

Newcastle Inner City Bypass Rankin Park to Jesmond

Traffic Modelling Report - Lower Hunter Traffic Model

Prepared for

Roads and Maritime Services

April 2016


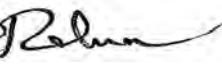

Incorporating



Roads and Maritime Services

Newcastle Inner City Bypass Rankin Park to Jesmond

Traffic Modelling Report - Lower Hunter Traffic Model

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CONTENTS

1	Introduction	3
1.1	Purpose of the Report	3
1.2	Project Overview	3
1.3	Study Area.....	4
1.4	Study Scope and Objectives	6
1.5	Study Approach	6
1.6	Reference Traffic Data and Modelling	7
1.7	Report Structure	7
2	Traffic Data Collection and Surveys	8
2.1	Traffic Surveys.....	8
2.2	Traffic Results.....	12
2.3	Origin-Destination (OD) Data Analysis	15
3	Refinement of the LHTM for the Project.....	17
3.1	Overview of the LHTM.....	17
3.2	LHTM Updates	17
4	Traffic Forecasts	20
4.1	Historical Traffic Growth	20
4.2	Future Traffic Growth.....	21
5	Traffic Assessment.....	23
5.1	Traffic Forecasts on the Project.....	24
5.2	Traffic Redistribution on Surrounding Road Network.....	25
5.3	Modelling Scenario on North Facing Ramps at Southern Interchange	32
6	Summary of Findings	42

APPENDICES

Appendix A Traffic Survey Data

Appendix B LHTM Updates

1 Introduction

1.1 Purpose of the Report

Roads and Maritime Services (Roads and Maritime) is planning for a 3.4 kilometre section of the Newcastle Inner City Bypass between Rankin Park to Jesmond, to the west of John Hunter Hospital. The Project would form part of the Newcastle Inner City Bypass.

Roads and Maritime engaged Arcadis Australia Pacific Pty Ltd (Arcadis formerly Hyder Consulting Pty Ltd) to undertake strategic traffic modelling using the Lower Hunter Traffic Model (LHTM) to identify future traffic growth and the forecast traffic redistribution on the surrounding road network with the Project.

Throughout this report the Newcastle Inner City Bypass Rankin Park to Jesmond is referred to as 'RP2J'.

This traffic modelling report (hereafter referred to as 'the study') has been prepared to support the 2007 Strategic Design review and refinement for the Newcastle Inner City Bypass Rankin Park to Jesmond ('the Project').

1.2 Project Overview

The Newcastle Inner City Bypass is part of Roads and Maritime's long-term strategy to provide an orbital road within Newcastle's road network to connect the Pacific Highway at Bennetts Green and the Pacific Highway at Sandgate. The Newcastle Inner City Bypass was first planned in the 1950's and sections have been opened progressively since the early 1980's as outlined in the Figure 1-1 below.



Figure 1-1 Overall Newcastle Inner City Bypass

The Project would form part of the Newcastle Inner City Bypass, which provides improved traffic flows across the western suburbs of Newcastle and connects key regional destinations such as Bennetts Green, Charlestown and Jesmond shopping centres, John Hunter Hospital, Newcastle University and the Pacific Highway.

The road network surrounding the Project currently experiences traffic congestion and delays at key intersections. The construction of the Rankin Park to Jesmond section would provide free flow north-south travel conditions and eliminate 11 sets of traffic control signals along the existing route.

It would provide traffic relief to key parts of the surrounding road network, in particular the existing route of Lookout Road, Croudace Street and Newcastle Road. The Project would have two lanes in each direction with median separation and would be signposted 90 kilometres per hour. The Project would reduce travel times, improve the reliability of journeys and provide more consistent driving conditions along the Newcastle Inner City Bypass.

The key objectives of the project are to:

- Provide continuity of the Newcastle Inner City Bypass between Bennetts Green and Sandgate
- Reduce travel times and the level of congestion on the Newcastle Inner City Bypass
- Provide traffic relief to key parts of the surrounding road network.

1.3 Study Area

The study area for this assessment includes:

- Newcastle Inner City Bypass between University Drive and Carnley Avenue
- Newcastle Road between Blue Gum Road and Croudace Street
- Croudace Street
- Howe Street
- Lookout Road
- Russell Road
- Kookaburra Circuit (John Hunter Hospital access)
- McCaffrey Drive
- Grandview Road
- Cardiff Road
- Carnley Avenue.
- Charlestown Road between Cardiff Road and Carnley Avenue

Figure 1-2 shows modelling study area for the Project.

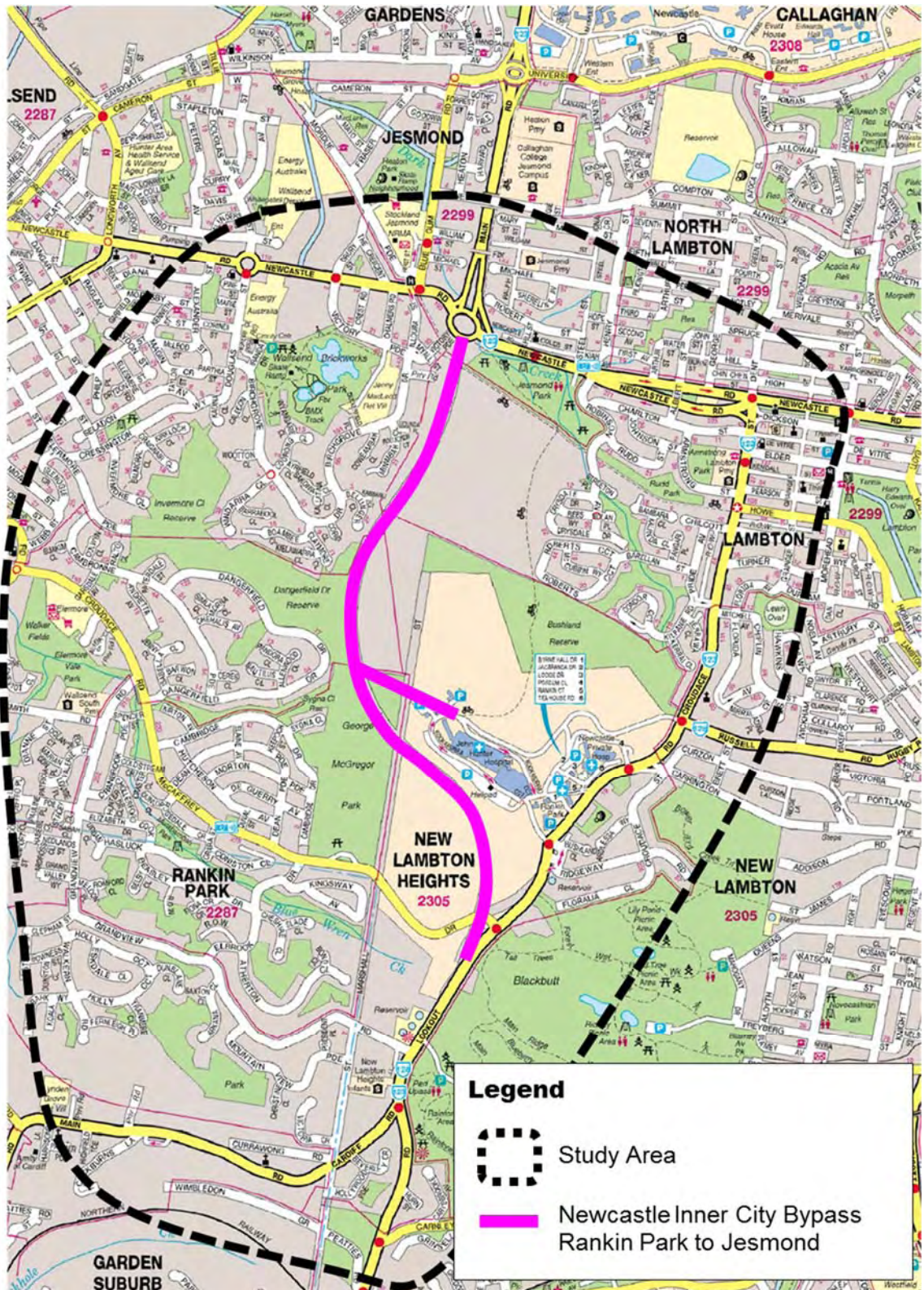


Figure 1-2 Modelling Study Area for RP2J Project

1.4 Study Scope and Objectives

The study assesses the traffic performance of the Newcastle Inner City Bypass Rankin Park to Jesmond. It examines the forecast traffic redistribution on the road network within the study area. Roads and Maritime's Lower Hunter Traffic Model (LHTM) was locally updated for the study area.

Key objectives of the study were to:

- Determine traffic flows on the existing road network within the study area
- Determine traffic forecasts for 2020, 2030 and 2040 with and without the Project taking into account forecast traffic increases from predicted growth in the study area
- Examine likely traffic redistribution attributable to the Project
- Prepare a traffic modelling report to support the 2007 Strategic Design review and refinement for the Newcastle Inner City Bypass Rankin Park to Jesmond.

1.5 Study Approach

In consultation with Roads and Maritime, the study developed a comprehensive modelling approach specifically to achieve the key study objectives and outcome. The study involved:

- Analysing traffic distribution patterns within the study area
- Augmenting the Lower Hunter Traffic model (LHTM) for the RP2J study area
- Updating LHTM demand trip tables using actual origin-destination (OD) surveys and traffic counts data
- Identifying future traffic growth
- Identifying likely traffic redistributions that would result from the RP2J Project.

The key steps carried out in the modelling approach included:

- **Traffic data, surveys and analysis.** This involved reviewing historical and existing data resources and understanding the regional and local traffic context. During the course of the study, two traffic survey data sets were provided by Roads and Maritime as follow:
 - *October 2014 survey data* – Roads and Maritime undertook traffic surveys between 7th and 13th October 2014. Two types of survey data were provided including origin-destination (OD) surveys at 10 locations and mid-block traffic counts at 13 locations. The October 2014 survey data provide key input to the LHTM refinement for RP2J study area
 - *May 2015 survey data* – Roads and Maritime carried out additional traffic survey between 5th and 11th May 2015. Three types of survey data were provided including origin-destination (OD) surveys at 15 locations, mid-block traffic counts at six locations and intersection turning movement counts at 10 locations. The OD surveys were re-collected and included additional locations in the south at Charlestown Road, Grandview Road, Cardiff Road, Carnley Avenue and in the west at Croudace Road west of Grandview Road. Intersection movement count data was collected to reinforce OD survey data for traffic distribution analysis. The May 2015 survey data formed the basis for further model refinement for the southern section of the study area between McCaffrey Drive and Carnley Avenue.

- **Refinement of the LHTM for the Project.** The LHTM was updated locally for the study area using actual origin-destination (OD) survey data and mid-block traffic count. This involved refining road network within the study area to include key arterial and local roads, refining loading points / centroid connectors, augmenting LHTM daily trip tables taking into account actual OD traffic distribution and mid-block traffic counts at key locations
- **Update future year daily LHTM.** This involved updating the LHTM with the proposed RP2J project including the proposed interchanges and new hospital access (western access) as per the design layout shown in Figure 5-1 of Section 5. Future years were modelled with and without the Project and traffic forecasts were prepared.

1.6 Reference Traffic Data and Modelling

For the purpose of the study, traffic and modelling data have been sourced from the Roads and Maritime LHTM. The LHTM included major developments being planned as per the Lower Hunter Regional Strategy (2006). New traffic surveys were undertaken by Roads and Maritime to satisfy the need and purpose of the traffic study. This included origin-destination (OD) surveys, mid-block traffic counts and intersection turning movement counts. To quantify the future traffic growth the LHTM was used. The modelling was undertaken using TransCAD modelling software.

1.7 Report Structure

The study is structured as follows:

- **Chapter 2:** Traffic Data Collection and Surveys – Provides an overview of traffic surveys and data collected for the purpose of the study. Results from traffic surveys including daily traffic volumes at key locations and origin-destination traffic distributions are summarised in this section
- **Chapter 3:** Refinement of the LHTM for the Project – Provides an overview of LHTM refinement for the study area. Results from model update are summarised in this section
- **Chapter 4:** Traffic Forecasts – Provides an overview of forecast traffic volumes on the Project and road network. It also provides future modelling results of the consequences of a no build condition
- **Chapter 5:** Traffic Assessment – Examines forecast daily traffic for the Project and the new western hospital access, as well as traffic redistribution on the surrounding road network. The modelling scenario for provision of north facing ramps with McCaffrey Drive at the southern interchange is discussed in this section
- **Chapter 6:** Summary of Findings – Provides a summary of key traffic findings from the study.

2 Traffic Data Collection and Surveys

2.1 Traffic Surveys

To satisfy the modelling requirements, Roads and Maritime carried out an extensive data collection involving origin-destination surveys, midblock counts and intersections turning counts in the study area. Two sets of traffic data were collected. Both data sets form basis for model refinement of LHTM for the Project. Two traffic survey data sets were collected in October 2014 and May 2015.

2.1.1 October 2014 Survey Data

The October 2014 survey was undertaken between 7 and 13 October 2014. Two types of survey data were collected including origin-destination (OD) surveys at 10 locations and mid-block traffic counts at 13 locations. Table 2-1a lists survey type and locations for the October 2014 survey. Figure 2-1a shows the locations of surveys. The October 2014 survey data provided key inputs to the LHTM refinement for the study area. Appendix A documents October 2014 survey data.

Table 2-1a October 2014 Survey Types and Locations

Survey Type/Date/Period	Locations
1. Origin-destination (OD) surveys conducted on Thursday 9 th October 2014 for 24 hours at 10 locations.	<ul style="list-style-type: none">▪ Lookout Road - south of McCaffrey Drive▪ McCaffrey Drive - west of Lookout Road▪ Kookaburra Circuit (John Hunter Hospital access)▪ Jacaranda Drive - (John Hunter Hospital access)▪ Russell Road - west of Brett Street▪ Howe Street - west of Grainger Street▪ Newcastle Road - east of Croudace Street▪ Dent Street - north of Newcastle Road▪ Newcastle Road - west of Inner City Bypass▪ Inner City Bypass - north of Newcastle Road
2. Mid-block traffic surveys conducted between 7 th and 13 th October 2014 at 13 key locations.	<ul style="list-style-type: none">▪ Lookout Road - south of McCaffrey Drive▪ McCaffrey Drive - west of Lookout Road▪ Kookaburra Circuit (John Hunter Hospital access)▪ Jacaranda Drive (John Hunter Hospital access)▪ Russell Road - west of Brett Street▪ Howe Street - west of Grainger Street▪ Newcastle Road - east of Croudace Street▪ Dent Street - north of Newcastle Road▪ Newcastle Road - west of Inner City Bypass▪ Inner City Bypass - north of Newcastle Road▪ Newcastle Road - east of Newcastle Inner City Bypass▪ Croudace Street - north of Elder Street▪ Lookout Road - south of Russell Road



Figure 2-1a October 2014 Survey Types and Locations

2.1.2 May 2015 survey data

In May 2015, Roads and Maritime carried out additional traffic surveys between 5 and 11 May 2015. Three types of survey data were provided including origin-destination (OD) surveys, mid-block traffic counts and intersection turning movement counts. The OD surveys were re-collected to include additional locations in the south including Charlestown Road, Grandview Road, Cardiff Rod, Carnley Avenue and Croudace Road west of Grandview Road. The intersection movement count data was collected to reinforce OD survey data for traffic distribution analysis. Appendix A documents May 2015 survey data.

Table 2-1b lists survey type and locations for the May 2015 surveys. Figure 2-1b shows the locations of surveys. The May 2015 survey data was used for further model refinement for the southern section of the study area between McCaffrey and Carnley Avenue. Appendix A documents May 2015 survey data.

Table 2-1b May 2015 Survey Types and Locations

Survey Type/Date/Period	Locations
1. Origin-destination (OD) surveys conducted on Wednesday 6 th May 2015 for the AM peak (7:00-10:00) and the PM peak (15:00-18:00) at 15 locations.	<ul style="list-style-type: none"> ▪ Charlestown Road - south of Carnley Avenue ▪ Carnley Avenue - east of Charlestown Road ▪ Cardiff Road - west of Lookout Road ▪ Grandview Road - west of Lookout Road ▪ McCaffrey Drive - west of Lookout Road ▪ Croudace Road - west of Grandview Road ▪ Lookout Road - north of McCaffrey Drive ▪ Kookaburra Circuit (John Hunter Hospital access) ▪ Russell Road - east of Lookout Road ▪ Newcastle Road - east of Croudace Street ▪ Newcastle Inner City Bypass - north of Newcastle Road ▪ Newcastle Road - west of Newcastle Inner City Bypass ▪ Dent Street - north of Newcastle Road ▪ Jacaranda Drive (John Hunter Hospital access) ▪ Howe Street - east of Croudace Street
2. Mid-block traffic surveys conducted between 5 th and 11 th May 2015 at 6 key locations	<ul style="list-style-type: none"> ▪ Charlestown Road - south of Cardiff Road ▪ Carnley Avenue - east of Charlestown Road ▪ Cardiff Road - west of Lookout Road ▪ Grandview Road - west of Lookout Road ▪ Croudace Road - west of Grandview Road ▪ Lookout Road - north of McCaffrey Drive
3. Intersection turning movement counts conducted for the AM peak (7:00-10:00) and the PM peak (15:00-18:00) for 10 intersections	<ul style="list-style-type: none"> ▪ Cardiff Road / Charlestown Road ▪ Grandview Road / Lookout Road ▪ Marshall Street / Grandview Road ▪ McCaffrey Drive / Elbrook Drive ▪ Croudace Road / Grandview Road / McCaffrey Drive ▪ Croudace Road / Cardiff Road ▪ Croudace Road / Lake Road ▪ Walford Street / Thomas Street ▪ Cardiff Road / Marshall Street ▪ Charlestown Road / Carnley Avenue

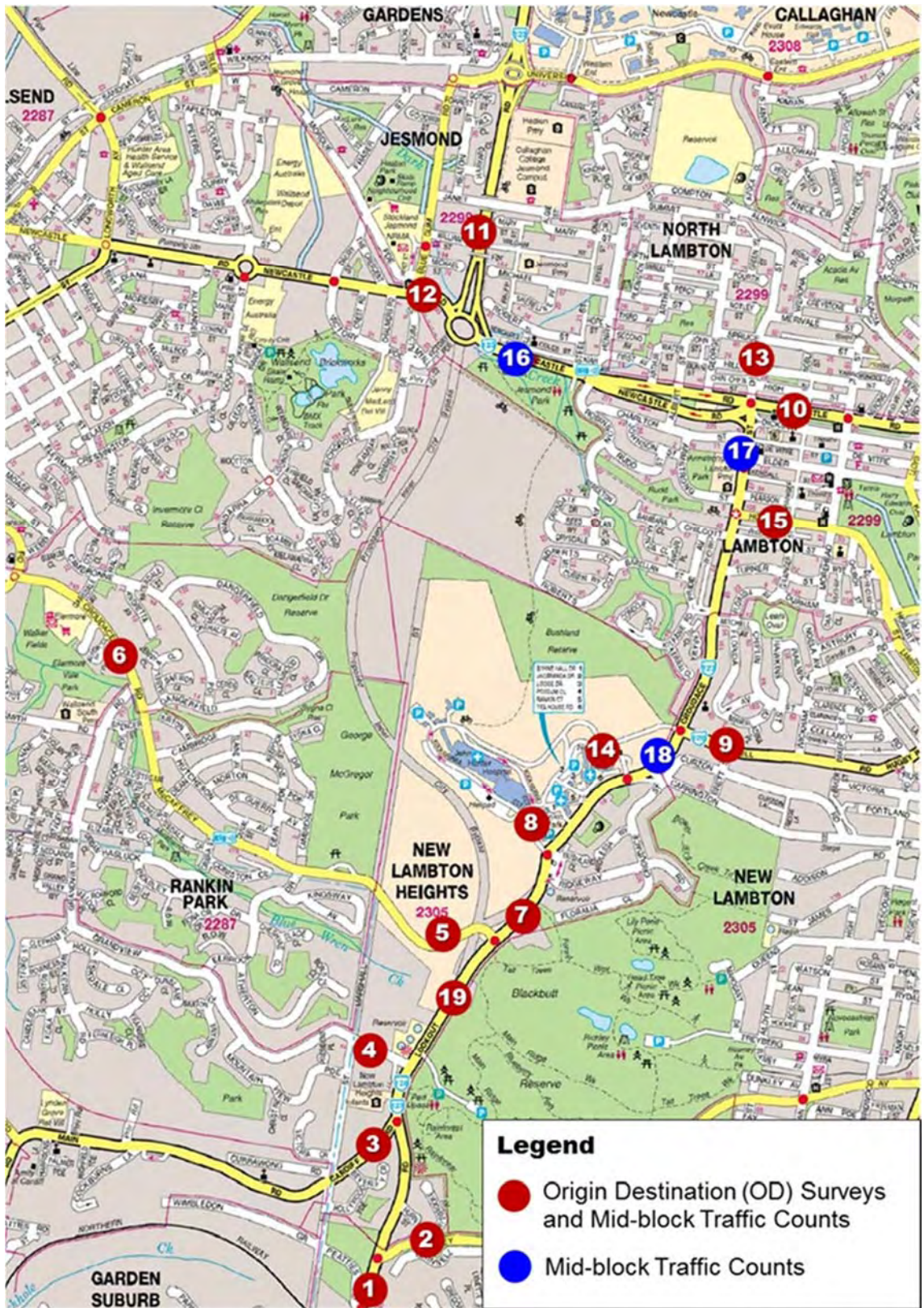


Figure 2-1b May 2015 Survey Types and Locations

2.2 Traffic Results

This section quantifies the daily traffic volumes on key roads and origin-destination (OD) traffic distribution within the study area. The traffic data forms the basis for LHTM refinement for the study area. The traffic data also provides a basis to consider likely traffic changes that would result from the Project and potential traffic growth. The traffic results are based on both the October 2014 and May 2015 survey data sets.

2.2.1 Weekday Daily Traffic

Table 2-2 summarise average weekday daily traffic volumes at 19 key locations. Figure 2-2 shows the existing 2014/15 daily traffic flows in the study area.

The 2014/15 traffic data found that:

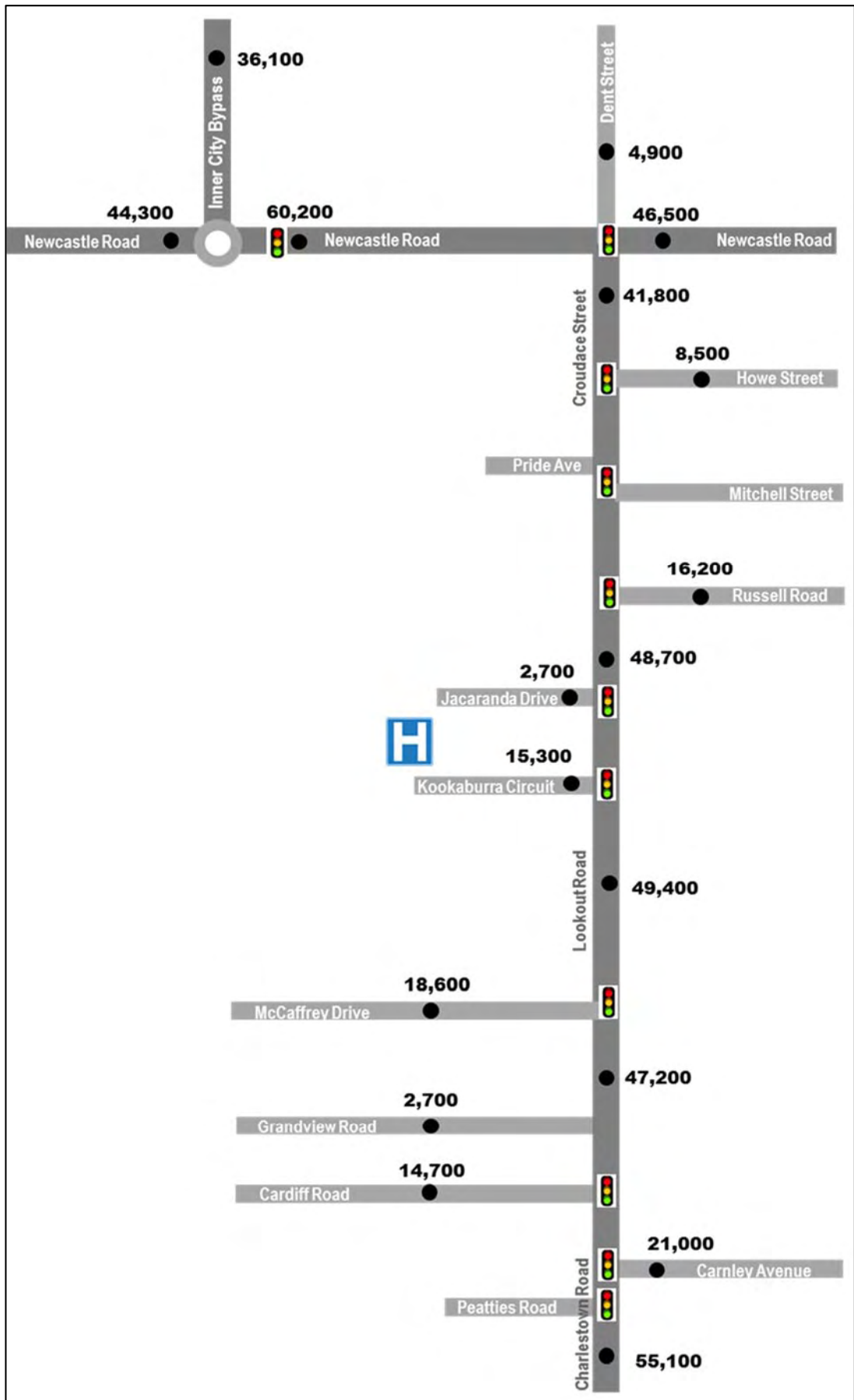
- Charlestown Road south of Carnley Avenue (ID1) carried about 55,000 vehicles per day in typical weekday condition
- Between Grandview Road and Russell Road, Lookout Road (ID7, ID18 and ID19) carried traffic between 47,200 and 49,400 vehicles per day
- Between Russell Road and Newcastle Road, Croudace Street (ID17) carried about 41,800 vehicles per day
- Newcastle Road west of the Newcastle Inner City Bypass (ID12) carried about 44,000 vehicles per day. Between the Newcastle Inner City Bypass and Croudace Street, Newcastle Road (ID16) in the order of 60,000 vehicles per day. East of Croudace Street, Newcastle Road (ID10) carried traffic about 46,500 vehicles per day
- The Newcastle Inner City Bypass north of Newcastle Road (ID11) carried in the order of 36,000 vehicles per day
- Dent Street north of Newcastle Road (ID13) carried in the order of 4,900 vehicles per day
- Howe Street east of Croudace Street (ID15) carried in the order of 8,500 vehicles per day
- At John Hunter Hospital accesses, Kookaburra Circuit (ID8) carried traffic about 15,300 vehicles per day. Jacaranda Drive (ID14) carried traffic about 2,700 vehicles per day
- Russell Road east of Lookout Road (ID9) carried traffic in the order of 16,200 vehicles per day
- McCaffrey Drive west of Lookout Road (ID5) currently carried traffic about 18,600 vehicles per day
- Cardiff Road west of Lookout Road (ID3) carried traffic in the order of 14,700 vehicles per day
- Grandview Road west of Lookout Road (ID4) carried traffic in the order of 2,700 vehicles per day
- Carnley Avenue east of Charlestown Road (ID2) carried traffic in the order of 21,000 vehicles per day.

Table 2-2 Average Daily Weekday Traffic Volumes

ID	Road/Location	Average Weekday Daily Traffic (two-way in vehicles)
1	Charlestown Road, south of Carnley Avenue ⁽²⁾	55,100
2	Carnley Avenue, east of Charlestown Road ⁽²⁾	21,000
3	Cardiff Road, west of Lookout Road ⁽²⁾	14,700
4	Grandview Road, west of Lookout Road ⁽²⁾	2,700
5	McCaffrey Drive, west of Lookout Road ⁽¹⁾	18,600
6	Croudace Road, west of Grandview Road ⁽²⁾	19,900
7	Lookout Road, north of McCaffrey Drive ⁽²⁾	49,400
8	Kookaburra Circuit (John Hunter Hospital access) ⁽¹⁾	15,300
9	Russell Road, east of Lookout Road ⁽¹⁾	16,200
10	Newcastle Road, east of Croudace Street ⁽¹⁾	46,500
11	Newcastle Inner City Bypass, north of Newcastle Road ⁽¹⁾	36,100
12	Newcastle Road, west of Newcastle Inner City Bypass ⁽¹⁾	44,300
13	Dent Street, north of Newcastle Road ⁽¹⁾	4,900
14	Jacaranda Drive (John Hunter Hospital access) ⁽¹⁾	2,700
15	Howe Street, east of Croudace Street ⁽¹⁾	8,500
16	Newcastle Road, east of Newcastle Inner City Bypass ⁽¹⁾	60,200
17	Croudace Street, north of Elder Street ⁽¹⁾	41,800
18	Lookout Road, south of Russell Road ⁽¹⁾	48,700
19	Lookout Road, south of McCaffrey Drive ⁽¹⁾	47,200

Note: Average Weekday Daily Traffic (two-way in vehicles)

Source: (1) October 2014 survey data, (2) May 2015 survey data.



Note: Average Weekday Daily Traffic (two-way in vehicles)

Figure 2-2 Daily Traffic Flows Diagram for Existing 2014/15

2.3 Origin-Destination (OD) Data Analysis

An origin-destination (OD) study is used to determine where and how much traffic are travelling during a typical day for a particular road network. Trips are defined as one-way movement, from where a trip starts (origin) to where the trip is going (destination). Video cameras are installed at OD survey stations throughout the study area. Number plates are recorded via video recognition with data between OD survey locations correlated to ascertain trip patterns.

To determine travel patterns for the study area, Roads and Maritime conducted an extensive OD survey in October 2014 at 10 survey locations and May 2015 at 15 survey locations. The OD data were reviewed and cross-checked by mid-block traffic counts and intersection movement counts to ensure its accuracy and validity. The OD survey data underpinned by mid-block traffic counts and has been analysed at the 15 OD survey stations which consist of:

- Charlestown Road, south of Cardiff Road
- Carnley Avenue, east of Charlestown Road
- Cardiff Road, west of Lookout Road
- Grandview Road, west of Lookout Road
- McCaffrey Drive, west of Lookout Road
- Croudace Road, west of Grandview Road
- Lookout Road, north of McCaffrey Drive
- Kookaburra Circuit, John Hunter Hospital access
- Russell Road, east of Lookout Road
- Newcastle Road, east of Croudace Street
- Newcastle Inner City Bypass, north of Newcastle Road
- Newcastle Road, west of Newcastle Inner City Bypass
- Dent Street, north of Newcastle Road
- Jacaranda Drive (John Hunter Hospital access)
- Howe Street, east of Croudace Street.

Appendix A shows the existing daily traffic distribution at 10 OD survey stations and the existing morning and afternoon peak hour traffic distribution at 15 OD survey locations.

OD distribution results found the following travel patterns for the study area:

- Major north-south through and regional traffic between Lookout Road and the Newcastle Inner City Bypass (Jesmond to Sandgate section) via Croudace Street and Newcastle Road
 - Of the total traffic observed at Lookout Road south of McCaffrey Drive, 23 to 24 per cent had an origin or destination at Newcastle Inner City Bypass north of Newcastle Road
 - Of the total traffic observed at the Newcastle Inner City Bypass north of Newcastle Road, 27 to 31 per cent had an origin or destination at Lookout Road south of McCaffrey Drive
- Of total traffic observed at Lookout Road south of McCaffrey Drive, 21 to 22 per cent had an origin or destination at McCaffrey Drive.

- Of total traffic observed at McCaffrey Drive west of Lookout Road, 50 to 53 per cent had an origin or destination south of McCaffrey Drive on Lookout Road.
- Of total traffic observed at McCaffrey Drive west of Lookout Road, 23 to 27 per cent had an origin or destination at Russell Road east of Lookout Road
- Of total traffic observed at Newcastle Road west of the Newcastle Inner City Bypass, 48 to 52 per cent had an origin or destination at Newcastle Road east of Croudace Street
- At McCaffrey Drive about 100 vehicles per day had an origin or destination at the Newcastle Inner City Bypass (Jesmond to Sandgate section) or Newcastle Road west of the Newcastle Inner City Bypass
- At Grandview Road more than 80 per cent of vehicles had an origin or destination south to Charlestown and Carnley Avenue, and east to Russell and Newcastle Road. A similar pattern was observed at Cardiff Road west of Charlestown Road
- At Kookaburra Circuit (hospital access), 44 to 45 per cent had an origin and destination at Lookout Road south of McCaffrey Drive.

Summary of key travel patterns identified include:

- Major north-south route for through and regional traffic between Lookout Road (South of McCaffrey) and the Newcastle Inner City Bypass (Jesmond to Sandgate) via the existing route of Lookout Road, Croudace Street and Newcastle Road
- Major south-west route between Lookout Road (south of McCaffrey) and McCaffrey Drive
- Major east-west movements via Newcastle Road
- Major east-west movement between McCaffrey Drive and Russell Road.

3 Refinement of the LHTM for the Project

3.1 Overview of the LHTM

Roads and Maritime's LHTM comprises a road network model of the entire Lower Hunter region. It covers the six statistical local areas (SLAs) of Newcastle – inner and remainder, Lake Macquarie, Cessnock, Maitland and Port Stephens. It also includes a small portion of the northern section of Wyong to ensure that the M1 Pacific Motorway is included in the model area.

The LHTM was developed in TransCAD transportation planning software. The LHTM network includes motorways, highways, main roads and major local roads in Lower Hunter. Travel zones in the model are based on those developed by the Bureau of Transport Statistics (BTS). The basic modelling approach for updating the LHTM follows a conventional four step modelling process by which the number of daily trips is estimated, distributed among origin and destination zones, divided according to mode of travel and assigned to the highway network.

Under the current form, LHTM can produce a daily forecast, representing the total 24-hour traffic volumes for an average weekday.

Traffic forecast for LHTM is based on land use assumptions, and forecast population and employment growth as predicted in the Lower Hunter Regional Strategy (LHRS). The Lower Hunter Regional Strategy applies to the five local government areas of Newcastle, Lake Macquarie, Port Stephens, Maitland and Cessnock, and is one of a number of regional strategies prepared by the Department of Planning.

The LHTM has provided strategic traffic inputs for a number of major road infrastructure planning and funding projects including the Hunter Expressway.

3.2 LHTM Updates

The Lower Hunter Traffic Model (LHTM) has been updated locally for the study area using actual origin-destination (OD) survey data and mid-block traffic counts. The updates to the LHTM include:

- Refining road network within the study area to include key arterial and local roads
- Refining travel zones for the study area. The loading points / centroid connectors have been reviewed and updated
- Augmenting the LHTM daily trip tables taking into account actual OD traffic distribution and mid-block traffic counts at key locations.

The October 2014 survey data set was used to refine LHTM for the study area. The May 2015 was used to future refine the model for southern section between McCaffrey Drive and Carnley Avenue.

Table 3-1 compares the 2014/15 counted and modelled daily volumes at 19 locations.

Table 3-2 shows model calibration results. The R^2 and Root Mean Square Error (RMSE) are used as statistic measures of the correlation between the 2014/15 daily traffic counts and the predicted model volumes. Figure 3-1 shows scatter plot analysis. The model achieved R^2 value of 0.99 (≥ 0.90) and RMSE of 5 (≤ 30) showing a very close match between daily traffic counted and modelled volumes at individual location. A comparison of 2014/15 traffic distributions at 15 OD survey locations (October 2014 and May 2015) compared with surveyed data is documented in Appendix B.

The daily model update results show high correlation between modelled and surveyed 2014/15 daily traffic volumes and OD traffic distributions. The model has been found to be adequately calibrated within the study area and fit for the study purpose.

Table 3-1 Comparison between 2014/15 Traffic Counts and Modelled Traffic Volumes

ID	Road/Location	Average Weekday Daily Traffic (two-way in vehicles)		% Diff.
		2014 Counts	2014 Modelled ⁽³⁾	
1	Charlestown Road, south of Cardiff Road ⁽²⁾	55,100	54,700	-1%
2	Carnley Avenue, east of Charlestown Road ⁽²⁾	21,000	22,300	6%
3	Cardiff Road, west of Lookout Road ⁽²⁾	14,700	15,500	5%
4	Grandview Road, west of Lookout Road ⁽²⁾	2,700	2,900	7%
5	McCaffrey Drive, west of Lookout Road ⁽¹⁾	18,600	18,300	-2%
6	Croudace Road, west of Grandview Road ⁽²⁾	19,900	18,900	-5%
7	Lookout Road, north of McCaffrey Drive ⁽²⁾	49,400	47,300	-4%
8	Kookaburra Circuit (John Hunter Hospital access) ⁽¹⁾	15,300	16,300	7%
9	Russell Road, east of Lookout Road ⁽¹⁾	16,200	16,400	1%
10	Newcastle Road, east of Croudace Street ⁽¹⁾	46,500	47,100	1%
11	Newcastle Inner City Bypass, north of Newcastle Road ⁽¹⁾	36,100	35,700	-1%
12	Newcastle Road, west of Newcastle Inner City Bypass ⁽¹⁾	44,300	47,300	7%
13	Dent Street, north of Newcastle Road ⁽¹⁾	4,900	5,300	8%
14	Jacaranda Drive (John Hunter Hospital access) ⁽¹⁾	2,700	2,700	0%
15	Howe Street, east of Croudace Street ⁽¹⁾	8,500	9,000	6%
16	Newcastle Road, east of Newcastle Inner City Bypass ⁽¹⁾	60,200	58,600	-3%
17	Croudace Street, north of Elder Street ⁽¹⁾	41,800	41,800	0%
18	Lookout Road, south of Russell Road ⁽¹⁾	48,700	47,900	-2%
19	Lookout Road, south of McCaffrey Drive ⁽¹⁾	47,200	45,900	-3%

Note: Average Weekday Daily Traffic (two-way in vehicles)

Source: (1) October 2014 survey data, (2) May 2015 survey data, (3) Lower Hunter Traffic Model (LHTM)

Table 3-2 Model Calibration Results

Calibration Criteria	Acceptability Standard ⁽¹⁾	Standard Achieved
R ² value including scatter plot See Figure 3.1	>0.90	0.99
Root Mean Square Error (RMSE)	<30	5

Source: Roads and Maritime Traffic Modelling Guideline for highway assignment model.

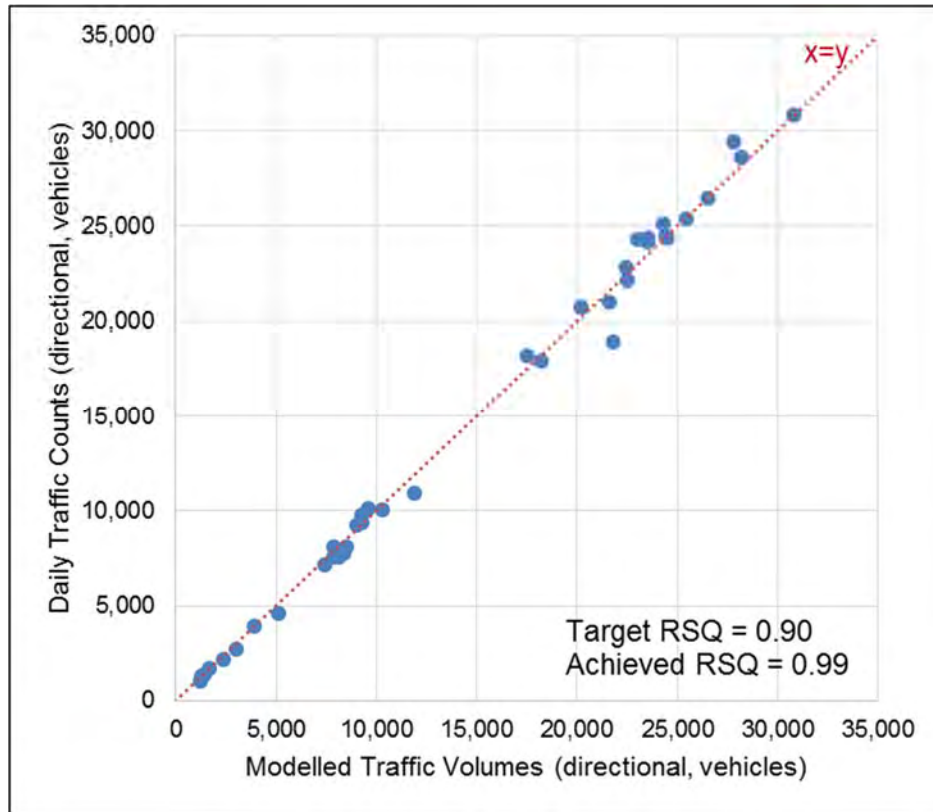


Figure 3-1 Scatter Plot Analysis for 2014 Daily Volumes (directional)

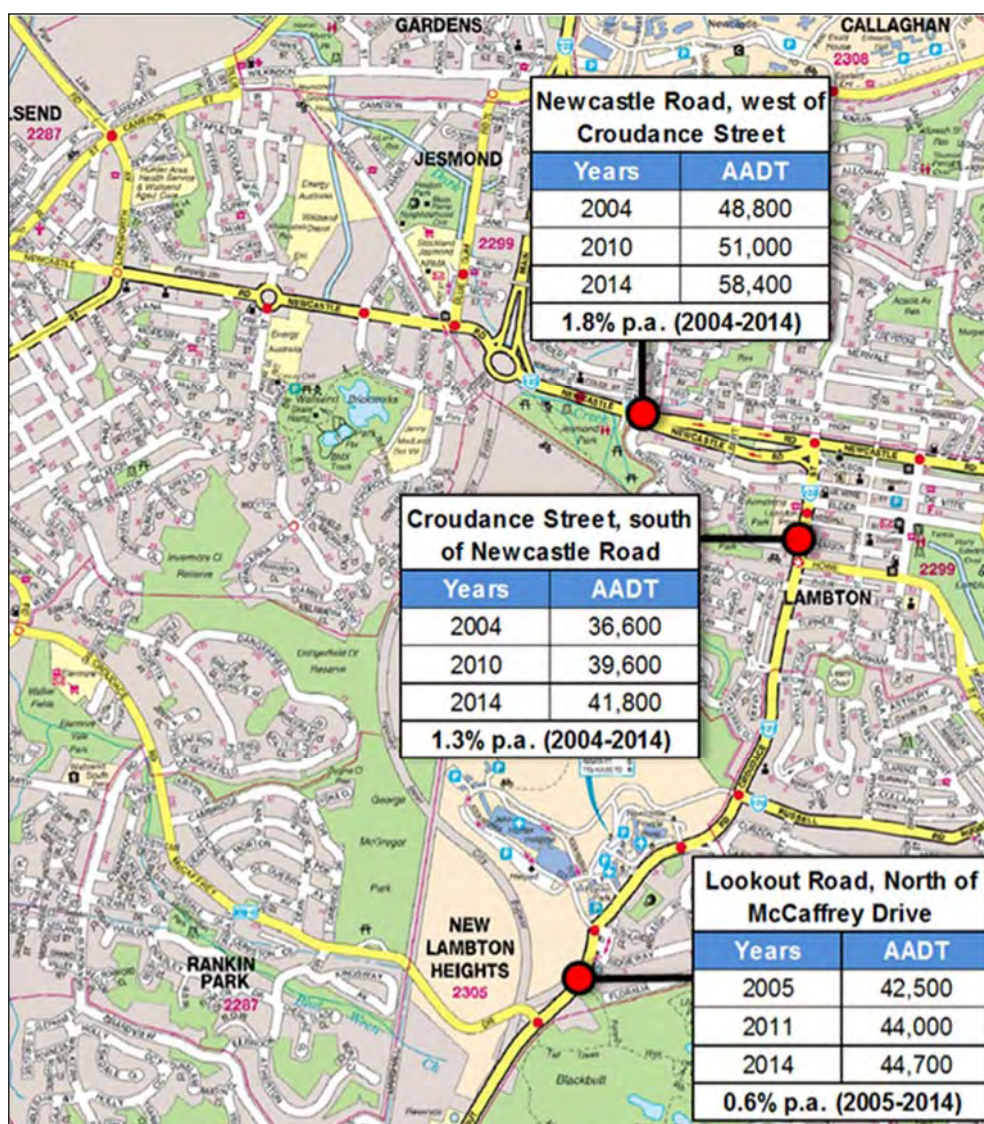
4 Traffic Forecasts

4.1 Historical Traffic Growth

Historical traffic data between 2004 and 2014 on the Lookout Road and Croudace Street through the study area was obtained from Roads and Maritime. The historical traffic data represents annual average daily traffic (AADT) on those roads. The data for 2014/15 was estimated from average weekday traffic (AWT) sourced from traffic surveys undertaken in October 2014 and May 2015.

Figure 4-1 shows historical traffic volumes for the last 10 years between 2004 and 2014 on Lookout Road, Croudace Street and Newcastle Road.

The historical data between 2004 and 2014 indicated that in the last 10 years traffic on Lookout Road and Croudace Street between McCaffrey Drive and Newcastle Road has grown by about 0.6 to 1.3 per cent per annum.



Source: Roads and Maritime

Figure 4-1 Historical Traffic Volumes on Key Road between 2004 and 2014

4.2 Future Traffic Growth

Future traffic volumes for the study area were determined taking into account population and employment increases projected in the Lower Hunter Regional Strategy.

