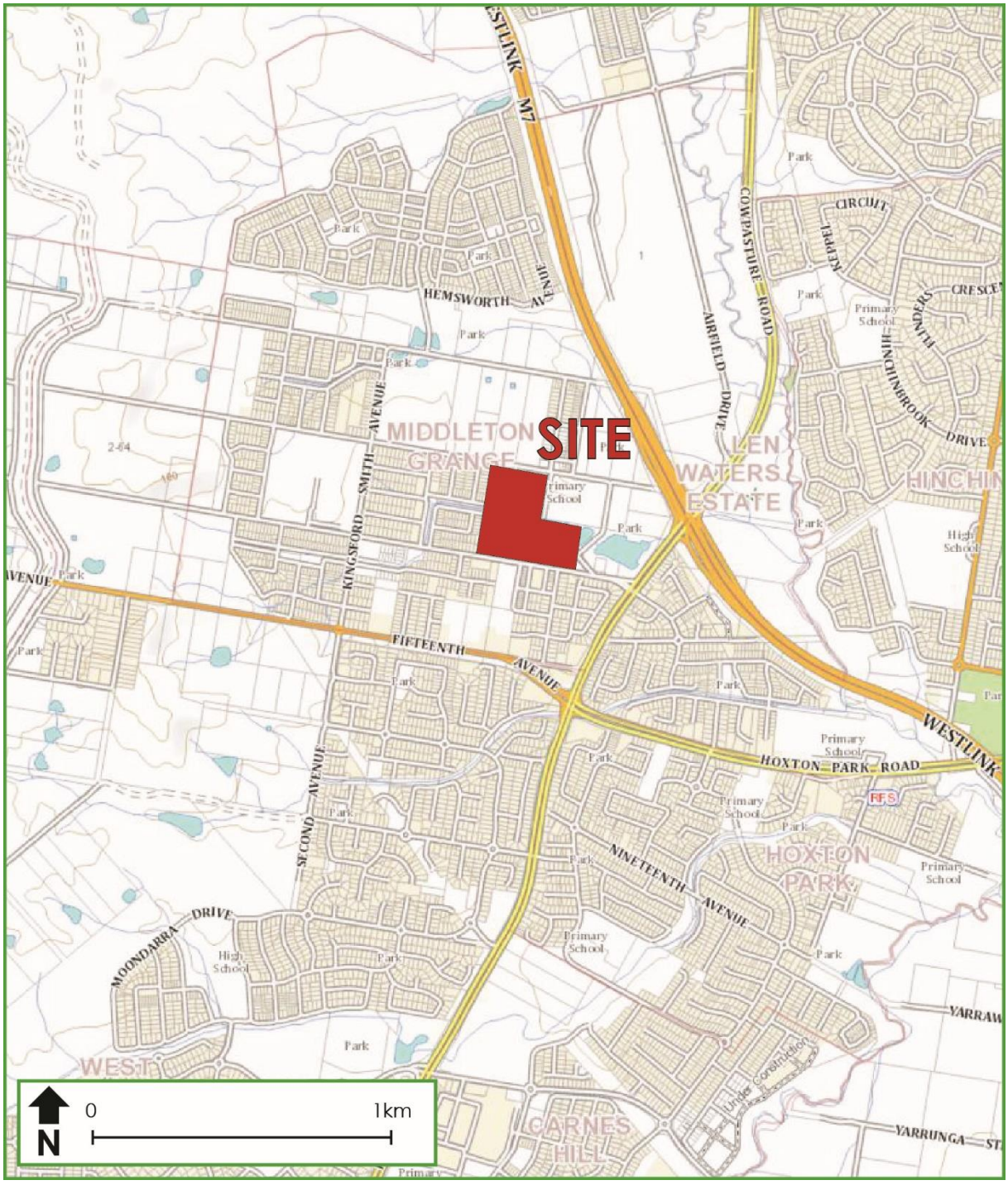

Figure 1: Location Plan

Figure 2: Precinct Plan

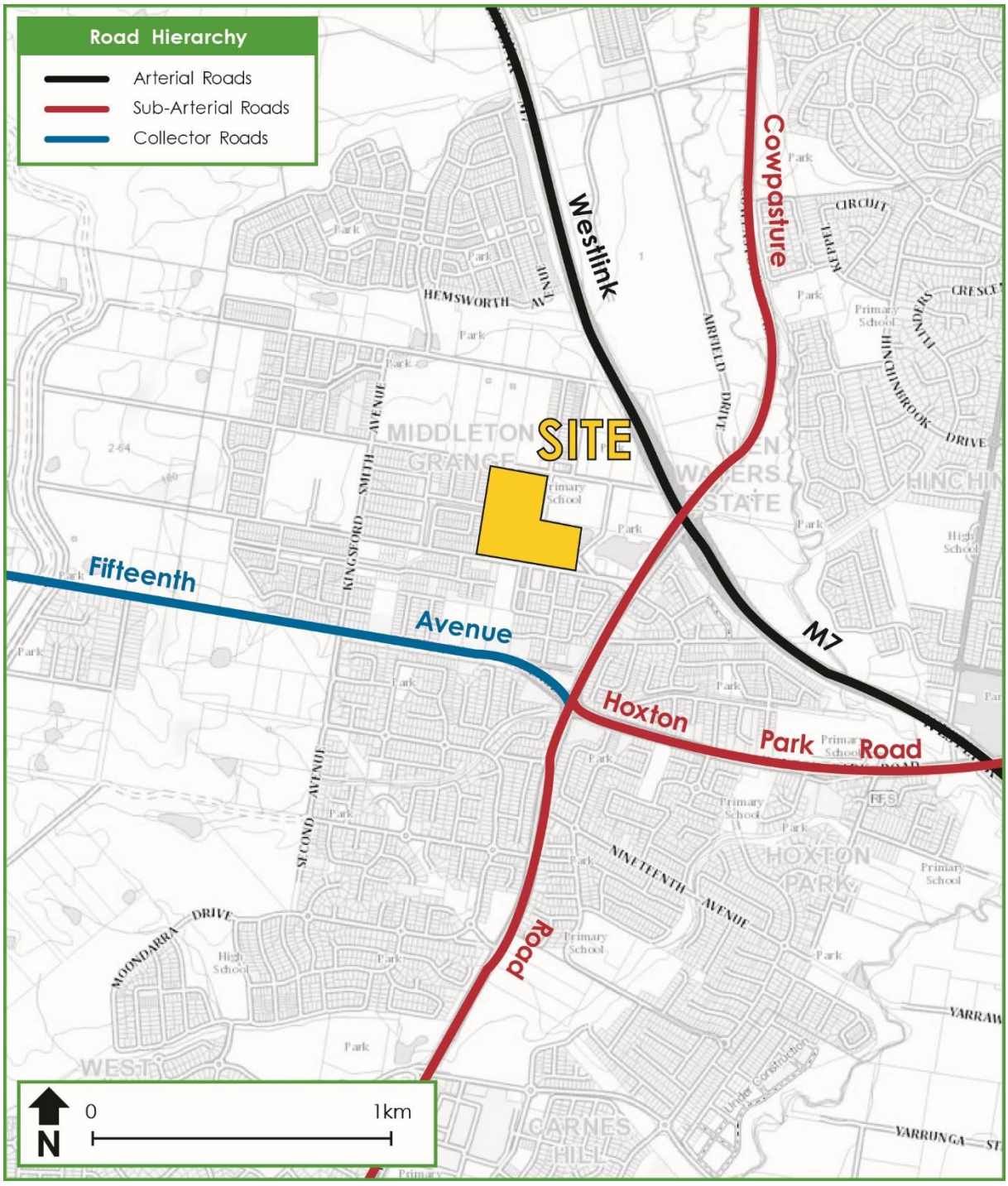

Figure 3: Existing Road Hierarchy

A Study Area Plan and its relationship to the site is presented in **Figure 4** below.

Figure 4: Study area

The dashed line is related to future cases which include Middleton Grange road connection under the M7, with Aviation Road.

1.3 Purpose and Scope of the Model

The purpose of developing a microsimulation model for this study is to assess future impacts associated with development and testing future options, including background growth and network upgrades. This Base Case Development Model provides the foundation for this subsequent stage

The modelled area to the west and south of this area are surrounded by Kingsford Smith Avenue and Fifteenth Avenue respectively while to the east it is bounded by the Cowpasture road. This study area also covers Middleton Drive and Aviation Road to the north.