Table 4-1 summarises forecast daily traffic volumes at 19 locations for 2020, 2030 and 2040 without the RP2J Project. Table 4-1 also shows predicted growth rates across the study area between 2014 and 2040 for a period of 26 years.

The traffic growth analysis found that:

- In general, the model predicted traffic growth for the study area of about 1 per cent per annum for next 26 years between 2014 and 2040
- The model predicted traffic on Lookout Road north of McCaffrey Drive (ID7) would grow by about 0.9 per cent per annum from 49,400 vehicles per day in 2014 to 63,100 vehicles per day in 2040. The forecast growth rate was found to be similar to observed historical growth at this location
- Traffic on Croudace Street, north of Elder Street (ID17) is predicted to grow by about 0.8 per cent per annum from 41,800 vehicles per day in 2014 to 50,800 vehicles per day in 2040.
- Traffic on Newcastle Road east of Newcastle Inner City Bypass (ID16) is predicted to grow by about 1.4 per cent per annum from 60,200
- Traffic on the Newcastle Inner City Bypass north of Newcastle Road (ID11) is predicted to grow in the order of 2.0 per cent per annum from 36,100 vehicles per day in 2014 to 60,300 vehicles per day in 2040
- Traffic at McCaffrey Drive (ID5), Grandview Road (ID4), Cardiff Road (ID3) and Carnley Avenue (ID2) is expected to grow by between 0.1 per cent to 0.5 per cent between 2014 and 2040
- Traffic on Lookout Road north of McCaffrey Drive (ID7) is predicted to grown by about 0.9 per cent per annum from 49,400 vehicles per day in 2014 to 63,100 vehicles per day in 2040

Table 4-1 Forecast Daily Traffic Volumes on 19 Locations for 2020, 2030 and 2040 without the Project

ID	Road/Location	Forecast Daily Traffic Volumes without the Project (two-way in vehicles)				Annual Growth Rate (%)
		2014	2020	2030	2040	2014-2040
						26 years
1	Charlestown Road, south of Cardiff Road	55,100	55,500	56,300	57,100	0.1%
2	Carnley Avenue, east of Charlestown Road	21,000	21,100	21,400	21,700	0.1%
3	Cardiff Road, west of Lookout Road	14,700	15,100	15,800	16,600	0.5%
4	Grandview Road, west of Lookout Road	2,700	2,800	3,000	3,100	0.5%
5	McCaffrey Drive, west of Lookout Road	18,600	19,100	20,000	20,900	0.4%
6	Croudace Road, west of Grandview Road	19,900	20,100	20,600	21,000	0.2%
7	Lookout Road, north of McCaffrey Drive	49,400	52,500	57,700	63,100	0.9%
8	Kookaburra Circuit (John Hunter Hospital access)	15,300	16,200	17,900	19,800	1.0%
9	Russell Road, east of Lookout Road	16,200	17,600	20,100	22,600	1.3%
10	Newcastle Road, east of Croudace Street	46,500	51,600	60,100	68,500	1.5%
11	Newcastle Inner City Bypass, north of Newcastle Road	36,100	41,700	51,000	60,300	2.0%
12	Newcastle Road, west of Newcastle Inner City Bypass	44,300	48,200	54,700	61,200	1.3%
13	Dent Street, north of Newcastle Road	4,900	5,400	6,300	7,200	1.5%
14	Jacaranda Drive (John Hunter Hospital access)	2,700	2,700	2,800	2,900	0.3%
15	Howe Street, east of Croudace Street	8,500	9,600	11,400	13,300	1.7%
16	Newcastle Road, east of Newcastle Inner City Bypass	60,200	66,200	76,200	86,200	1.4%
17	Croudace Street, north of Elder Street	41,800	43,900	47,300	50,800	0.8%
18	Lookout Road, south of Russell Road	48,700	51,500	56,400	61,300	0.9%
19	Lookout Road, south of McCaffrey Drive	47,200	48,300	50,200	52,200	0.4%
	Total study area					1.0%

Note, Average Weekday Daily Traffic (two-way in vehicles).
Source: Lower Hunter Traffic Model (LHTM).

5 Traffic Assessment

This section summarises the traffic impact assessment for the Project. Figure 5-1 shows the refined strategic design for the Newcastle Inner City Bypass Rankin Park to Jesmond (RP2J).



Source: Roads and Maritime

Figure 5-1 Refined Strategic Design (2016) - Rankin Park to Jesmond (RP2J)

The following interchange configurations were modelled as part of the study:

- **Southern interchange:** A half interchange with Lookout Road with 'south facing ramps'. This provides a northbound exit ramp to Lookout Road and southbound entry ramp from Lookout Road. Modelling and assessment of 'north facing ramps' to and from McCaffrey Drive was undertaken separately (see Section 5.3 and Section 5.5).
- **New western hospital access** via a connection from the bypass to the rear of the John Hunter Hospital. A half interchange was modelled in this location, with north facing ramps. This provides hospital access to and from the north. Modelling and assessment of 'south facing ramps' to and from the new western hospital access was undertaken separately (see Section 5.4).
- **Northern interchange:** A full interchange at the northern connection with Newcastle Road and the existing Jesmond to Shortland section of the Newcastle Inner City Bypass.

5.1 Traffic Forecasts on the Project

Traffic has been forecast for the Project for 2020, 2030 and 2040, are shown in Table 5-1. The traffic forecasts for 2014 have been prepared to compare and examine predicted changes of the Project on the road network based on current traffic conditions. Traffic forecasts are prepared for the RP2J northern and southern sections and the new western hospital access. Figure 5-2 to Figure 5-5 show forecast traffic on the Project.

Forecast traffic volumes found that:

- Based on current traffic volumes, the RP2J is predicted to carry between 21,600 and 29,400 vehicles per day on average weekdays (2014). The northern section between Newcastle Road and the new western hospital access is expected to carry higher traffic. The new western hospital is predicted to carry about 7,300 vehicles per day
- In 2020 traffic on the RP2J northern section south of Newcastle Road is projected to be about 31,300 vehicles per day. By 2030, traffic is forecast to grow to about 34,500 vehicles per day and by 2040 to be about 37,700 vehicles per day
- Traffic on the RP2J southern section north of McCaffrey Drive is projected to be about 23,100 vehicles per day in 2020. By 2030, traffic is forecast to grow to about 25,600 vehicles per day and by 2040 to be about 28,100 vehicles per day
- Traffic on the new western hospital access, east of RP2J is predicted to be about 7,800 vehicles per day in 2020. By 2040, traffic is forecast to grow to the order of 9,500 vehicles per day.

Table 5-1 Forecast Daily Traffic Volumes on Project

ID	Road/Location	Forecast Daily Traffic Volumes (two-way in vehicles)			
		2014	2020	2030	2040
20	RP2J northern section, south of Newcastle Road	29,400	31,300	34,500	37,700
21	RP2J southern section, west of McCaffrey Drive	21,600	23,100	25,600	28,100
22	New Western Hospital Access, east of RP2J	7,300	7,800	8,600	9,500

Note, Average Weekday Daily Traffic (two-way in vehicles).
Source: Lower Hunter Traffic Model (LHTM).

5.2 Traffic Redistribution on Surrounding Road Network

Table 5-2 shows forecast daily traffic at 19 locations for 2014, 2020, 2030 and 2040 with the Project. The corresponding traffic reductions and increase in 2014, 2020, 2030 and 2040 with the Project are shown in Figure 5-2 to Figure 5-5.

Existing daily traffic for 2014 with and without the Project and relative traffic reduction and increase have been forecast to compare and examine predicted changes of the Project on the road network based on current traffic conditions. Notable traffic predicted traffic volume changes at key locations include:

- The Project is expected to increase traffic on Charlestown Road south of Carnley Avenue (ID1) by 3,000 vehicles per day (five per cent) from about 55,100 vehicles per day (without RP2J) to about 58,100 vehicles per day (with RP2J)
- Similarly, the Project is expected to increase traffic on Lookout Road south of McCaffrey (ID19) by 4,300 vehicles per day (9 per cent) from about 47,200 vehicles per day (without RP2J) to about 51,500 vehicles per day (with RP2J)
- The Project is expected to reduce north-south and west-south through and regional traffic on the existing route of Lookout Road (north of McCaffrey Drive), Croudace Street and Newcastle Road (between Croudace Street and Newcastle Inner City Bypass). The Project would reduce traffic on these roads by 27 to 43 per cent depending on the location. This would substantially improve traffic flow along the existing route
- The Project is expected to substantially reduce traffic on Lookout Road north of McCaffrey Drive (ID7) by 17,600 vehicles per day (36 per cent) from about 49,400 vehicles per day (without RP2J) to about 31,800 vehicles per day (with RP2J)
- The Project is expected to reduce traffic on Croudace Street north of Elder Street (ID17) by about 17,800 vehicles per day (43 per cent) from about 41,800 vehicles per day (without RP2J) to about 23,900 vehicles per day (with RP2J)
- Traffic on Newcastle Road east of Newcastle Inner City Bypass (ID16) is expected to decrease due to the Project, by about 16,000 vehicles per day (27 per cent) from about 60,200 vehicles per day (without RP2J) to about 44,200 vehicles per day (with RP2J)
- The Project is expected to reduce traffic on McCaffrey Drive (ID5) by 3,600 vehicles per day (19 per cent) from about 18,600 vehicles per day (without RP2J) to about 15,000 vehicles per day (with RP2J)
- The Project is expected to increase traffic on the Newcastle Inner City Bypass north of Newcastle Road (ID11) by about 4,900 vehicles per day (14 per cent) from about 36,100 vehicles per day (without RP2J) to about 41,000 vehicles per day (with RP2J)
- The Project is expected to reduce traffic on Newcastle Road east of Croudace Street (ID10) by about 3,500 vehicles per day (eight per cent) from 46,500 vehicles per day (without RP2J) to 43,000 vehicles per day (with RP2J)
- The Project is expected to marginally reduce traffic on Dent Street north of Newcastle Road (ID13) by about 600 vehicles per day
- The Project is expected to marginally increase traffic on Grandview Road west of Lookout Road (ID4) by about 200 vehicles per day
- The Project is expected to marginally increase traffic on Carnley Avenue east of Lookout Road (ID2) by about 300 vehicles per day
- The new western hospital access is expected to significantly reduce traffic on the existing access via Kookaburra Circuit (ID8) by about 7,300 vehicles per day (48 per cent) from 15,300 vehicles per day (without RP2J) to 8,000 vehicles per day (with RP2J).

In future years 2020, 2030 and 2040, similar traffic redistribution from the RP2J Project on the surrounding road network are expected.

The Project would primarily redistribute traffic in the study area and surrounding road network for north-south and south-west movements.

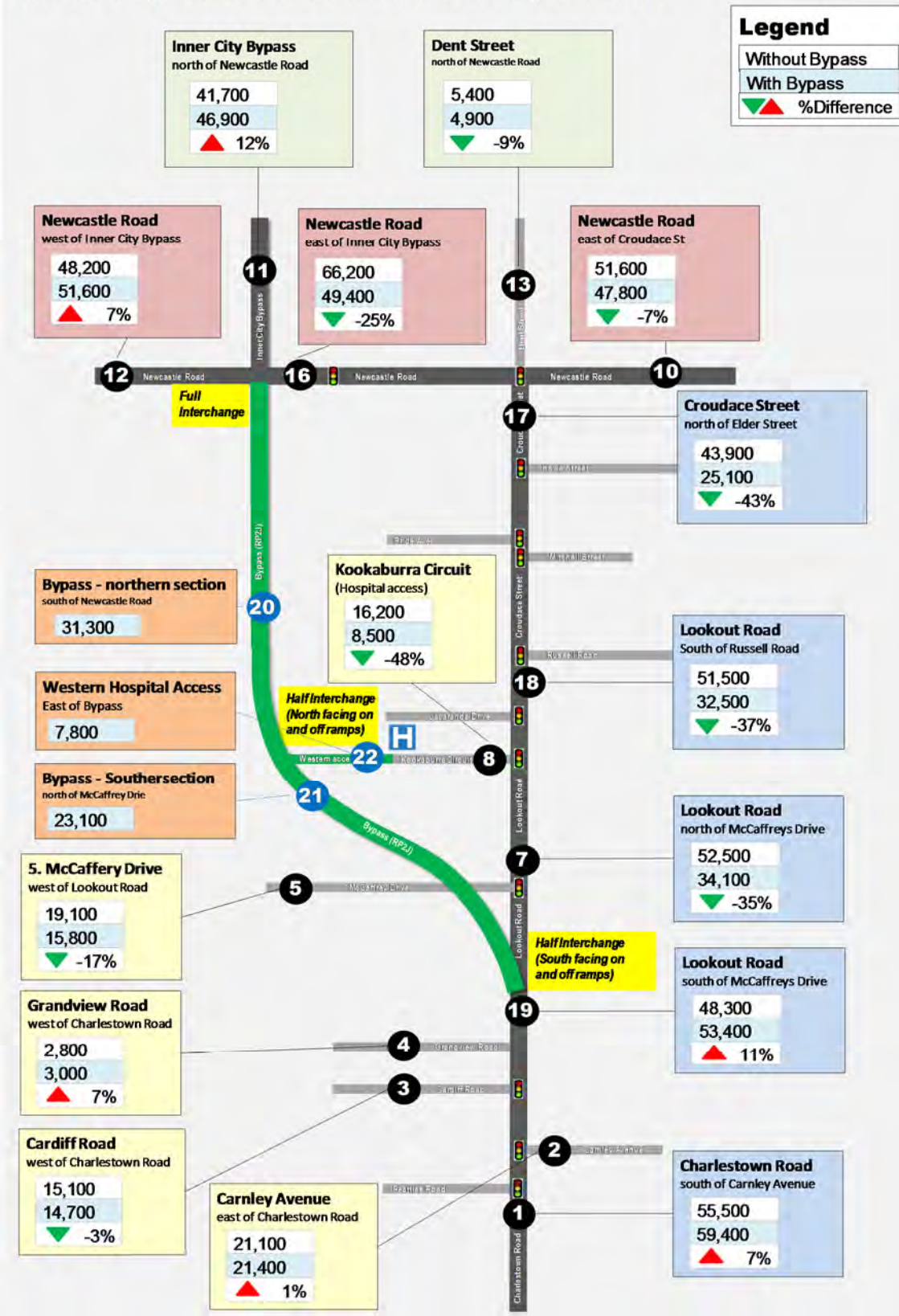
Table 5-2 Forecast Daily Traffic Volumes on 19 Locations for 2014, 2020, 2030 and 2040 with and without RP2J Project

ID	Road/Location	Forecast Daily Traffic Volumes (two-way in vehicles)											
		2014			2020			2030			2040		
		No RP2J	with RP2J	Change	No RP2J	with RP2J	Change	No RP2J	with RP2J	Change	No RP2J	with RP2J	Change
1	Charlestown Road, south of Cardiff Road	55,100	58,100	3,000	55,500	59,400	3,900	56,300	61,700	5,400	57,100	64,000	6,900
2	Carnley Avenue, east of Charlestown Road	21,000	21,300	300	21,100	21,400	300	21,400	21,600	200	21,700	21,900	200
3	Cardiff Road, west of Lookout Road	14,700	14,500	-200	15,100	14,700	-400	15,800	15,100	-700	16,600	15,500	-1,100
4	Grandview Road, west of Lookout Road	2,700	2,900	200	2,800	3,000	200	3,000	3,200	200	3,100	3,400	300
5	McCaffrey Drive, west of Lookout Road	18,600	15,000	-3,600	19,100	15,800	-3,300	20,000	17,000	-3,000	20,900	18,200	-2,700
6	Croudace Road, west of Grandview Road	19,900	16,100	-3,800	20,100	16,600	-3,500	20,600	17,500	-3,100	21,000	18,500	-2,500
7	Lookout Road, north of McCaffrey Drive	49,400	31,800	-17,600	52,500	34,100	-18,400	57,700	38,000	-19,700	63,100	42,300	-20,800
8	Kookaburra Circuit (John Hunter Hospital access)	15,300	8,000	-7,300	16,200	8,500	-7,700	17,900	9,300	-8,600	19,800	10,300	-9,500
9	Russell Road, east of Lookout Road	16,200	15,300	-900	17,600	16,800	-800	20,100	19,400	-700	22,600	21,900	-700
10	Newcastle Road, east of Croudace Street	46,500	43,000	-3,500	51,600	47,800	-3,800	60,100	55,900	-4,200	68,500	64,000	-4,500
11	Newcastle Inner City Bypass, north of Newcastle Road	36,100	41,000	4,900	41,700	46,900	5,200	51,000	56,800	5,800	60,300	66,900	6,600
12	Newcastle Road, west of Newcastle Inner City Bypass	44,300	47,500	3,200	48,200	51,600	3,400	54,700	58,500	3,800	61,200	65,300	4,100
13	Dent Street, north of Newcastle Road	4,900	4,300	-600	5,400	4,900	-500	6,300	5,900	-400	7,200	6,800	-400
14	Jacaranda Drive (John Hunter Hospital access)	2,700	2,700	0	2,700	2,700	0	2,800	2,800	0	2,900	2,900	0
15	Howe Street, east of Croudace Street	8,500	8,600	100	9,600	9,700	100	11,400	11,700	300	13,300	13,600	300
16	Newcastle Road, east of Newcastle Inner City Bypass	60,200	44,200	-16,000	66,200	49,400	-16,800	76,200	58,200	-18,000	86,200	67,100	-19,100
17	Croudace Street, north of Elder Street	41,800	23,900	-17,900	43,900	25,100	-18,800	47,300	27,100	-20,200	50,800	29,100	-21,700
18	Lookout Road, south of Russell Road	48,700	30,500	-18,200	51,500	32,500	-19,000	56,400	36,000	-20,400	61,300	39,500	-21,800
19	Lookout Road, south of McCaffrey Drive	47,200	51,500	4,300	48,300	53,400	5,100	50,200	56,600	6,400	52,200	59,800	7,600

Note, Average Weekday Daily Traffic (two-way in vehicles).

Source: Lower Hunter Traffic Model (LHTM).

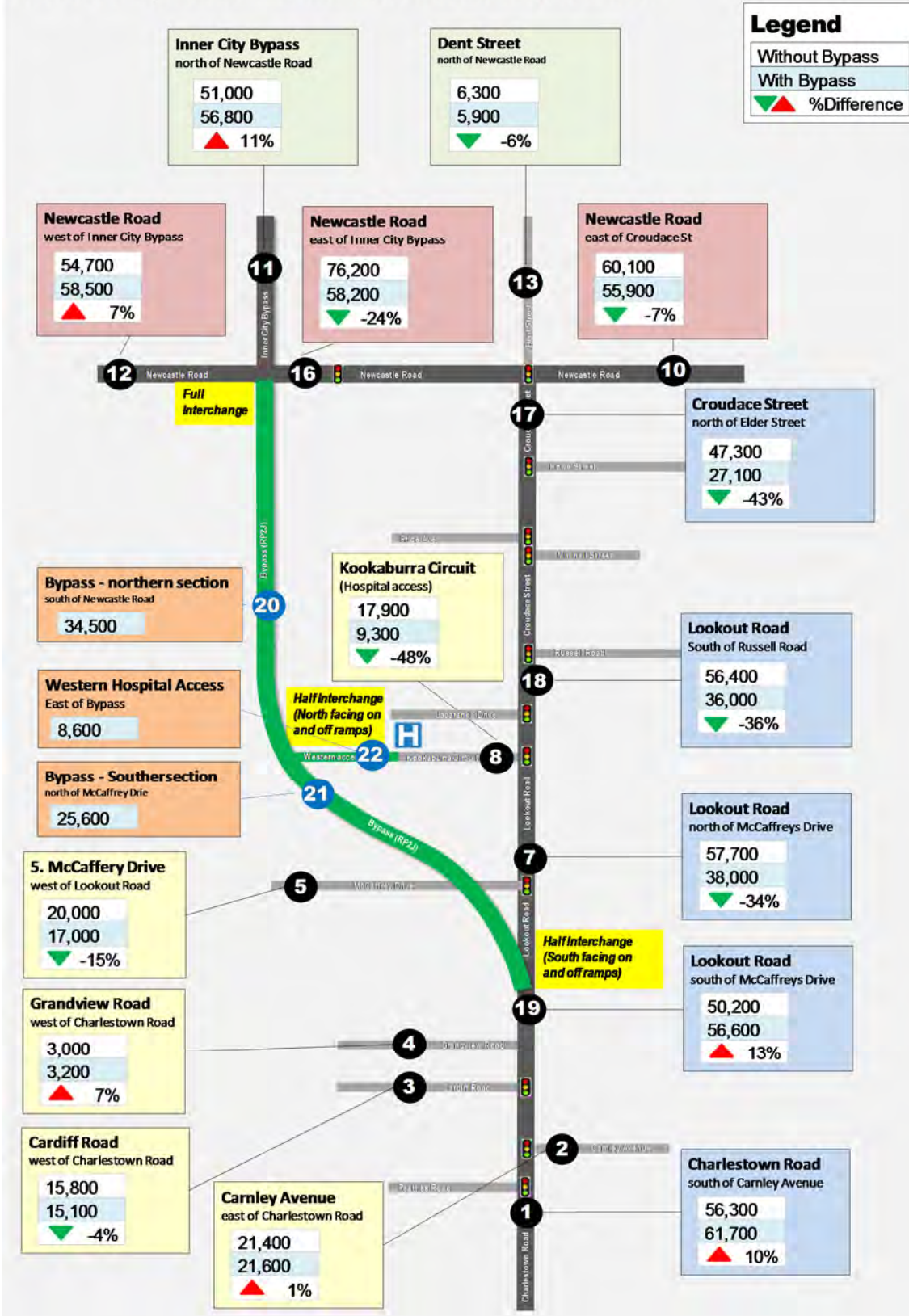
Forecast Daily Traffic with and Without RP2J Project in 2020



Note, Average Weekday Daily Traffic (two-way in vehicles).
 Source: Lower Hunter Traffic Model (LHTM).

Figure 5-3 Forecast Daily Traffic with and without the Project in 2020

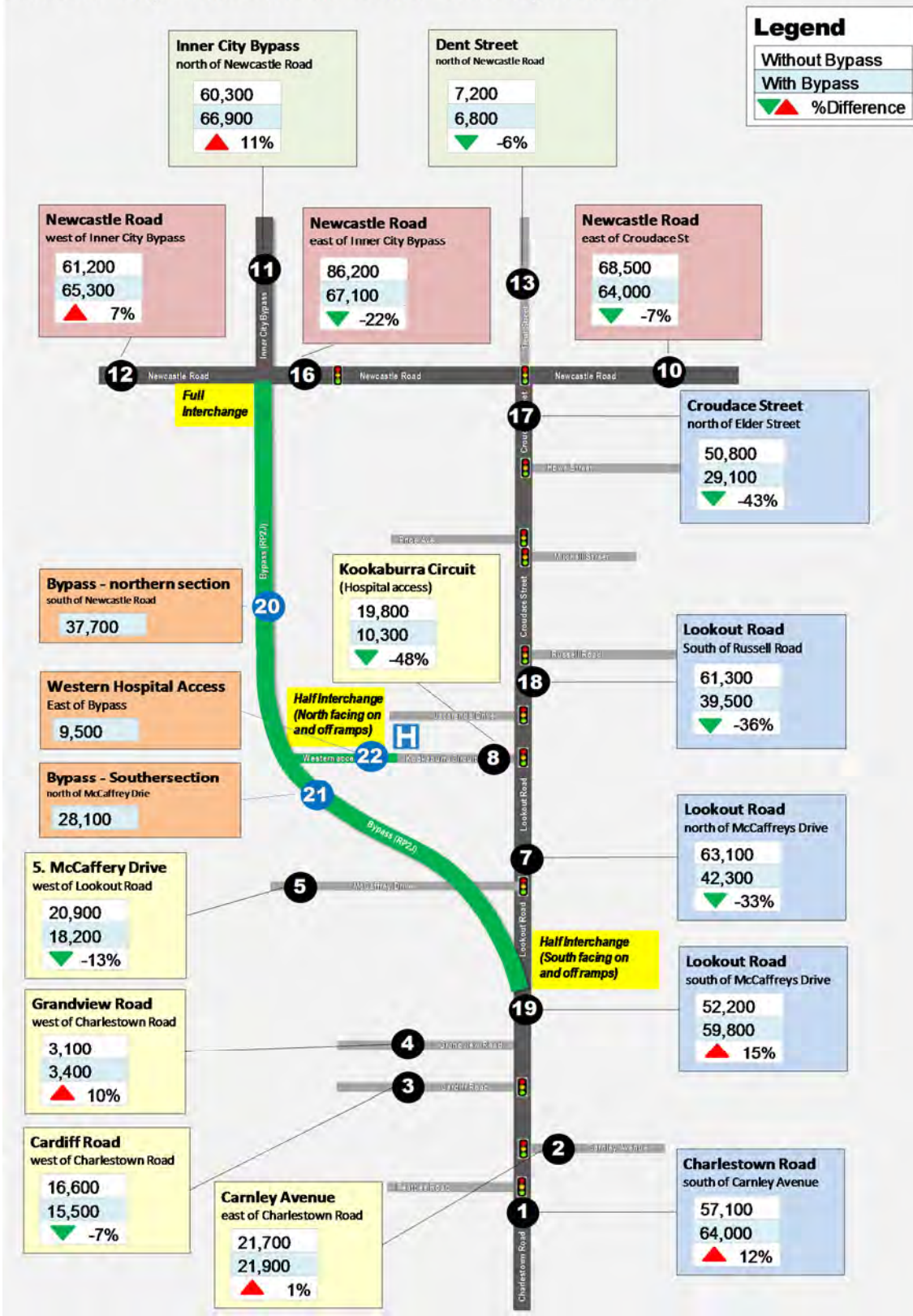
Forecast Daily Traffic with and Without RP2J Project in 2030



Note, Average Weekday Daily Traffic (two-way in vehicles).
Source: Lower Hunter Traffic Model (LHTM).

Figure 5-4 Forecast Daily Traffic with and without the Project in 2030

Forecast Daily Traffic with and Without RP2J Project in 2040



Note, Average Weekday Daily Traffic (two-way in vehicles).
Source: Lower Hunter Traffic Model (LHTM).

Figure 5-5 Forecast Daily Traffic with and without the Project in 2040

5.3 Modelling Scenario A -North Facing Ramps at Southern Interchange

Scenario modelling was carried out to investigate likely traffic impacts from the provision of “north facing ramps” at the southern interchange with McCaffrey Drive and Lookout Road. The north facing ramps comprise a northbound on ramp from McCaffrey Drive and a southbound off ramp to McCaffrey Drive. The north facing ramps would primarily provide direct access between McCaffrey Drive and the Project.

5.3.1 Existing Traffic Distributions at McCaffrey Drive

Origin-destination (OD) distributions at McCaffrey Drive west of Lookout Road were analysed to examine predicted traffic that would use the Project via north facing ramps at the southern interchange based on existing traffic distributions. The traffic that was predicted to use the Project is traffic at McCaffrey Drive that had an origin or destination at either:

- Newcastle Inner City Bypass, North of Newcastle Road (refer Table 5.2 ID11)
- Newcastle Road, West of Newcastle Inner City Bypass (refer Table 5.2 ID12)

Figure 5-6 shows the existing daily traffic distributions at McCaffrey Drive west of Lookout Road. Figure 5-7 and Figure 5-8 show respective morning and afternoon peak hour traffic distributions at McCaffrey Drive.

Of the total about 18,600 daily vehicles observed at McCaffrey Drive west of Lookout Road the traffic distribution results from the daily origin-destination survey indicate the following:

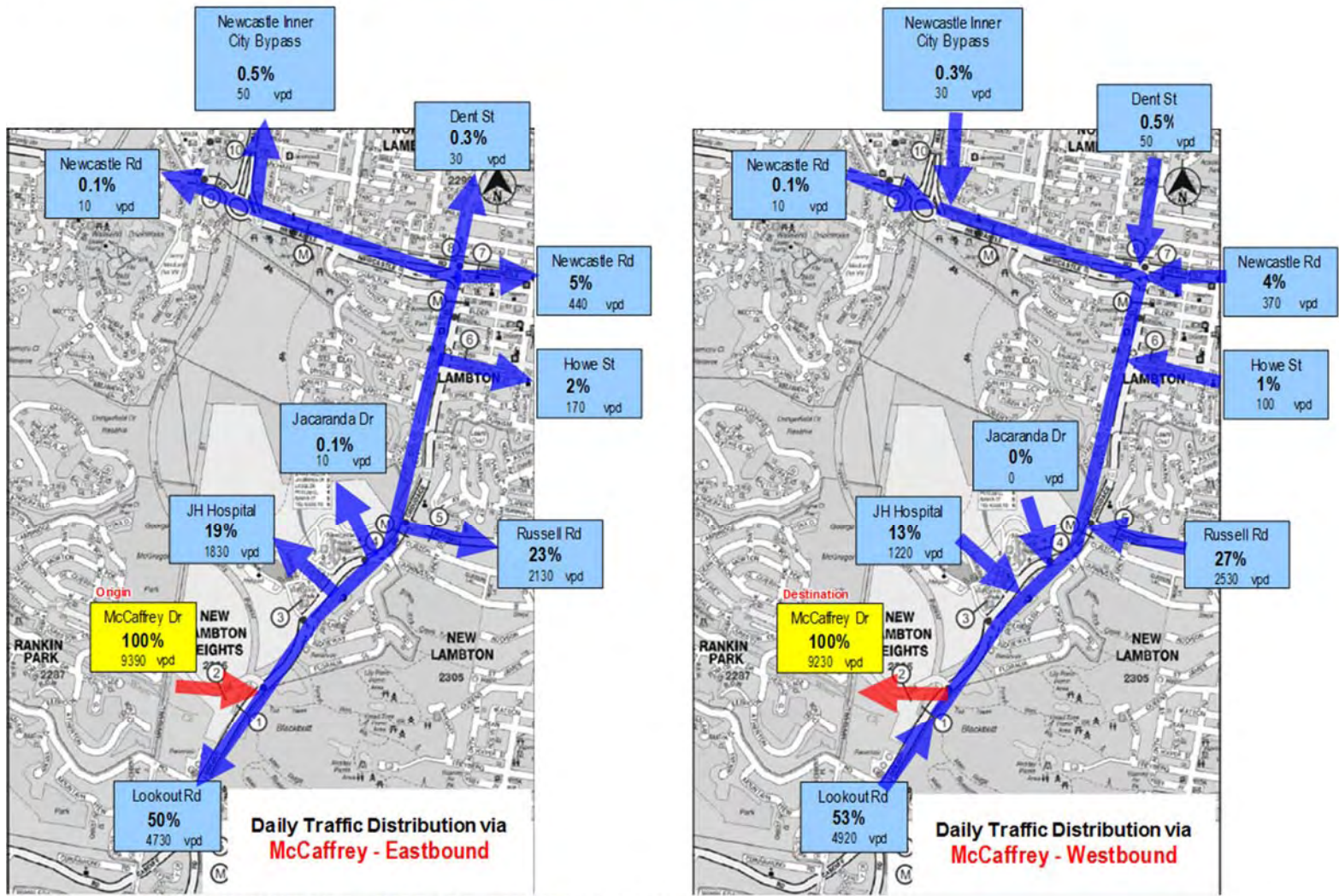
- About 99% of McCaffrey Drive traffic had an origin or destination other than the Project:
 - About 52% (9,650 vehicles) had origin or destination south of McCaffrey Drive via Lookout Road
 - About 25% (4,660 vehicles) had origin or destination to the east via Russell Road
 - About 16% (3,050 vehicles) had origin or destination at the John Hunter Hospital.
 - About 6% (1,080 vehicles) had origin or destination to the east via Howe Street or Newcastle Road
- About 0.5% (100 daily vehicles) had an origin or destination on the Newcastle Inner City Bypass north of Newcastle Road (ID11) or Newcastle Road west of the Newcastle Inner City Bypass (ID12). This traffic would use the Project

Similar patterns were observed during morning and afternoon peak OD surveys:

- The morning peak OD distributions at McCaffrey Drive shows about 1% would use the Project (ID11 or ID12) with 9 vehicles travelled toward north to Newcastle Inner City Bypass and Newcastle Road. About 4 vehicles travelled from Newcastle Inner City Bypass and Newcastle Road to McCaffrey Drive
- Similarly, the afternoon peak OD distributions at McCaffrey Drive shows about 1% would use the Project (ID11 or ID12) with 5 vehicles travelled toward north to Newcastle Inner City Bypass and Newcastle Road. About 12 vehicles travelled from Newcastle Inner City Bypass and Newcastle Road to McCaffrey Drive.

In summary, the existing traffic distributions indicate very low volume of traffic would use the north facing ramps to access the Project to and from McCaffrey Drive.

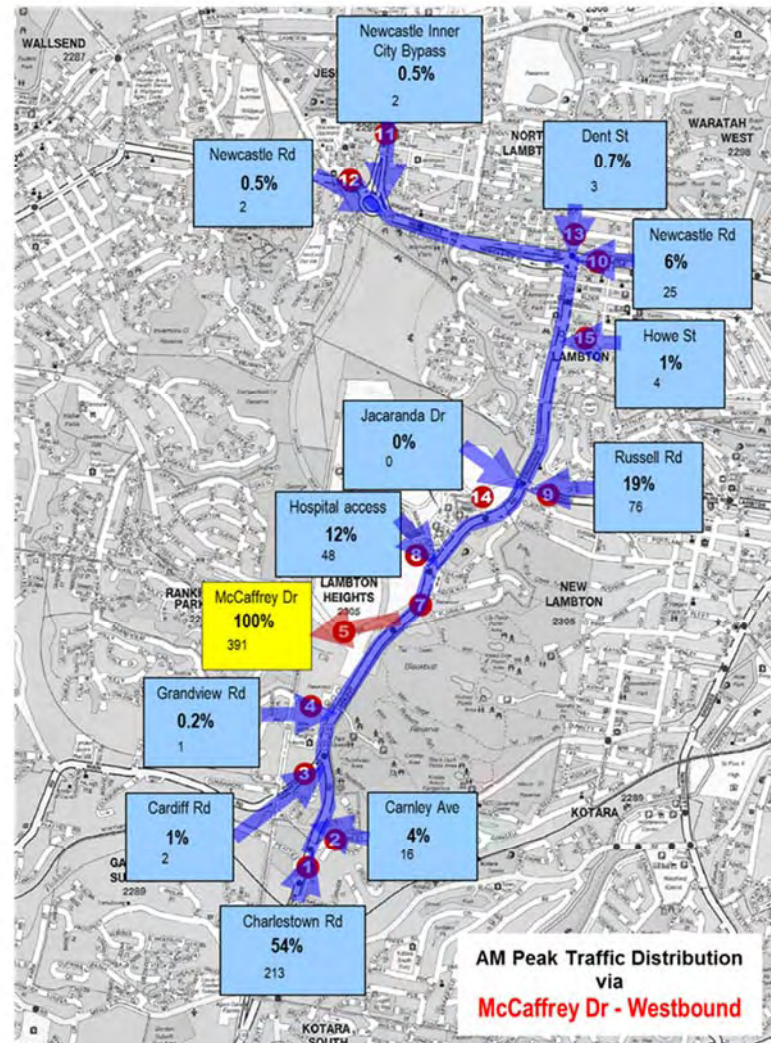
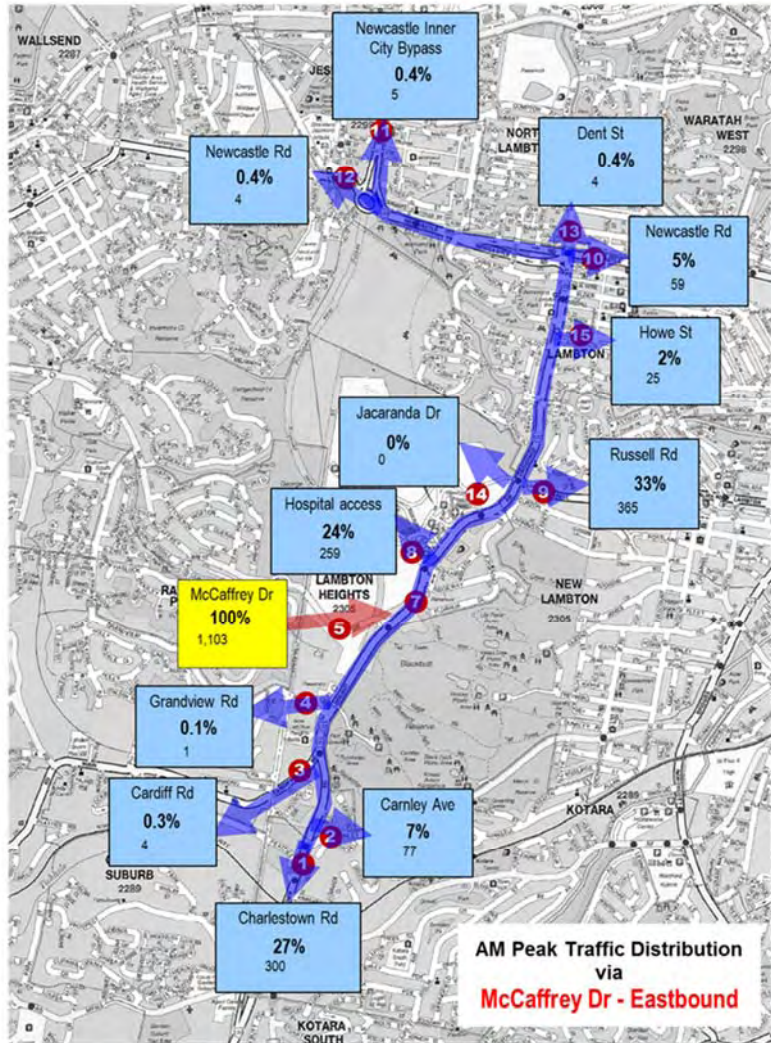
RP2J - Daily Traffic Distribution via McCaffrey Drive - west of Lookout Road



File location: F:\AA006517\Var4_RP2J&M12RT\Calculations\OD Data Analysis\PR2J_OD Data Analysis_Client version.xlsx

Figure 5-6 Daily OD Distribution via McCaffrey Drive west of Lookout Road

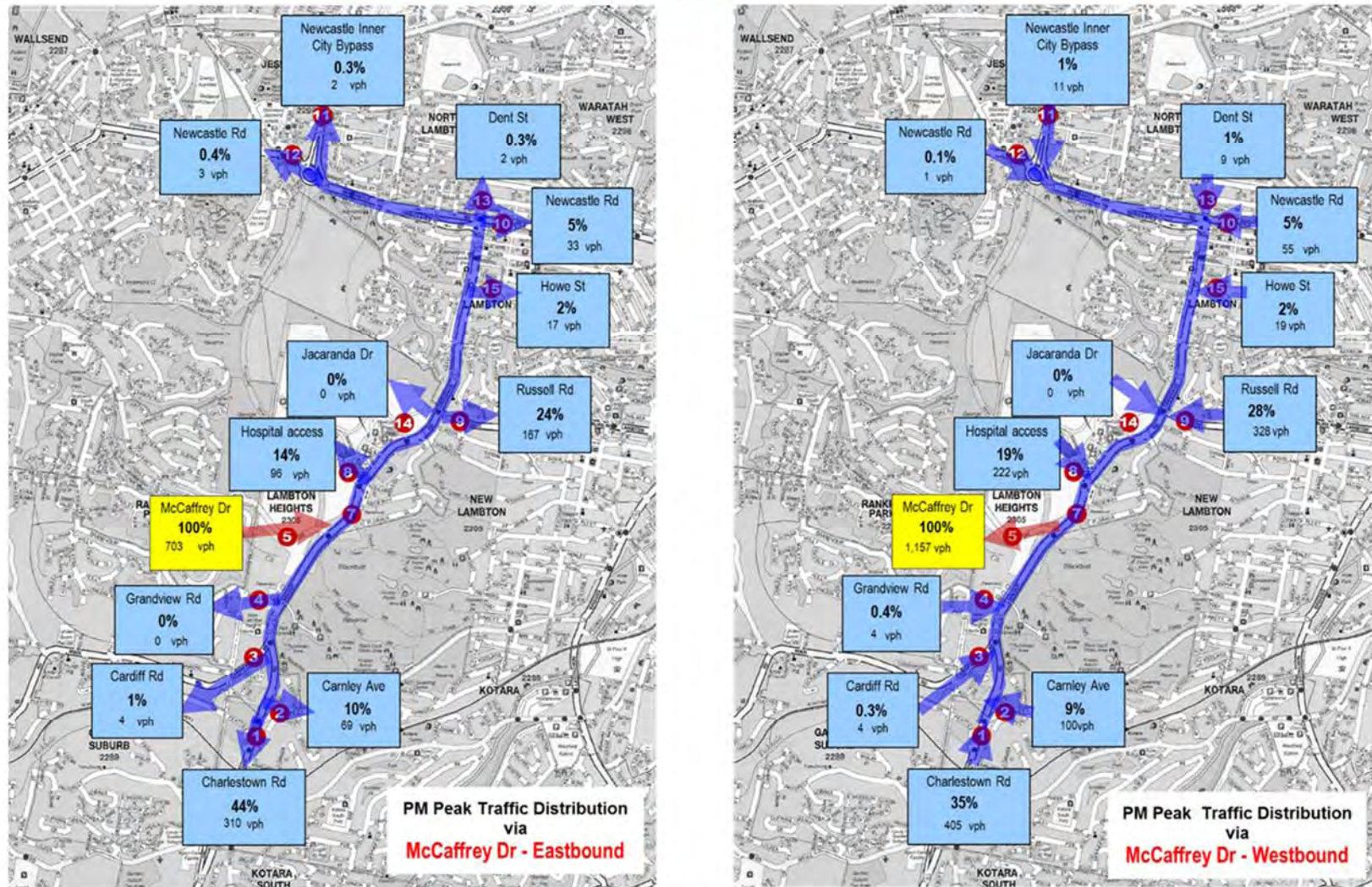
AM Peak Traffic Distribution via McCaffrey Road- West of Lookout Road



File location: F:\aa006517\Vari4_RP2J\M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J>SelectLink_May2015_C2_AM

Figure 5-7 AM Peak OD Distribution via McCaffrey Drive west of Lookout Road

PM Peak Traffic Distribution via McCaffrey Road- West of Lookout Road



File location: F:\AA006517\Vari4_RP2J&M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_PM

Figure 5-8 PM Peak OD Distribution via McCaffrey Drive west of Lookout Road

5.3.2 Forecast Traffic Distribution – Scenario A

Forecast traffic distribution from the provision of “north facing ramps” at the southern interchange were investigated for 2014 existing traffic conditions and 2020, 2030 and 2040 for future traffic conditions using the LHTM.

Table 5-3 shows forecast daily traffic at locations for 2014/15 with and without north facing ramps. Figure 5-9 shows traffic volume changes with the north facing ramps at key locations.

Traffic modelling results for 2014/15 predicted that:

- About 150 vehicles per day would use the ramps to travel to/from north to the Newcastle Inner City Bypass and/or Newcastle Road.
- The modelling outcomes are supported by existing OD traffic distributions as discussed in previous Section 5.3.1.
- Given the predicted low volumes of traffic forecast to use both of the north facing ramps, the modelling indicates that the omission of north facing ramps from the southern interchange would have negligible traffic volume impacts on local roads including Grandview Road and Marshall Street
- The traffic volumes predicted to use Grandview Road and Marshall Street are essentially the same with or without the north facing ramps. This is supported by the extra distance McCaffrey Drive traffic would have to travel if it used Grandview Road in order to access the Project.

In 2020, the north facing ramps are forecast to carry about 175 daily vehicles increased to 200 in 2030 and 225 in 2040.