For this microsimulation modelling, AIMSUN version 8.2.0 microsimulation software package has been adopted; in addition Excel VBA 2016, Python 2.7 and DB Browser for SQLite 3.8 are the other tools used to boost the calibration and validation process

2. Data Collection

Data required for modelling, and the extent of data to be collected were identified in an inception meeting on 29th of March. The collected data included the following:

- Intersection Counts
- Signal layout and signal control plans
- IDM data including signal timing and phasing
- Signal Coordination and Signal offset times
- SCATS detector counts
- Queue length data
- Travel time data
- Data of previous studies

Furthermore, the modelling team also inspected the site and visited the study area both on foot and by car to assess existing conditions during the survey date and obtain additional characteristics of the road network

The intersections included for calibration and validation process are shown in Figure 5.

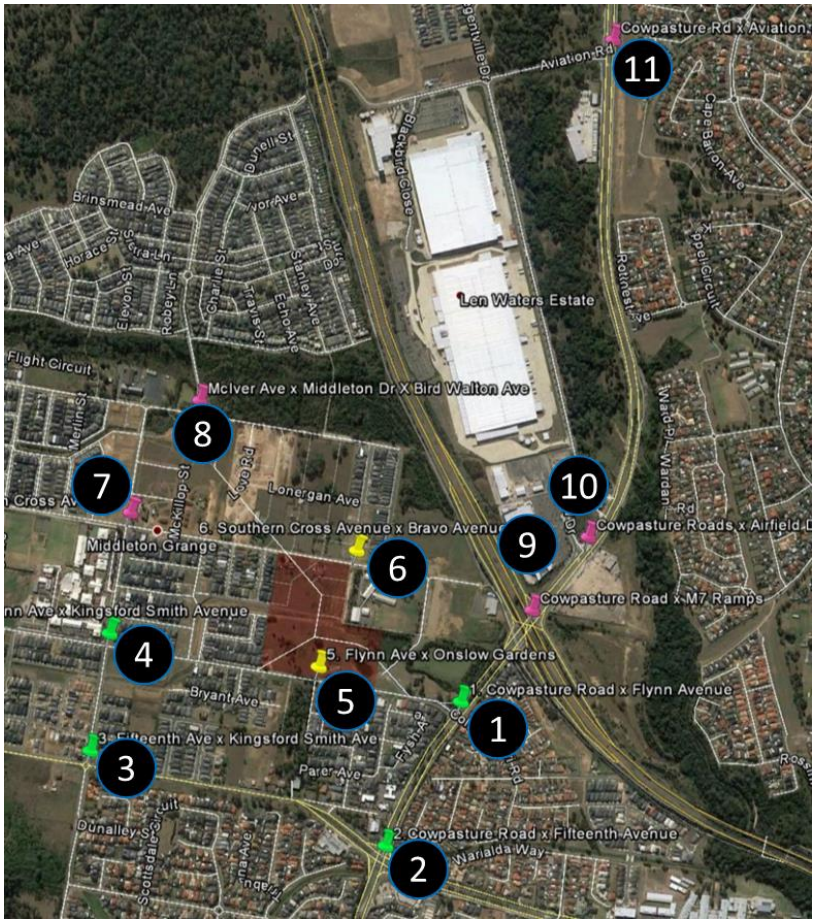

Figure 5: Intersections included in turning movement counts

1. Cowpasture Road / Flynn Avenue
2. Cowpasture Road / Fifteenth Avenue
3. Fifteenth Ave / Kingsford Smith Avenue
4. Flynn Ave / Kingsford Smith Avenue
5. Flynn Avenue / Onslow Gardens
6. Southern Cross Avenue / Bravo Avenue
7. Southern Cross Avenue / Kingsford Smith Avenue.
8. Middleton Drive / Bird Walton Avenue / McIver Avenue
9. Cowpasture Road / M7 Ramps
10. Cowpasture Roads / Airfield Drive
11. Cowpasture Rd / Aviation Road

Intersection turning movement counts for intersections 1 to 6 are based on 2016 surveys, and the rest (intersection 7 to 11) are collected on Thursday 6 April 2017. These survey were in 15 minute intervals between 7:00am and 9:00am and 4:00pm and 6:00pm with distinguishing between heavy and light vehicles.

The application of the collected data is explained with further details in each relevant section of the report including network coding, demand development as well as model calibration and validation.

3. Network Development

3.1 Base Model

All of the road segments have been coded based on the latest aerial photographs provided by Nearmap. AIMSUN open street map data has also been extracted and then corrected based on these latest aerial maps, as well as from the photographic records from the site inspections. The base model (existing) network is shown in **Figure 6**.

Figure 6: The Base Model Network

3.2 Network Coding

Charactrestics of existing transport supply within the area are introduced to the model and all sections were verified and calibrated to represent real conditions through the site visits, photographic records and aerial photography. These sections have been categorised into appropriate types in accordance with their characteristics. Nodes were coded as objects indicating intersecting points of the network, with turning movements and properties subsequently defined.

Road segment properties such as lane widths, lane lengths, number of lanes, direction of travel, road positioning, speed limits, location of bus stops and intersection configurations are set at this stage. Modelling software also allows the user to classify the roads within the model to replicate driver behaviour within each group. The relevant road hierarchy for the study area is shown in figure 7.

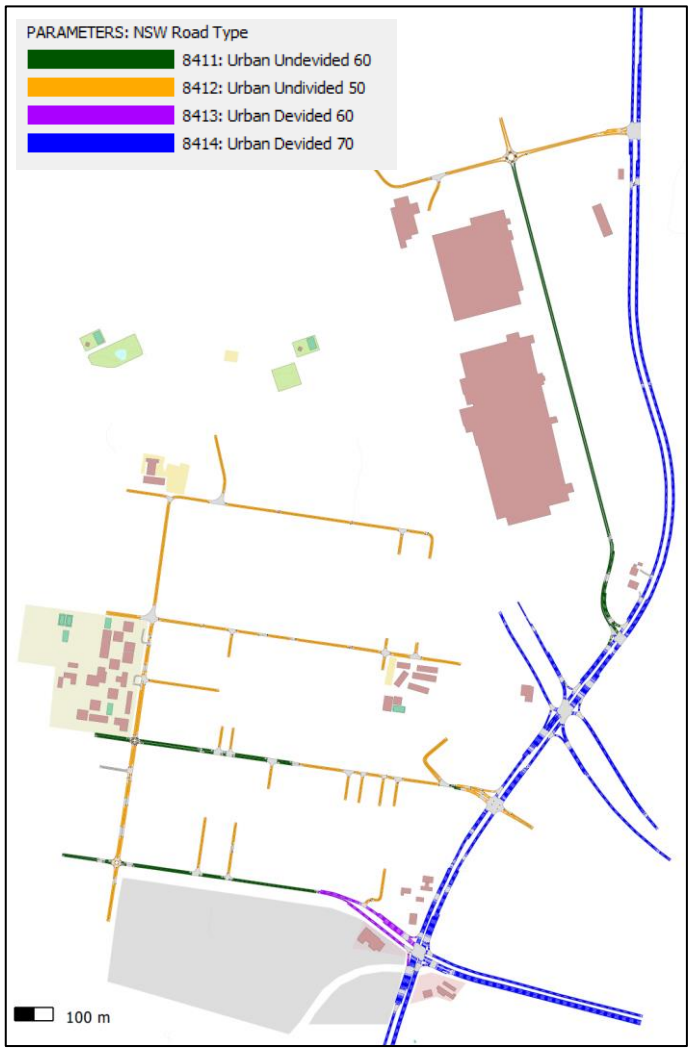

Figure 7: Road Hierarchy

3.3 Signalised Intersections

There are five (5) signalised intersections included in the Aimsun Base model. The intersections are:

- Cowpasture Road / Flynn Avenue
- Cowpasture Road / Fifteenth Avenue
- Cowpasture Road / M7
- Cowpasture Road / Airfield Drive
- Cowpasture Road / Aviation Road

For each of these, the following traffic signal data was obtained from Roads and Maritime Service:

- Intersection Diagnostic Monitor (IDM) data.
- Signal Layout Plans (TCS drawings).
- LX File of the region.

TRAFFIX was provided with a complete set of raw IDMs for Thursday 6th of April, which is in accordance with the onsite survey, data collection and site inspection for the site.

IDM data contains all traffic signal operation statistics at each site on a cycle by cycle basis. These IDM records include traffic signal phases, minimum, maximum and average green time, interphase and cycle time operated during each interval. Overall, the IDM provides a comprehensive snapshot of how the traffic signals operate at each intersection.