Figure 5-10 shows the daily traffic volumes predicted to use the southern interchange in 2014/15 with south facing ramps and north facing ramps. Key points include:

About 28,500 vehicles per day would use the south facing ramps:

- About 13,800 vehicles per day would use the northbound off ramp bridge over the bypass to continue on Lookout Road
- About 14,700 vehicles per day would use the southbound on ramp to join with the Newcastle Inner City Bypass south of McCaffrey Drive

About 150 vehicles per day would use the north facing ramps:

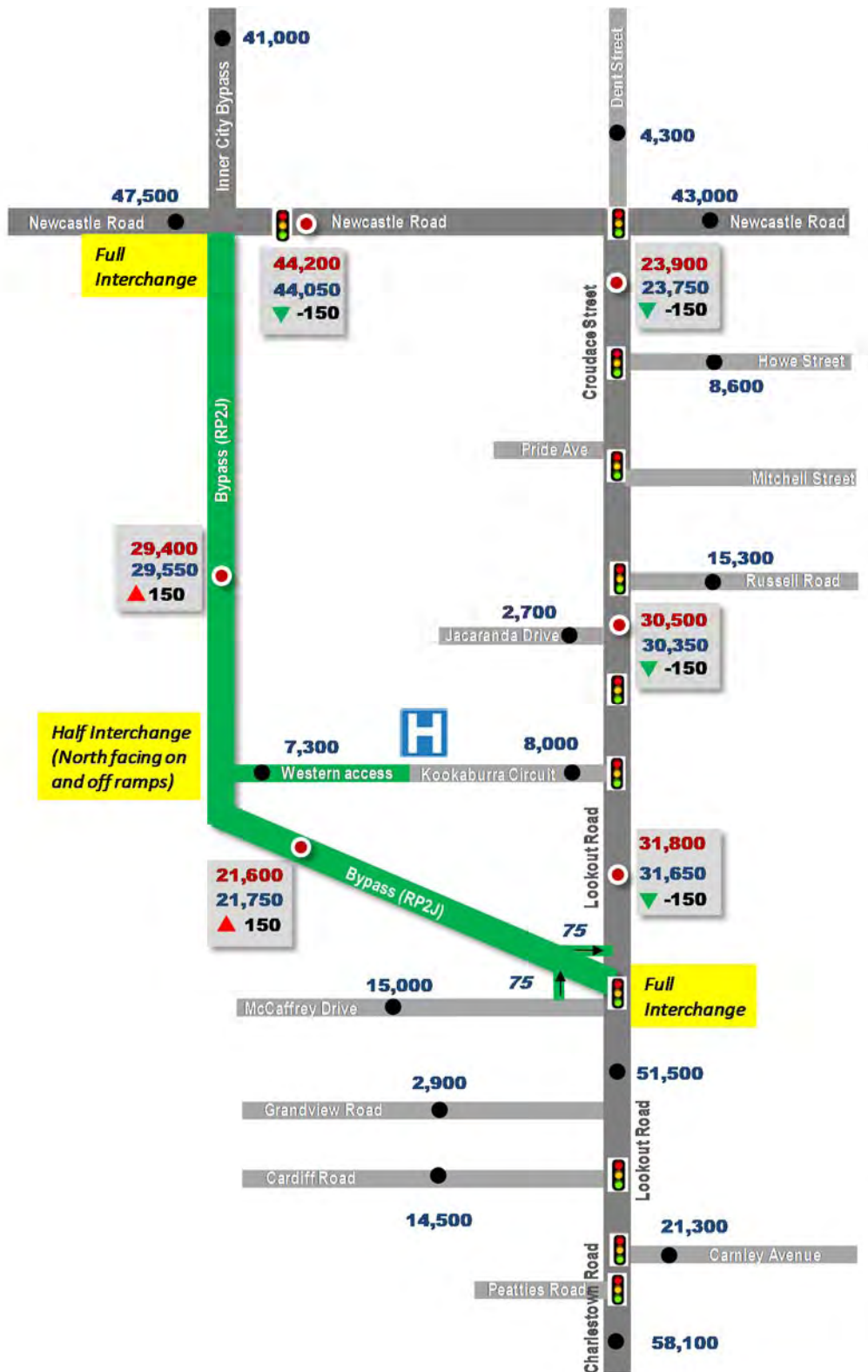
- About 75 vehicles per day would use the northbound on ramp to enter the Project from McCaffrey Drive
- About 75 vehicles per day would use the southbound off ramp to exit the Project to McCaffrey Drive

In summary, the forecast traffic distribution with the Project indicates very low volumes would use the north facing ramps to access the Project to and from McCaffrey Drive.

Table 5-3 Forecast Daily Traffic Volumes on Locations for 2014/15 with and without North Facing Ramps at the Southern Interchange

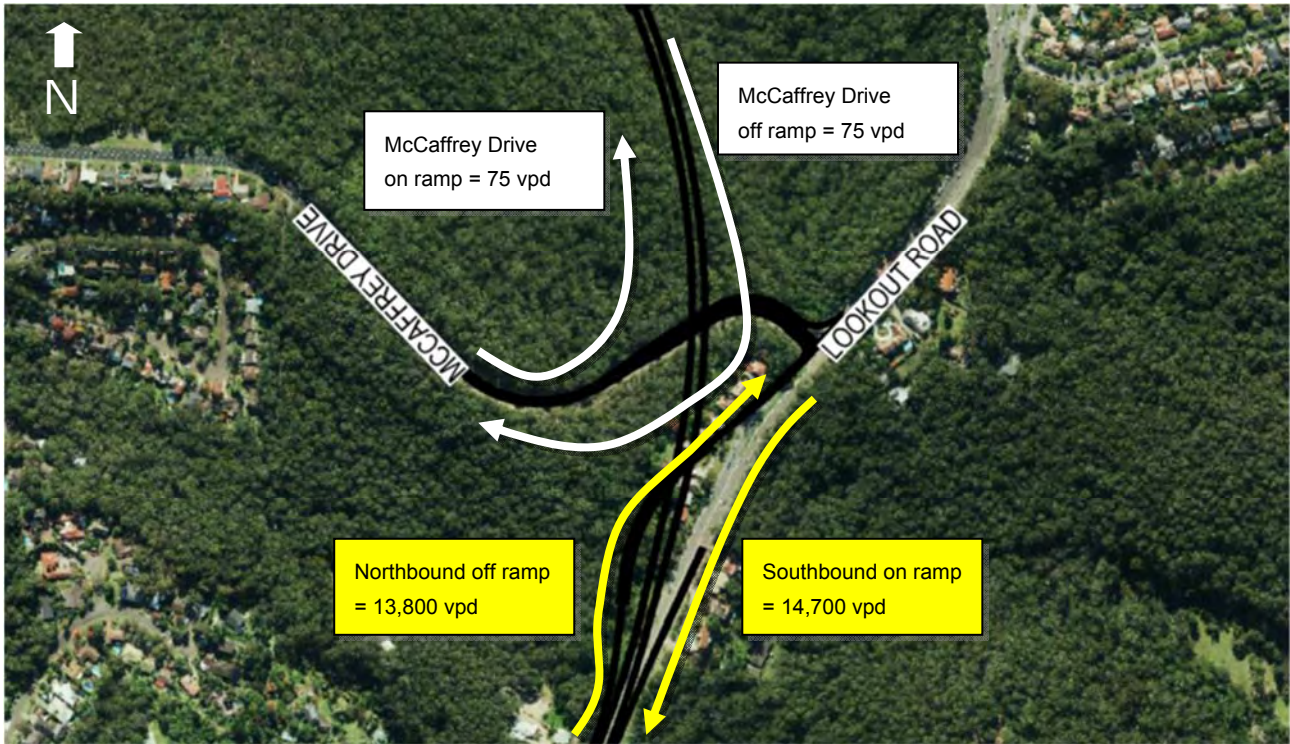
ID	Road/Location	Forecast Daily Traffic Volumes (two-way in vehicles)		
		2014 With the Project		
		Without North Facing Ramps	With North Facing Ramps	Change
	Southern Interchange – North Facing Ramps:			
23	Northbound on ramp	n/a	75	
24	Southbound off ramp	n/a	75	
	The Project:			
20	RP2J northern section, south of Newcastle Road	29,400	29,550	150 ▲
21	RP2J southern section, west of McCaffrey Drive	21,600	21,750	150 ▲
22	New Western Hospital Access, east of RP2J	7,300	7,300	No change
	Key locations:			
1	Charlestown Road, south of Cardiff Road	58,100	58,100	No change
2	Carnley Avenue, east of Charlestown Road	21,300	21,300	No change
3	Cardiff Road, west of Lookout Road	14,500	14,500	No change
4	Grandview Road, west of Lookout Road	2,900	2,900	No change
5	McCaffrey Drive, west of Lookout Road	15,000	15,000	No change
6	Croudace Road, west of Grandview Road	16,100	16,100	No change
7	Lookout Road, north of McCaffrey Drive	31,800	31,650	-150 ▼
8	Kookaburra Circuit (John Hunter Hospital access)	8,000	8,000	No change
16	Newcastle Road, east of Newcastle Inner City Bypass	44,200	44,050	-150 ▼
17	Croudace Street, north of Elder Street	23,900	23,750	-150 ▼
18	Lookout Road, south of Russell Road	30,500	30,350	-150 ▼

Note, Average Weekday Daily Traffic (two-way in vehicles).
Source: Lower Hunter Traffic Model (LHTM).



Note, Average Weekday Daily Traffic (two-way in vehicles).
 Source: Lower Hunter Traffic Model (LHTM).

Figure 5-9 Forecast Daily Traffic (2014) with and without North Facing Ramps at Southern Interchange



Note, Average Weekday Daily Traffic (one-way in vehicles).
 Source: Lower Hunter Traffic Model (LHTM).

Figure 5-10 Forecast Southern Interchange Daily Traffic Volumes (2014/15)

5.4 Modelling Scenario B - South Facing Ramps at Western Hospital Interchange

Scenario modelling was carried out to investigate likely traffic impacts from the provision of “south facing ramps” at the Western Hospital interchange. The south facing ramps comprise a northbound off ramp to the hospital and a southbound on ramp from the hospital.

5.4.1 Forecast Traffic Distribution – Scenario B

Forecast traffic distribution from the provision of “south facing ramps” at the Western Hospital interchange were investigated for 2014 existing traffic conditions and 2020, 2030 and 2040 for future traffic conditions using the LHTM.

Traffic modelling results for 2014/15 predicted that:

- About 1,100 vehicles per day would use each of the south facing ramps at the Western Hospital interchange. This is a total of 2,200 vehicles per day. This compares with about 7,300 vehicles per day that would use the north facing ramps
- A further 3,500 vehicles per day from the south are forecast to continue to use the existing eastern hospital accesses off Lookout Road.
- Motorists from the south can continue to use the existing eastern main hospital access off Lookout Road, which provides a shorter travel distance (1km versus 2.5km) albeit that motorist would need to pass through 2 sets of traffic signals on the existing route.
- In contrast, the provision of north facing ramps at the western Hospital Interchange would substantially reduce travel times and travel distance (1.5km versus 4km) for hospital trips to/from the north with 8 sets of traffic signals bypassed on the existing route.
- Given the predicted lower volumes of traffic forecast to use the south facing ramps, the shorter alternative route via the existing eastern hospital accesses and the forecast reduction of traffic along Lookout Road north of McCaffrey, the modelling indicates that the omission of south facing ramps from the Western Hospital interchange would have a low impacts traffic flow on the short section of road between McCaffrey Drive and the Eastern Hospital access.
- In summary, the western Hospital Interchange design with north facing ramps only, provides northern access via a new western entrance to the hospital and southern access via the existing eastern to the hospital, with a forecast approximate 50/50 split of traffic between the two hospital accesses.
- In the future, should the John Hunter Hospital campus change its internal configuration and expand its facilities, there may be additional traffic which switches from using the existing Eastern access to the new Western access which would increase the use of the south facing ramps.
- The proposed Western Hospital Half-Interchange design (north facing ramps only), does not preclude the south facing ramps from being added at a future stage.

In future years 2020, 2030 and 2040, similar traffic redistribution from the south facing ramps on the surrounding road network are expected.

5.5 Modelling Scenario C - South Facing Ramps at western Hospital Interchange and North Facing Ramps at the Southern Interchange

Scenario modelling was carried out to investigate likely traffic impacts from the provision of both:

- South facing ramps at the Western Hospital interchange
- North facing ramps at the Southern Interchange

5.5.1 Forecast Traffic Distribution – Scenario C

Forecast traffic distribution from the provision of with both “south facing ramps” at the Western Hospital interchange and “north facing ramps” at the Southern interchange were investigated for 2014 existing traffic conditions and 2020, 2030 and 2040 for future traffic conditions using the LHTM.

Traffic modelling results for 2014/15 predicted that:

- About 300 vehicles per day would use each of the north facing ramps at the southern interchange. This is a total of 600 vehicles per day which represents about 2% of traffic using the southern section of the Project
- This traffic primarily uses the ramps to travel between McCaffrey Drive and the new western hospital access (about 450 vehicles per day)
- About 150 vehicles per day would use the ramps to travel further to/from north to the Newcastle Inner City Bypass and/or Newcastle Road, as discussed in Section 5.3.2
- The addition of north facing ramps at the southern interchange, would increase the use of the south facing ramps (as discussed in Section 5.4) by 450 vehicles per day from 2,200 to 2,650 vehicles per day.
- The modelling outcomes are supported by existing OD traffic distributions as discussed in previous Section 5.3.1.
- Given the predicted low volumes of traffic, the modelling indicates that the omission of both south facing ramps at the Western Hospital Interchange and the north facing ramps from the southern interchange would have negligible traffic volume impacts on the surrounding road network.
- The traffic volumes predicted to use Grandview Road and Marshall Street are essentially the same with or without the north facing ramps at the southern interchange and the south facing ramps at the western hospital interchange.

In future years 2020, 2030 and 2040, similar traffic redistribution from both the south facing ramps at the Western Hospital Interchange and north facing ramps at the Southern Interchange, on the surrounding road network are expected.

6 Summary of Findings

Overview

Roads and Maritime is planning for a 3.4 kilometre section of the Newcastle Inner City Bypass between Rankin Park to Jesmond, to the west of John Hunter Hospital (“the Project”). The Project would form part of the Newcastle Inner City Bypass, which provides improved traffic flows across the western suburb of Newcastle and connects key regional destinations such as Bennetts Green, Charlestown and Jesmond shopping centres, John Hunter Hospital, Newcastle University and the Pacific Highway.

This traffic modelling report has been prepared to support the 2007 Strategic Design review and refinement for the Newcastle Inner City Bypass Rankin Park to Jesmond.

Existing Conditions

To satisfy the modelling requirements, Roads and Maritime carried out an extensive traffic data collection exercise involving origin-destination surveys, midblock counts and intersections turning counts in the study area. Two sets of traffic data were collected in October 2014 and May 2015. These two data sets form 2014/15 traffic data.

The 2014/15 traffic count data indicated that:

- Charlestown Road south of Carnley Avenue carried about 55,000 vehicles per day
- Between Grandview Road and Russell Road, Lookout Road carried traffic between 47,200 and 49,400 vehicles per day
- Between Russell Road and Newcastle Road, Croudace Street carried about 41,800 vehicles per day
- Newcastle Road west of the Newcastle Inner City Bypass carried about 44,000 vehicles per day.
- Between the Newcastle Inner City Bypass and Croudace Street, Newcastle Road carried about 60,000 vehicles per day.
- East of Croudace Street, Newcastle Road carried traffic about 46,500 vehicles per day
- The Newcastle Inner City Bypass north of Newcastle Road carried about 36,000 vehicles per day

Origin-destination (OD) distributions identified the following travel patterns:

- Major north-south route for through and regional traffic between Lookout Road (South of McCaffrey Drive) and the Newcastle Inner City Bypass (Jesmond to Sandgate) via the existing route of Lookout Road, Croudace Street and Newcastle Road
- Major south-west route between Lookout Road (south of McCaffrey Drive) and McCaffrey Drive
- Major east-west movements via Newcastle Road
- Major east-west movement between McCaffrey Drive and Russell Road.

The Project would redistribute traffic in the study area and surrounding road network for north-south and south-west movements.

Historical Traffic Growth

The historical data between 2004 and 2014 indicated that in the last 10 years traffic in the study area has grown in the order of about 1 per cent per annum.

Future Traffic Growth

The Lower Hunter Traffic Model (LHTM) has been updated locally for the study area using actual origin-destination (OD) survey data and mid-block traffic counts. Future traffic volumes for the study area were determined taking into account of population and employment increase projected in the Lower Hunter Regional Strategy.

The traffic growth analysis found that:

- In general, the model predicted traffic growth for the study area of about 1 per cent per annum to 2040
- Traffic on Lookout Road north of McCaffrey Drive is predicted to grow by about 0.9 per cent per annum from 49,400 vehicles per day in 2014 to 63,100 vehicles per day in 2040. Similar traffic growth rates were predicted on Croudace Street. The forecast growth rate was found to be similar to observed historical growth at this location
- Traffic on Newcastle Road east of Newcastle Inner City Bypass is predicted to grow by about 1.4 per cent per annum from 60,200 vehicles per day in 2014 to 86,200 vehicles per day in 2040
- Traffic on the Newcastle Inner City Bypass north of Newcastle Road is predicted to grow in the order of 2.0 per cent per annum from 36,100 vehicles per day in 2014 to 60,300 vehicles per day in 2040.

Traffic Forecast on the Project

Traffic has been forecast on the Project for 2020, 2030 and 2040. The traffic forecasts for 2014 have been prepared to compare and examine the predicted changes of the Project on the road network based on today traffic conditions.

With existing 2014 volumes, the RP2J is predicted to carry between 21,600 and 29,400 vehicles per day on average weekdays. The northern section between Newcastle Road and the new western hospital access is expected to carry higher traffic volumes. With 2014 volumes, the new western hospital is predicted to carry about 7,300 vehicles per day.

Traffic on the RP2J northern section south of Newcastle Road is projected to be about 31,300 vehicles per day in 2020. By 2030, traffic is forecast to grow to about 34,500 vehicles per day and by 2040 to be about 37,700 vehicles per day

Traffic on the RP2J southern section north of McCaffrey is projected to be about 23,100 vehicles per day in 2020. By 2030, traffic is forecast to grow to about 25,600 vehicles per day and by 2040 to be about 28,100 vehicles per day

Traffic on the new western hospital access, east of RP2J is predicted to be about 7,800 vehicles per day in 2020. By 2040, traffic is forecast to grow to the order of 9,500 vehicles per day.

Traffic Redistribution on Surrounding Road Network

Predicted traffic redistribution with the Project on the surrounding road network was investigated using the Lower Hunter Traffic Model (LHTM) for 2020, 2030 and 2040.

Forecast daily traffic at key locations were also prepared for existing 2014 with and without the RP2J to compare and examine predicted changes of the Project on road network based on today traffic conditions.

Notable traffic changes predicted for 2014 at key locations include:

- The Project is predicted to increase traffic on Lookout Road south of McCaffrey Drive by about 9 per cent
- The Project is expected to increase traffic on the Newcastle Inner City Bypass north of Newcastle Road by about 14 per cent
- The Project is expected to reduce north-south and west-south through and regional generated traffic from the existing route by 27 to 43 per cent depending on the location. This would substantially improve traffic flow along the existing route.
- The Project is expected to reduce traffic on McCaffrey Drive by about 19 per cent
- The Project is expected to marginally increase traffic on Dent Street, Grandview Road, Cardiff Road and Carnley Avenue
- The potential new western hospital access would substantially reduce traffic on existing access via Kookaburra Circuit by 48 per cent
- In future years 2020, 2030 and 2040, similar traffic changes from the RP2J Project on road network are expected.

Modelling Scenario A - North Facing Ramps at Southern Interchange

Modelling was carried out to investigate the predicted traffic distribution and changes from the provision of “north facing ramps” at the southern interchange with Lookout Road.

Key results of the traffic modelling:

- Based on the results of the origin-destination surveys, existing traffic distribution indicates very low volume of existing traffic (100 vehicles per day) would use north facing ramps to access the Project to and from McCaffrey Drive north facing ramps. This traffic represents about 0.5% of the existing McCaffrey Drive traffic volume of 18,600 vehicles per day
- Based on the results of the traffic modelling, forecast traffic distribution indicates very low volume of traffic (75 vehicles per day) would use each of the north facing ramps to access the Project to and from McCaffrey Drive north facing ramps.
- About 150 vehicles per day would use the ramps to travel to/from the Newcastle Inner City Bypass and/or Newcastle Road.
- Given the predicted low volumes of traffic forecast to use both of the north facing ramps, the modelling indicates that the omission of north facing ramps from the southern interchange would have negligible traffic volume impacts on local roads including Grandview Road and Marshall Street.
- The traffic volumes predicted to use Grandview Road and Marshall Street are essentially the same with or without the north facing ramps. This is supported by the extra distance McCaffrey Drive traffic would have to travel if it used Grandview Road in order to access the Project.

- In 2020, the north facing ramps are forecast to carry about 175 daily vehicles increased to 200 daily vehicles in 2030 and 225 daily vehicles in 2040.

Modelling Scenario B - South Facing Ramps at western Hospital Interchange

Modelling was carried out to investigate the predicted traffic distribution and changes from the provision of “south facing ramps” at the western hospital access.

Key results of the traffic modelling:

- Based on the results of the traffic modelling, forecast traffic distribution indicates lower volume of traffic (2,000 vehicles per day) would use the south facing ramps to access the hospital compared to 7,300 vehicles per day using the north facing ramps.
- Motorists from the south can continue to use the existing eastern main hospital access off Lookout Road, which provides a shorter travel distance (1km versus 2.5km) albeit that motorist would need to pass through 2 sets of traffic signals on the existing route.
- In contrast, the provision of north facing ramps at the Western Hospital Interchange would substantially reduce travel times and travel distance (1.5km versus 4km) for hospital trips to/from the north with 8 sets of traffic signals bypassed on the existing route.
- In summary, the Western Hospital Interchange design with north facing ramps only, provides northern access via a new western entrance to the hospital and southern access via the existing eastern to the hospital, with a forecast approximate 50/50 split of traffic between the two hospital accesses.

Modelling Scenario on both South Facing Ramps at Western Hospital Interchange and North Facing Ramps at Southern Interchange

- Based on the results of the traffic modelling, forecast traffic distribution indicates very low volume of traffic (600 vehicles per day) would use the north facing ramps to access the Project to and from McCaffrey Drive north facing ramps.
- This traffic primarily uses the ramps to travel between McCaffrey Drive and the new western hospital access (about 450 vehicles per day)
- About 150 vehicles per day would use the ramps to travel further to/from north to the Newcastle Inner City Bypass and/or Newcastle Road.
- The addition of north facing ramps at the southern interchange, would increase the use of the south facing ramps (as discussed in Section 5.4) by 450 vehicles per day from 2,160 to 2,610 vehicles per day.
- Given the predicted low volumes of traffic, the modelling indicates that the omission of both south facing ramps at the Western Hospital Interchange and the north facing ramps from the southern interchange would have negligible traffic volume impacts on the surrounding road network including Grandview Road and Marshall Street
- The traffic volumes predicted to use Grandview Road and Marshall Street are essentially the same with or without the north facing ramps at the southern interchange and the south facing ramps at the western hospital interchange.

APPENDIX A

TRAFFIC SURVEY DATA

Appendix A – Traffic Survey Data

1 October 2014 Traffic Survey Data

The October 2014 survey data set was used to refine LHTM for the study area. The survey involves origin-destination surveys and mid-block traffic counts.

1.1 Survey Locations

Figure A1 shows locations of October 2014 origin-destination (OD) surveys and mid-block traffic counts.

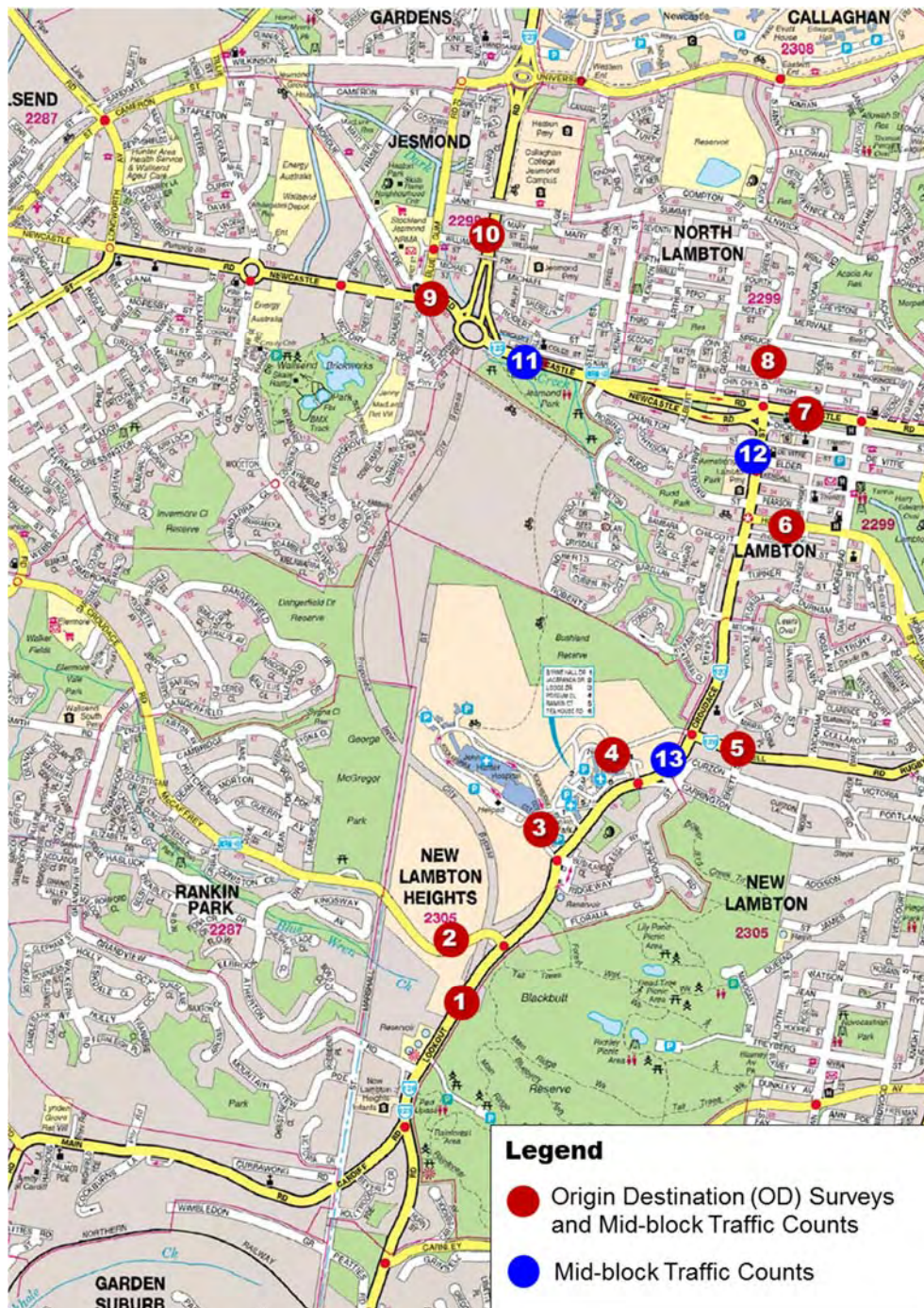


Figure A1 October 2014 Survey Types and Locations

1.2 October 2014 Mid-block Traffic Counts

Table A1 summaries average weekday daily traffic volumes at 13 key locations collected in October 2014. Table A2 listed origin-destination (OD) survey locations.

Table A1 Average Weekday Daily Traffic at Key Locations (see Figure 1 for locations)

ID (Figure 1)	Road/Location	Average Weekday Daily Traffic (vehicles)		
		NB/EB	SB/WB	2way
1	Lookout Rd - south of McCaffrey Dr	22,866	24,383	47,249
2	McCaffrey Dr - west of Lookout Rd	9,392	9,227	18,620
3	Kookaburra Circuit - west of Lookout Rd (hospital access)	7,752	7,561	15,313
4	Jacaranda Dr - west of Lookout Rd (hospital access)	1,307	1,383	2,691
5	Russell Rd - west of Brett St	8,104	8,075	16,178
6	Howe St - west of Grainger St	3,911	4,627	8,538
7	Newcastle Rd - east of Croudace St	24,371	22,171	46,542
8	Dent St - north of Newcastle Rd	2,175	2,733	4,908
9	Newcastle Rd - west of Inner City Bypass	18,930	25,409	44,339
10	Inner City Bypass - north of Newcastle Road	18,204	17,937	36,140
11	Newcastle Rd - east of Inner City Bypass	30,822	29,421	60,243
12	Croudace St - north of Elder St	20,783	20,999	41,782
13	Lookout Rd - south of Russell Rd	24,438	24,214	48,652

Note: Average Weekday Daily Traffic, All Vehicles. Source: RMS's October 2014 traffic survey.

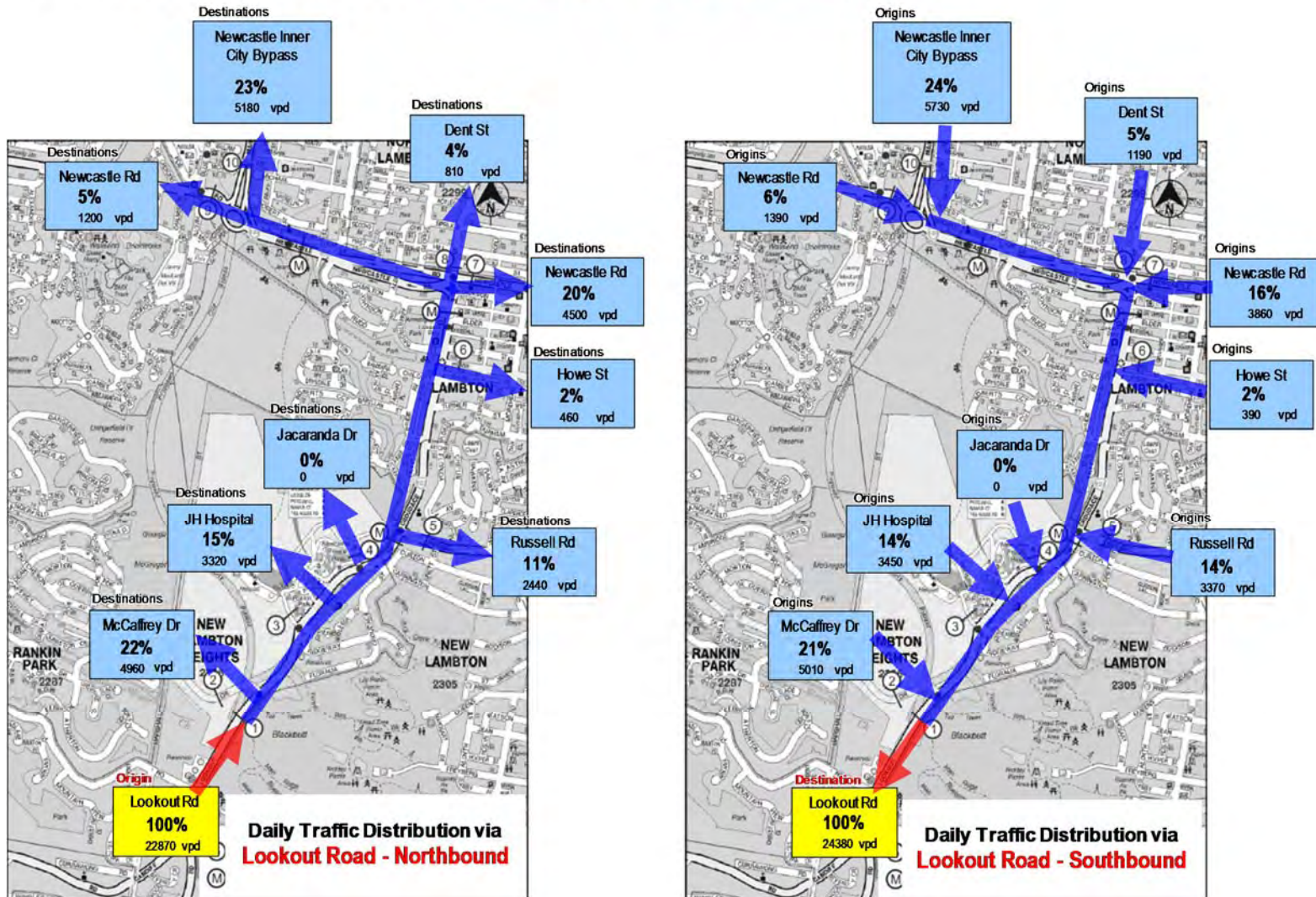
Table A2 OD Survey Stations (see Figure 1 for locations)

ID (Figure 1)	Road/Location
1	Lookout Rd - south of McCaffrey Dr
2	McCaffrey Dr - west of Lookout Rd
3	Kookaburra Circuit - west of Lookout Rd (hospital access)
4	Jacaranda Dr - west of Lookout Rd (hospital access)
5	Russell Rd - west of Brett St
6	Howe St - west of Grainger St
7	Newcastle Rd - east of Croudace St
8	Dent St - north of Newcastle Rd
9	Newcastle Rd - west of Inner City Bypass
10	Inner City Bypass - north of Newcastle Road

1.3 October 2014 Origin-Destination Surveys

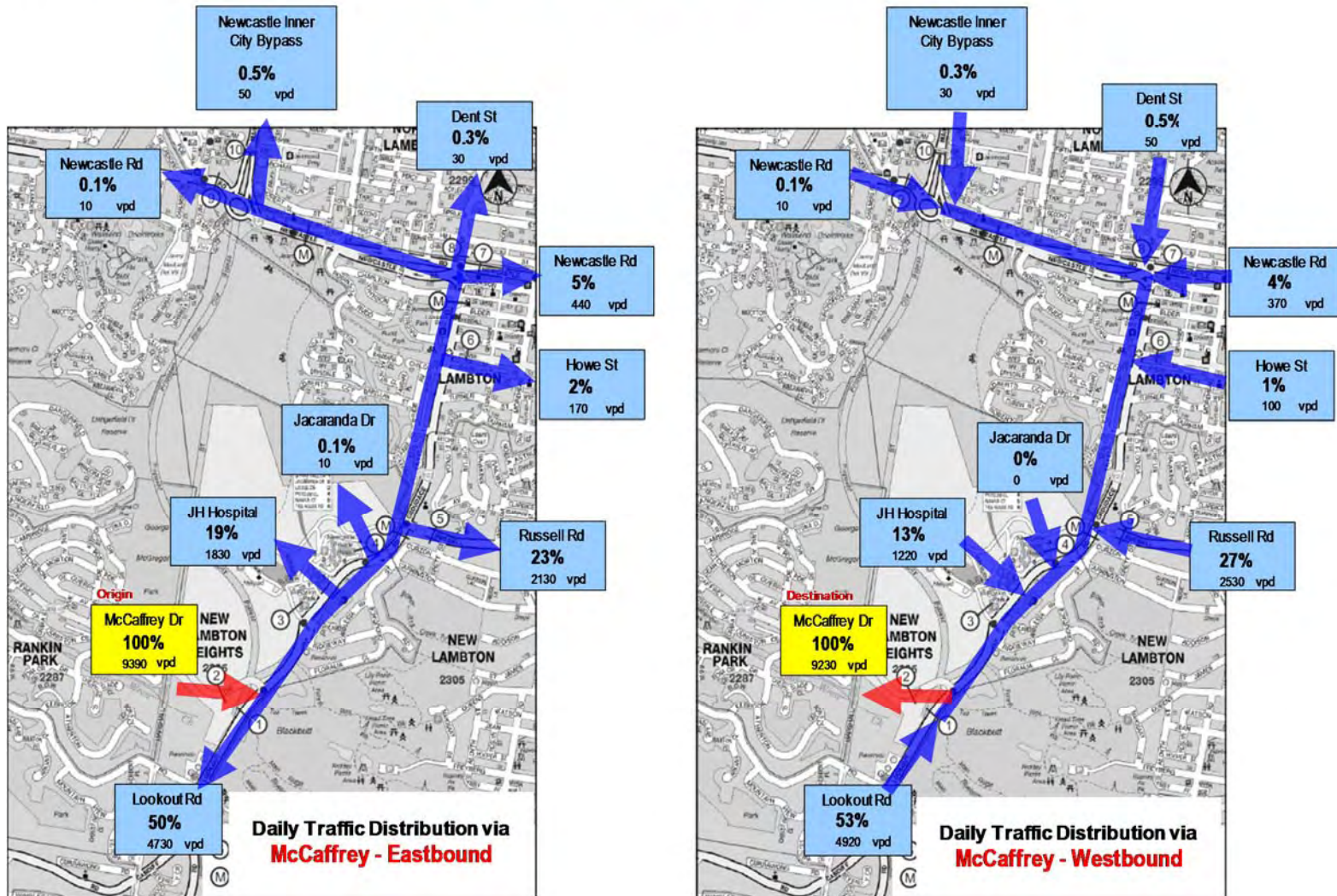
Figure A2 (overleaf) graphically presents exiting daily traffic distributions at 10 OD survey locations.

RP2J - Daily Traffic Distribution via 1. Lookout Road - south of McCaffrey Drive



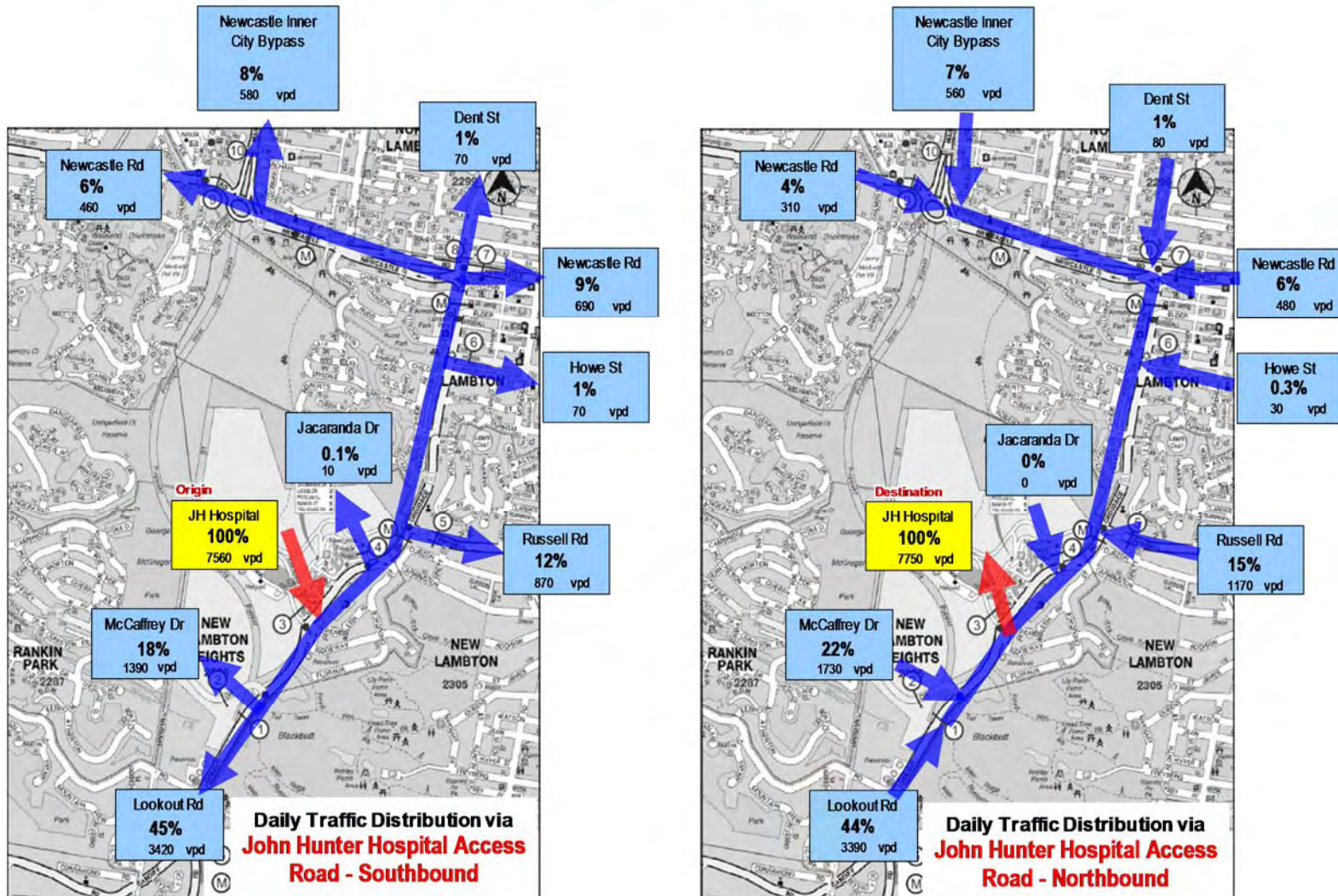
Note: Average Weekday Daily Traffic, All Vehicles. Source: RMS, October 2014 traffic survey
 Figure A2 OD Analysis Results, (1) Lookout Road – south of McCaffrey Drive

RP2J - Daily Traffic Distribution via McCaffrey Drive - west of Lookout Road



Note: Average Weekday Daily Traffic, All Vehicles. Source: RMS, October 2014 traffic survey
 Figure A2 OD Analysis Results, (2) McCaffrey Drive – west of Lookout Road

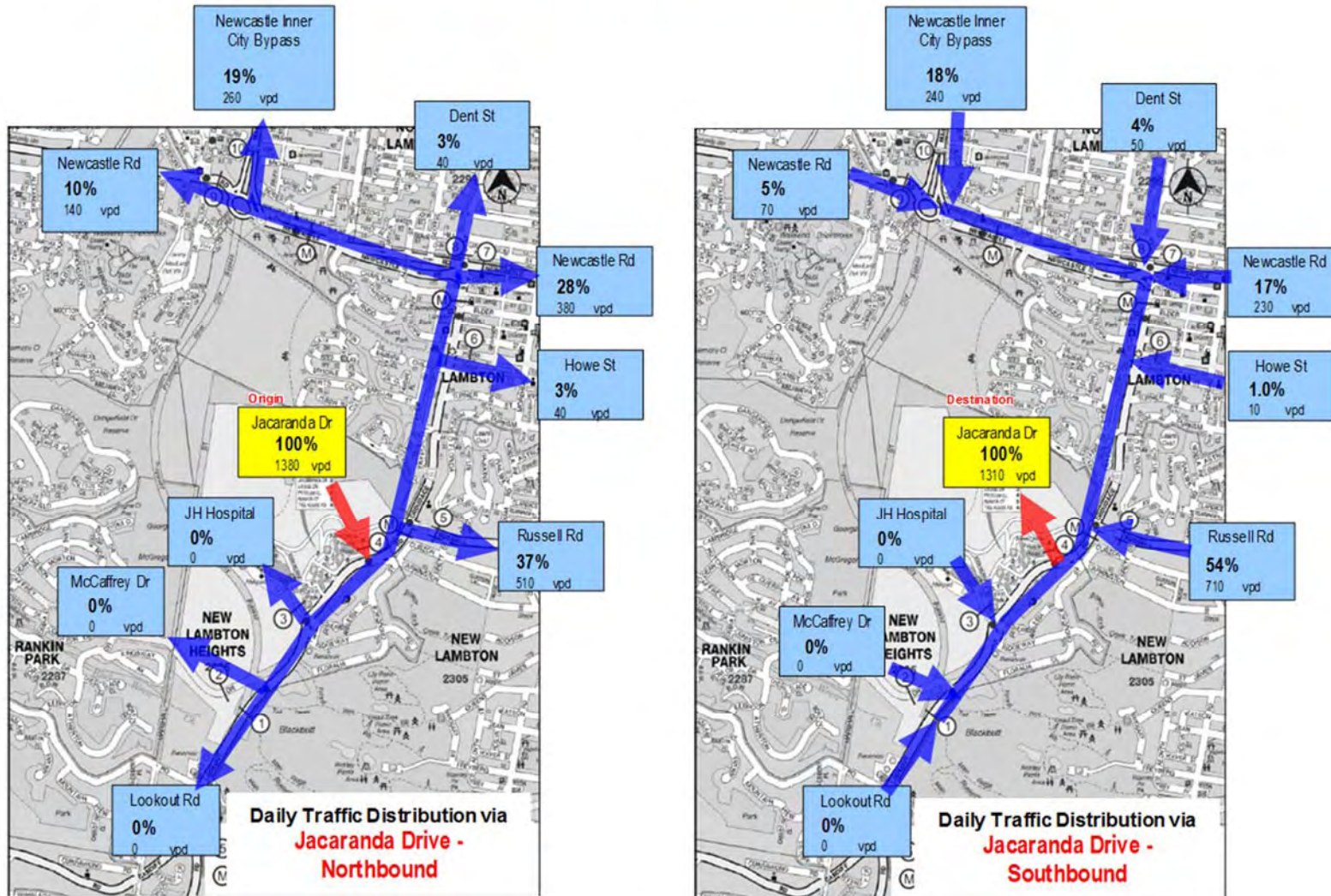
RP2J - Daily Traffic Distribution via 3. John Hunter Hospital Access Road



Note: Average Weekday Daily Traffic, All Vehicles. Source: RMS, October 2014 traffic survey

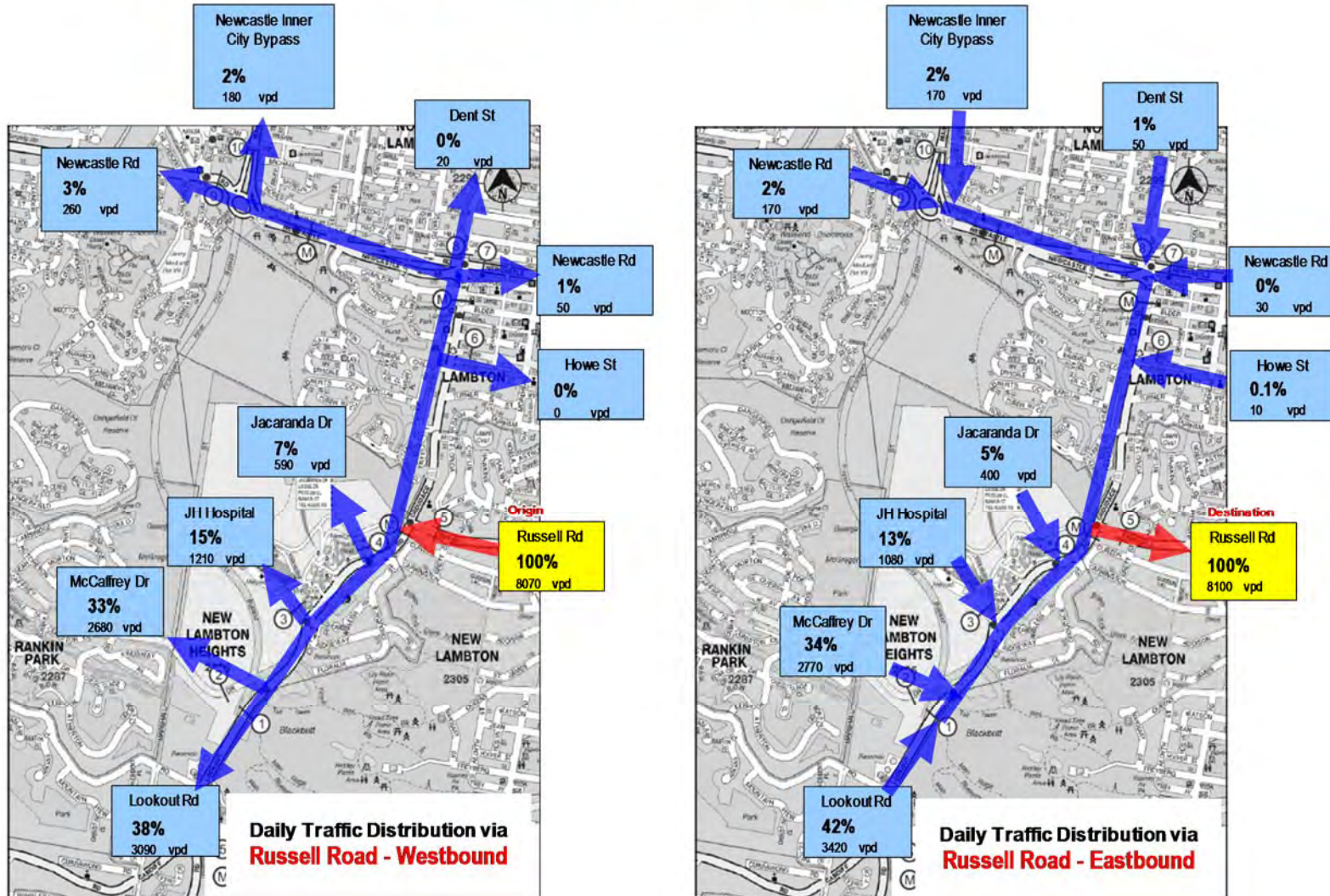
Figure A2 OD Analysis Results, (3) Kookabura Circuit, John Hunter Hospital Access Road

RP2J - Daily Traffic Distribution via 4. Jacaranda Drive - north of Lookout Road



Note: Average Weekday Daily Traffic, All Vehicles. Source: RMS, October 2014 traffic survey
Figure A2 OD Analysis Results, (4) Jacaranda Drive – north of Lookout Road

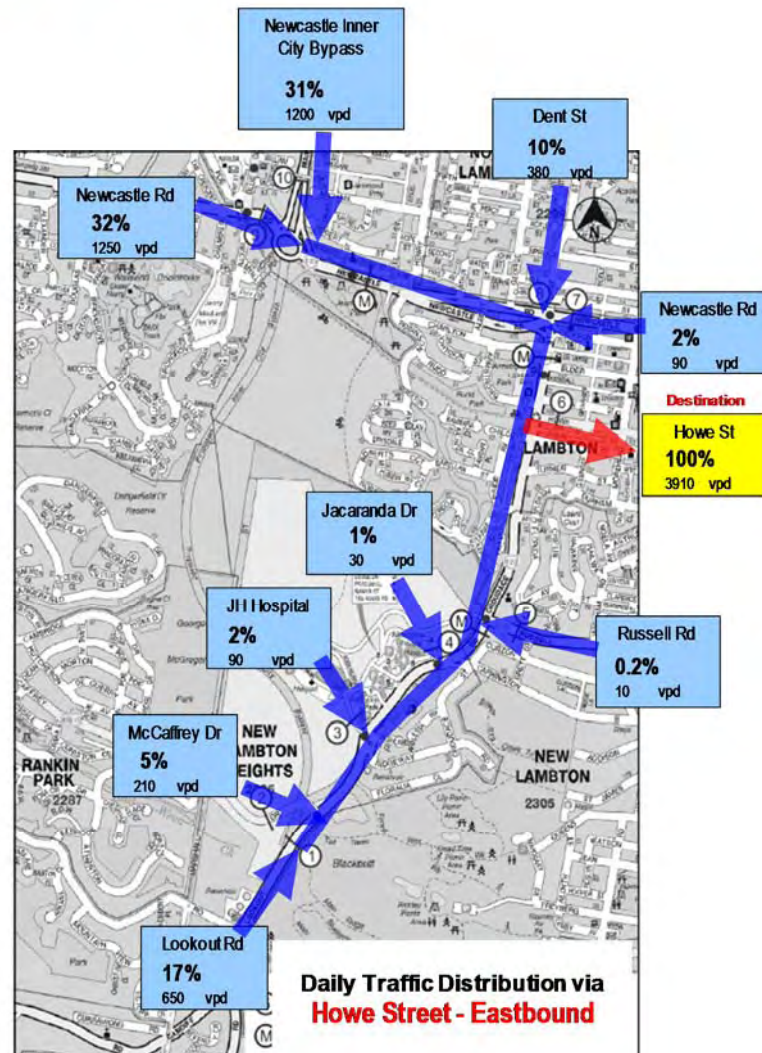
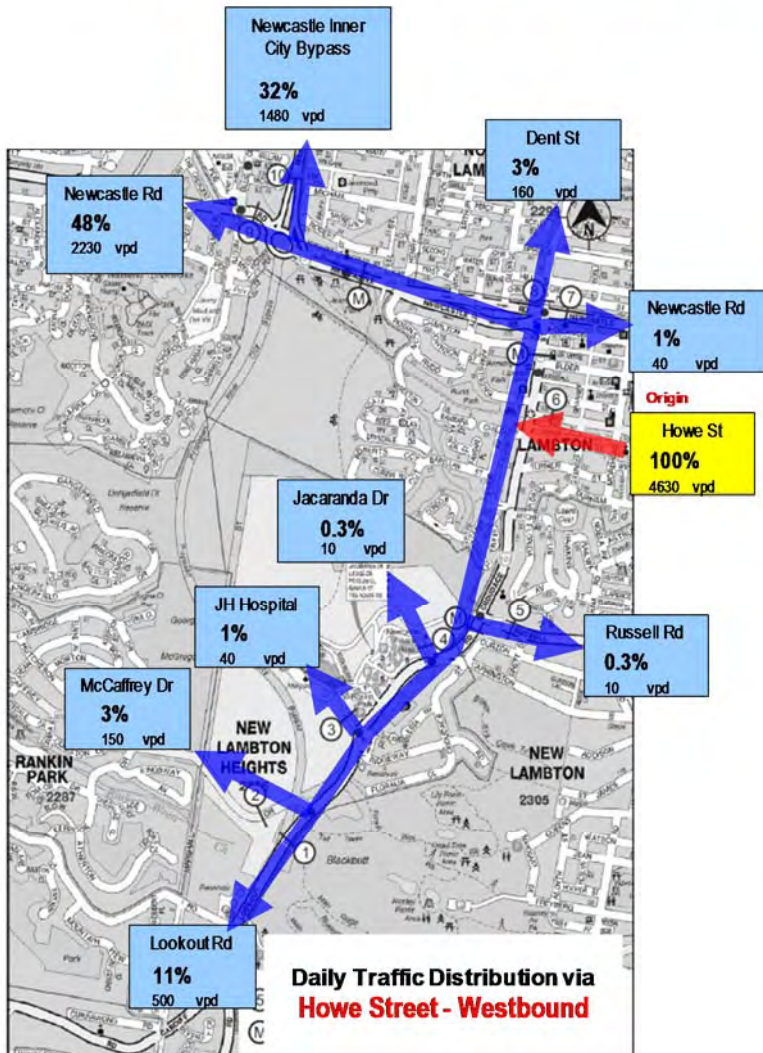
RP2J - Daily Traffic Distribution via 5. Russell Road - west of Brett Street



Note: Average Weekday Daily Traffic, All Vehicles. Source: RMS, October 2014 traffic survey

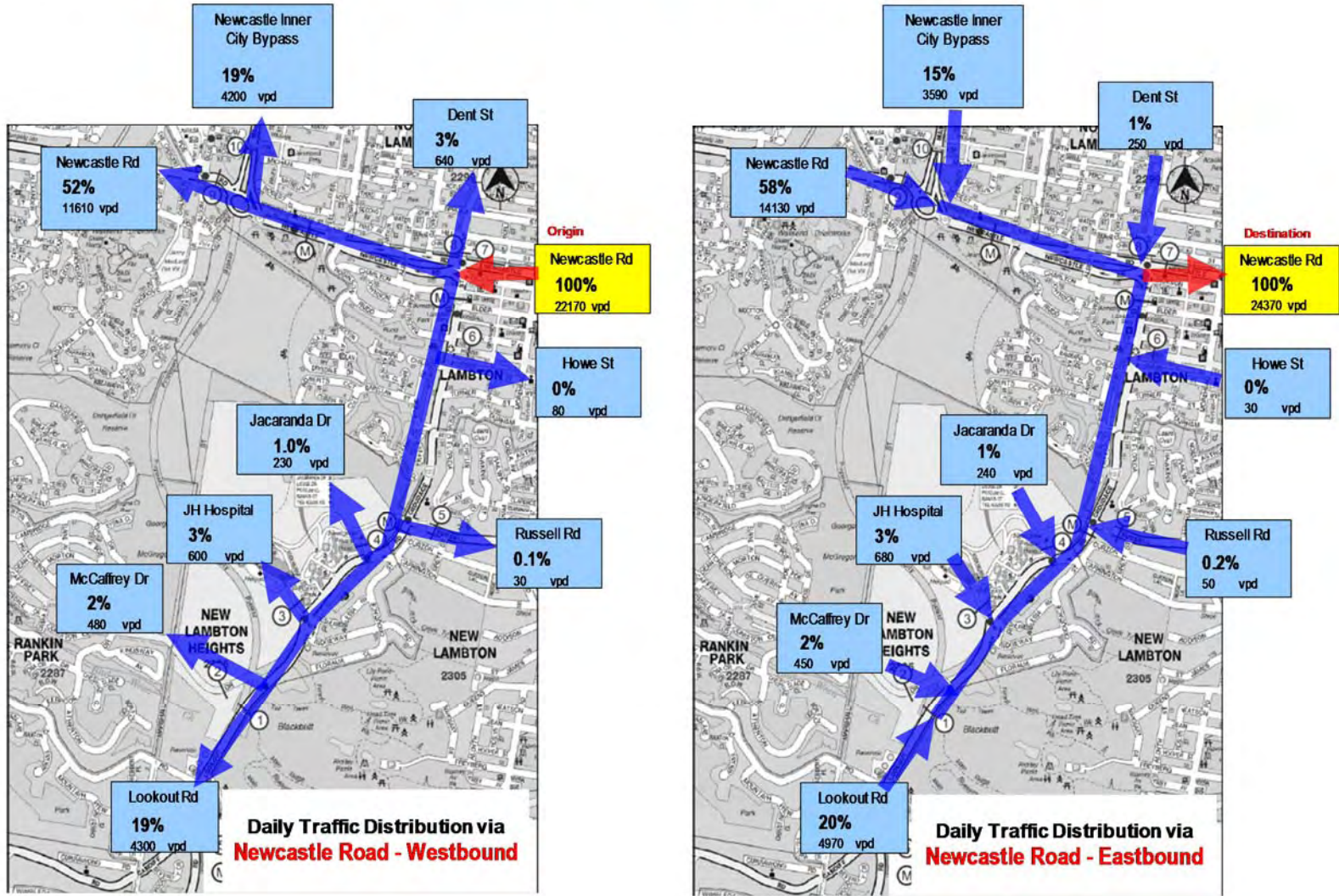
Figure A2 OD Analysis Results, (5) Russell Road – west of Brett Street

RP2J - Daily Traffic Distribution via 6. Howe Street - west of Grainger Street



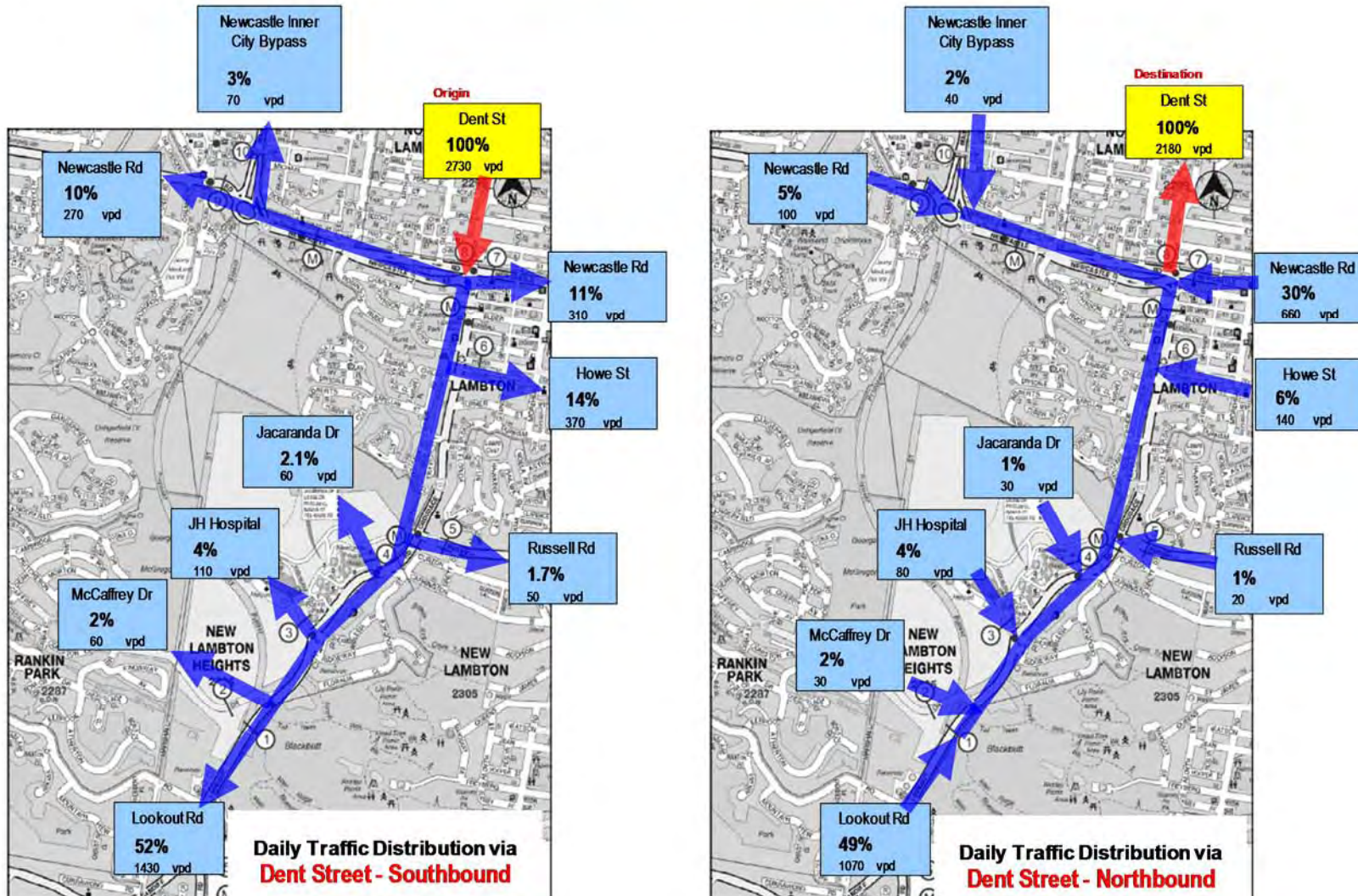
Note: Average Weekday Daily Traffic, All Vehicles. Source: RMS, October 2014 traffic survey
 Figure A2 OD Analysis Results, (6) Howe Street – west of Grainger Street

RP2J - Daily Traffic Distribution via 7. Newcastle Road - east of Croudace Street



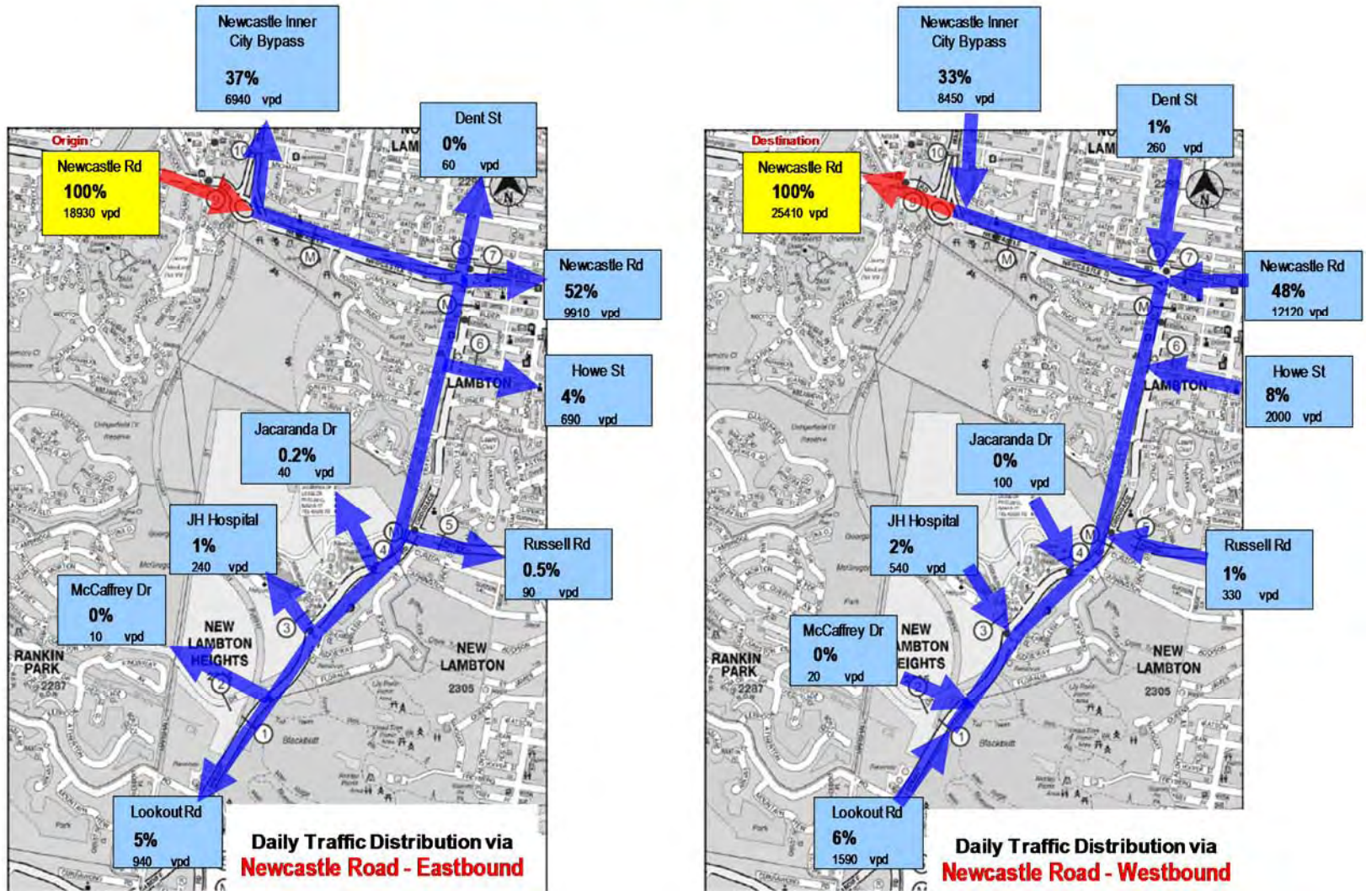
Note: Average Weekday Daily Traffic, All Vehicles. Source: RMS, October 2014 traffic survey
 Figure A2 OD Analysis Results, (7) Newcastle Road – east of Croudace Street

RP2J - Daily Traffic Distribution via 8. Dent Street - north of Newcastle Road



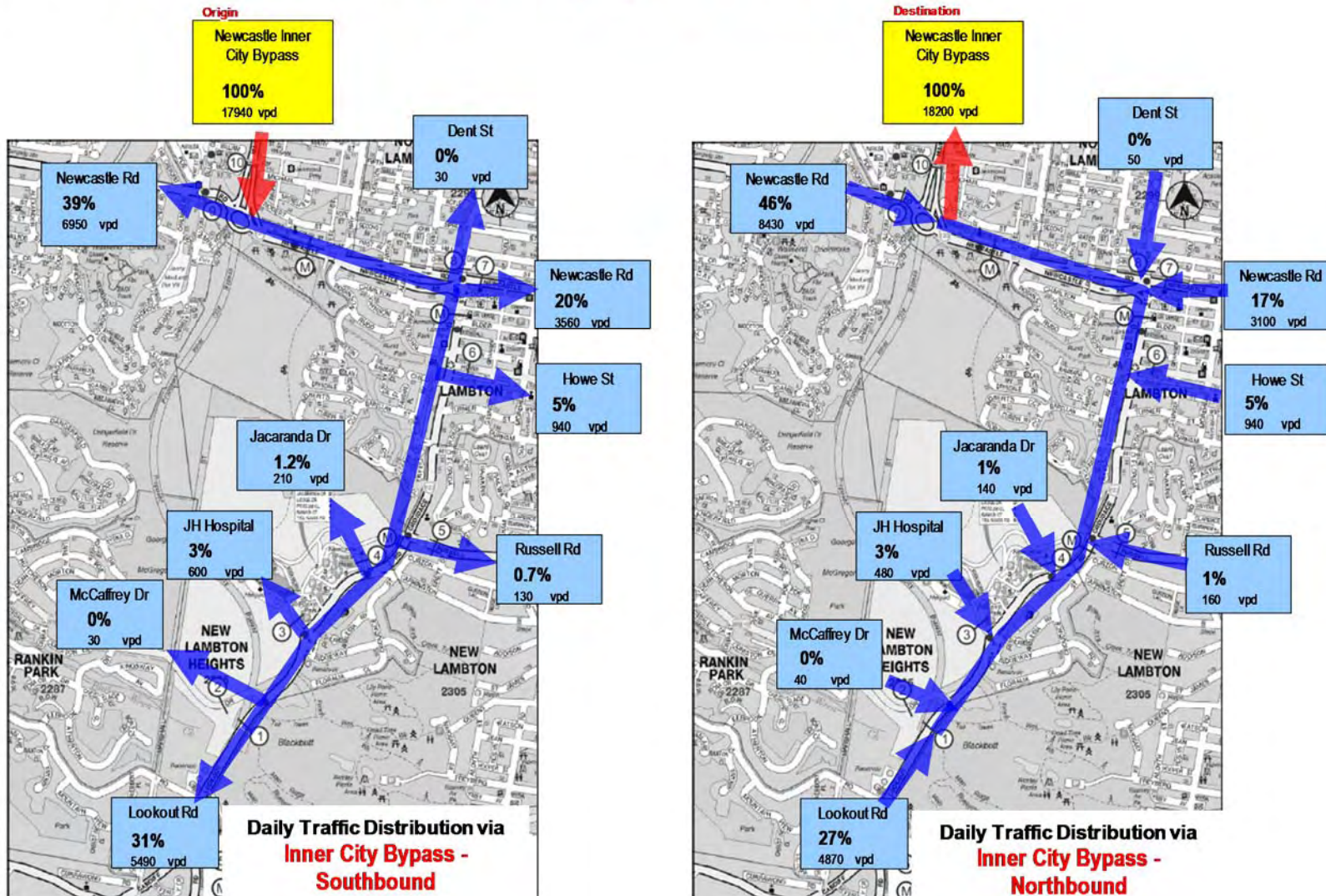
Note: Average Weekday Daily Traffic, All Vehicles. Source: RMS, October 2014 traffic survey
 Figure A2 OD Analysis Results, (8) Dent Street – north of Newcastle Road

RP2J - Daily Traffic Distribution via 9. Newcastle Road - west of Inner City Bypass



Note: Average Weekday Daily Traffic, All Vehicles. Source: RMS, October 2014 traffic survey
 Figure A2 OD Analysis Results, (9) Newcastle Road – west of Inner City Bypass

RP2J - Daily Traffic Distribution via 10. Inner City Bypass - north of Newcastle Road



Note: Average Weekday Daily Traffic, All Vehicles. Source: RMS, October 2014 traffic survey
 Figure A2 OD Analysis Results, (10) Inner City Bypass – north of Newcastle Road

2 May 2015 Survey

The May 2015 survey involving origin-destination surveys and mid-block traffic counts. Figure A3 below shows OD surveys and mid-block traffic counts locations for May 2015 survey. The May 2015 data was used to further refine the model for southern section between McCaffrey Drive and Carnley Avenue.

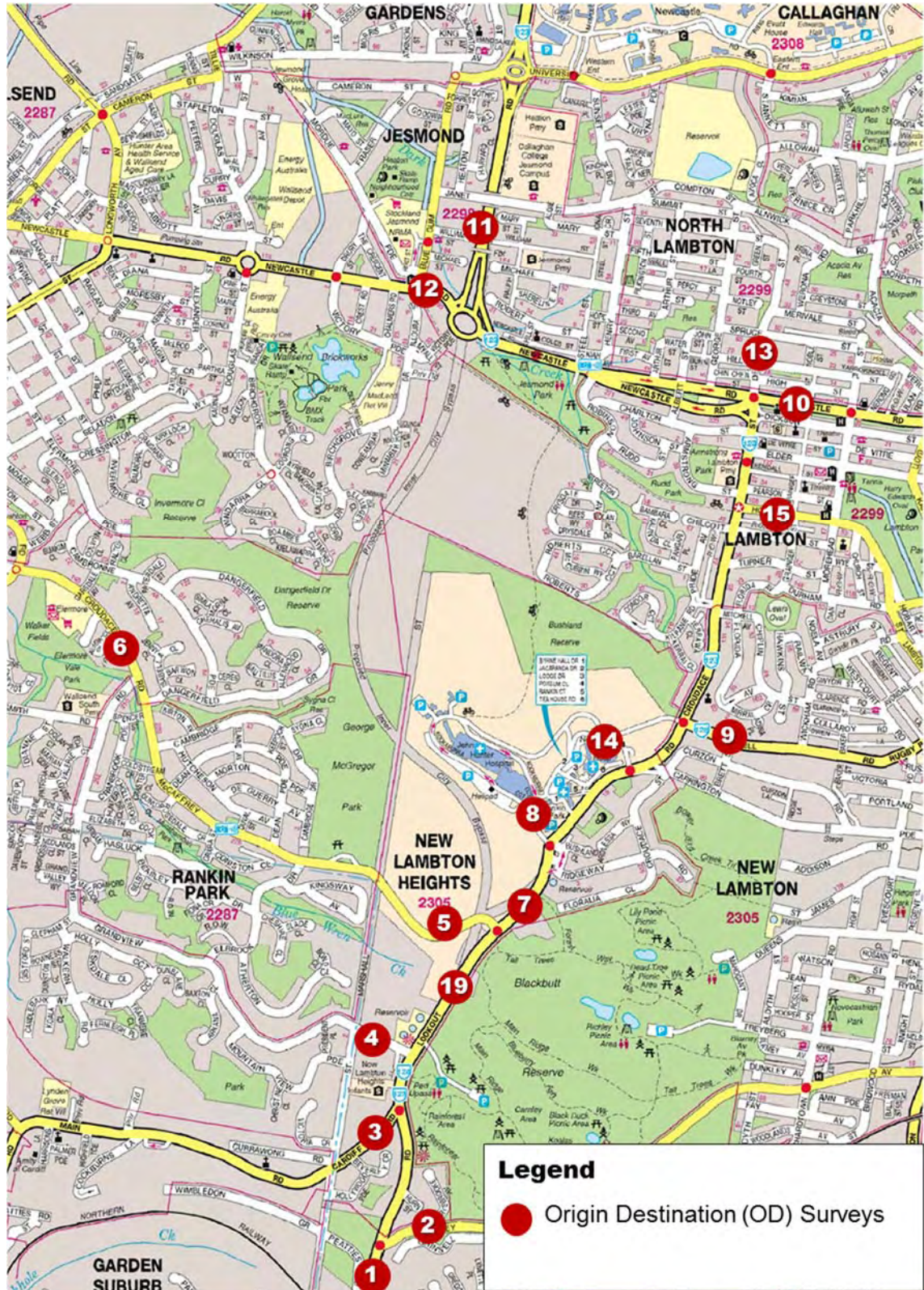


Figure A3 May 2015 Survey Locations

2.1 Mid-block Traffic Count

Additional midblock tube counts were undertaken between 5th and 11th May 2015 at six locations. Table A3 shows average weekday daily.

Table A3 Average Weekday Daily Traffic at Survey Locations (see Figure 3 for locations)

ID Figure 3	Road/Location	Average Weekday Daily Traffic (vehicles)		
		NB/EB	SB/WB	2way
1	Charlestown Road - south of Cardiff Road	26,482	28,627	55,110
2	Carnley Avenue - east of Charlestown Road	10,068	10,952	21,020
3	Cardiff Road - west of Lookout Road	7,533	7,134	14,667
4	Grandview Road - west of Lookout Road	1,038	1,696	2,733
6	Croudace Road - west of Grandview Road	10,101	9,754	19,855
	Lookout Road - north of McCaffrey Drive	24,313	25,121	49,434

Note: Average Weekday Daily Traffic, All Vehicles, Source: May 2015 Traffic Survey

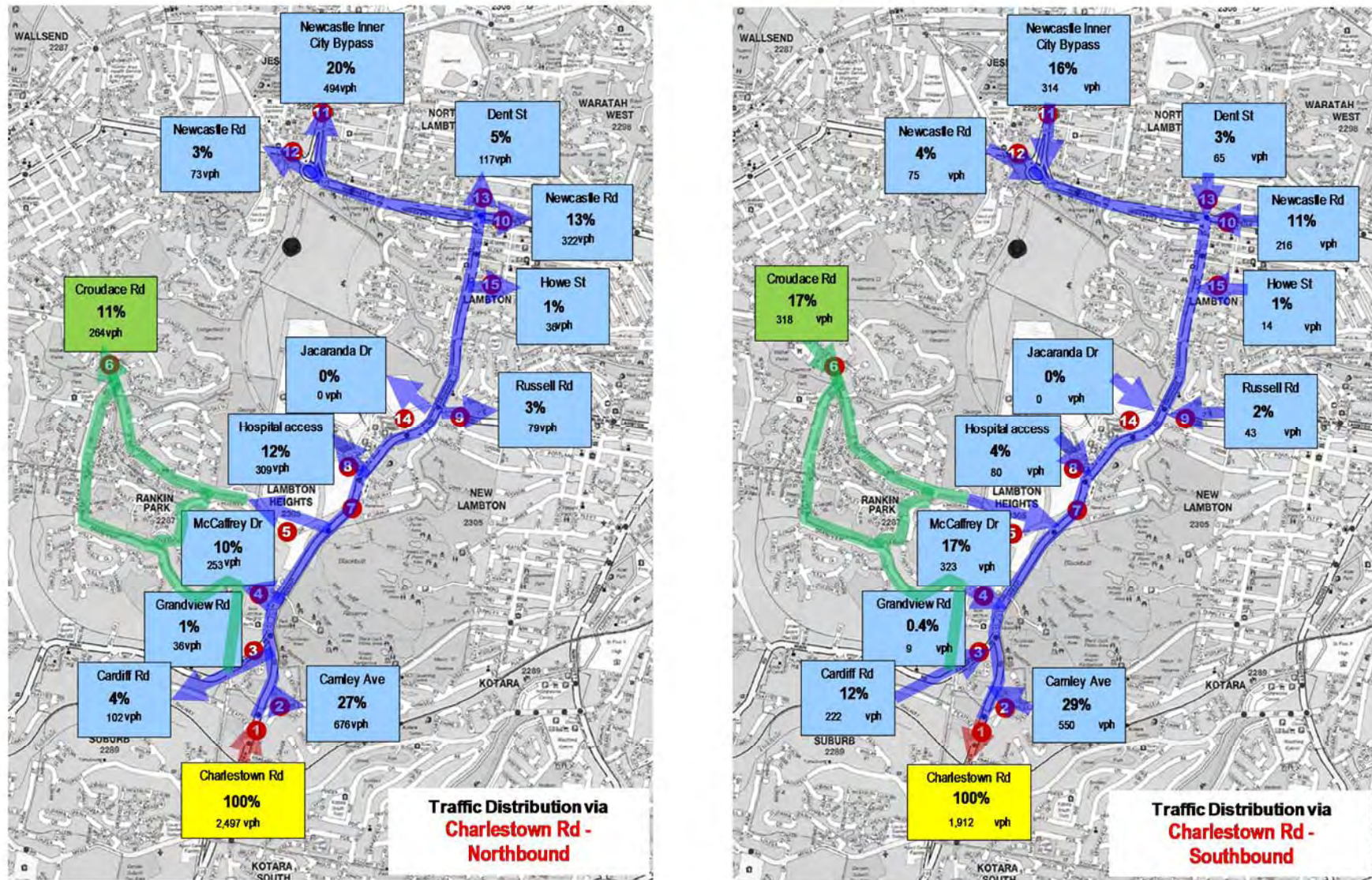
2.2 Origin-Destination Survey

Additional Origin Destination (OD) survey was undertaken on Wednesday 6th May 2015 at 15 locations (referred to ID1 to ID15 in Figure 3) including.

1. Charlestown Road - south of Carnley Avenue
2. Carnley Avenue - east of Charlestown Road
3. Cardiff Road - west of Lookout Road
4. Grandview Road - west of Lookout Road
5. McCaffrey Drive - west of Lookout Road
6. Croudace Road - west of Grandview Road
7. Lookout Road - north of McCaffrey Drive
8. Kookaburra Circuit (John Hunter Hospital access)
9. Russell Road - east of Lookout Road
10. Newcastle Road - east of Croudace Street
11. Newcastle Inner City Bypass - north of Newcastle Road
12. Newcastle Road - west of Newcastle Inner City Bypass
13. Dent Street - north of Newcastle Road
14. Jacaranda Drive (John Hunter Hospital access)
15. Howe Street - east of Croudace Street

Following Figure A4 and Figure A5 summarise OD distribution at 15 OD locations for AM and PM peak periods.

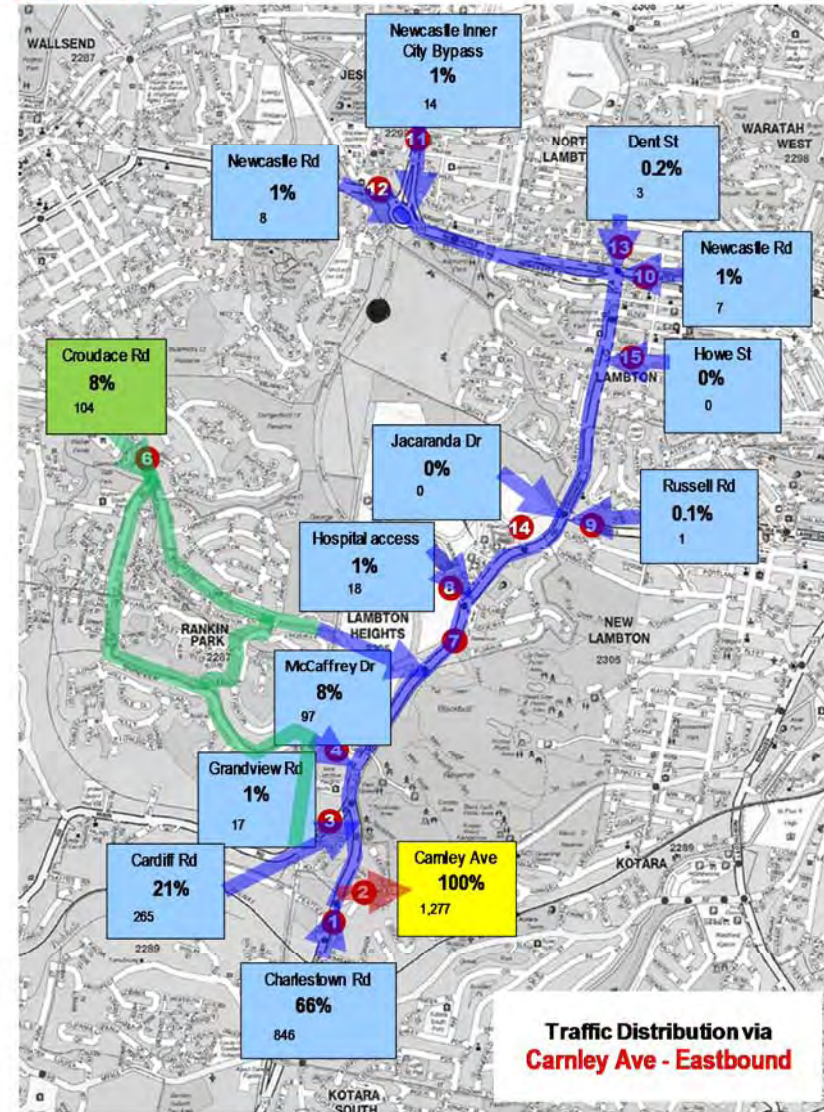
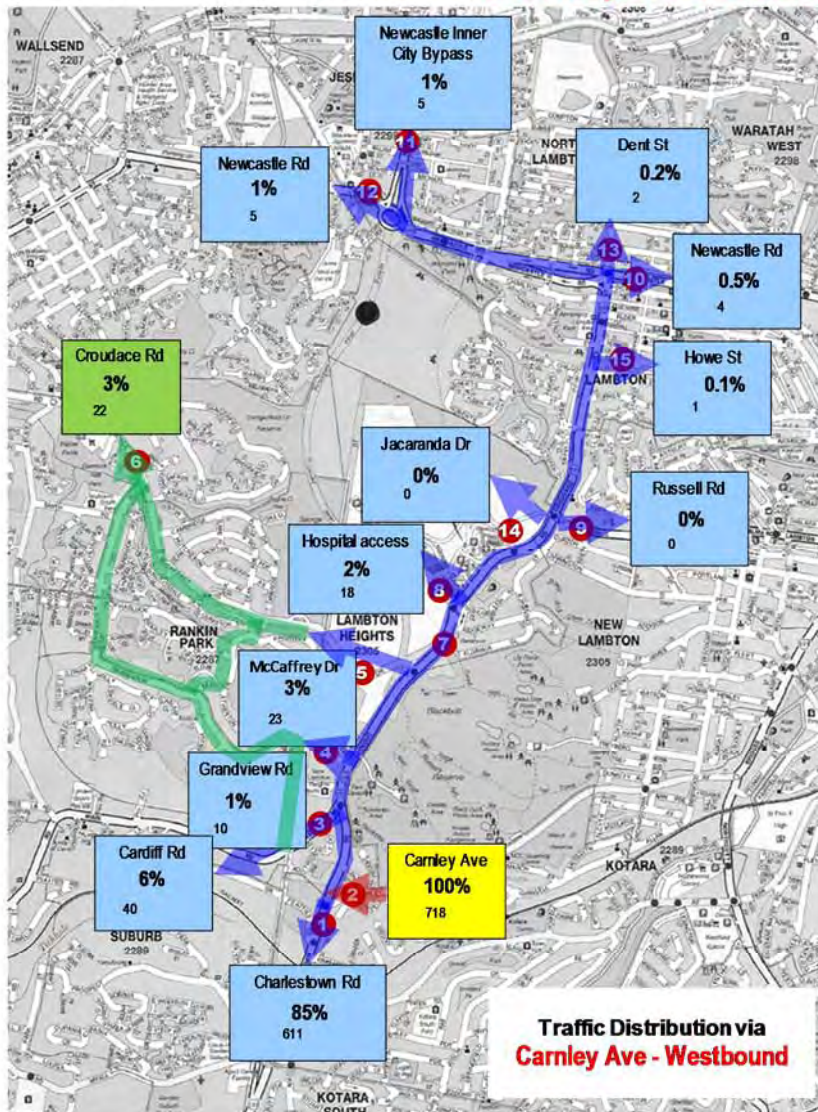
RP2J - AM1H Traffic Distribution via 1. Charlestown Road - South of Cardiff Road



File location: F:\AA006517\Vari4_RP2J\M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_AM

Figure A4 May 2015 OD Analysis Results – AM Peak

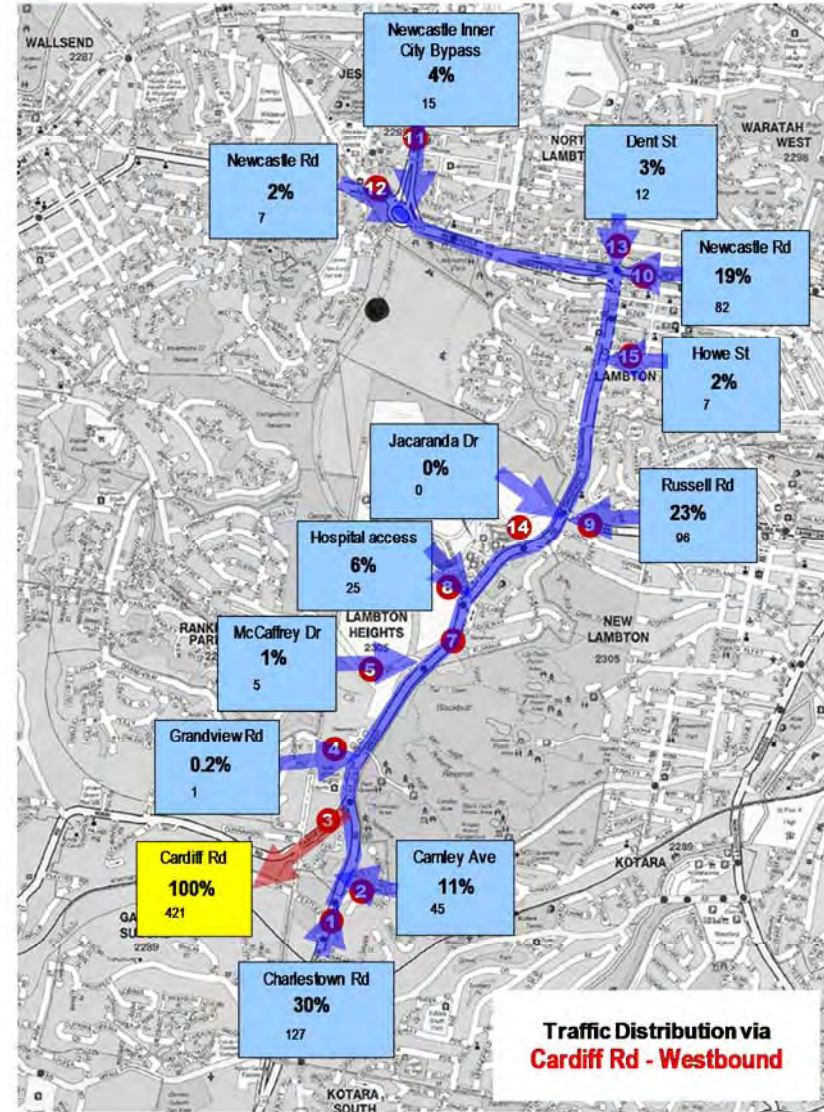
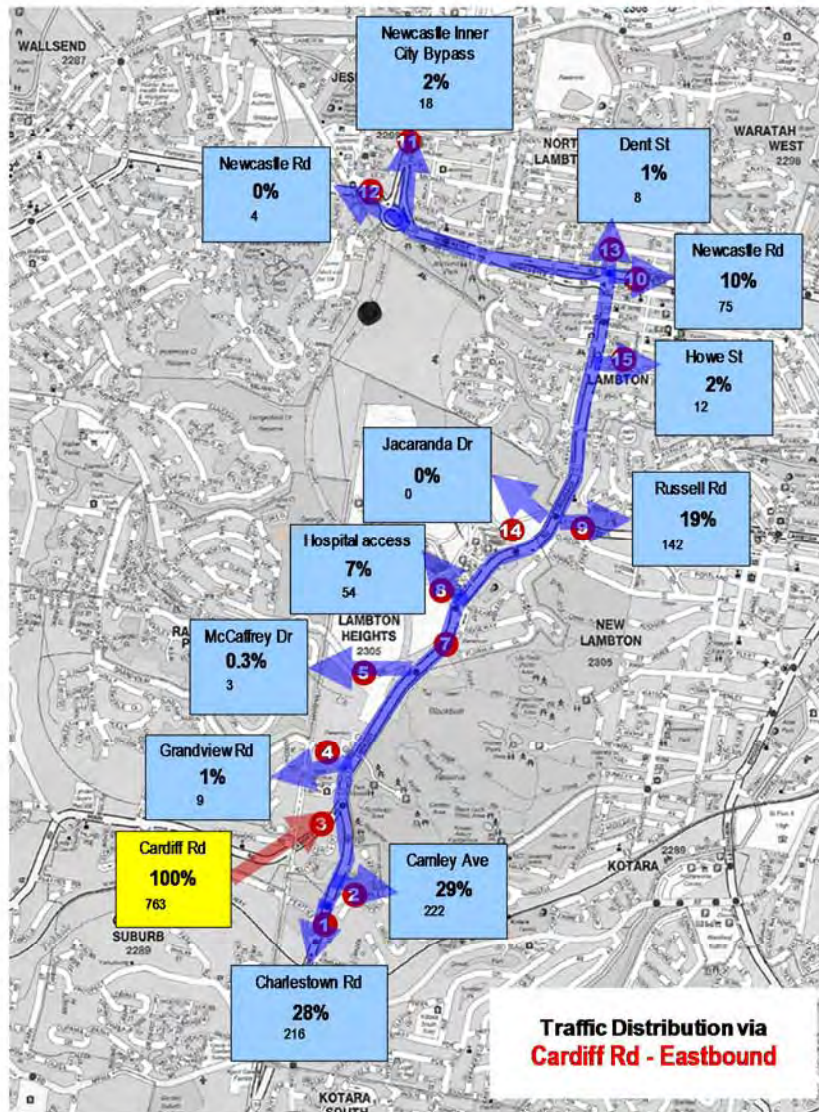
RP2J - AM1H Traffic Distribution via 2. Camley Avenue - East of Charlestown Road