Each of the signalised intersections has been coded as ‘actuated’ in the model. All of the signalised intersections along Cowpasture Road (five (5) in total) are configured based on active phases on survey and data collection date. These signals are modelled as coordinated, using average offset times during each peak period on the survey date. The cycle times, minimum, maximum and average green time have been derived from the IDM data and were used as inputs in the model. Moreover, pedestrian signals are included to model their effect on intersections.

3.3.1 Cowpasture Road / Flynn Avenue (Sixteen Avenue)

This is a seven-potential-phase intersection that operates with a phase sequence A-B-C-D-E-F-G and phase sequence D1-D2-F2-G1 and G2 as alternatives for the main phases. A summary of the phasing sequences is provided in **Figure 8**.

Phase G1 is the repeat of B and Phase G2 is the repeat of C. None of these phases operated during AM and PM Peak on collecting IDM data and the intersection operated as A-D-E-G basis during both peaks.

Figure 8: Cowpasture Road / Flynn Avenue phase sequences

3.3.2 Cowpasture Road / Fifteenth Avenue

This is a seven-potential-phase intersection that operates with a phase sequence A-B-C-D-E-F1-G and phase sequence D1-D2-F2-G1 and G2 are alternatives for the main phases. A summary of the phasing sequences is provided in **Figure 9**.

Phase G1 is the repeat of C and Phase F1 is the repeat of D1. None of these phases operated during AM Peak and the intersection operated as A-B-D-E-G basis while phase B was much less frequent than A, D, E and G. In addition, during PM peak the signal operated on A-D-E-G sequences.

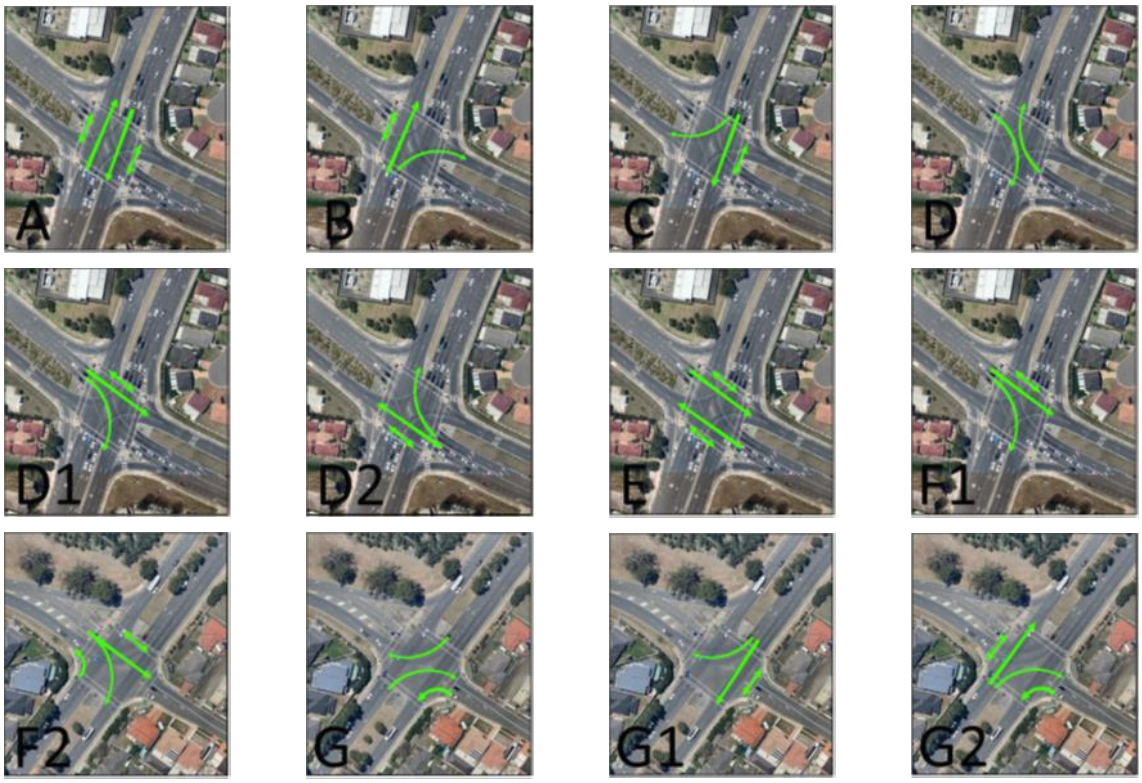

Figure 9: Cowpasture Road / Fifteenth Avenue phase sequences

3.3.3 Cowpasture Road / M7

This is a five-phase intersection that operates with a phase sequence A-B-C-D and E. A summary of the phasing sequences is provided in **Figure 10**.

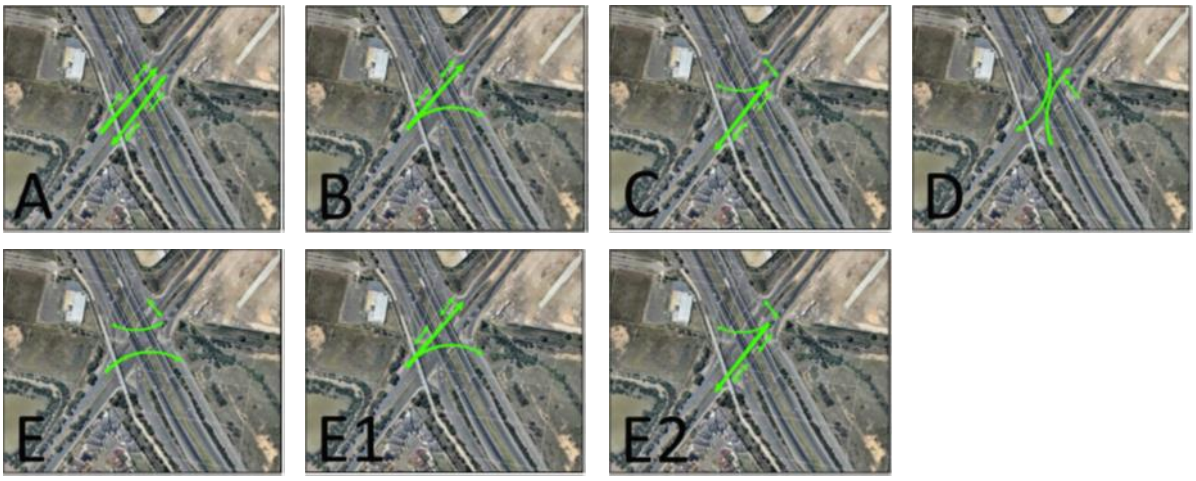

Figure 10: Cowpasture Road / M7

According to IDM data, phase E2, which is the repeat of phase C, and Phase E1, which is the repeat of B were not active during the survey date, and the signal operated on A-D-E sequence.

3.3.4 Cowpasture Road / Airfield Drive

This is a four-phase intersection that operates with a phase sequence A-B-C and D. A summary of the phasing sequences is provided in **Figure 11**.

Figure 11: Cowpasture Road / Airfield Drive

Phase B is less frequent than Phases A and B. According to IDM SCATS data, phase D, which is the repeat of phase B, was not active during the survey date, and the signal generally operated on A-B-C sequence.

3.3.5 Cowpasture Road / Aviation Road

This is a four-phase intersection that operates with a phase sequence A-B-C and D. A summary of the phasing sequences is provided in **Figure 12**.

Figure 12: Cowpasture Road / Aviation Road

Phase C is less frequent than other phases. According to IDM SCATS data, phase D, which is the repeat of phase B, was not active during the survey date, and the signal generally operated on A-B-C sequence.

3.3.6 Signal Coordination and offset times

Signalised intersections within the study area are coordinated for their main phase along Cowpasture Road. This coordination is identified in the site inspections during both AM and PM peak periods. Appropriate scripts is also developed to extract the offset times of consecutive intersections. The results are summarised in **Table 1**.

Table 1: Signal offset times along Cowpasture Road

Reference	Time Period	1. Fifteenth Avenue	2. Sixteenth Avenue	3. M7 Ramps	4. Airfield Drive	5. Aviation Road
Preceding signal	AM Peak	0	27	14	10	-47
	PM Peak	0	-15	-22	-5	20
First Signal (Cumulative offset)	AM Peak	0	27	41	51	4
	PM Peak	0	-15	-37	-42	-22

These offset times are modelled using vehicle actuated control plans with coordinated phases along Cowpasture road.

3.3.7 Queue Lengths at Signalised Intersections

Queue length data for the signalised intersections has been collected to be used for calibration and validation of the model. These queue lengths has been based on recorded videos. The results are the maximum number of vehicles in queue for each approach of the intersection; all lanes combined. The locations of the collected queues on 6th April 2017 are as follows:

- Cowpasture Road / M7 Ramps
- Cowpasture Roads / Airfield Drive
- Cowpasture Rd / Aviation Road

It should be noted that journey route time data sets cover main road segments within the study area and this supplementary queue length data is collected to enable additional checks. Queue length results in each approach is shown in **Table 2**.

Table 2: Queue Length survey results

Time		Cowpasture Road/ M7 Ramps				Cowpasture Roads/ Airfield Drive			Cowpasture Rd/ Aviation Road		
Start	End	NA	EA	SA	WA	NA	SA	WA	NA	SA	WA
7:00	7:15	9	8	24	10	10	8	5	5	10	3
7:15	7:30	16	6	18	8	11	9	6	7	15	2
7:30	7:45	20	7	25	10	18	11	5	12	15	3
7:45	8:00	15	8	25	9	20	15	4	11	16	4
8:00	8:15	14	6	18	7	17	16	7	15	17	2
8:15	8:30	14	5	16	6	11	9	6	10	18	2
8:30	8:45	12	3	16	5	15	7	5	10	14	2
8:45	9:00	11	4	15	5	9	7	6	9	12	2
16:00	16:15	27	6	20	10	18	28	4	10	10	2
16:15	16:30	24	8	15	8	15	22	5	15	10	2
16:30	16:45	28	4	18	10	16	25	5	12	14	2
16:45	17:00	20	4	18	8	8	28	4	12	12	2
17:00	17:15	22	8	16	9	16	25	6	15	10	2
17:15	17:30	16	5	12	8	14	22	6	16	8	2
17:30	17:45	16	4	11	10	17	26	5	17	10	3
17:45	18:00	15	5	11	8	15	20	4	12	7	2
18:00	18:15	19	5	10	10	12	19	4	10	8	2
18:15	18:30	16	5	11	7	15	17	4	9	8	2

Note: SA: South Approach EA: East Approach WA: West Approach NA: North Approach

3.4 Priority Intersections

There are several priority intersections in the study area and six (6) of them are included in turning movement count surveys and further calibration and validation process. The priority intersections were coded based on existing give way priority road rules, noting that U-Turn movements are prohibited at these intersections:

- Fifteenth Ave / Kingsford Smith Avenue
- Flynn Ave / Kingsford Smith Avenue
- Flynn Avenue / Onslow Gardens
- Southern Cross Avenue / Bravo Avenue

- Southern Cross Avenue / Kingsford Smith Avenue.
- Middleton Drive / Bird Walton Avenue / Mclver Avenue

3.5 Vehicle Speeds

The maximum speed of vehicles in sections of road network are defined based on posted speeds and observed traffic signs. A summary of these speeds is the following:

- Cowpasture Road 70 Km/h;
- Fifteenth Avenue 60 Km/h;
- Kingsford Smith Avenue 50 Km/h, and subject to a 40km/h speed zoning during the hours of 7:30am to 9:30am and 2:30pm to 4:00pm during school days;
- Southern Cross Avenue 50 Km/h, and subject to a 40km/h speed zoning during the hours of 8:00am to 9:30am and 2:30pm to 4:00pm during school days;
- Flynn Avenue 50 Km/h, and subject to a 40km/h speed zoning during the hours of 8:00am to 9:30am and 2:30pm to 4:00pm during school days;
- Onslow Gardens 50 Km/h;
- Bravo Avenue 50 Km/h;
- Middleton Drive 50 Km/h;
- Bird Walton Avenue 50 Km/h;
- Mclver Avenue 50 Km/h

To model school zone conditions a python script automatically changes the section speeds when the time is within school zone hours.

3.6 Public Transport

The existing bus routes and their characteristics has been modelled in the AIMSUN. There are four bus routes that traverse roads within the study area:

- Route 852 – Carnes hill to Liverpool via Greenway Dr & Cowpasture Road
- Route 853 – Carnes hill to Liverpool via Hoxton Park Road.
- Route 854 – Carnes hill to Liverpool via Greenway Dr & Hoxton Park Road.
- Route 855 – Rutleigh Park to Liverpool via Austral & Leppington Station.

The AM and PM peak timetables have been reviewed for each route and the timetables with the corresponding headways have been coded in the model. Each bus therefore arrives according to its timetable. Bus stops has been coded based on their real locations.

4. Demand Development

All available data was used to define the traffic demand in Aimsun for the existing demand. The existing traffic volumes are determined from the following sources:

- Traffic counts, and
- Turning movement counts.

The counts were carried out for two (2) hours during AM period from 7:00 to 9:00 and for two and half (2.5) hours during PM period from 14:00 to 16:30 and recorded in 15 minutes increments. The vehicles are classified as light and heavy vehicles. The number of heavy vehicles has been taken directly from the classified traffic surveys.

4.1 Peak Periods and Profiles

The traffic count data demonstrated the following AM and PM peak periods and accordingly, these time periods were adopted for the model:

- AM: 7:30am to 8:30am,
- PM: 4:45pm to 5:45pm.

Sufficient traffic count data was collected to allow traffic profiles to be established at 15 minute intervals over the AM and PM peak periods. **Table 3** provides these profiles, calculated by summing the approach volumes on all major intersections every 15 minutes.

Table 3: Traffic Profiles

AM Period	% of Peak	PM Period	% of Peak
07:30 - 07:45	25.4%	16:45 - 17:00	24.4%
07:45 - 08:00	25.6%	17:00 - 17:15	25.4%
08:00 - 08:15	25.0%	17:15 - 17:30	24.9%
08:15 - 08:30	24.0%	17:30 - 17:45	25.3%

Separate traffic demands for adequate warm-up period of 30 minutes during each peak (which is also not less than the longest trip) has also been included in the model to ensure the network is populated prior to the data collection period.

In addition to existing demand, at next stage of modelling which is related to future scenarios, the future traffic demand will also be included in the model. This demand will reflect background traffic growth and the additional demand generated by development during AM and PM peak periods.

4.2 Saturday Traffic

To identify the extent of additional impacts a separate Saturday model could assess, and if demand development for Saturday may change the outcome of study, a separate data analysis is undertaken. To do so, at first step SCATS detectors counts of intersections experiencing most delay and highest volumes, for both Weekday and Saturday condition is obtained. Afterwards, maximum hourly traffic volumes entering these intersections are extracted and summarised in Table 4. The results indicate lower levels of traffic on Saturday peaks in comparison with weekday conditions.

Table 4: Throughput of major intersections near the site

Intersection	Weekday peak (Hourly)	Saturday Peak (Hourly)	Ratio (WD/Sat)
Cowpasture Road / Fifteenth Avenue	4938	4030	23%
Cowpasture Road / Flynn (Sixteenth) Avenue	4144	3504	18%

Data suggests that existing throughput of major intersections in vicinity of the site during weekday peak hours are about 18 to 23 percent greater than that of Saturday.

Accordingly, models for am and pm peak periods during the modelled weekday are reflective of more critical conditions.

5. Model Stability

The model has been run under different seed numbers. A model is considered 'stable' when it produces similar and comparable results between runs. The AM and PM models have been run using the standard seed numbers (28, 2894, 560, 86524 and 7771) as defined in the RMS Modelling Guide.

The total travel time in the network can be used as an indication of model stability. The travel times for each seed run is provided in **Table 5 and Table 6** during AM and PM peak period of 7:30-8:30am and 16:45-17:45pm respectively. It is noted that each run included a 30 minutes warm-up period prior to the start of data collection period.

Table 5. Total Travel time in Network during AM Peak

Seed Value	AM Total Travel Time (h)
560	500
28	524
7771	489
86524	507
2849	518
Average	503

Table 6. Total Travel time in Network during PM Peak

Seed Value	PM Total Travel Time (h)
560	389
28	416
7771	409
86524	415
2849	415
Average	409

Some sections of the existing network experience significant queues and delays; however, no blockage occurs in the network and the number of vehicles waiting to enter is zero. Tables 5 and 6 demonstrate that the total travel time in the network are comparable between the various runs over the period 7:30-8:30am and 16:45-17:45pm. Both the AM and PM models are therefore considered stable.

6. Model Calibration and Validation

To show if the model represents real traffic conditions within the area, the modelling outputs are examined in comparison with observed values. This includes a comparison of observed and modelled traffic volumes, journey time, queue lengths, and signal timing and phasing.

The criteria used to calibrate and validate the models have been adopted from the microsimulation modelling section of the RMS Traffic Modelling Guidelines.

After checking the model stability, the model has been validated with the use of network statistics stored in model database and outputs generated by the model with statistics based on observed on-site data sets.