File location: F:\AA006517\Vari4_RP2J\M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_AM

Figure A4 May 2015 OD Analysis Results – AM Peak

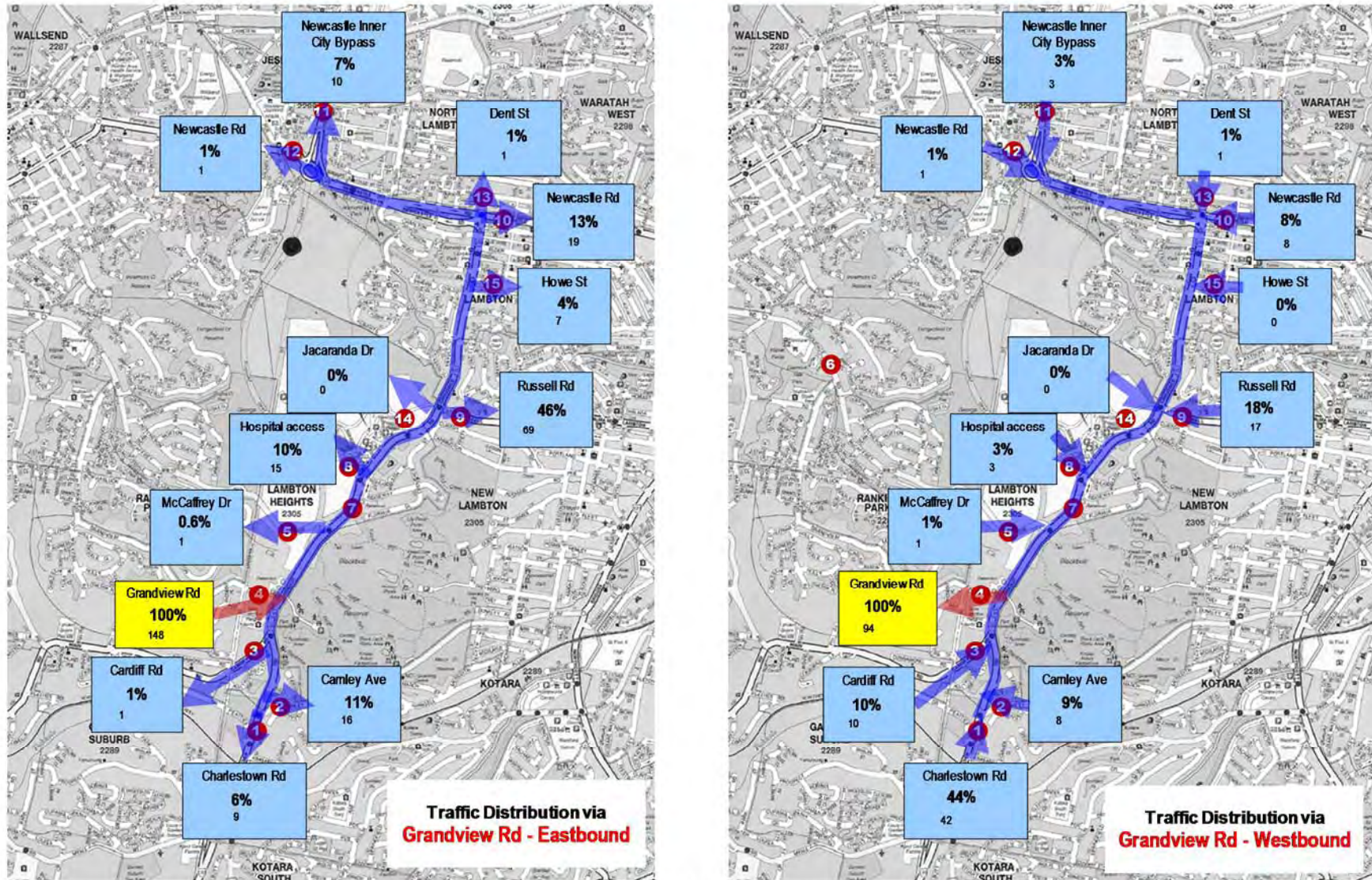
RP2J - AM1H Traffic Distribution via 3. Cardiff Road- West of Lookout Road



File location: F:\AA006517\Vari4_RP2J&M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_AM

Figure A4 May 2015 OD Analysis Results – AM Peak

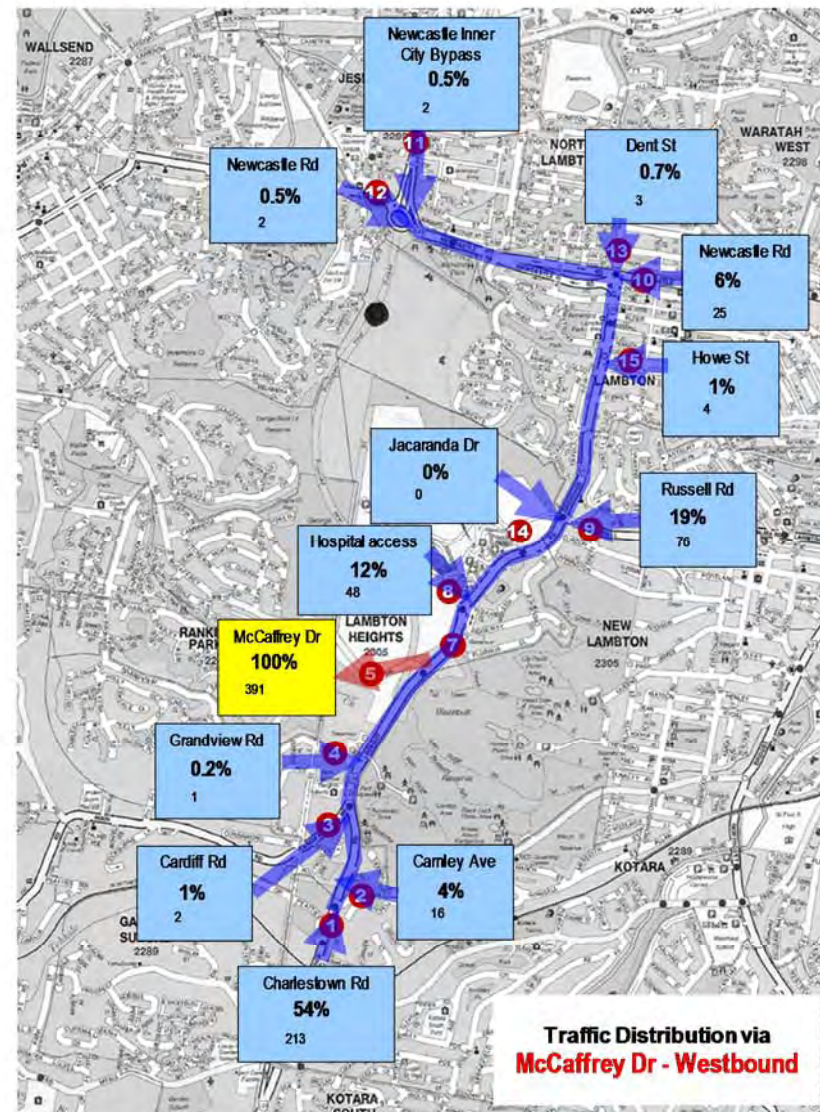
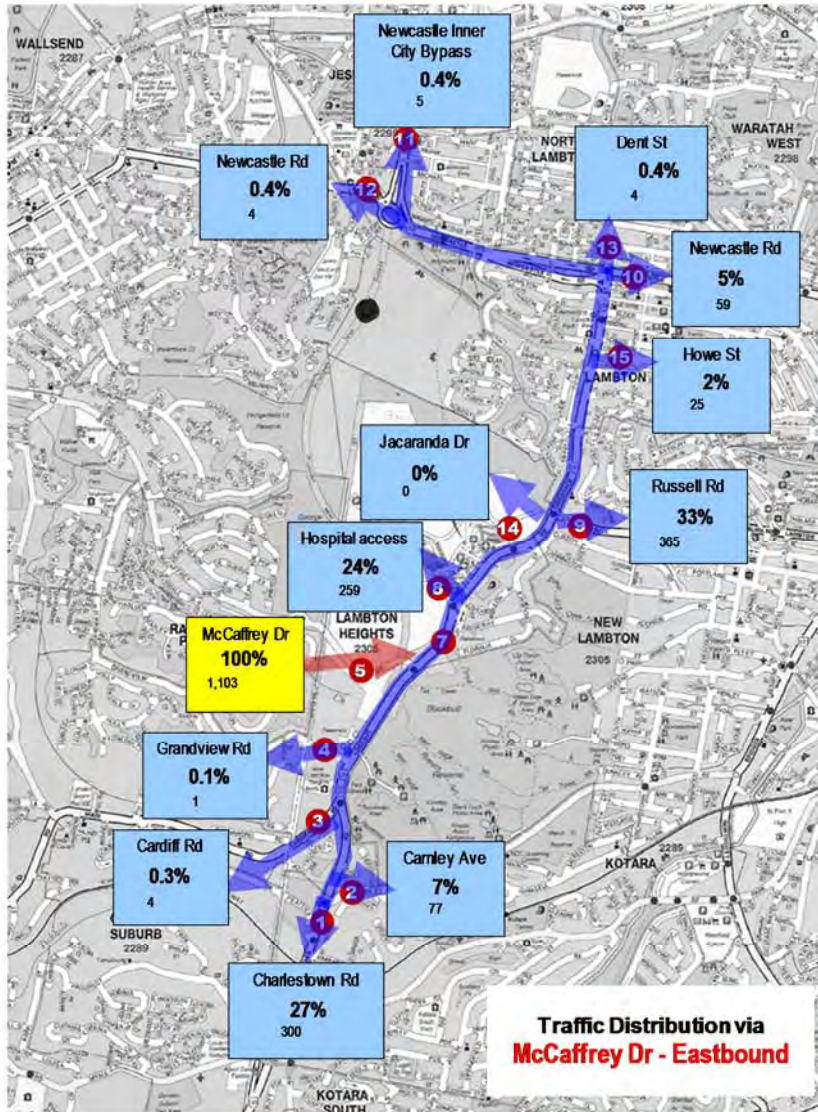
RP2J - AM1H Traffic Distribution via 4. Grandview Road - West of Lookout Road



File location: F:\AA006517\Vari4_RP2J&M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_AM

Figure A4 May 2015 OD Analysis Results – AM Peak

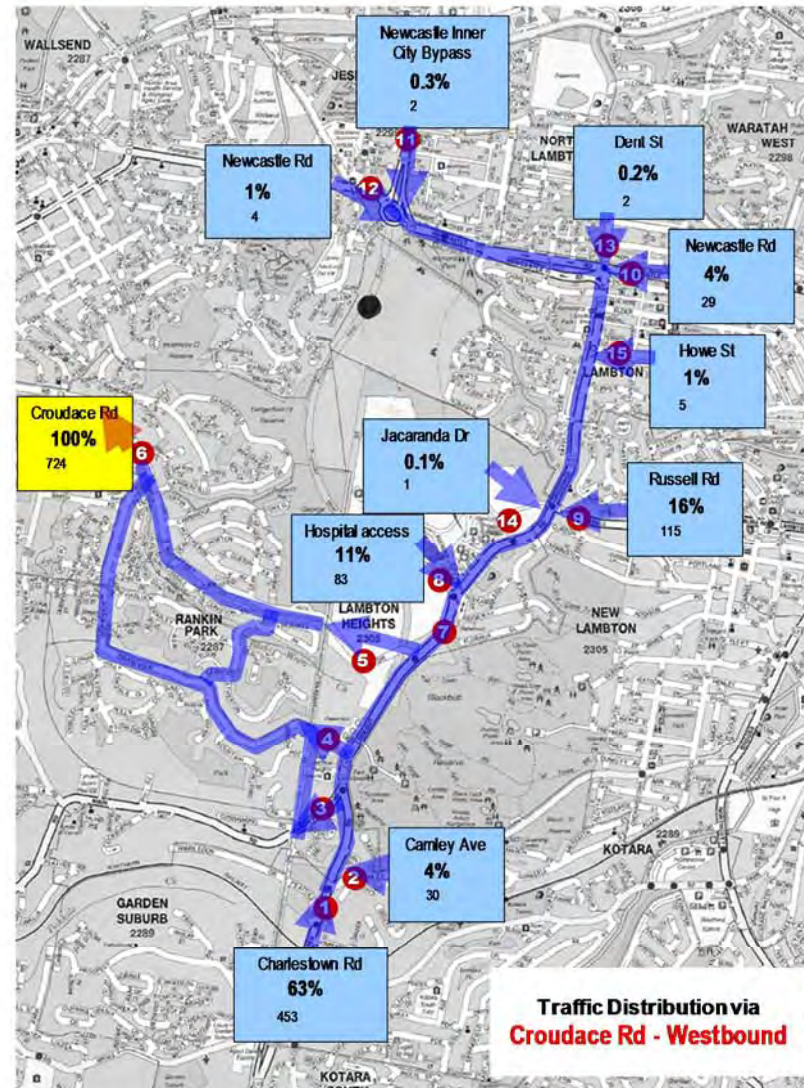
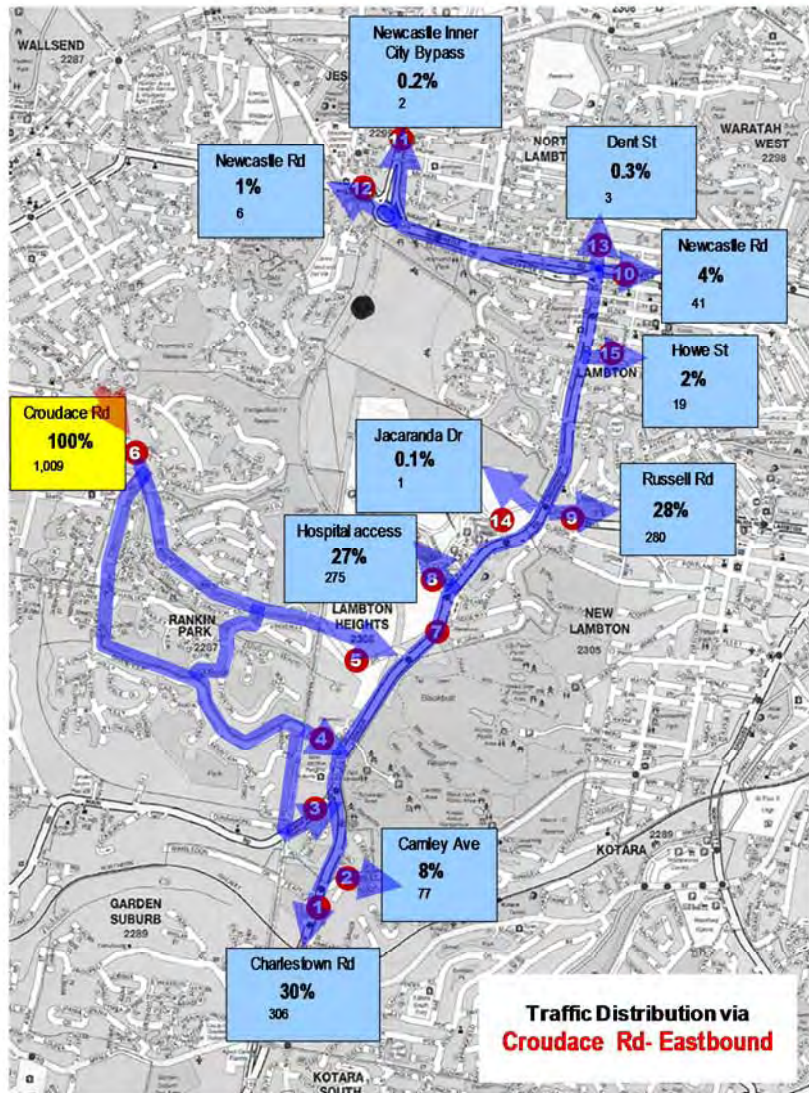
RP2J - AM1H Traffic Distribution via 5. McCaffrey Road- West of Lookout Road



File location: F:\AA006517\Vari4_RP2J\M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_AM

Figure A4 May 2015 OD Analysis Results – AM Peak

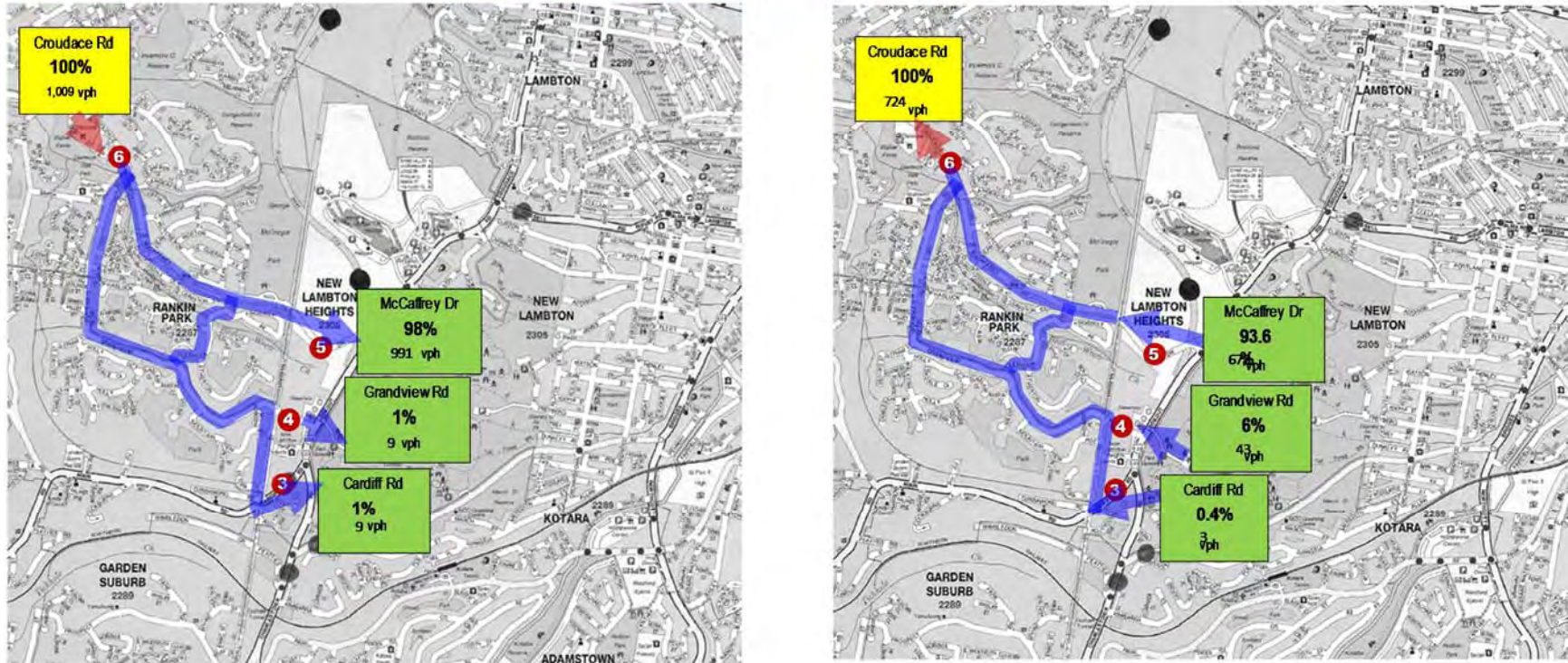
RP2J - AM1H Traffic Distribution via 6. Croudace Road - West of Grandview Road



File location: F:\aa006517\Vari4_RP2J&M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C1_AM

Figure A4 May 2015 OD Analysis Results – AM Peak

RP2J - AM1H Traffic Distribution via 6. Croudace Road - West of Grandview Road



File location: F:\AA006517\Vari4_RP2J&M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C1_AM

Figure A4 May 2015 OD Analysis Results – AM Peak

RP2J - AM1H Traffic Distribution via 7. Lookout Road - North of McCaffrey Drive

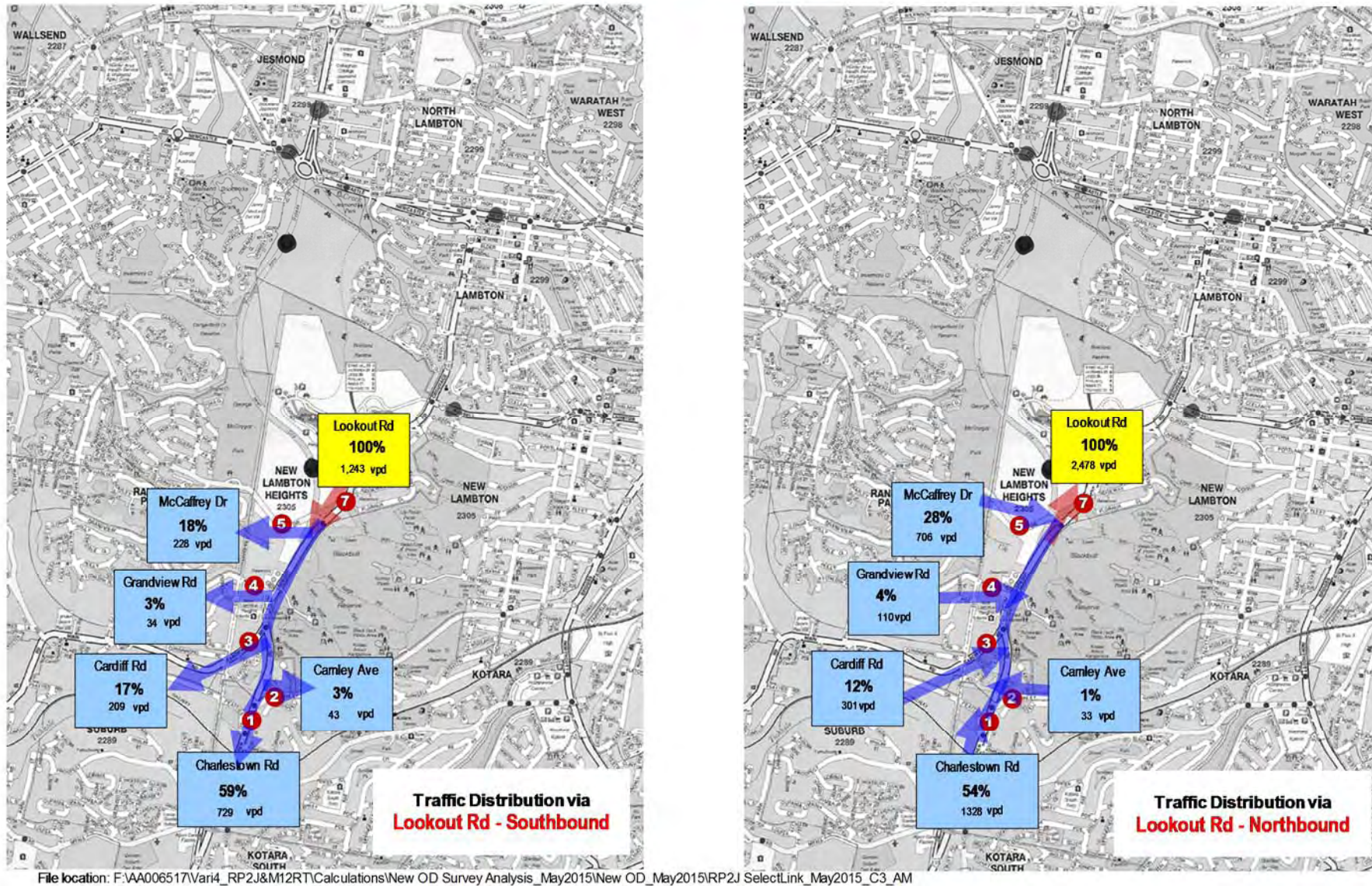
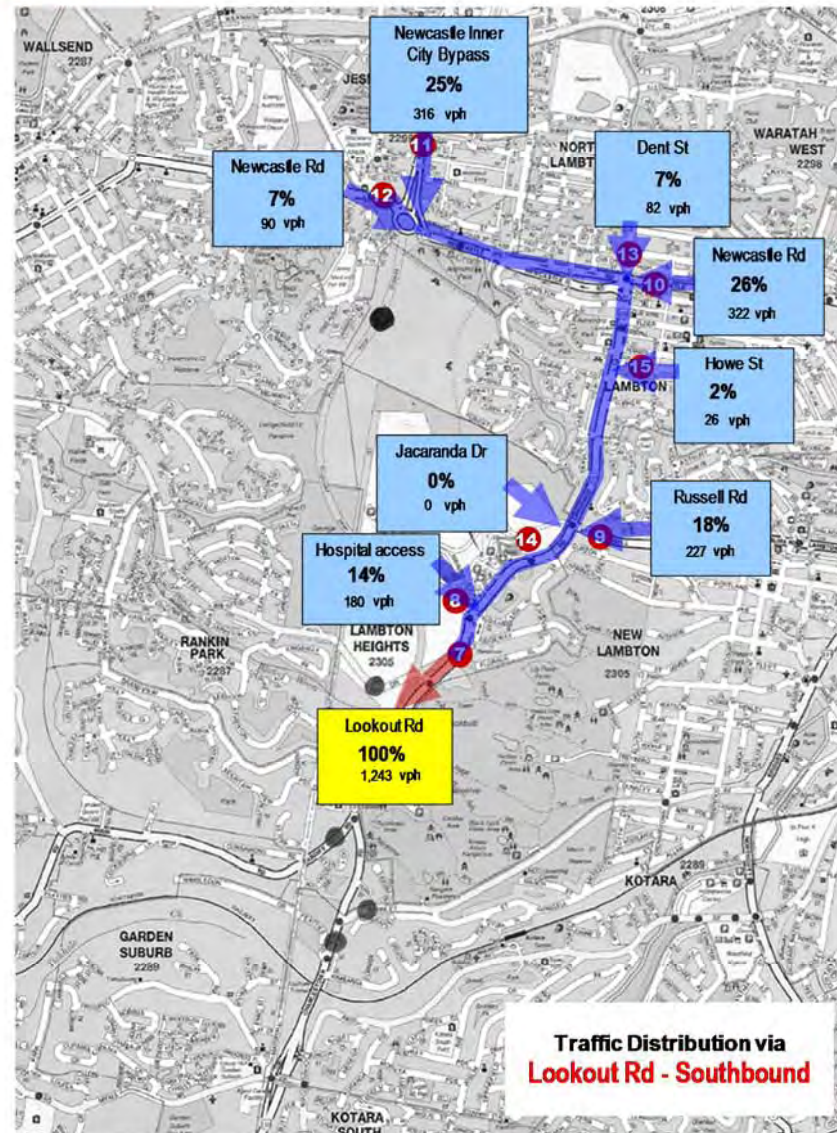
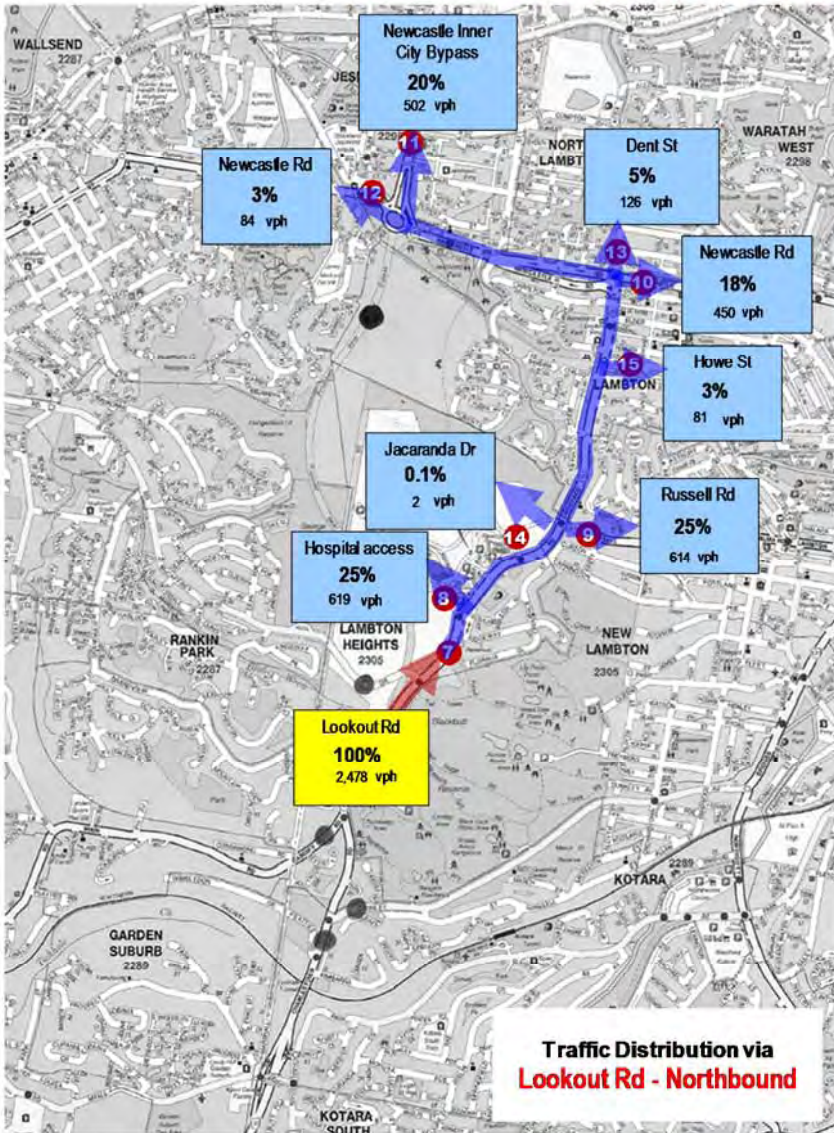


Figure A4 May 2015 OD Analysis Results – AM Peak

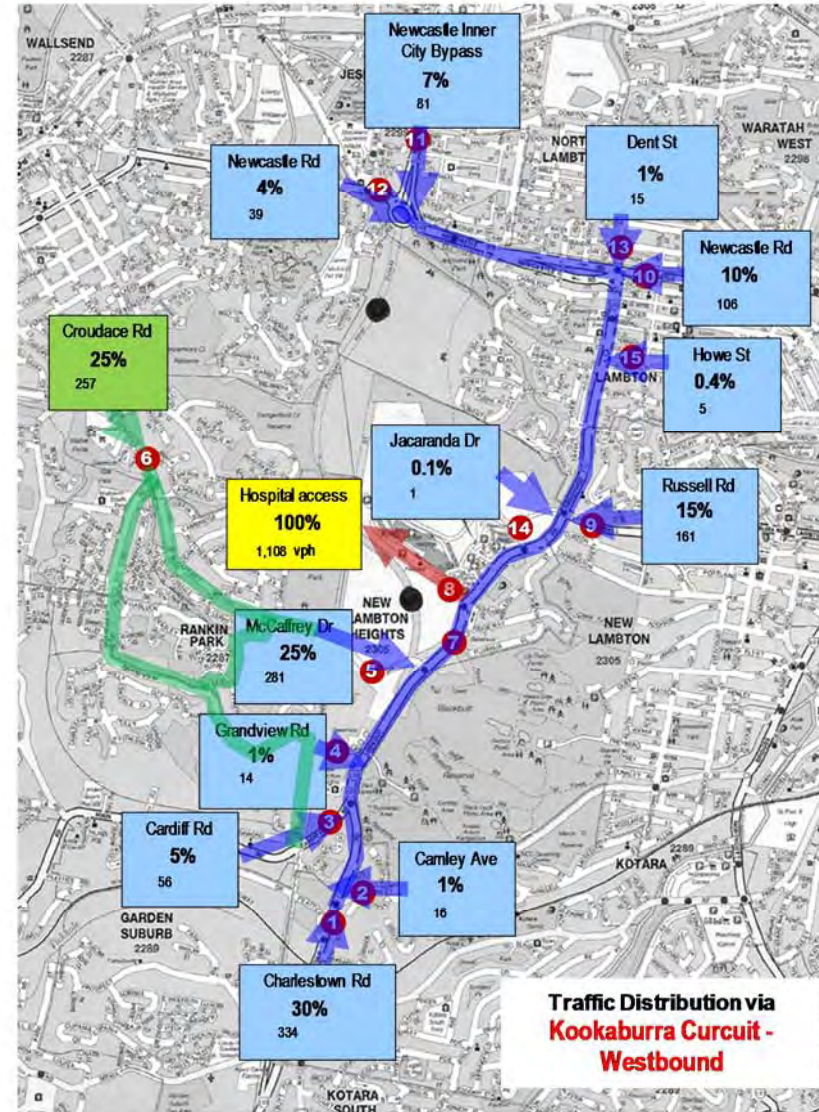
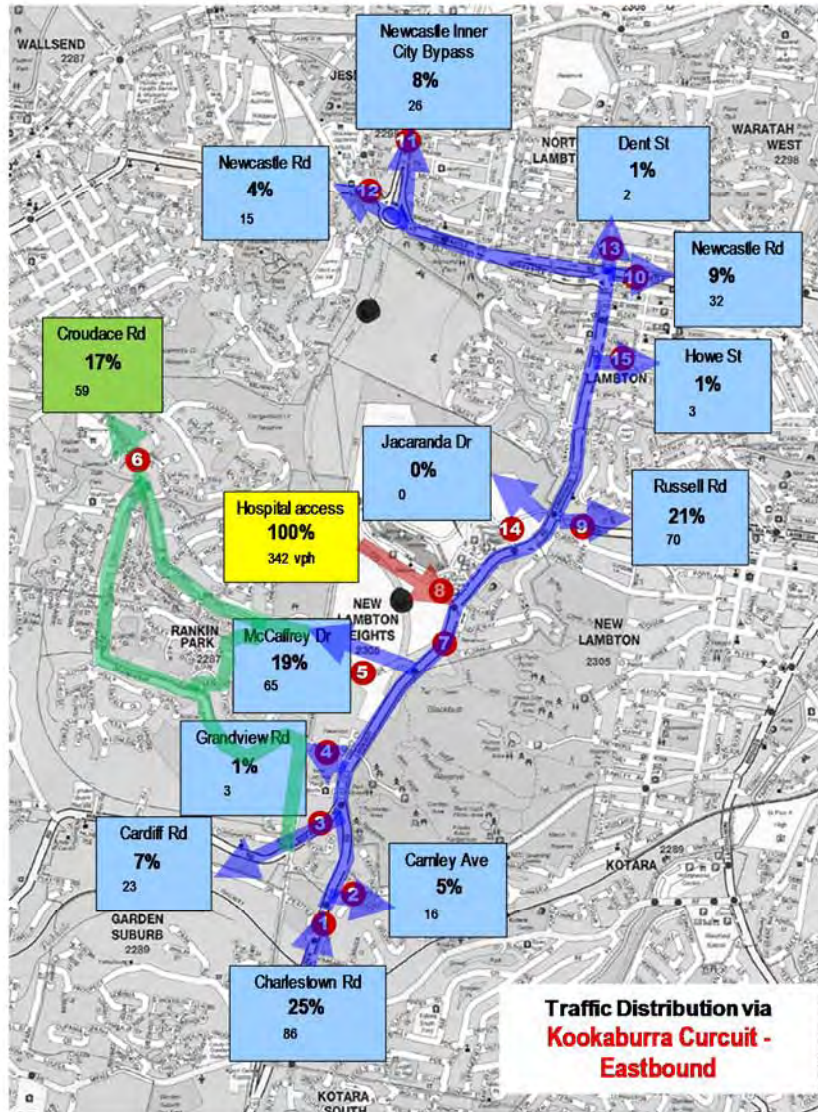
RP2J - AM1H Traffic Distribution via 7. Lookout Road - North of McCaffrey Drive



File location: F:\AA006517\Vari4_RP2J&M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C4_AM

Figure A4 May 2015 OD Analysis Results – AM Peak

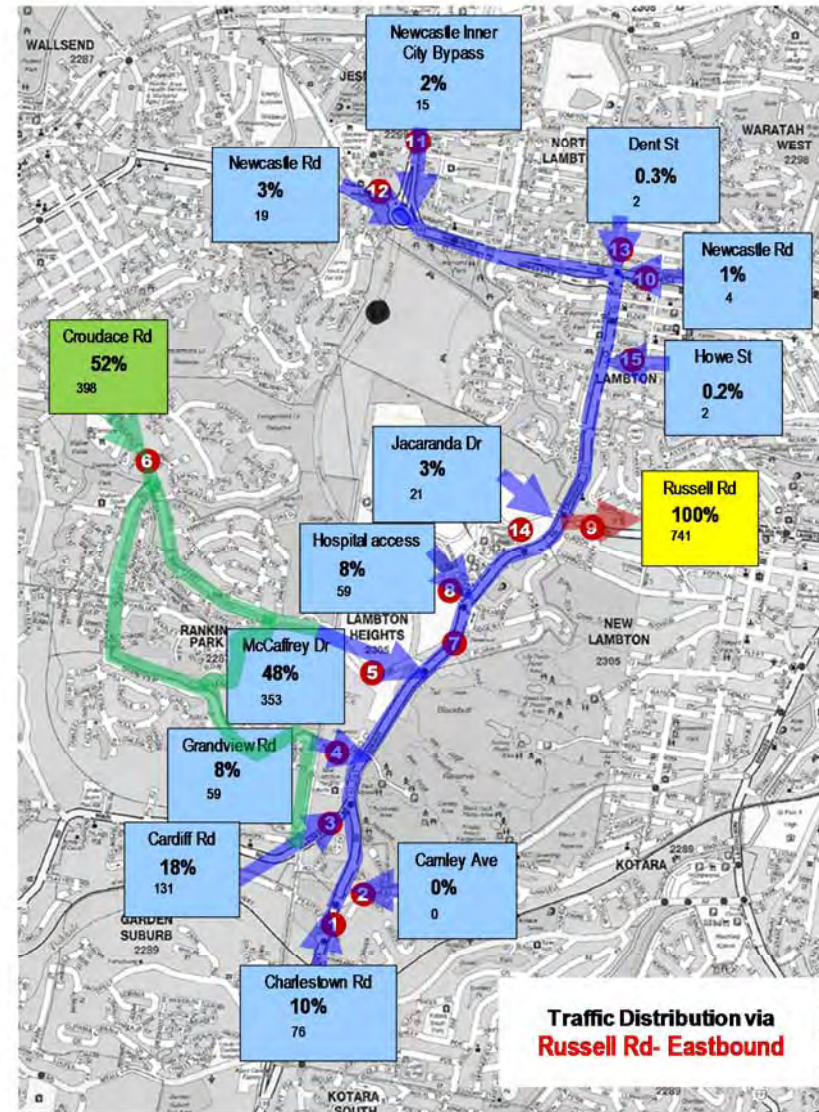
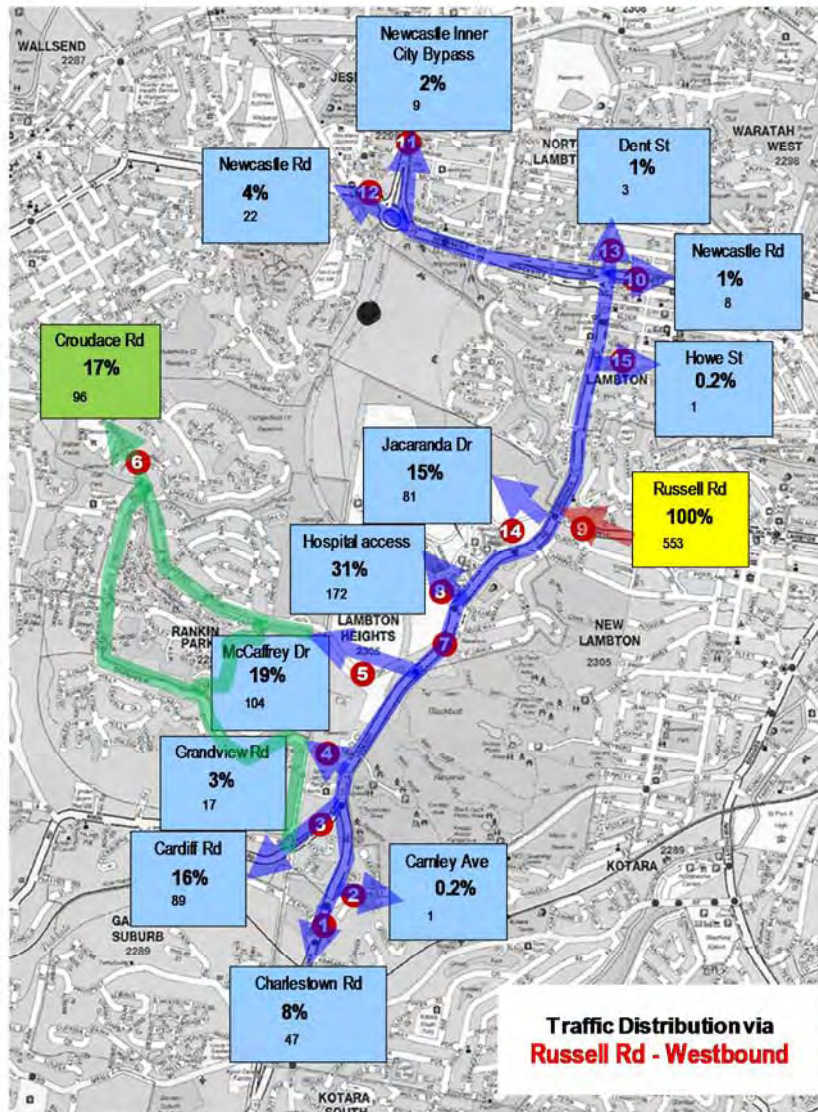
RP2J - AM1H Traffic Distribution via 8. Kookaburra Curcuit - JHH



File location: F:\AA006517\Vari4_RP2J&M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_AM

Figure A4 May 2015 OD Analysis Results – AM Peak

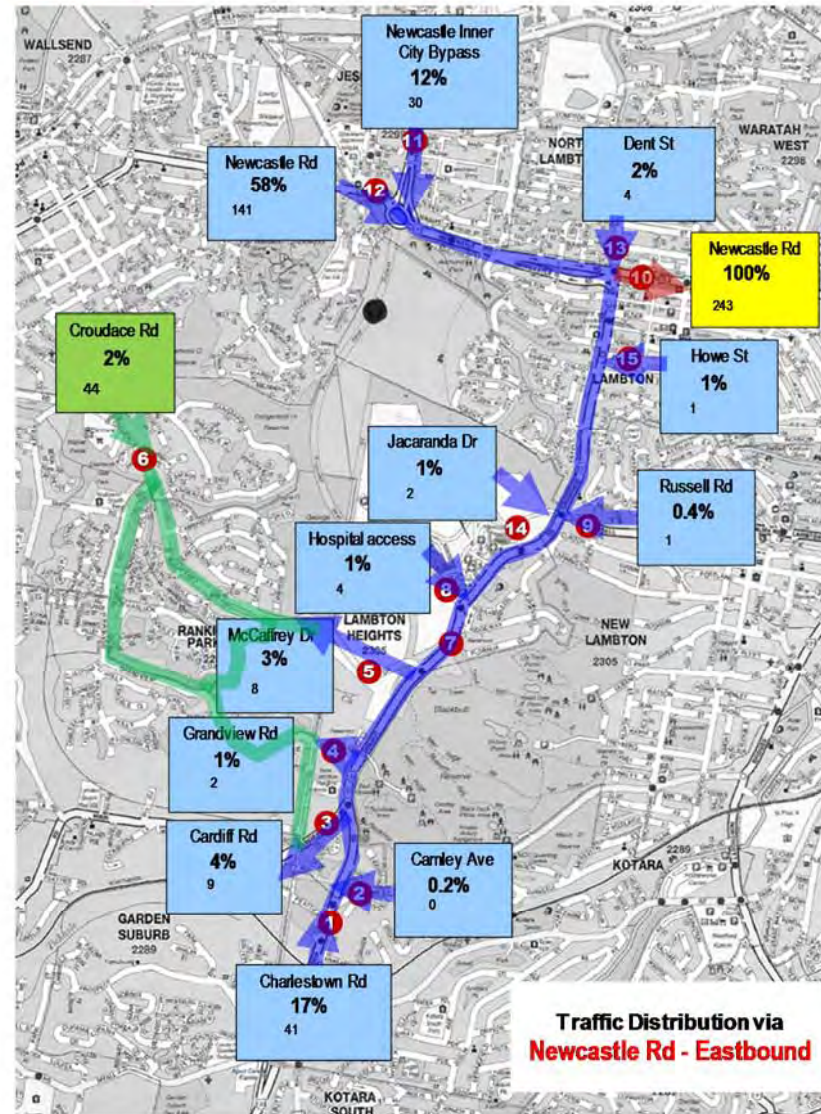
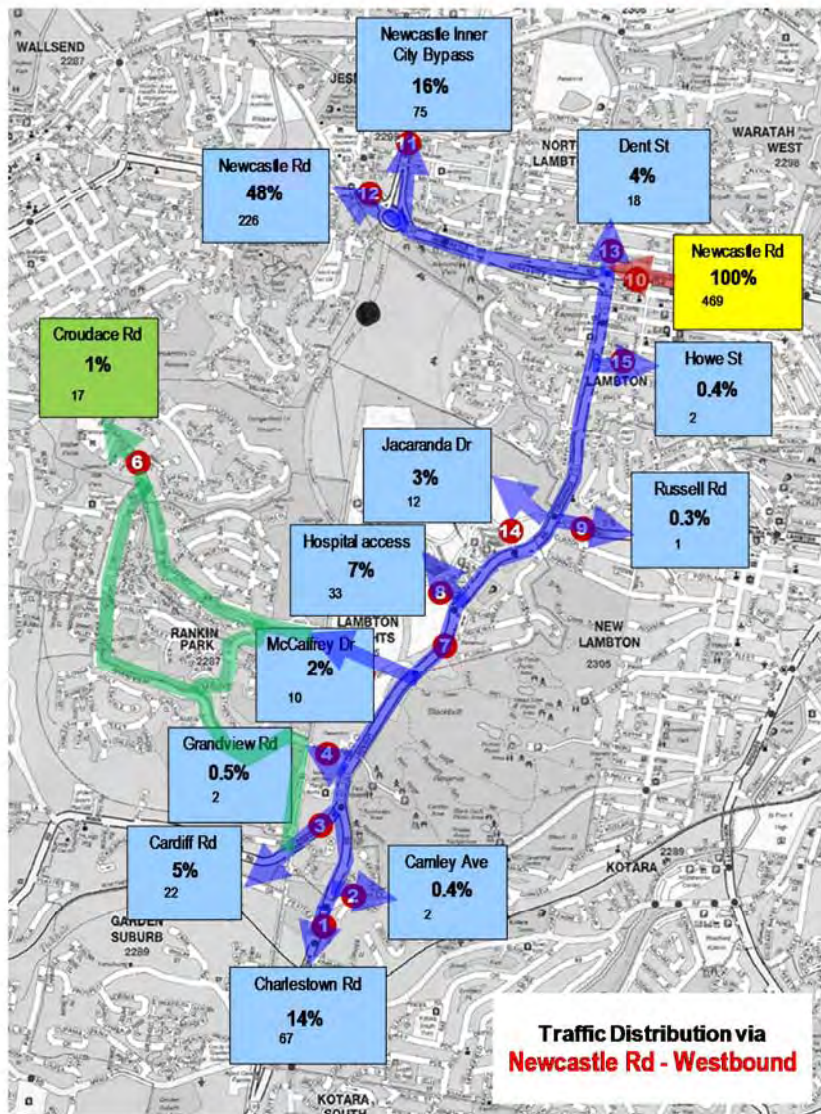
RP2J - AM1H Traffic Distribution via 9. Russell Road - East of Lookout Road



File location: F:\AA006517\Var4_RP2J&M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_AM

Figure A4 May 2015 OD Analysis Results – AM Peak

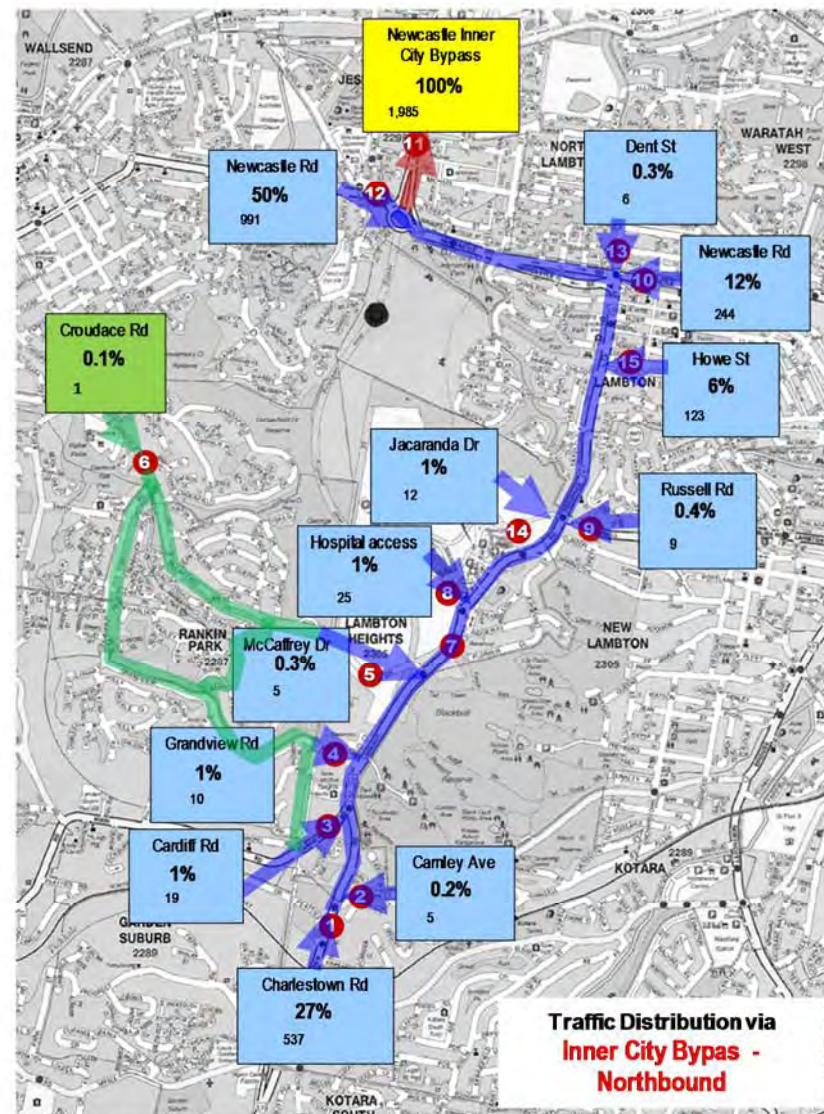
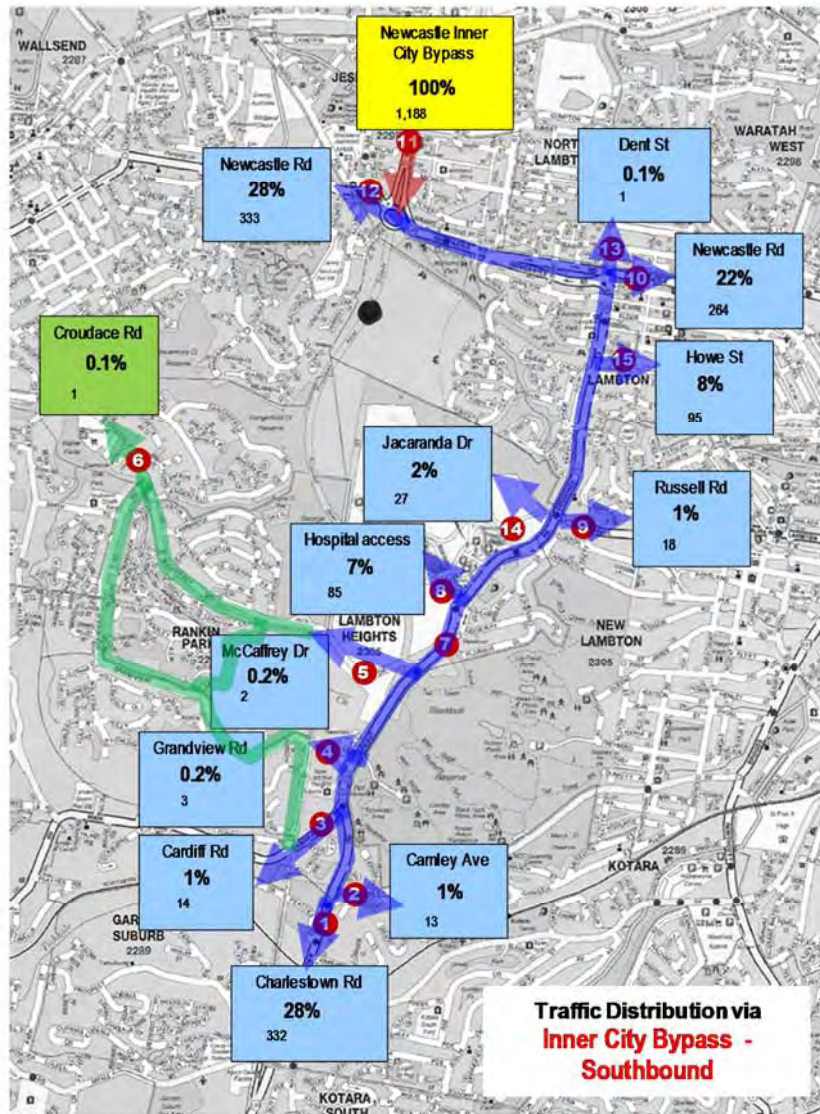
RP2J - AM1H Traffic Distribution via 10. Newcastle Road - East of Croudace Street



File location: F:\AA006517\Vari4_RP2J\M2RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_AM

Figure A4 May 2015 OD Analysis Results – AM Peak

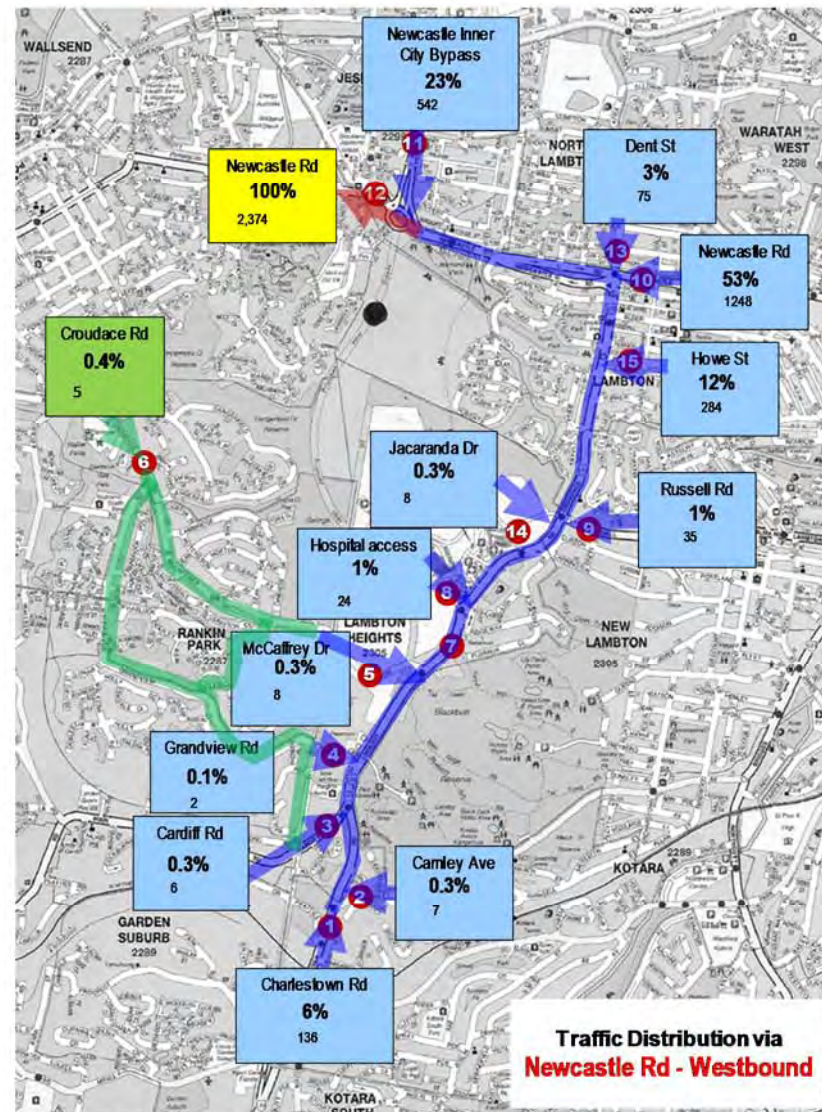
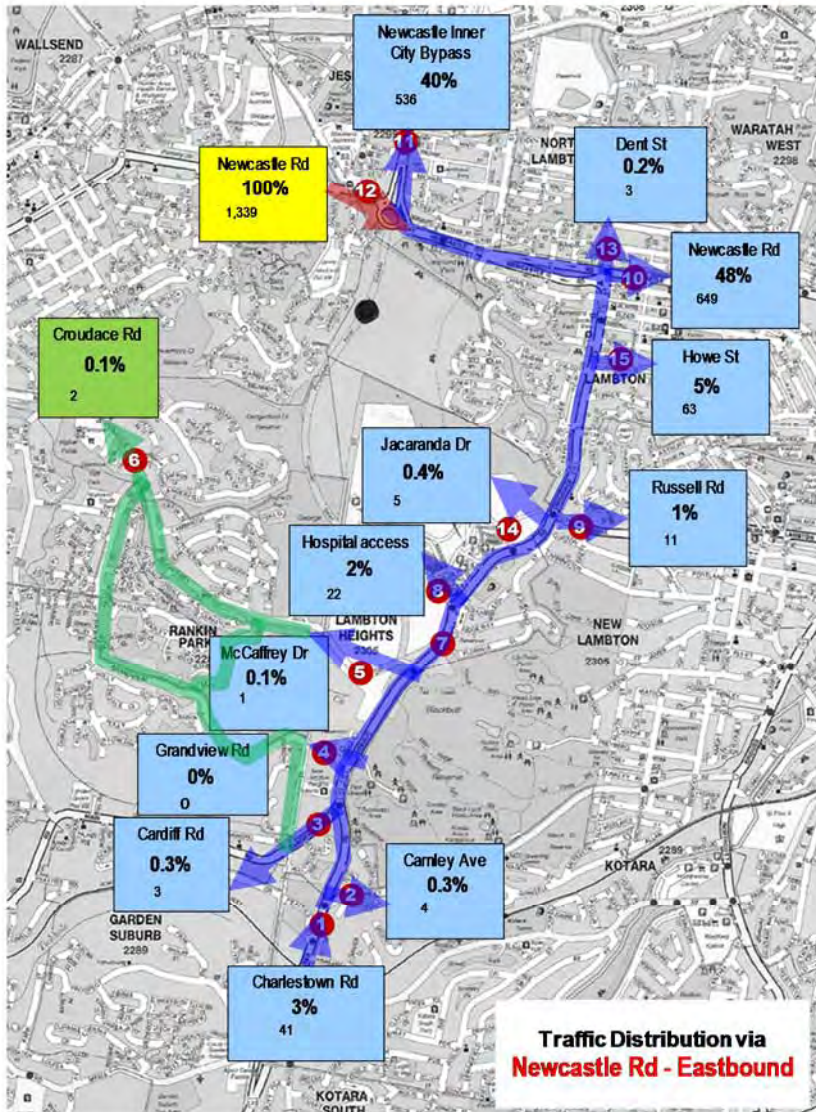
RP2J - AM1H Traffic Distribution via 11. Newcastle Inner City Bypass - North of Newcastle Road



File location: F:\aa006517\Vari4_RP2J\M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_AM

Figure A4 May 2015 OD Analysis Results – AM Peak

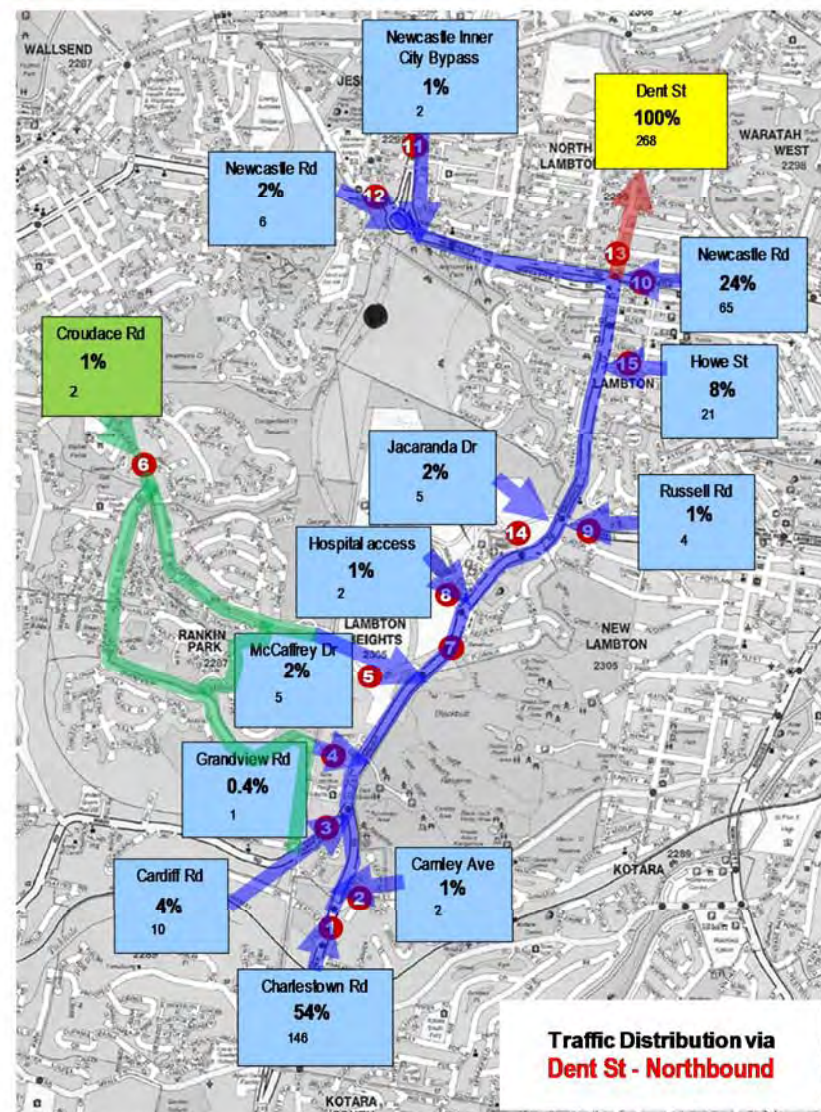
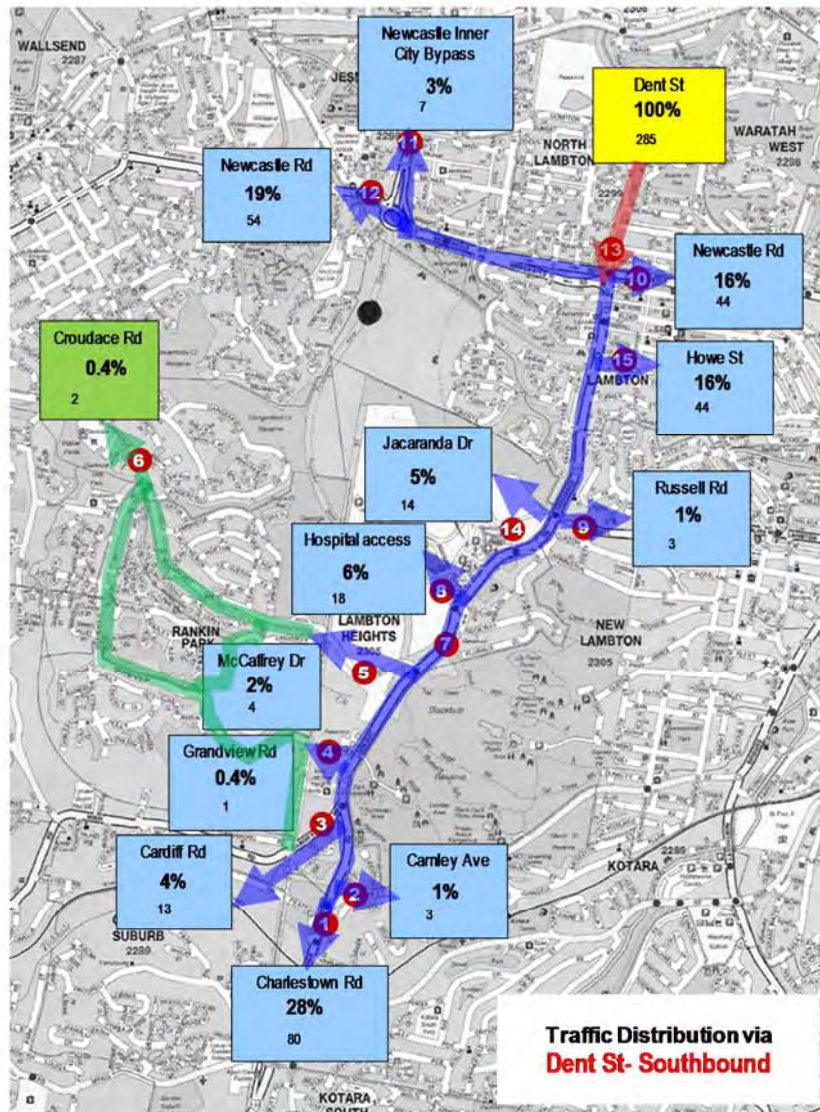
RP2J - AM1H Traffic Distribution via 12. Newcastle Road - West of Newcastle Inner City Bypass



File location: F:\AA006517\Vari4_RP2J\M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_Am

Figure A4 May 2015 OD Analysis Results – AM Peak

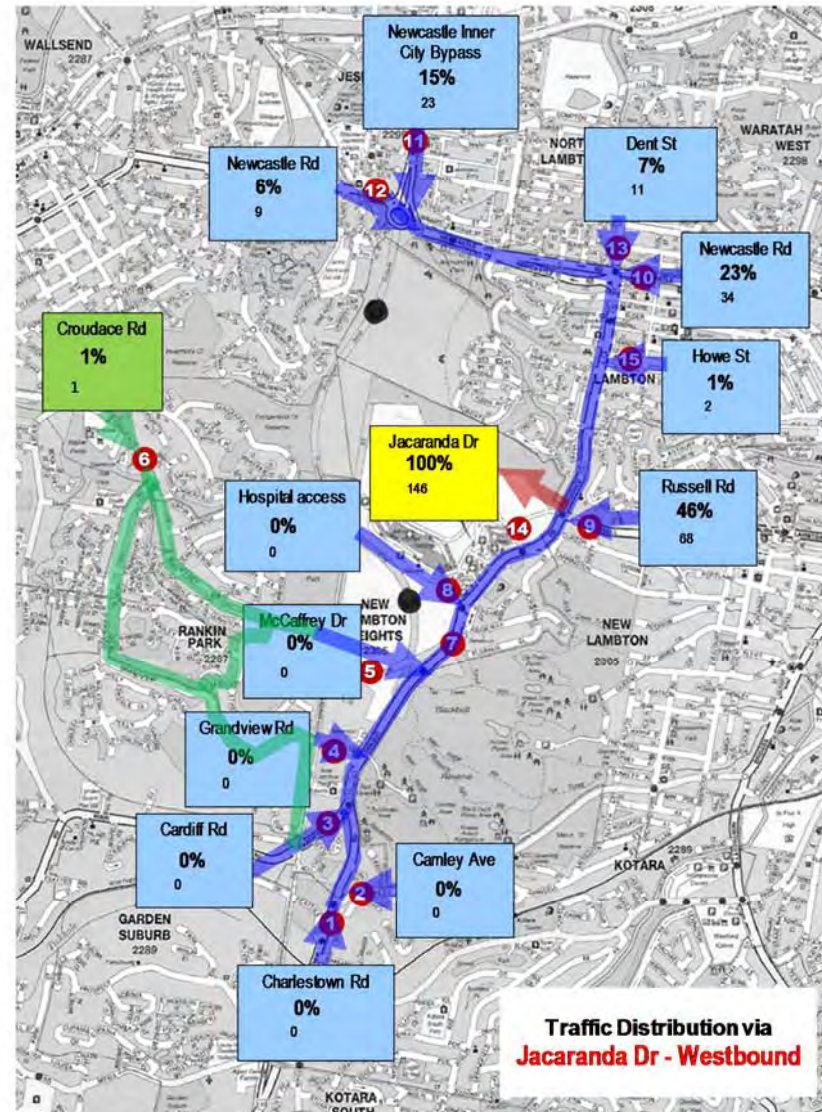
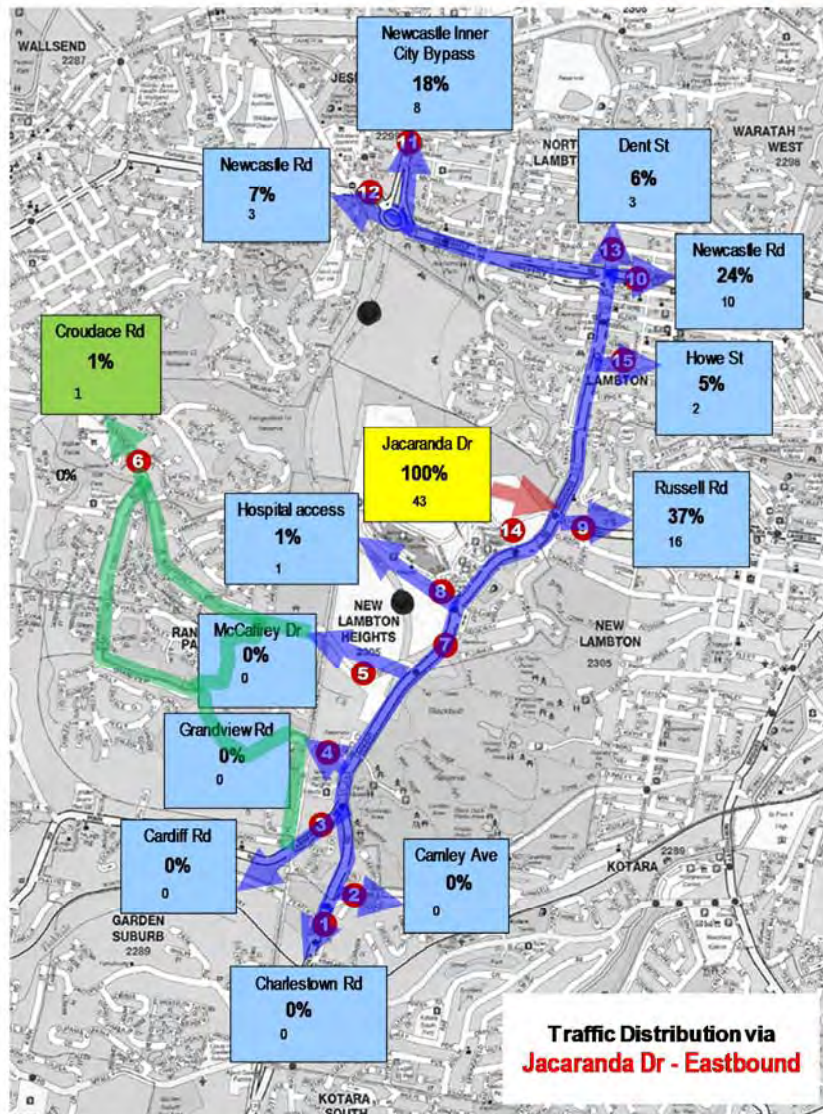
RP2J - AM1H Traffic Distribution via 13. Dent Street - North of Newcastle Road



File location: F:\AA006517\Vari4_RP2J\M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_AM

Figure A4 May 2015 OD Analysis Results – AM Peak

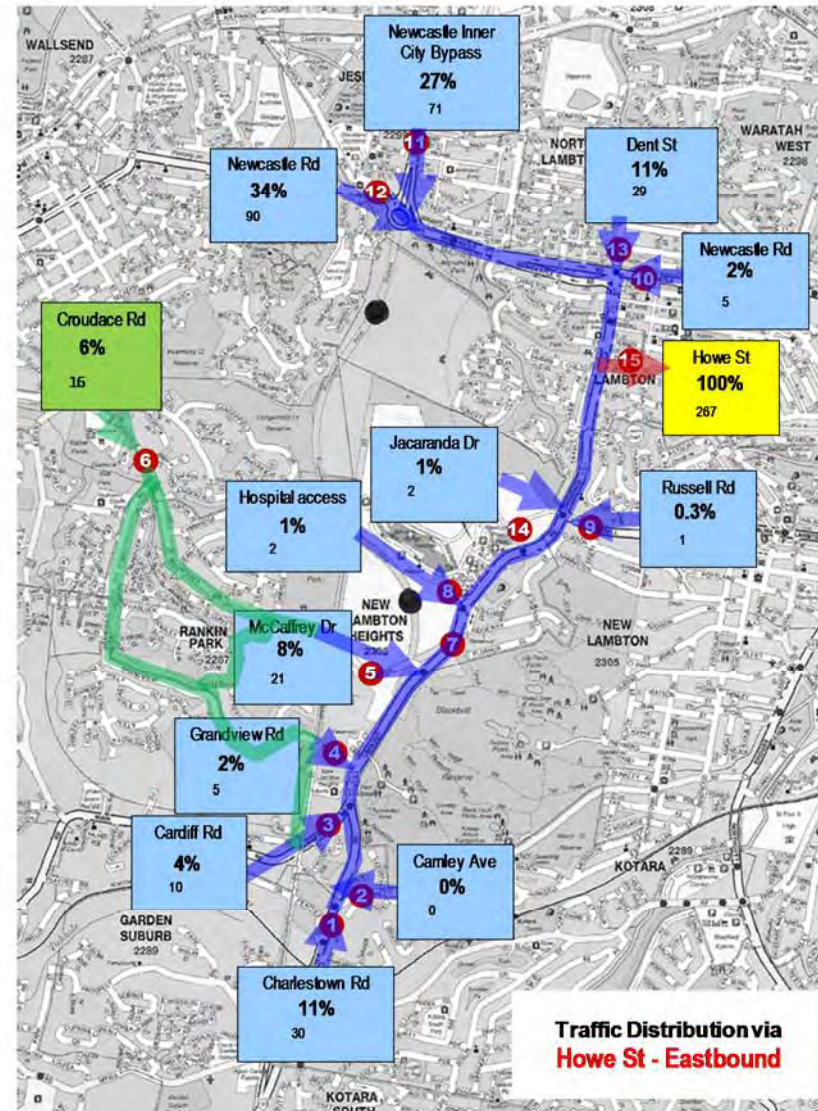
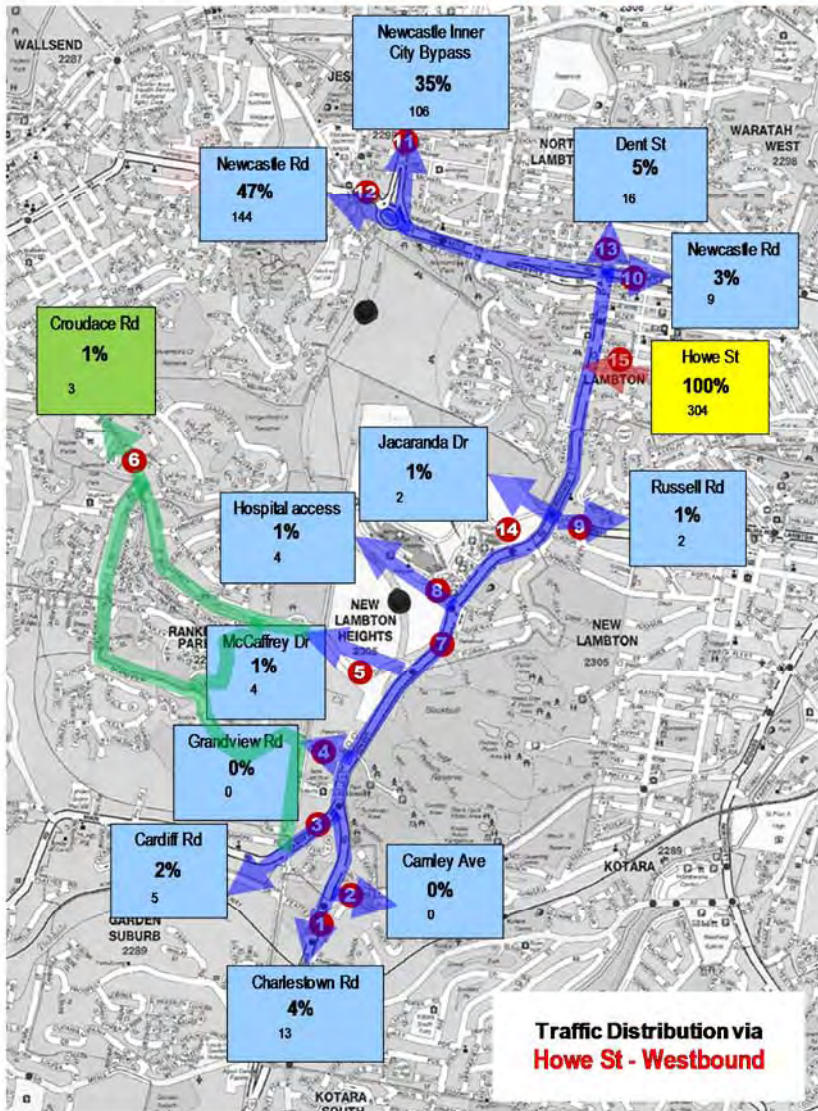
RP2J - AM1H Traffic Distribution via 14. Jacaranda Drive - JHH access



File location: F:\AA006517\Vari4_RP2J\M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_A5

Figure A4 May 2015 OD Analysis Results – AM Peak

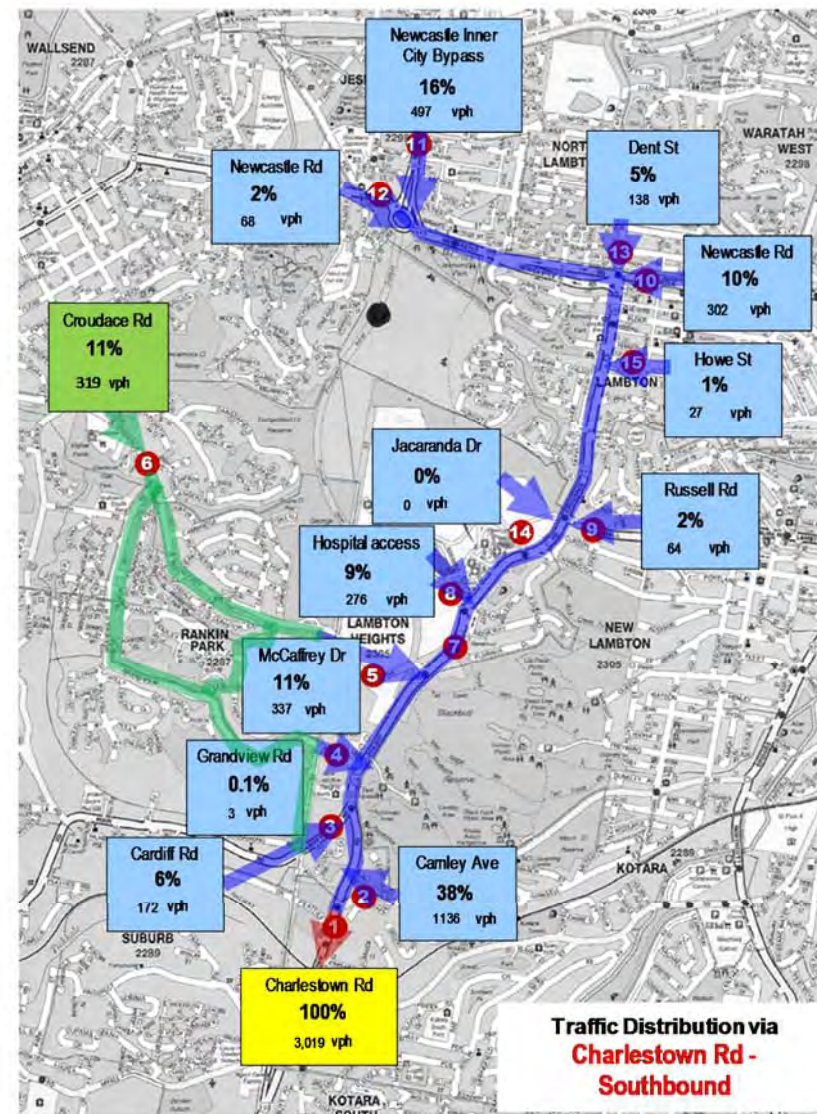
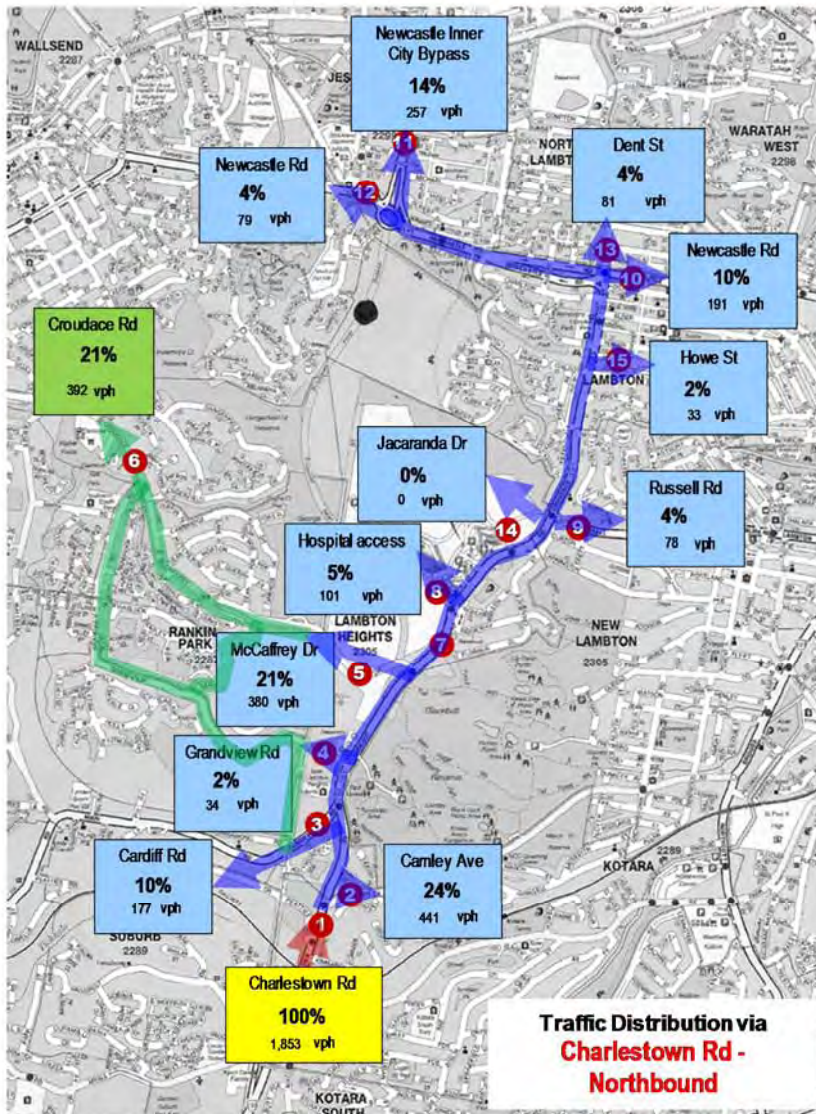
RP2J - AM1H Traffic Distribution via 15. Howe St - East of Croudace Street



File location: F:\aa006517\Vari4_RP2J\M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_AM

Figure A4 May 2015 OD Analysis Results – AM Peak

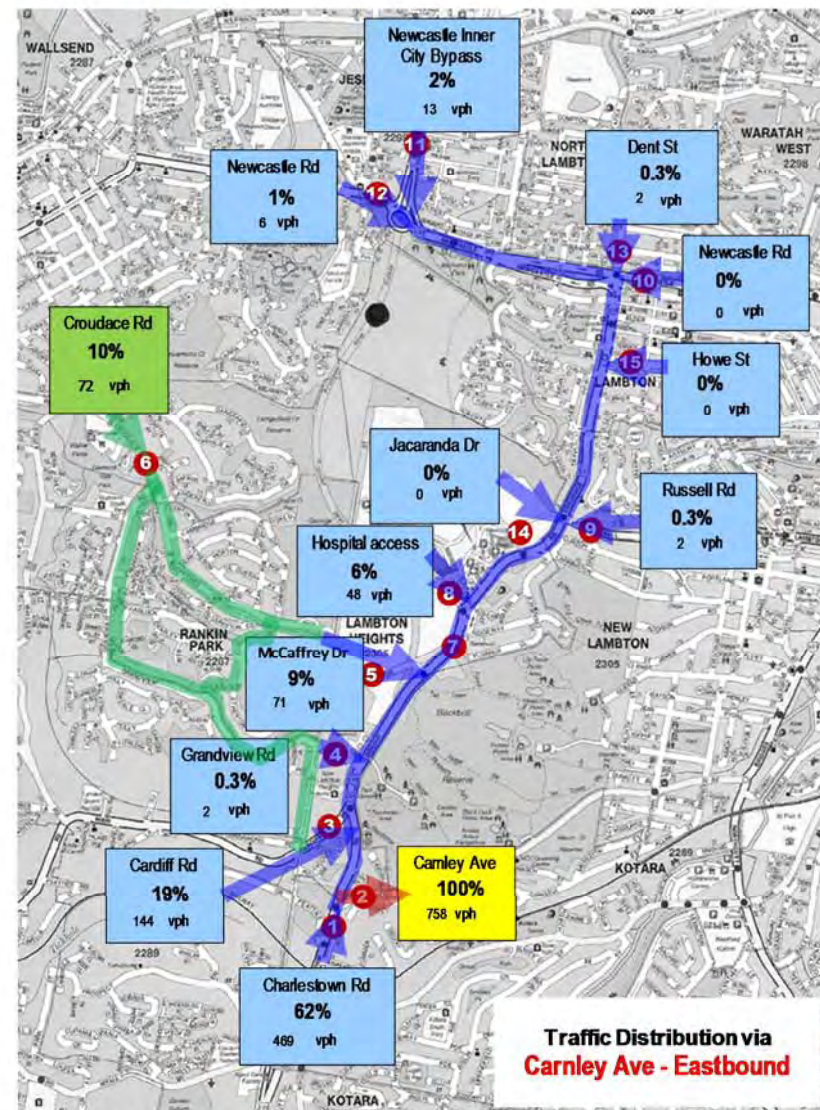
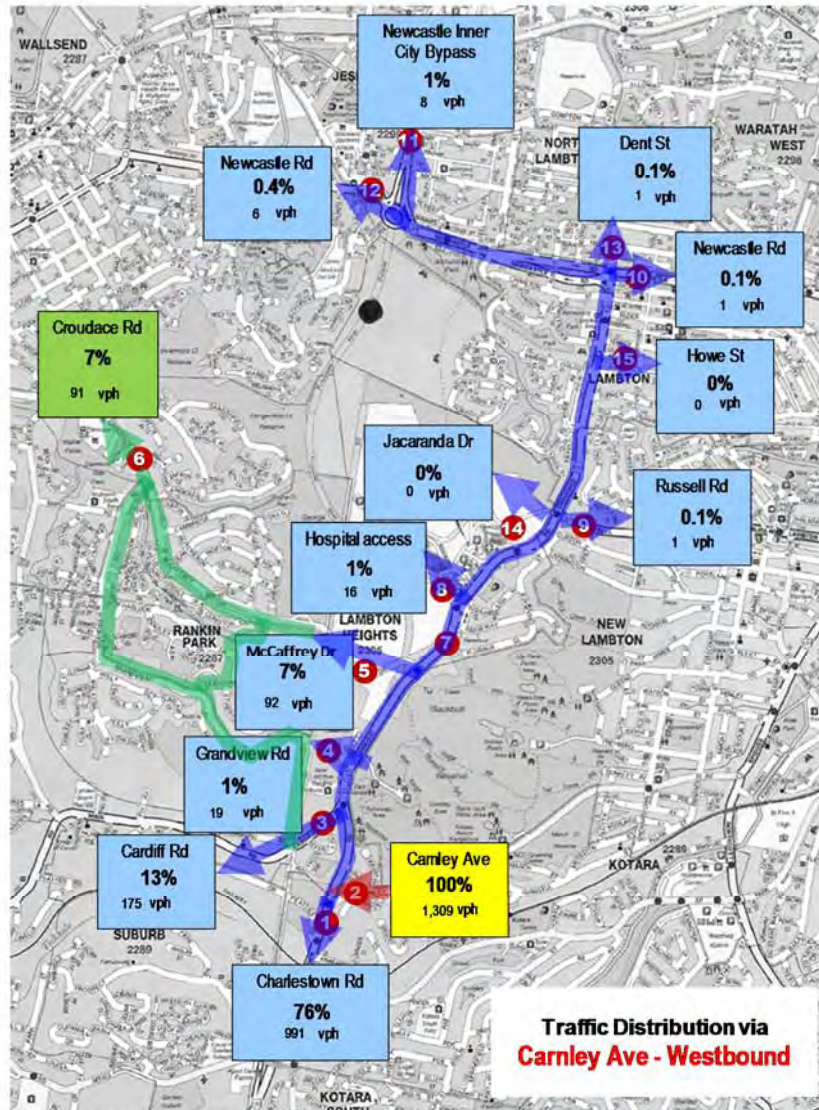
RP2J - PM1H Traffic Distribution via 1. Charlestown Road - South of Cardiff Road



File location: F:\AA006517\Vari4_RP2J\M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_MP