6.1 Traffic Volumes

According to Table 11.2 of the Microsimulation Modelling – RMS Modelling Guidelines, the following criteria is used to test the validity of traffic flows.

- Flows<99- to be within 10 vehicles of observed value
- Flows 100 to 999- to be within 10 percent of observed vehicles
- Flows 1000 to 1999- to be within 100 vehicles of observed values
- Flows >2000 - to be within 5 percent of observed value
- 100 percent of observations to be within tolerance limits
- R^2 value to be included with plots and to be >0.95

The full set of modelled and observed data, and their relative differences is provided in **Appendix B**. **Figure 13** and **Figure 14** show plots of observed and modelled traffic flows during the AM peak hour. **Figure 15** and **Figure 16** also show plots of observed and modelled traffic flows during the PM peak hour.

It should be noted that many studies use GEH as the criterion of model calibration and target to have volumes with GEH less than five (5) for about over 85 percent of individual turns. Since this study has

used a more rigorous criteria, the latter criteria is fully met and all GEH at the level of turning movement are below two (2).

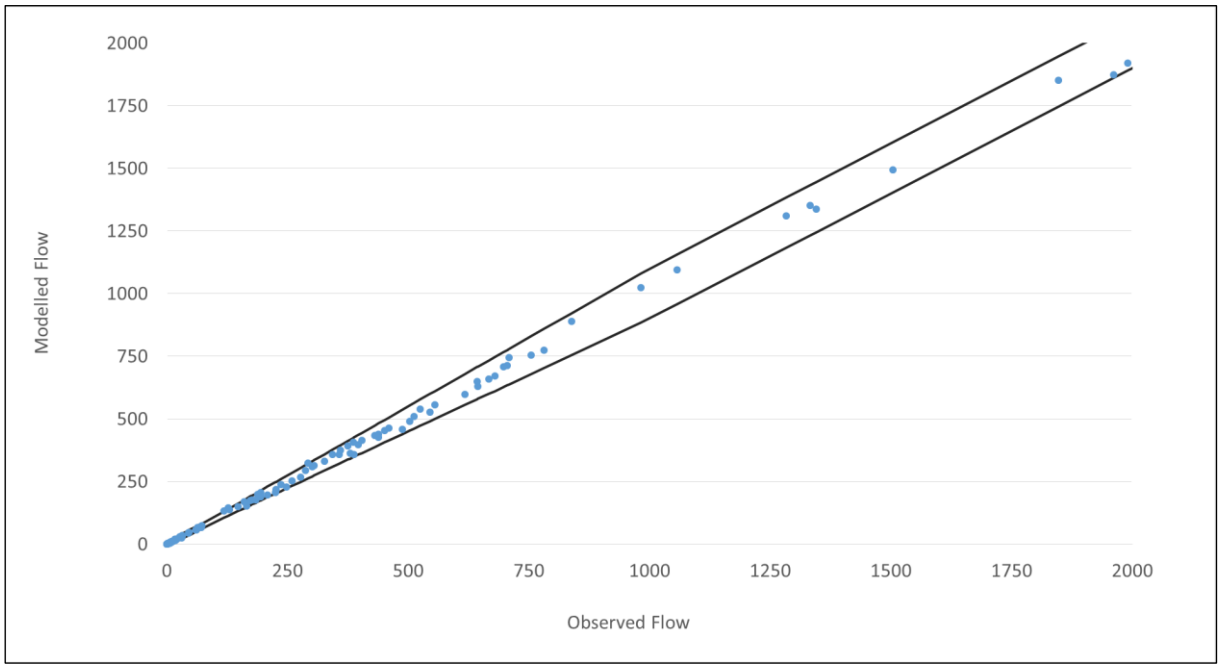

Figure 13. AM peak observed and modelled traffic flows

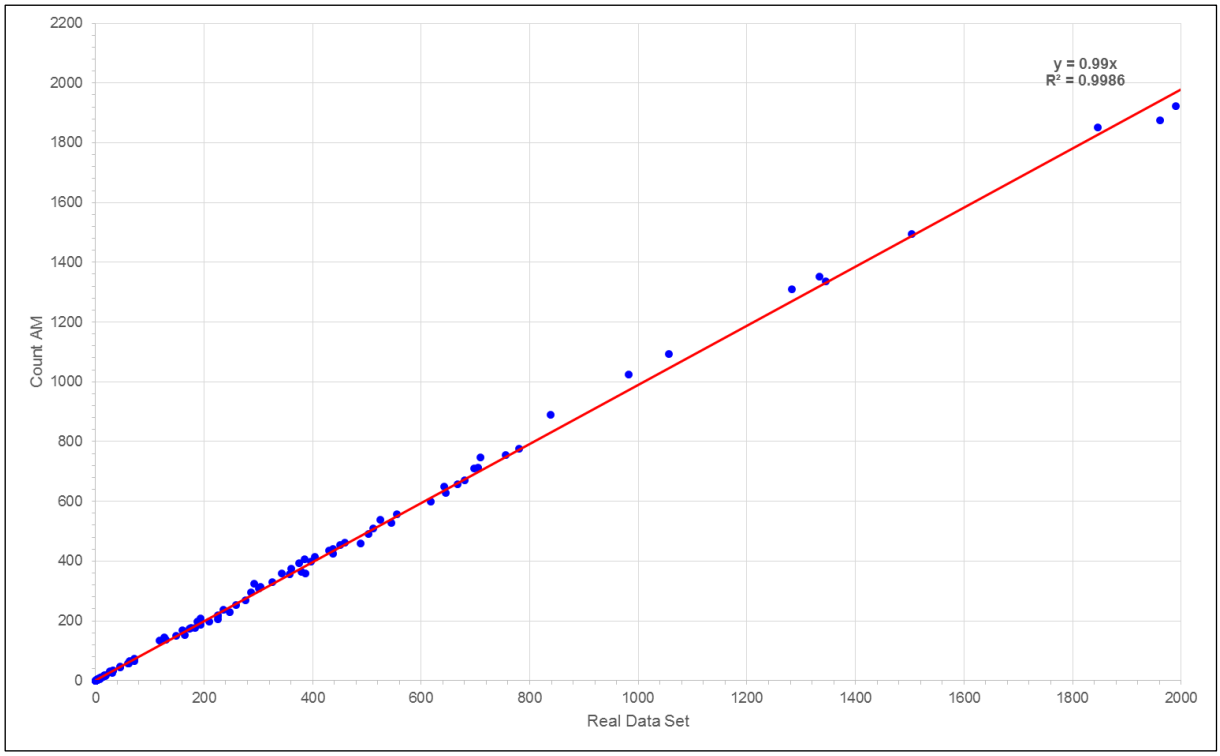

Figure 14. AM peak observed and modelled traffic flows

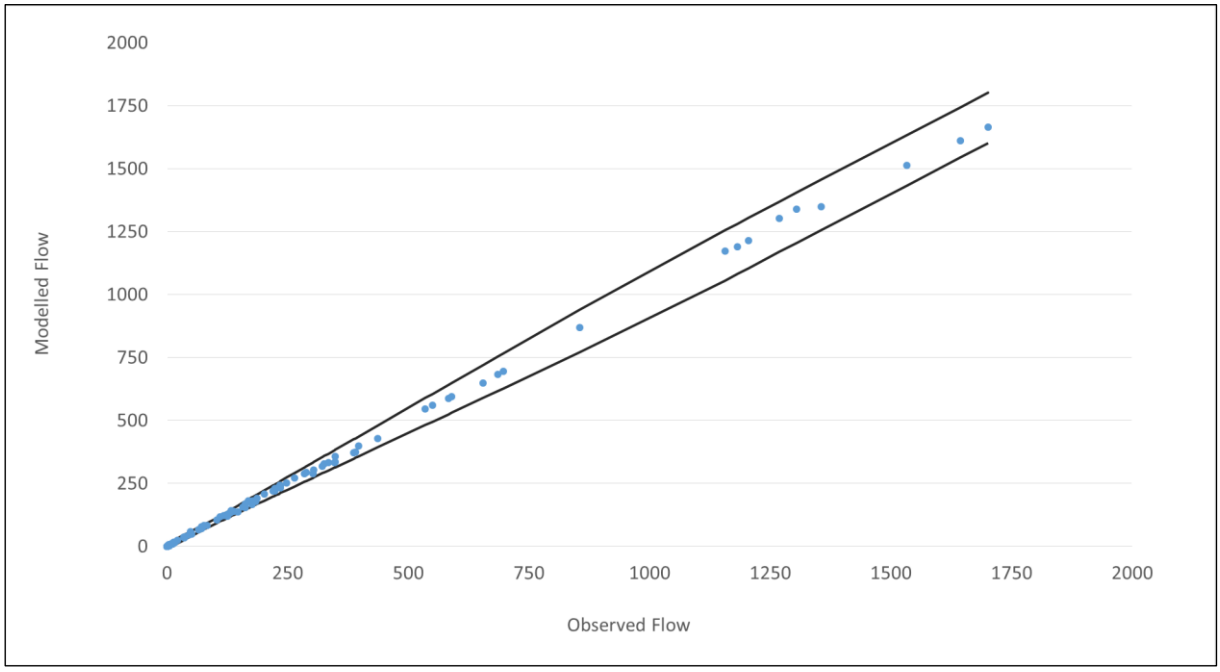

Figure 15. PM peak observed and modelled traffic flows

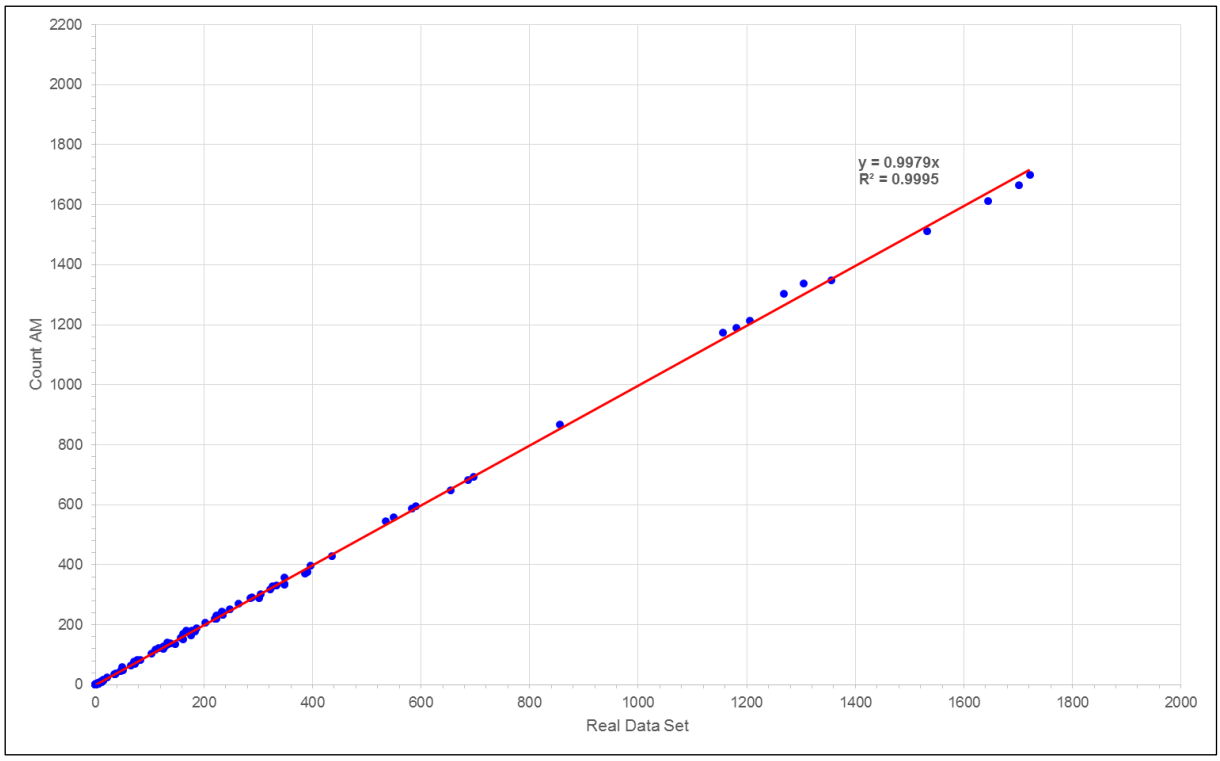

Figure 16. PM peak observed and modelled traffic flows

6.2 Journey Time Routes

The observed and modelled journey times along the routes shown in **Figure 17** are compared to control whether the model generates outputs similar to real conditions. **Table 7** below presents that the difference of average observed and modelled journey times during the AM and PM peak periods are within 15 percent tolerance limit or less than one minute.

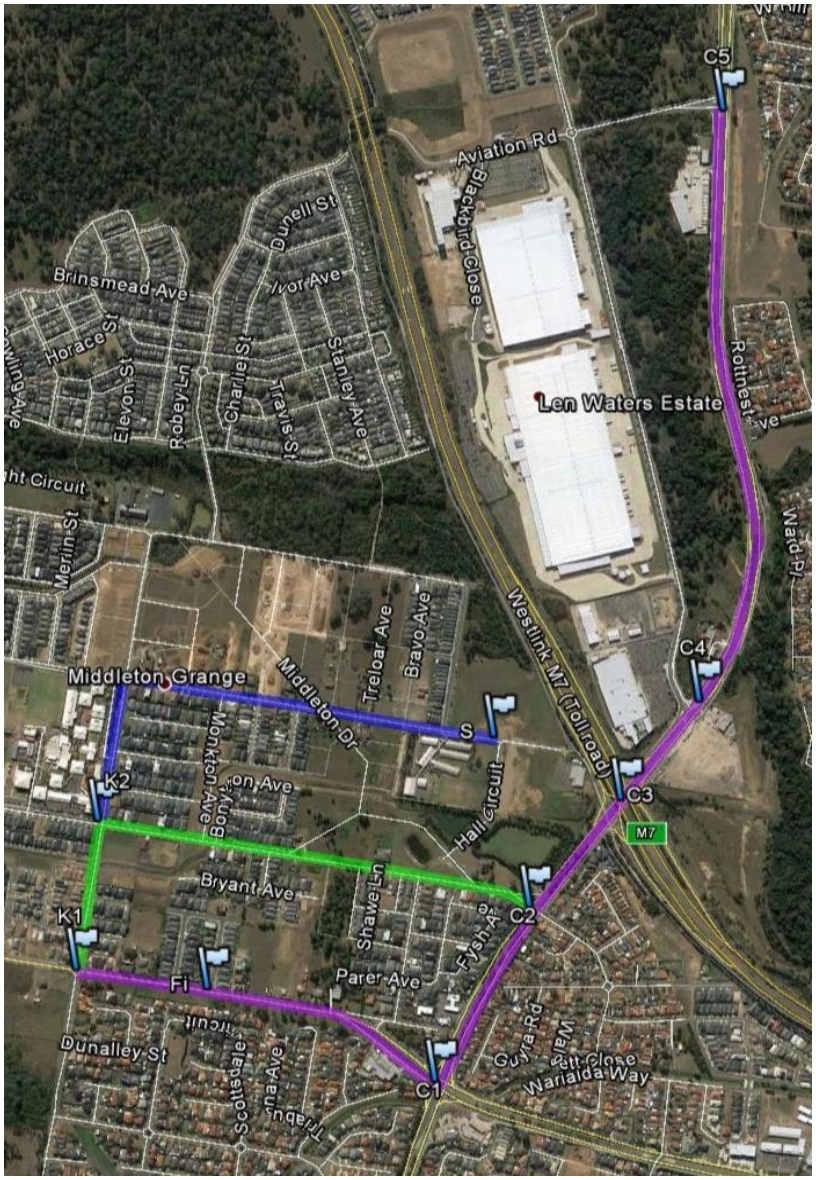

Figure 17. Journey Time Routes

Table 7: Journey Travel time calibration

Route	AM Peak			PM Peak			Control
	Average Observed (Sec)	Average Modelled (Sec)	Absolute difference (Sec)	Average Observed (Sec)	Average Modelled (Sec)	Absolute difference (Sec)	Difference <60 Sec or <15%
Route 1 from West to East and then to the North	377	384	6	317	295	22	✓
Route 1 from North to South and then to the West	366	365	1	377	321	56	✓
Route 2 from East to West and then to the South	162	183	22	177	139	38	✓
Route 2 to North and East	164	175	11	187	137	50	✓
Route 3 from East to West and then to the South	142	150	8	145	133	12	✓
Route 3 from West to North and East	143	142	1	153	128	25	✓

The AM and PM models therefore meet the validation criteria related to journey travel times.

6.3 Queue Length

The queue length survey encompassed all approaches for signalised intersections surveyed in 6 April 2017.

In this study, the queue lengths at the surveyed intersections are compared to model outputs during both AM and PM peak periods. **Table 8** provides a comparison between maximum observed queue lengths and maximum modelled queue lengths for each of the intersections. This shows that the model queues are comparable to real observed values.