Figure A5 May 2015 OD Analysis Results – PM Peak

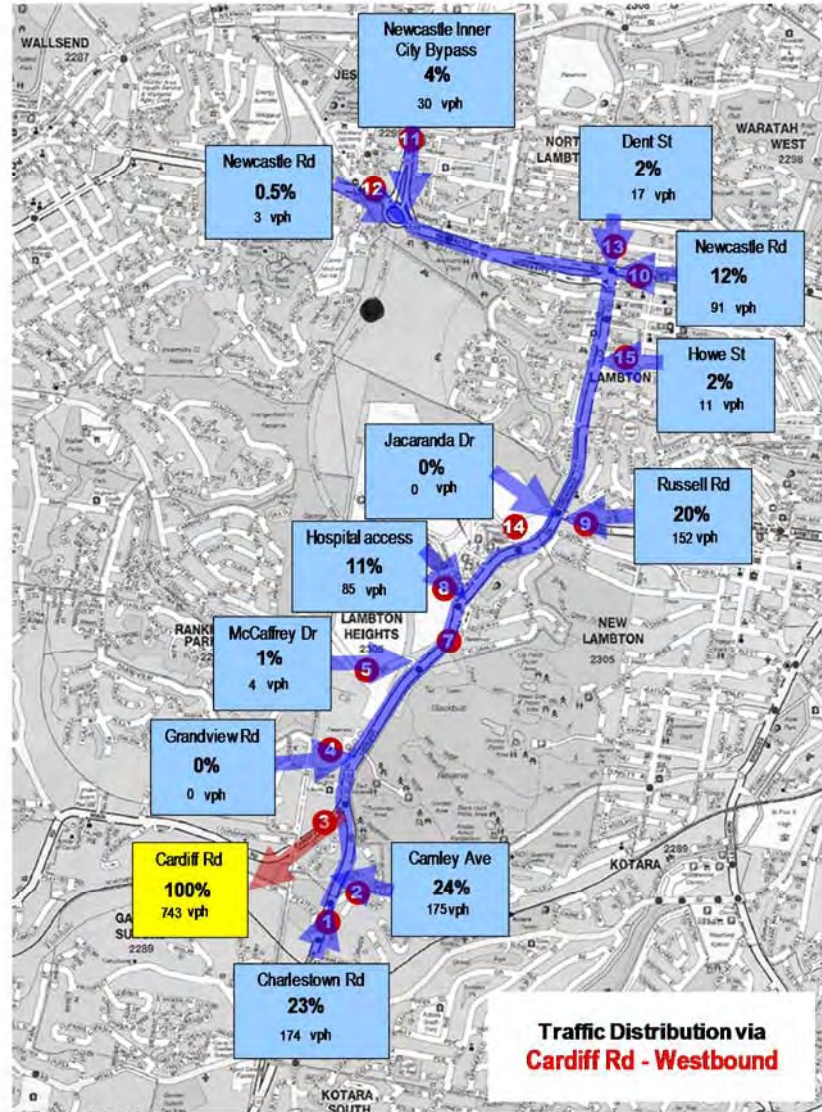
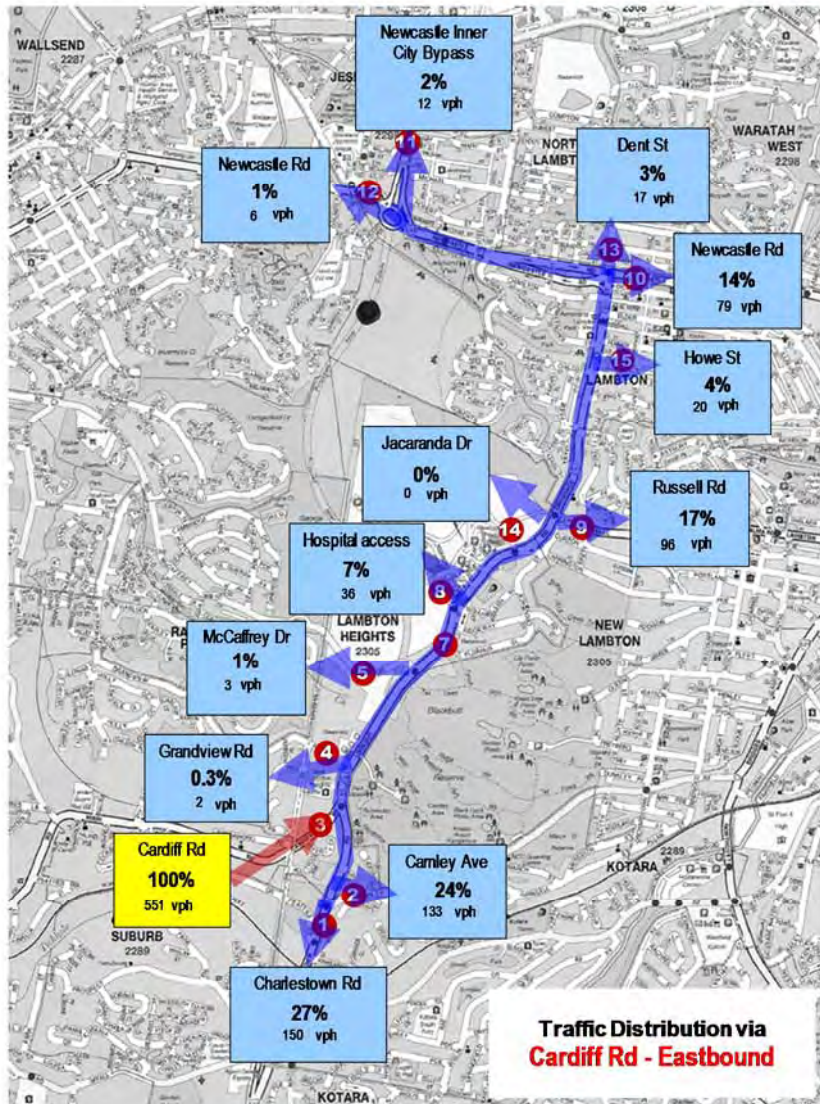
RP2J - PM1H Traffic Distribution via 2. Camley Avenue - East of Charlestown Road



File location: F:\AA006517\Vari4_RP2J\M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_PM

Figure A5 May 2015 OD Analysis Results – PM Peak

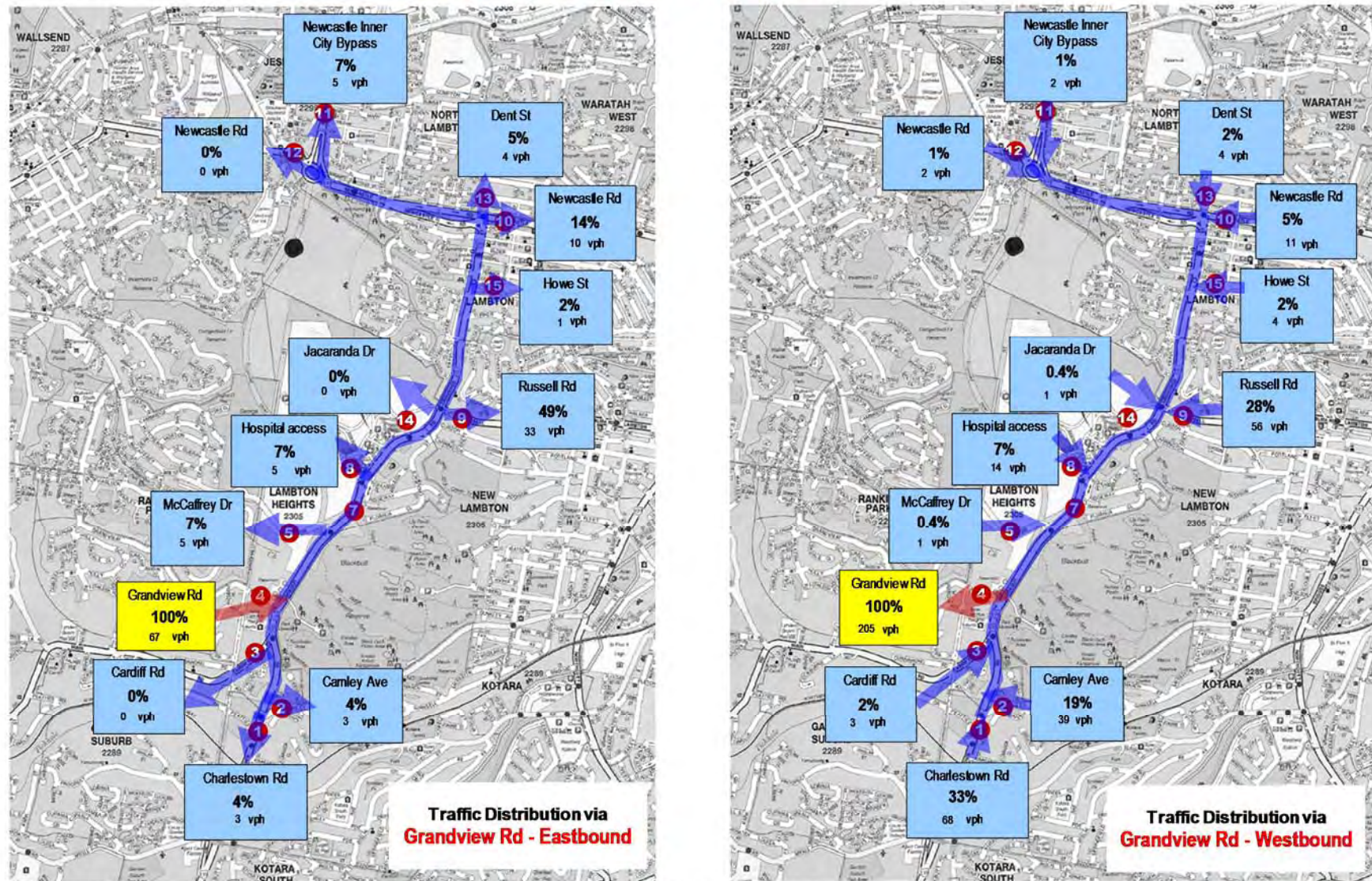
RP2J - PM1H Traffic Distribution via 3. Cardiff Road- West of Lookout Road



File location: F:\AA006517\Vari4_RP2J&M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_PM

Figure A5 May 2015 OD Analysis Results – PM Peak

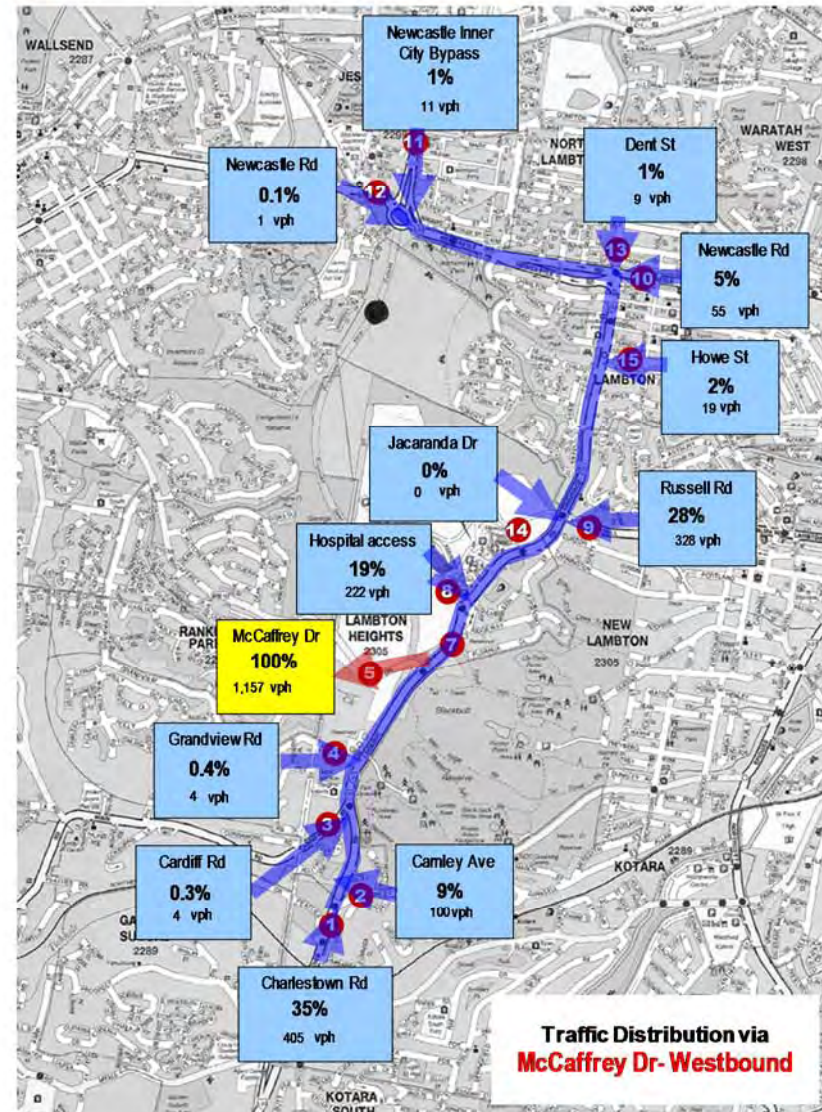
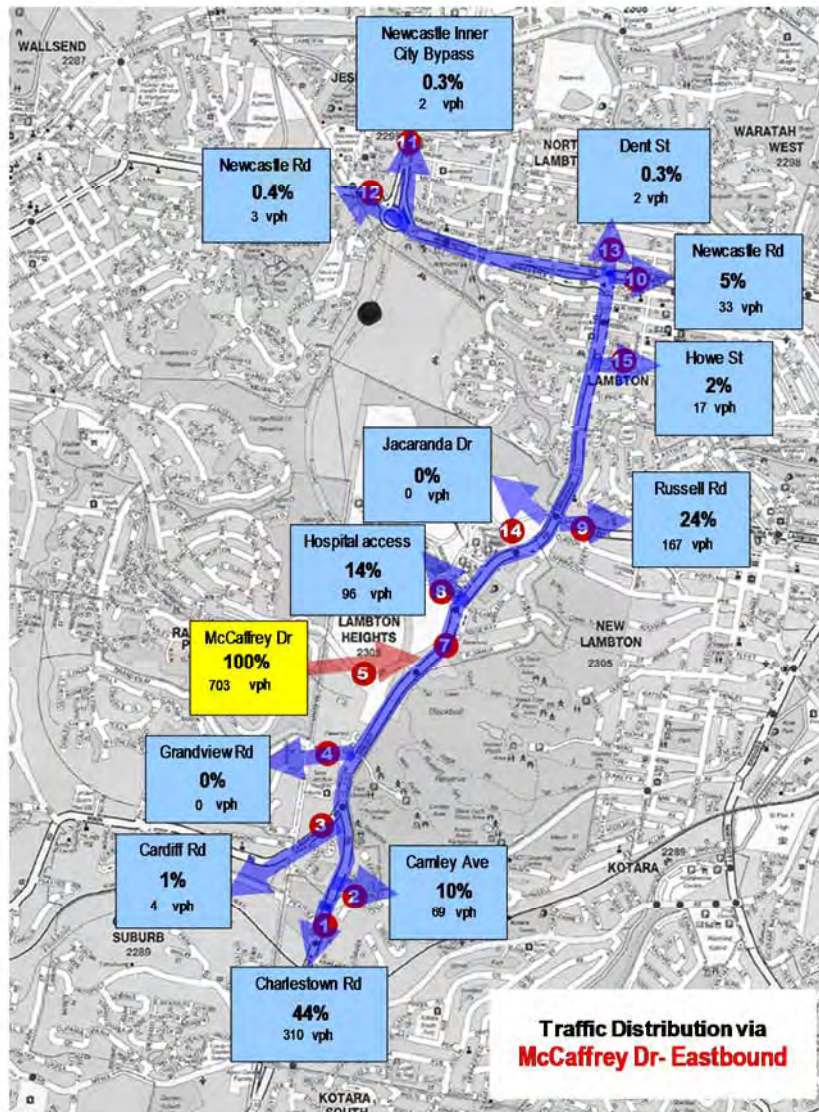
RP2J - PM1H Traffic Distribution via 4. Grandview Road- West of Lookout Road



File location: F:\AA006517\Vari4_RP2J&M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_PM

Figure A5 May 2015 OD Analysis Results – PM Peak

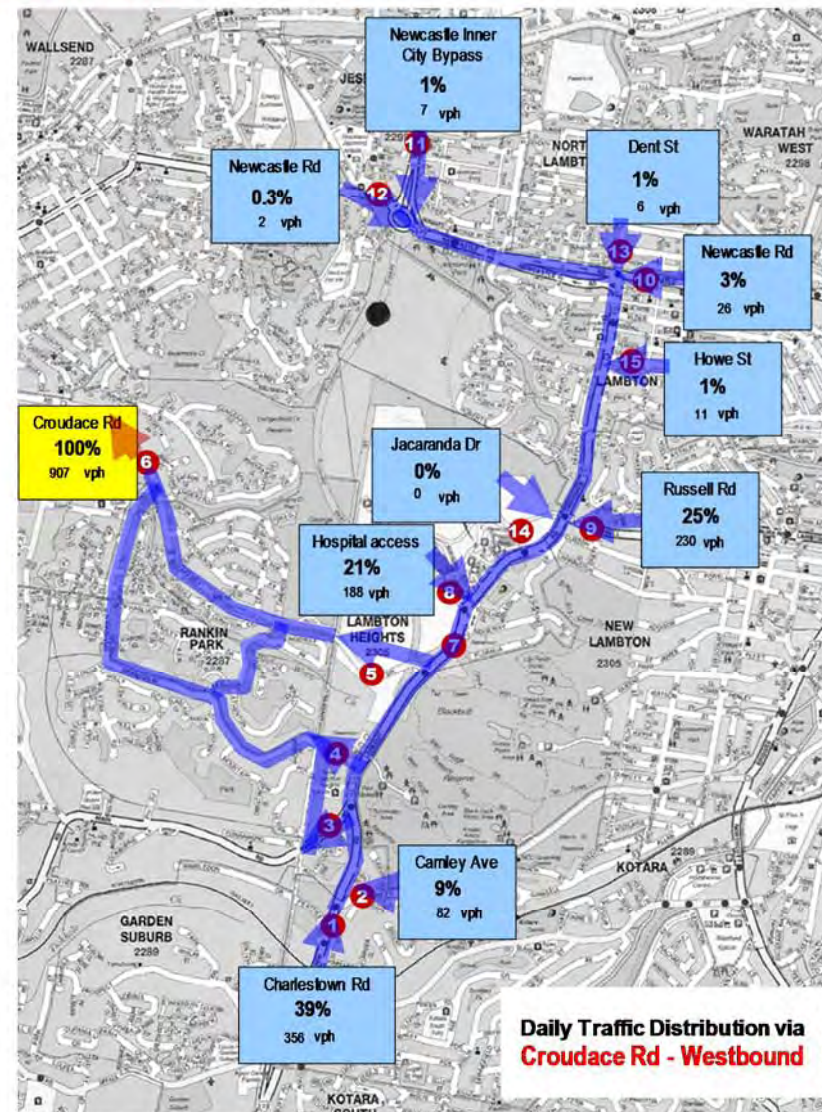
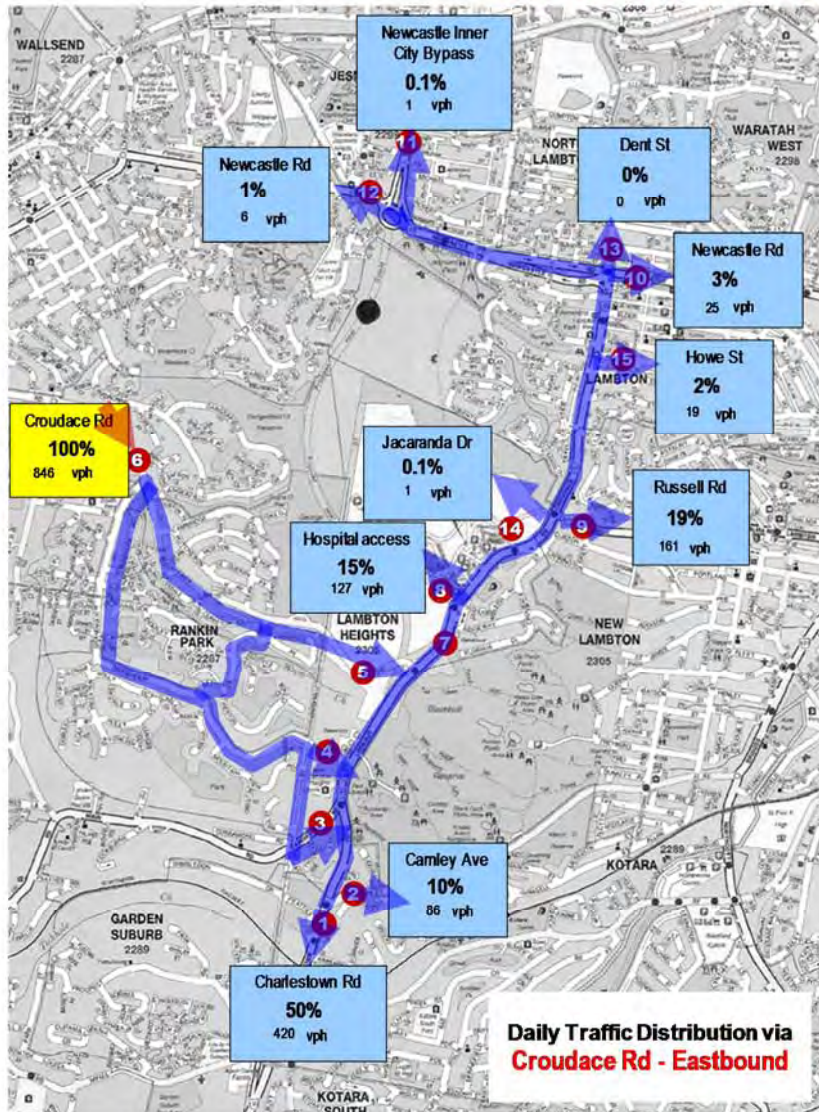
PM Peak Traffic Distribution via 5. McCaffrey Road- West of Lookout Road



File location: F:\AA006517\Vari4_RP2J\M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_PM

Figure A5 May 2015 OD Analysis Results – PM Peak

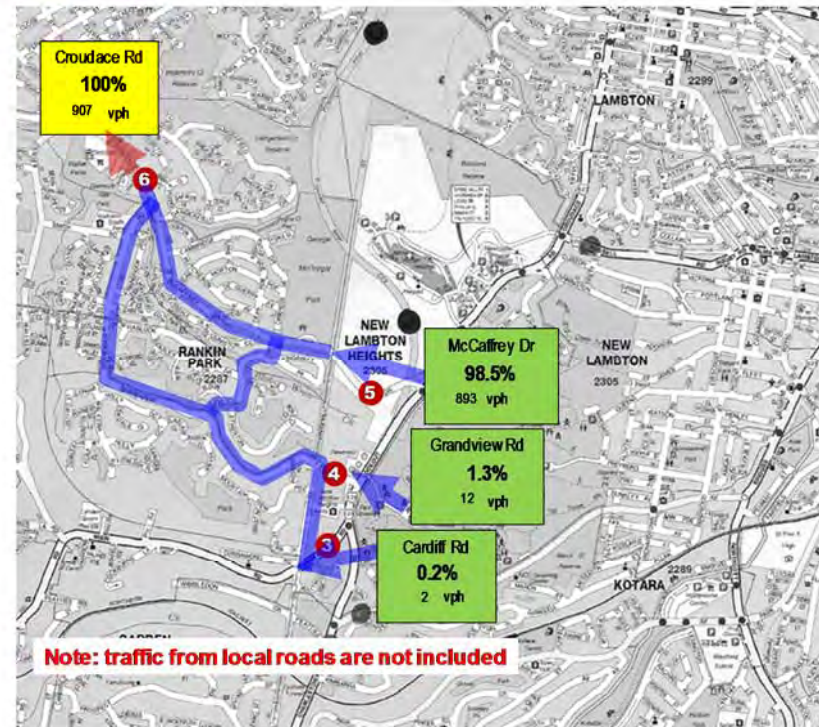
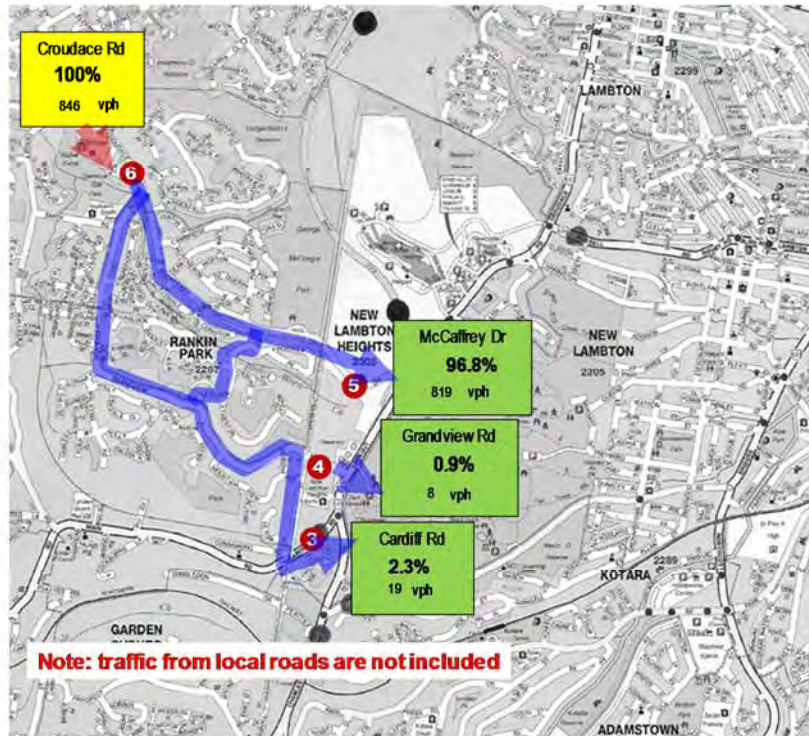
RP2J - PM1H Traffic Distribution via 6. Croudace Road - West of Grandview Road



File location: F:\AA006517\Vari4_RP2J&M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C1_PM

Figure A5 May 2015 OD Analysis Results – PM Peak

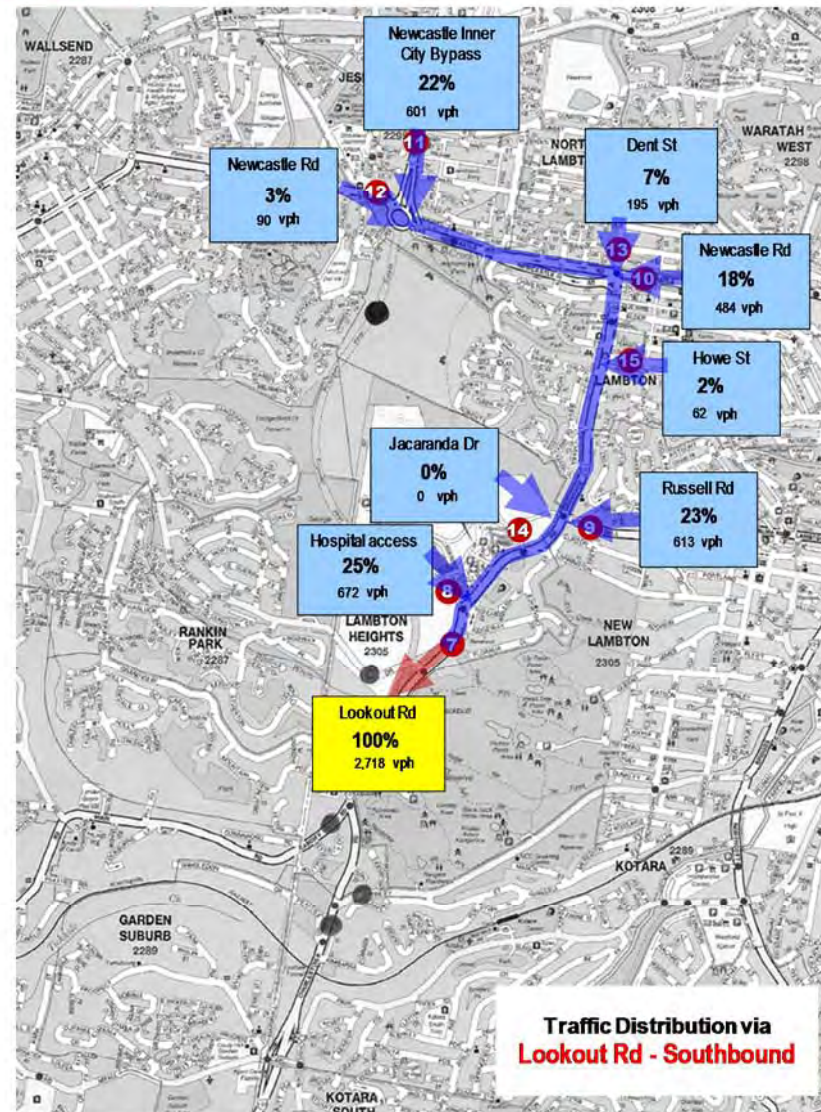
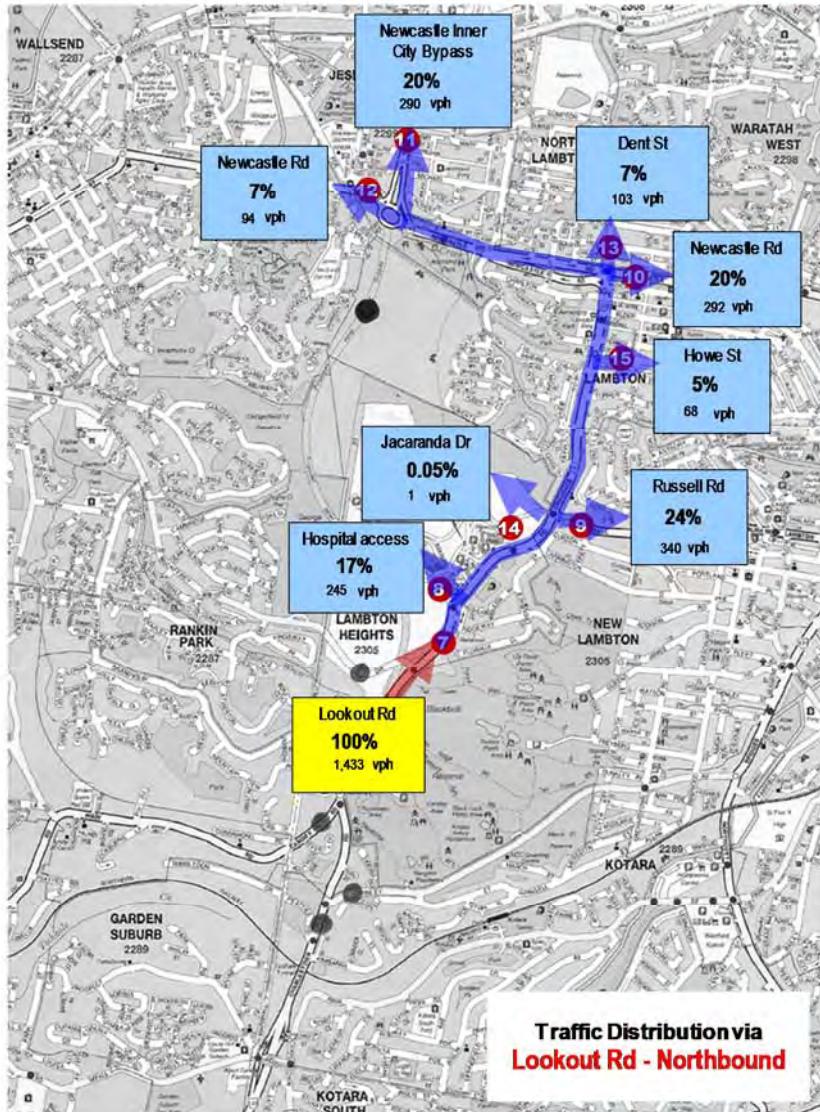
RP2J - PM1H Traffic Distribution via 6. Croudace Road - West of Grandview Road



File location: F:\AA006517\Vari4_RP2J&M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C1_PM

Figure A5 May 2015 OD Analysis Results – PM Peak

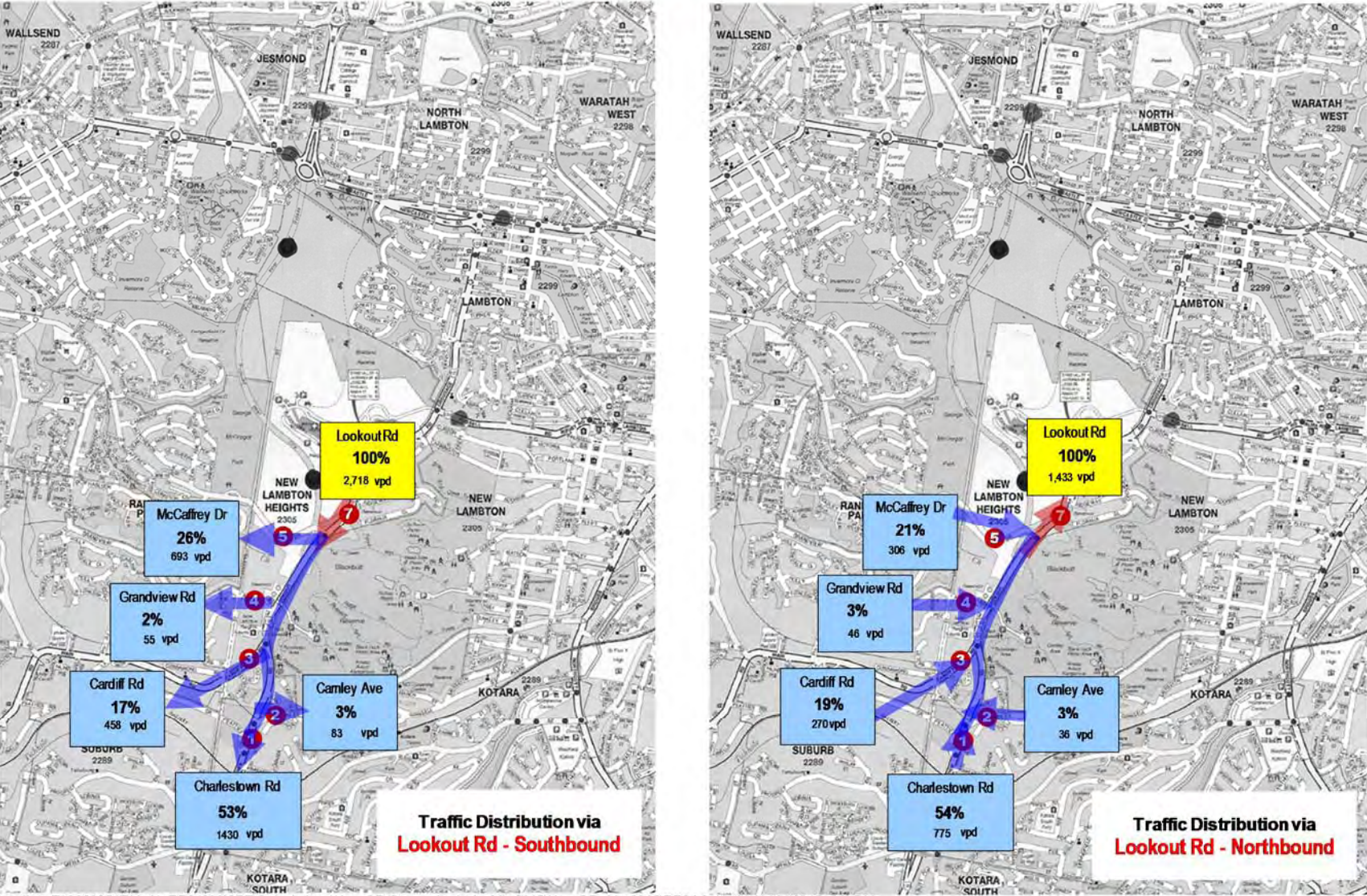
RP2J - PM1H Traffic Distribution via 7. Lookout Road - North of McCaffrey Drive



File location: F:\AA006517\Vari4_RP2J\M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C4_PM

Figure A5 May 2015 OD Analysis Results – PM Peak

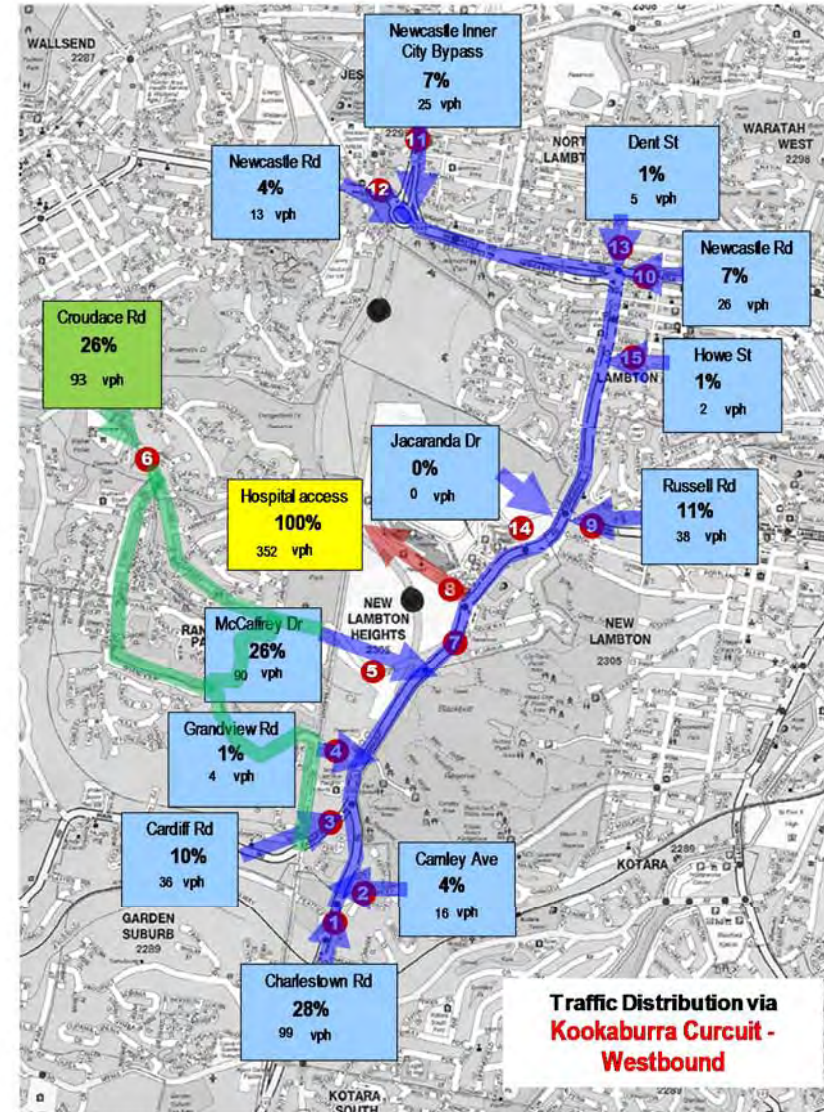
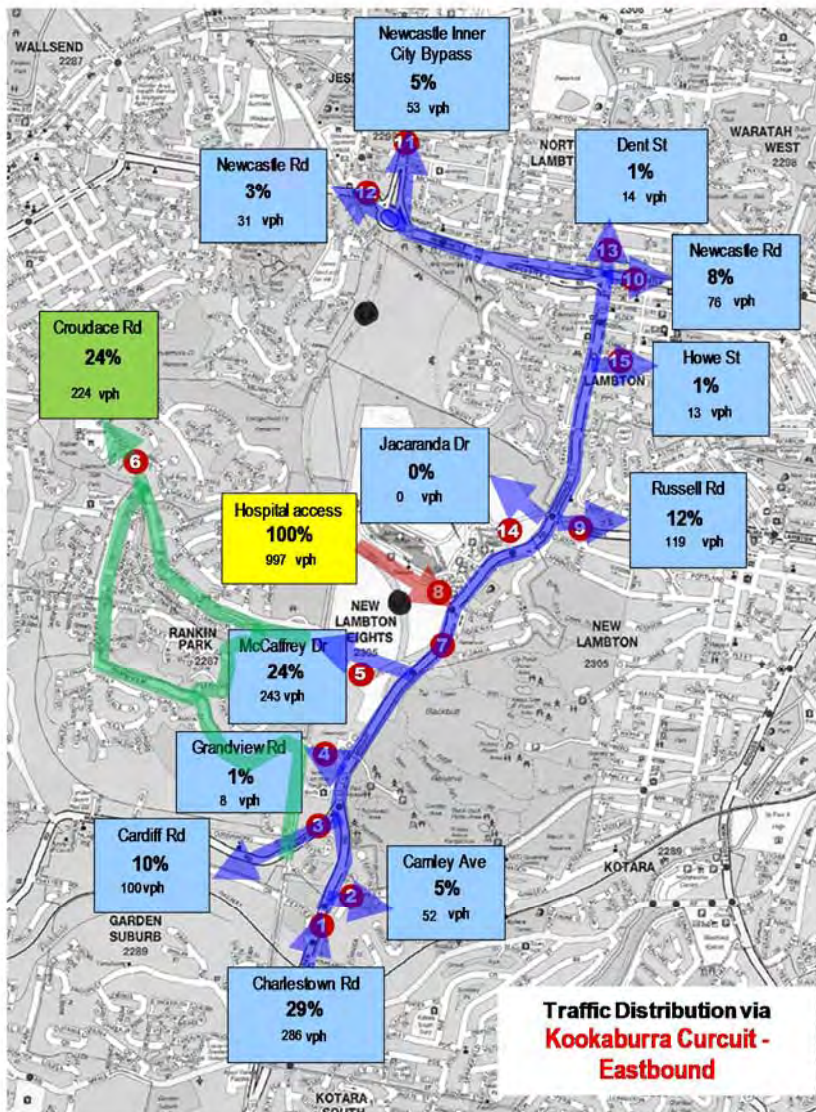
RP2J - PM1H Traffic Distribution via 7. Lookout Road - North of McCaffrey Drive



File location: F:\AA006517\Vari4_RP2J\M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C3_PM

Figure A5 May 2015 OD Analysis Results – PM Peak

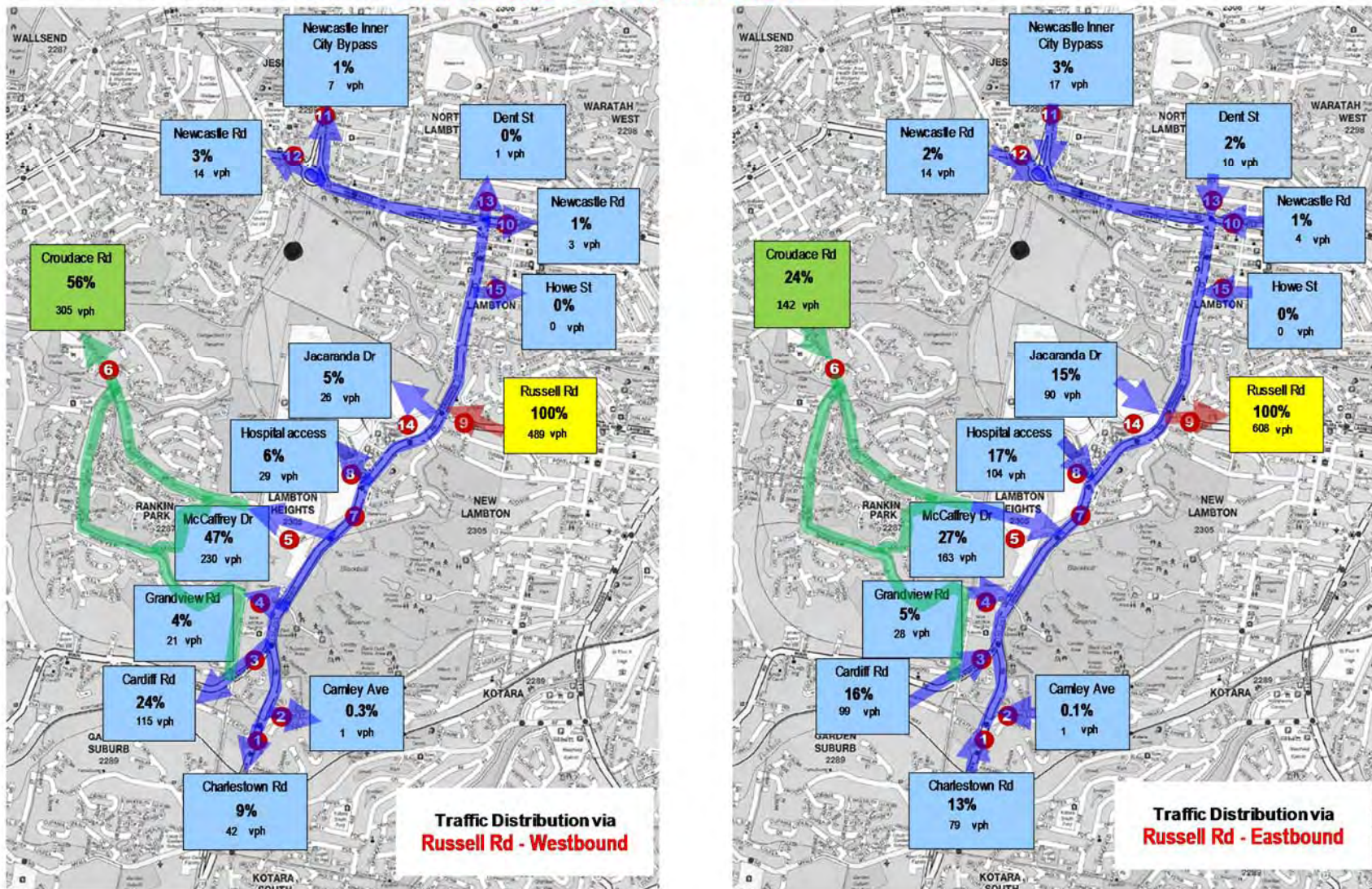
RP2J - PM1H Traffic Distribution via 8. Kookaburra Curcuit - JHH



File location: F:\AA006517\Vari4_RP2J&M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_PM