It should be noted that the maximum queue length generated by model at some intersection legs may not be the same as that observed values. The random driving behaviour, differences between arrival rates as well as limitations in ordinary surveys to cover long queues would be some reasons causing these queue length differences.

Table 8: AM and PM comparison of queue length

Intersection	Approach	AM		PM	
		Observed max queue	Model max queue	Observed max queue	Model max queue
Cowpasture Road/ M7 Ramps	North	20	19	near capacity	near capacity
	East	8	9	8	12
	South	25	31	18	28
	West	10	13	10	19
Cowpasture Roads/ Airfield Drive	North	20	19	17	21
	South	16	14	28	27
	West	7	12	6	7
Cowpasture Rd/ Aviation Road	North	15	12	17	17
	South	18	15	12	21
	West	4	5	3	3

It can be seen from **Table 8** that the maximum modelled queue lengths are comparable with the maximum observed queues and therefore the modelled queues are considered representative of existing conditions.

6.4 Signal Timing

To measure the similarity of traffic signals in the model and the reality, the modelling outputs are compared with the observed datasets, provided by RMS in the form of relevant SCATS output. In section 3.3 the inclusion of coordinated traffic signals in the model as actuated traffic signal controls has been explained.

Table 9 compares the average percentage of signal phases generated by the model with the percentages of corresponding active phases in real datasets during am peak. **Table 10** shows the same contents during PM peak.

To obtain these tables, Aimsun is set to record traffic control events into the model database and using SQL queries, data required for this comparison is extracted. A separate datasheet and script is also prepared to extract data sets of observed phase percentages from raw IDM data.

According to the outputs of the model, the operation of the signal cycles and timings are considered similar to the recorded on-street operation.

Table 9: AM peak observed and model simulated phase time

Intersection	Active Phases	Average Phase Time Observed	Average Phase Time Simulated	Difference
Cowpasture Road/ Fifteenth Avenue	A	39.2%	35.9%	3.3%
	D	16.5%	18.1%	-1.6%
	E	25.6%	25.6%	0.1%
	G	18.7%	20.4%	-1.8%
Cowpasture Road/ Flynn Avenue (Sixteenth Ave)	A	59.4%	54.7%	4.7%
	D	12.9%	15.4%	-2.5%
	E	14.2%	14.8%	-0.5%
	G	13.4%	15.1%	-1.7%
Cowpasture Road/ M7 Ramps	A	66.2%	64.8%	1.3%
	D	17.0%	17.3%	-0.3%
	E	16.9%	17.8%	-1.0%
Cowpasture Roads/ Airfield Drive	A	72.8%	72.5%	0.3%
	B	12.1%	12.4%	-0.3%
	C	15.1%	15.1%	-0.1%
Cowpasture Rd/ Aviation Road	A	79.4%	81.0%	-1.6%
	B	10.3%	10.1%	0.1%
	C	10.3%	8.8%	1.5%

Table 10: PM peak observed and model simulated phase time

Intersection	Active Phases	Average Phase Time Observed	Average Phase Time Simulated	Difference
Cowpasture Road/ Fifteenth Avenue	A	47.4%	43.4%	4.0%
	D	16.5%	18.3%	-1.7%
	E	20.3%	21.6%	-1.3%
	G	15.7%	16.7%	-1.0%
Cowpasture Road/ Flynn Avenue (Sixteenth Ave)	A	59.7%	55.8%	3.9%
	D	11.8%	13.7%	-1.9%
	E	12.9%	11.3%	1.6%
	G	15.6%	19.2%	-3.6%
Cowpasture Road/ M7 Ramps	A	65.1%	67.1%	-1.9%
	D	18.1%	19.3%	-1.2%
	E	16.8%	13.6%	3.1%
Cowpasture Roads/ Airfield Drive	A	68.0%	71.1%	-3.1%
	B	13.3%	12.8%	0.4%
	C	18.7%	16.1%	2.7%
Cowpasture Rd/ Aviation Road	A	70.8%	74.1%	-3.3%
	B	15.3%	13.2%	2.1%
	C	13.9%	12.7%	1.1%

7. Summary

The purpose of modelling at this stage is to prepare the Base Case Model which will subsequently be used to assess the impact of development and future scenarios.

The model stability is checked and the reliability of Base Model has been assessed by comparisons of traffic volumes, queue lengths, travel times, and signal timing and phasing as following:

Model stability	Total travel times generated by using five different seeds are compared in order to show the stability of the model; additional controls also show that no blockage occurs within the network and vehicles do not queue outside of study area
Modeled traffic volumes versus observed volumes	All turning movement volumes generated by the models are near to the observed values in 11 surveyed intersections. All GEH values are less than 2 and the volumes are within the limits required by RMS modelling guidelines.
Modelled journey route times versus observed values	The travel times generated by the model are compared with observed values. All the differences between observed average route travel time and outputs of the model are less than one (1) minute.
Modelled signal phasing timing versus real signal phasing and timing	Signal phasing and timing assigned by vehicle actuated control plans with signal coordination are near to that extracted from IDM data of survey date and with less than 5 percent difference.
Modelled queue lengths versus observed queues	Traffic queue lengths are comparable to observed surveyed values indicating the same overall traffic behaviours within the study area

The calibration and validation of the AM and PM base models demonstrates that the models are stable and representative of the observed traffic conditions. In this regard, both the AM and PM models are considered adequate for future year scenario testing and traffic impact assessment.

Appendix A

Photographic records

View looking West along Flynn Avenue at Flynn Avenue / Kingsford Smith Avenue

View looking north along Kingsford Smith Avenue

View looking south along Kingsford Smith Avenue
at Kingsford Smith Avenue / Southern Cross Avenue

View looking north along Onslow Gardens

View looking west along Flyn Avenue at Flyn Avenue / Onslow Gardens

View looking north along Cowpasture Road
at Copasture Road / Flyn (Sixteenth) Avenue

View looking at Cowpasture Road / Airfield Drive

View looking south along Cowpasture Road at Cowpasture Road / Fifteenth Avenue

View looking south at Cowpasture Road / Sixteenth Avenue, pm peak

View looking south along Cowpasture Road at Cowpasture Road / M7 Ramps, pm peak

Appendix B

Traffic Volume Calibration

AM Peak Turning Movement Statistics

Object	Count - Real Data Set AM - All	Count - AM Model- All	Absolute Difference	Relative Difference (%)	GEH
8442	1533	1513	-19.98	-1.30	0.51
8443	232	235	3.23	1.39	0.21
8448	178	180	2.55	1.44	0.19
8449	436	429	-7.37	-1.69	0.35
8492	302	289	-13.40	-4.44	0.78
8493	134	137	2.43	1.81	0.21
8495	1356	1349	-7.23	-0.53	0.20
8496	177	165	-11.35	-6.43	0.87
8497	348	334	-14.04	-4.04	0.76
8499	349	358	9.20	2.64	0.49
8500	855	868	12.17	1.42	0.41
8501	326	328	1.73	0.53	0.10
8581	235	241	6.13	2.61	0.40
8582	51	50	-1.39	-2.73	0.20
8584	38	39	0.69	1.83	0.11
8585	1205	1214	9.44	0.78	0.27
8586	130	131	1.34	1.03	0.12
8587	22	24	2.03	9.34	0.43
8588	36	35	-1.17	-3.26	0.20
8589	10	11	0.60	6.00	0.19
8590	1701	1666	-35.72	-2.10	0.87
8591	71	78	7.39	10.40	0.85
8592	387	372	-14.67	-3.79	0.75
8593	46	47	0.61	1.32	0.09
8594	5	3	-2.20	-44.00	1.11
9024	655	648	-7.20	-1.10	0.28
9025	590	594	4.40	0.75	0.18
9027	233	243	9.80	4.21	0.64
9028	202	207	5.20	2.57	0.36
9029	117	123	5.60	4.79	0.51
9030	686	683	-2.60	-0.38	0.10
9031	583	587	4.00	0.69	0.17
9032	550	560	9.60	1.75	0.41
9033	220	219	-0.60	-0.27	0.04
9034	235	234	-0.60	-0.26	0.04
9035	288	293	4.80	1.67	0.28
9036	535	545	9.60	1.79	0.41
9064	186	189	3.40	1.83	0.25
9067	235	233	-2.40	-1.02	0.16

Object	Count - Real Data Set AM - All	Count - AM Model- All	Absolute Difference	Relative Difference (%)	GEH
9068	110	118	7.80	7.09	0.73
9069	103	104	0.80	0.78	0.08
9070	348	336	-12.20	-3.51	0.66
9071	304	303	-0.60	-0.20	0.03
9072	223	230	7.20	3.23	0.48
9073	147	136	-10.60	-7.21	0.89
9074	223	221	-2.00	-0.90	0.13
9075	285	288	3.40	1.19	0.20
9076	334	331	-2.60	-0.78	0.14
9077	184	177	-6.60	-3.59	0.49
9285	1	1	0.40	40.00	0.37
9286	1	1	-0.40	-40.00	0.45
9288	168	180	11.80	7.02	0.89
9289	4	6	1.80	45.00	0.81
9290	322	317	-4.80	-1.49	0.27
9400	138	139	0.60	0.43	0.05
9401	72	72	0.00	0.00	0.00
9402	162	153	-9.20	-5.68	0.73
9403	2	3	1.20	60.00	0.74
9404	74	74	0.40	0.54	0.05
9405	3	3	0.40	13.33	0.22
9509	697	694	-2.64	-0.38	0.10
9510	397	398	1.43	0.36	0.07
9536	15	13	-1.60	-10.67	0.42
9537	12	10	-1.80	-15.00	0.54
9539	3	5	1.80	60.00	0.91
9540	1	2	1.00	100.00	0.82
9543	5	6	0.80	16.00	0.34
9639	162	169	7.00	4.32	0.54
9640	65	66	0.60	0.92	0.07
9641	15	13	-1.60	-10.67	0.42
9642	83	83	0.00	0.00	0.00
9644	1	2	1.00	100.00	0.82
9645	7	6	-1.00	-14.29	0.39
9646	2	3	0.60	30.00	0.40
9647	5	4	-1.00	-20.00	0.47
9648	35	35	0.40	1.14	0.07
9649	1	1	0.00	0.00	0.00
9650	4	3	-0.80	-20.00	0.42
9866	1181	1190	8.90	0.75	0.26

Object	Count - Real Data Set AM - All	Count - AM Model- All	Absolute Difference	Relative Difference (%)	GEH
9867	157	157	0.32	0.20	0.03
10255	1269	1303	34.40	2.71	0.96
10257	125	119	-6.40	-5.12	0.58
10261	133	142	8.80	6.62	0.75
10279	248	251	3.00	1.21	0.19
10280	1156	1174	17.60	1.52	0.52
10281	72	71	-1.40	-1.94	0.17
10295	264	271	6.60	2.50	0.40
10323	125	128	3.00	2.40	0.27
10324	224	231	6.80	3.04	0.45
10336	1644	1611	-32.80	-2.00	0.81
10338	77	84	6.80	8.83	0.76
10353	14	16	2.40	17.14	0.62
10354	390	375	-14.80	-3.79	0.76
10372	4	3	-1.00	-25.00	0.53
10381	1	1	0.40	40.00	0.37
10382	1852	1833	-19.40	-1.05	0.45
10440	1304	1339	34.60	2.65	0.95
10441	11	10	-1.00	-9.09	0.31
10442	1851	1824	-27.40	-1.48	0.64
10443	49	58	9.20	18.78	1.26
10449	50	54	4.40	8.80	0.61
10450	5	4	-0.60	-12.00	0.28
10693	1721	1699	-22.00	-1.28	0.53

PM Peak Turning Movement Statistics

Object	Count - Real Data Set PM - All	Count - PM Model - All	Absolute Difference	Relative Difference (%)	GEH
8442	1533	1513	-19.98	-1.30	0.51
8443	232	235	3.23	1.39	0.21
8448	178	180	2.55	1.44	0.19
8449	436	429	-7.37	-1.69	0.35
8492	302	289	-13.40	-4.44	0.78
8493	134	137	2.43	1.81	0.21
8495	1356	1349	-7.23	-0.53	0.20
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8497	348	334	-14.04	-4.04	0.76
8499	349	358	9.20	2.64	0.49
8500	855	868	12.17	1.42	0.41
8501	326	328	1.73	0.53	0.10
8581	235	241	6.13	2.61	0.40
8582	51	50	-1.39	-2.73	0.20
8584	38	39	0.69	1.83	0.11
8585	1205	1214	9.44	0.78	0.27
8586	130	131	1.34	1.03	0.12
8587	22	24	2.03	9.34	0.43
8588	36	35	-1.17	-3.26	0.20
8589	10	11	0.60	6.00	0.19
8590	1701	1666	-35.72	-2.10	0.87
8591	71	78	7.39	10.40	0.85
8592	387	372	-14.67	-3.79	0.75
8593	46	47	0.61	1.32	0.09
8594	5	3	-2.20	-44.00	1.11
9024	655	648	-7.20	-1.10	0.28
9025	590	594	4.40	0.75	0.18
9027	233	243	9.80	4.21	0.64
9028	202	207	5.20	2.57	0.36
9029	117	123	5.60	4.79	0.51
9030	686	683	-2.60	-0.38	0.10
9031	583	587	4.00	0.69	0.17
9032	550	560	9.60	1.75	0.41
9033	220	219	-0.60	-0.27	0.04
9034	235	234	-0.60	-0.26	0.04
9035	288	293	4.80	1.67	0.28
9036	535	545	9.60	1.79	0.41
9064	186	189	3.40	1.83	0.25
9067	235	233	-2.40	-1.02	0.16

Object	Count - Real Data Set PM - All	Count - PM Model - All	Absolute Difference	Relative Difference (%)	GEH
9068	110	118	7.80	7.09	0.73
9069	103	104	0.80	0.78	0.08
9070	348	336	-12.20	-3.51	0.66
9071	304	303	-0.60	-0.20	0.03
9072	223	230	7.20	3.23	0.48
9073	147	136	-10.60	-7.21	0.89
9074	223	221	-2.00	-0.90	0.13
9075	285	288	3.40	1.19	0.20
9076	334	331	-2.60	-0.78	0.14
9077	184	177	-6.60	-3.59	0.49
9285	1	1	0.40	40.00	0.37
9286	1	1	-0.40	-40.00	0.45
9288	168	180	11.80	7.02	0.89
9289	4	6	1.80	45.00	0.81
9290	322	317	-4.80	-1.49	0.27
9400	138	139	0.60	0.43	0.05
9401	72	72	0.00	0.00	0.00
9402	162	153	-9.20	-5.68	0.73
9403	2	3	1.20	60.00	0.74
9404	74	74	0.40	0.54	0.05
9405	3	3	0.40	13.33	0.22
9509	697	694	-2.64	-0.38	0.10
9510	397	398	1.43	0.36	0.07
9536	15	13	-1.60	-10.67	0.42
9537	12	10	-1.80	-15.00	0.54
9539	3	5	1.80	60.00	0.91
9540	1	2	1.00	100.00	0.82
9543	5	6	0.80	16.00	0.34
9639	162	169	7.00	4.32	0.54
9640	65	66	0.60	0.92	0.07
9641	15	13	-1.60	-10.67	0.42
9642	83	83	0.00	0.00	0.00
9644	1	2	1.00	100.00	0.82
9645	7	6	-1.00	-14.29	0.39
9646	2	3	0.60	30.00	0.40
9647	5	4	-1.00	-20.00	0.47
9648	35	35	0.40	1.14	0.07
9649	1	1	0.00	0.00	0.00
9650	4	3	-0.80	-20.00	0.42
9866	1181	1190	8.90	0.75	0.26

Object	Count - Real Data Set PM - All	Count - PM Model - All	Absolute Difference	Relative Difference (%)	GEH
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10261	133	142	8.80	6.62	0.75
10279	248	251	3.00	1.21	0.19
10280	1156	1174	17.60	1.52	0.52
10281	72	71	-1.40	-1.94	0.17
10295	264	271	6.60	2.50	0.40
10323	125	128	3.00	2.40	0.27
10324	224	231	6.80	3.04	0.45
10336	1644	1611	-32.80	-2.00	0.81
10338	77	84	6.80	8.83	0.76
10353	14	16	2.40	17.14	0.62
10354	390	375	-14.80	-3.79	0.76
10372	4	3	-1.00	-25.00	0.53
10381	1	1	0.40	40.00	0.37
10382	1852	1833	-19.40	-1.05	0.45
10440	1304	1339	34.60	2.65	0.95
10441	11	10	-1.00	-9.09	0.31
10442	1851	1824	-27.40	-1.48	0.64
10443	49	58	9.20	18.78	1.26
10449	50	54	4.40	8.80	0.61
10450	5	4	-0.60	-12.00	0.28
10693	1721	1699	-22.00	-1.28	0.53