Figure A5 May 2015 OD Analysis Results – PM Peak

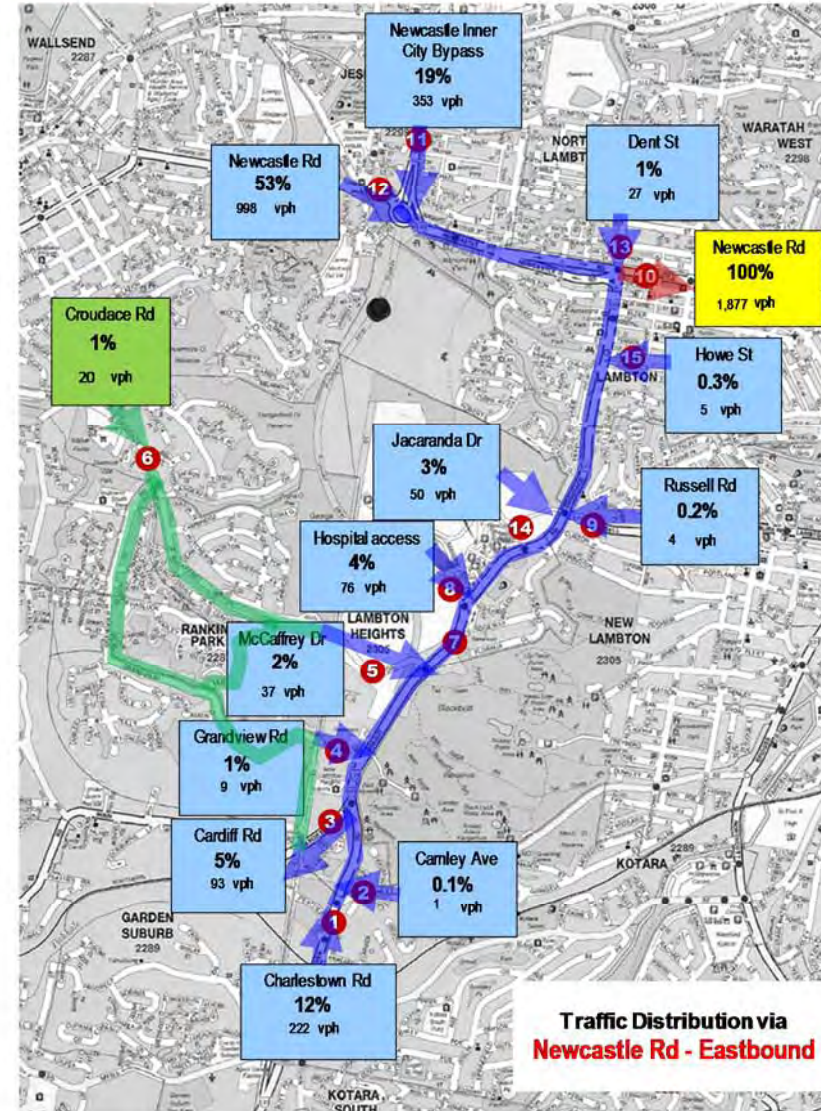
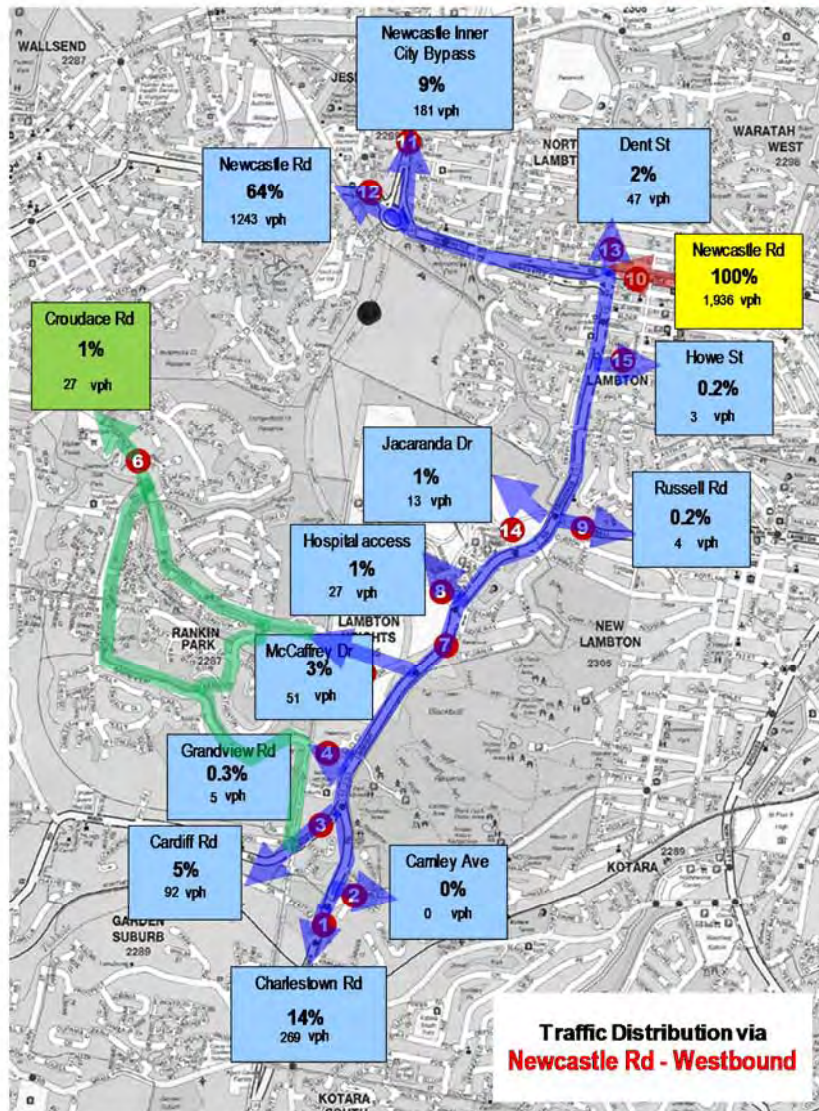
RP2J - PM1H Traffic Distribution via 9. Russell Road - East of Lookout Road



File location: F:\AA006517\Vari4_RP2J\M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_PM

Figure A5 May 2015 OD Analysis Results – PM Peak

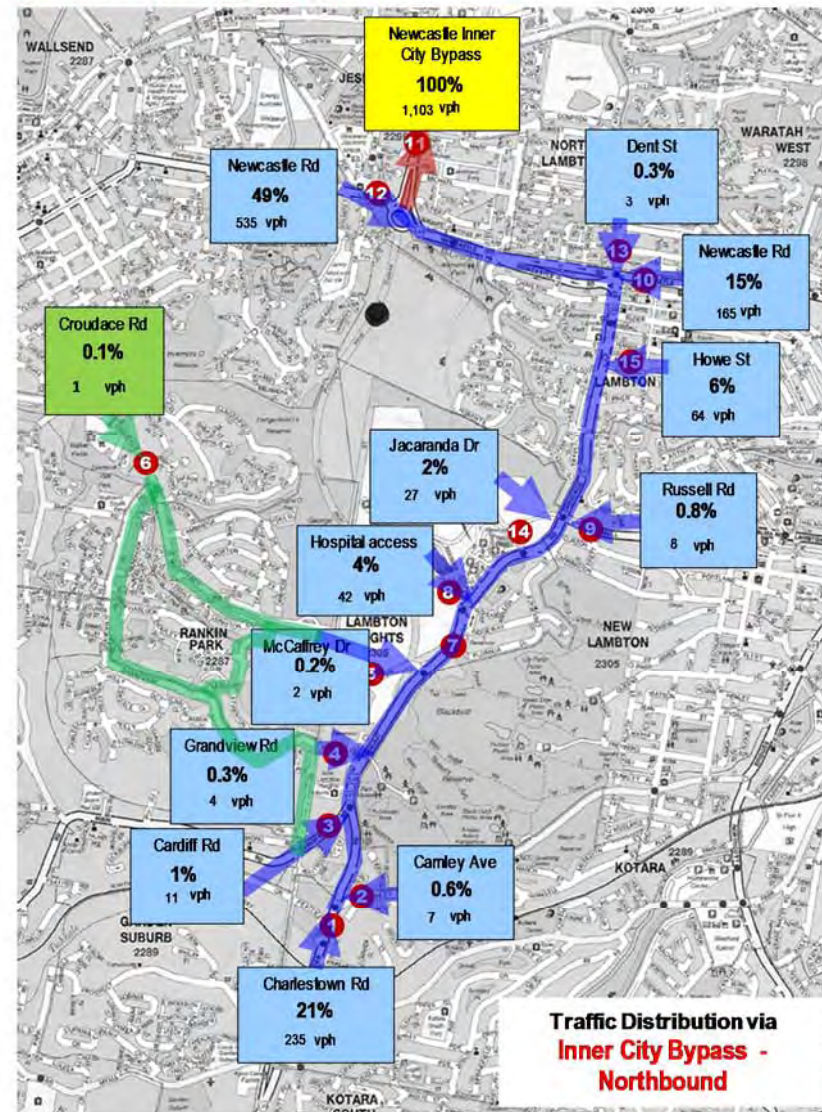
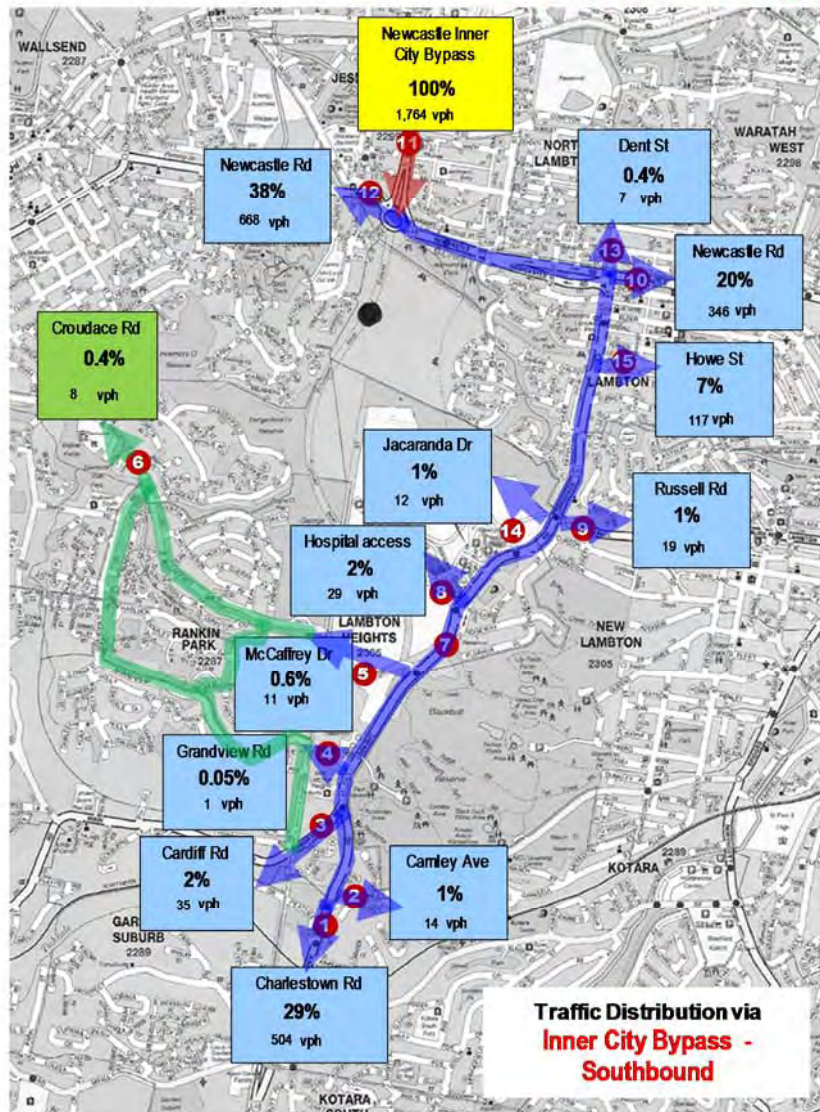
RP2J - PM1H Traffic Distribution via 10. Newcastle Road - East of Croudace Street



File location: F:\AA006517\Vari4_RP2J&M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_PM

Figure A5 May 2015 OD Analysis Results – PM Peak

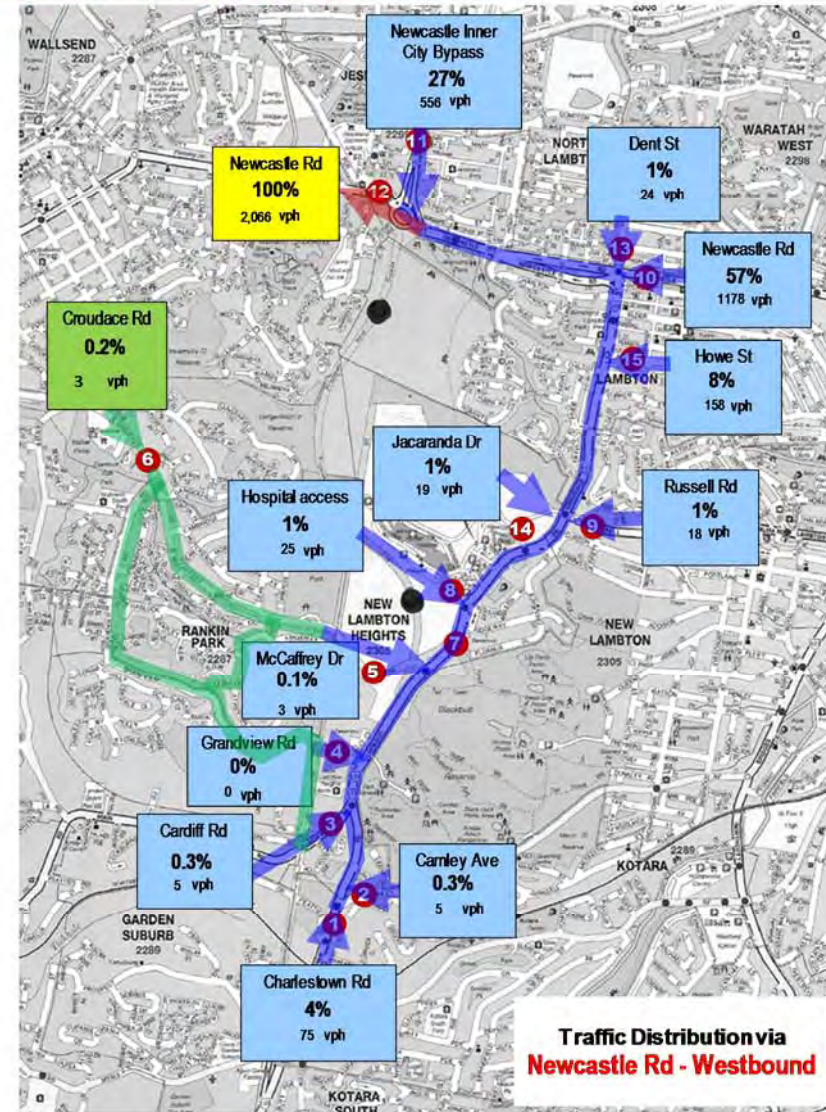
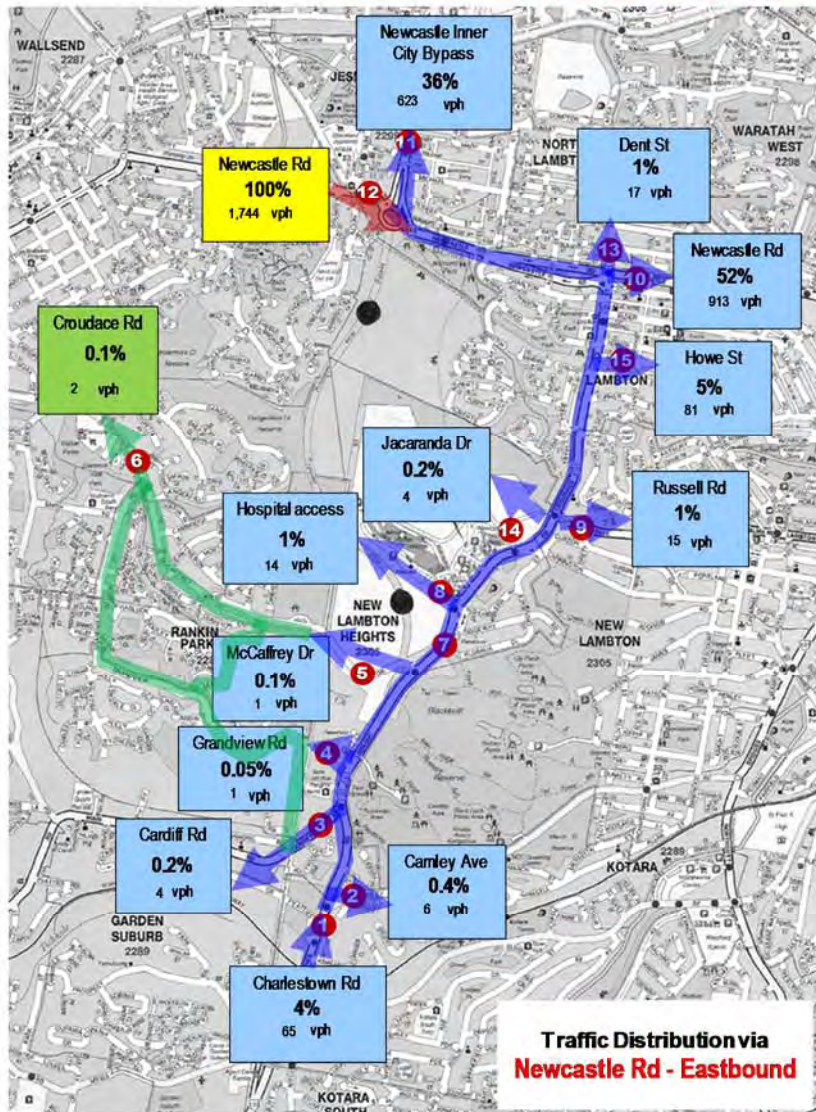
RP2J - PM1H Traffic Distribution via 11. Newcastle Inner City Bypass - North of Newcastle Road



File location: F:\AA006517\Vari4_RP2J\M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_PM

Figure A5 May 2015 OD Analysis Results – PM Peak

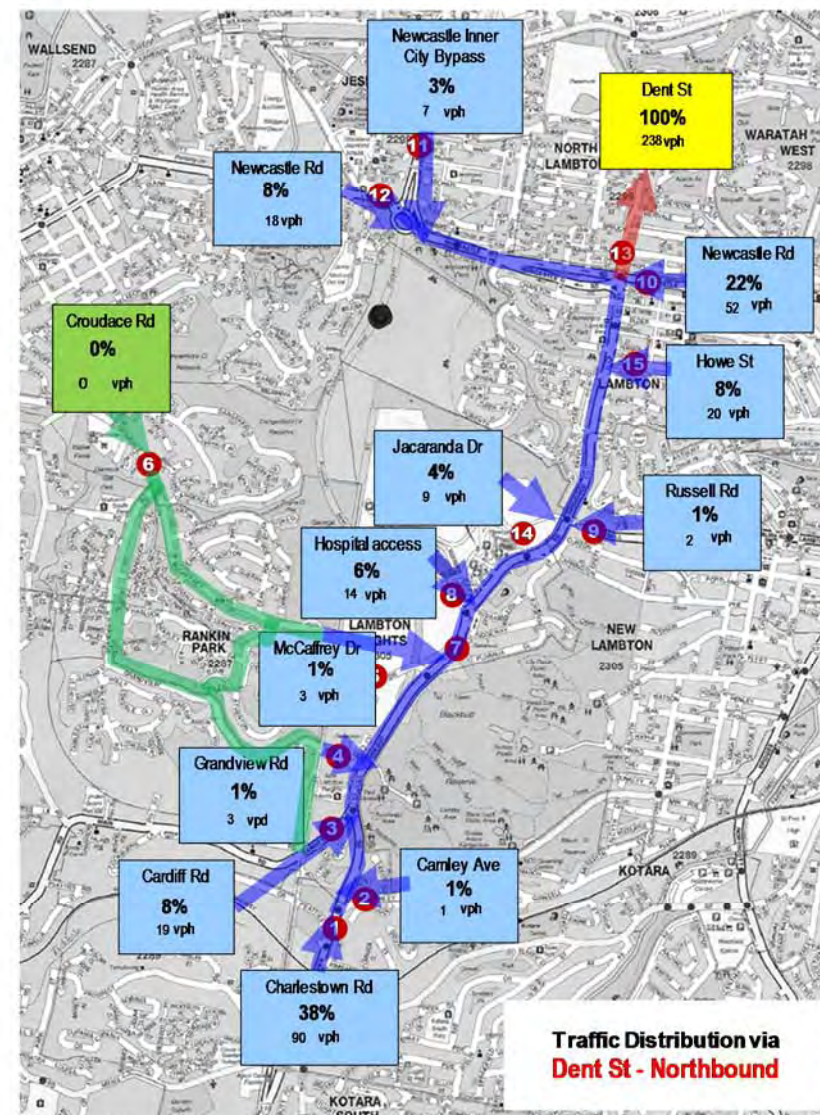
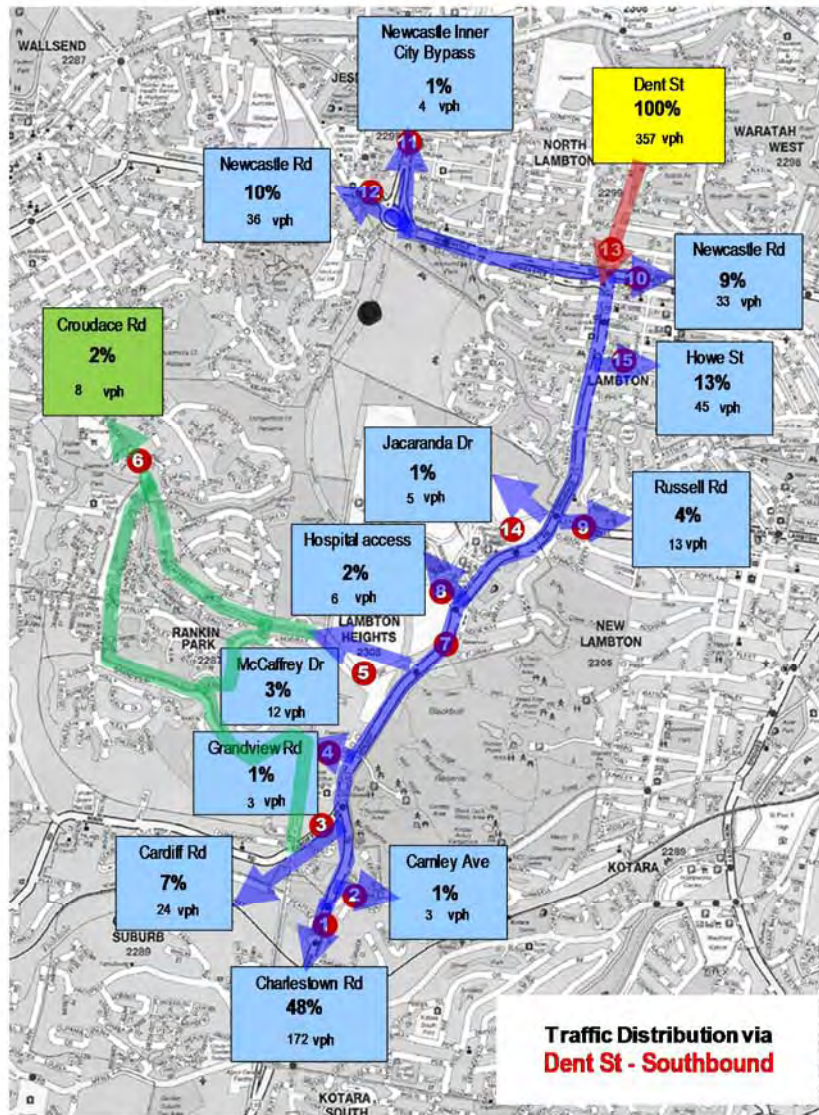
RP2J - PM1H Traffic Distribution via 12. Newcastle Road - West of Newcastle Inner City Bypass



File location: F:\AA006517\Vari4_RP2J&M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_PM

Figure A5 May 2015 OD Analysis Results – PM Peak

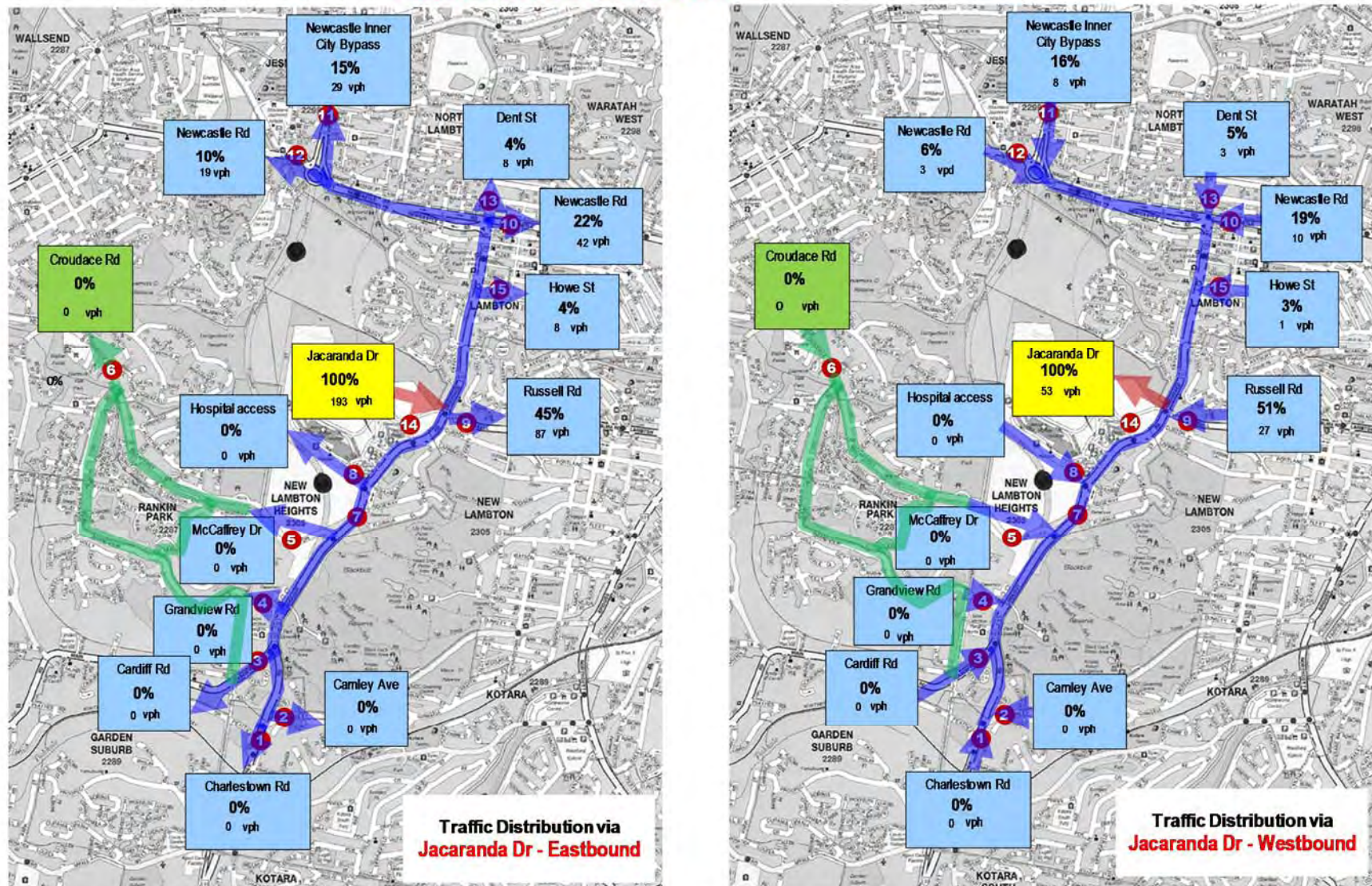
RP2J - PM1H Traffic Distribution via 13. Dent Street - North of Newcastle Road



File location: F:\aa006517\Vari4_RP2J&M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_PM

Figure A5 May 2015 OD Analysis Results – PM Peak

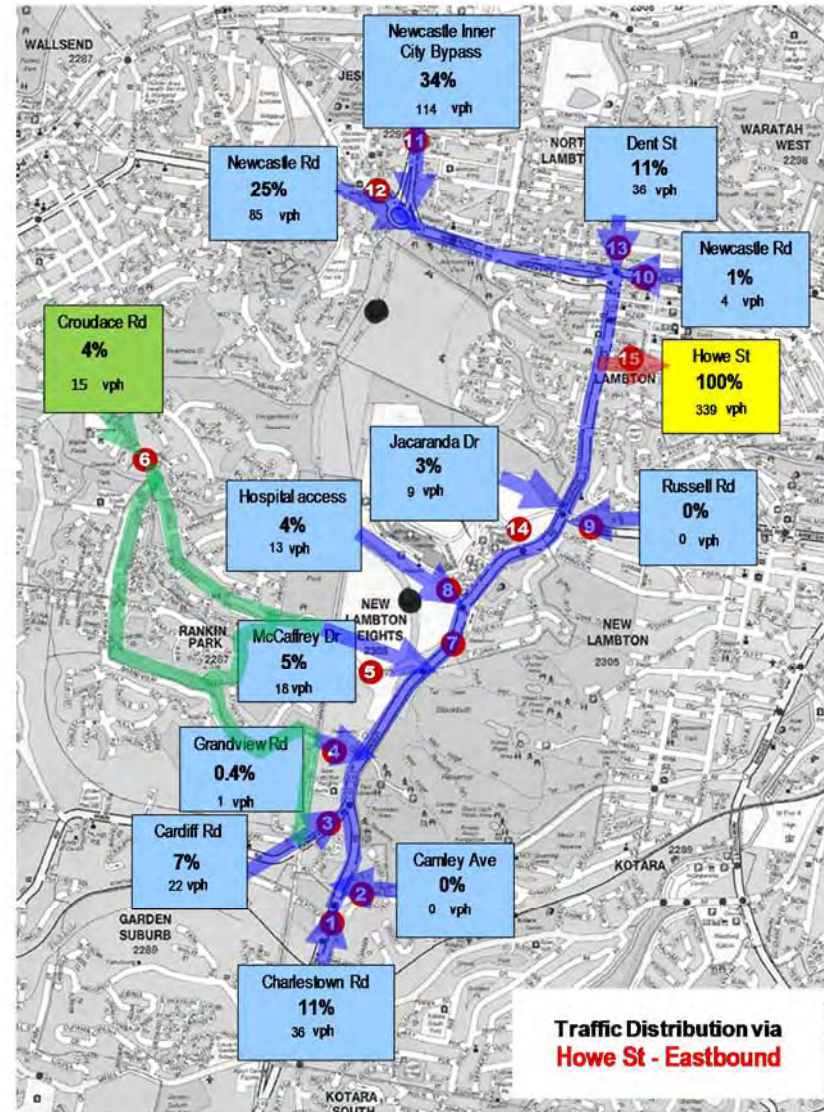
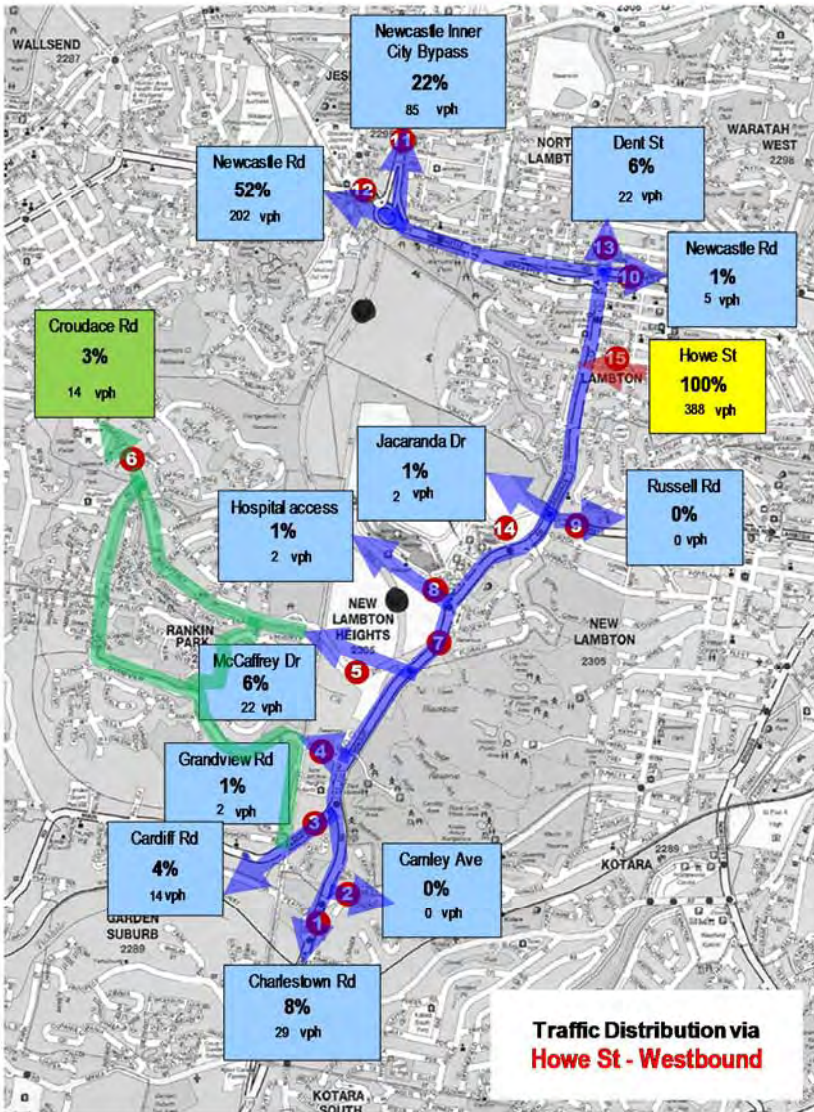
RP2J - PM1H Traffic Distribution via 14. Jacaranda Drive - JHH access



File location: F:\AA006517\Vari4_RP2J&M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_PM

Figure A5 May 2015 OD Analysis Results – PM Peak

RP2J - PM1H Traffic Distribution via 15. Howe St - East of Croudace Street



File location: F:\AA006517\Vari4_RP2J&M12RT\Calculations\New OD Survey Analysis_May2015\New OD_May2015\RP2J SelectLink_May2015_C2_PM

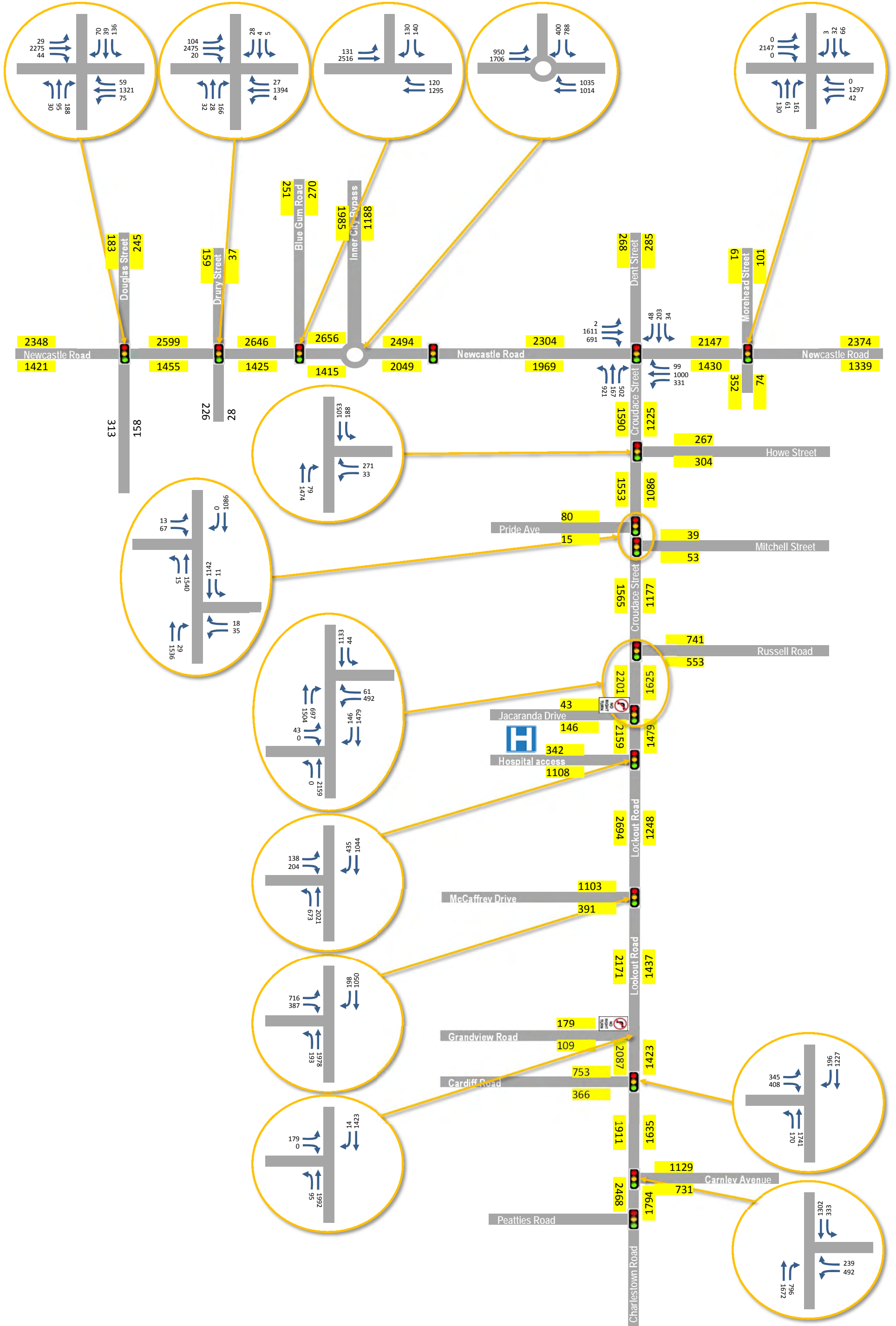
Figure A5 May 2015 OD Analysis Results – PM Peak

2.3 Intersection Movement Counts

Following figures graphically present existing AM peak one hour and PM peak one hour turning volumes.

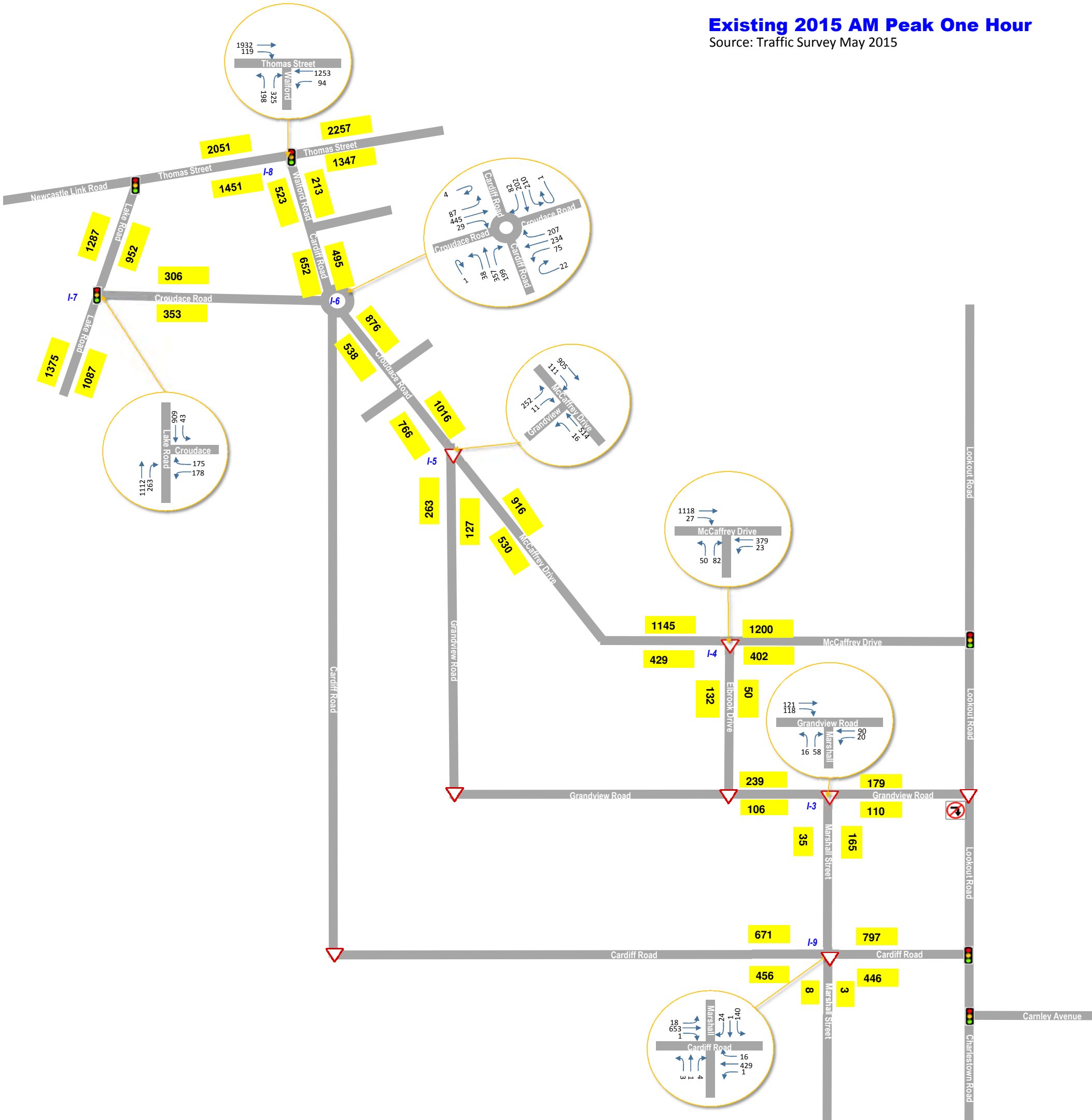
Existing 2014 AM Peak One Hour

Source: Traffic Survey May and June 2014

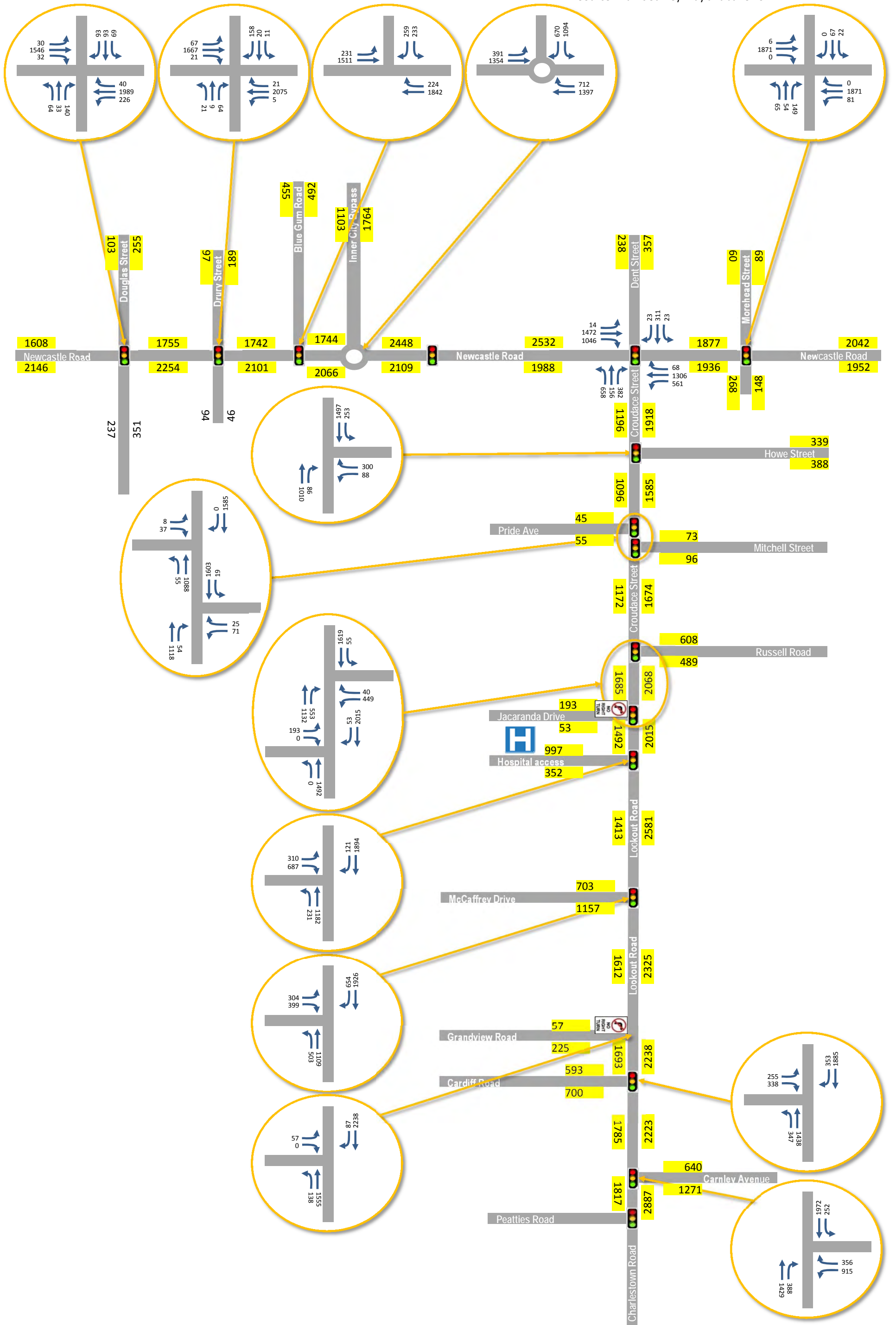


Existing 2015 AM Peak One Hour

Source: Traffic Survey May 2015

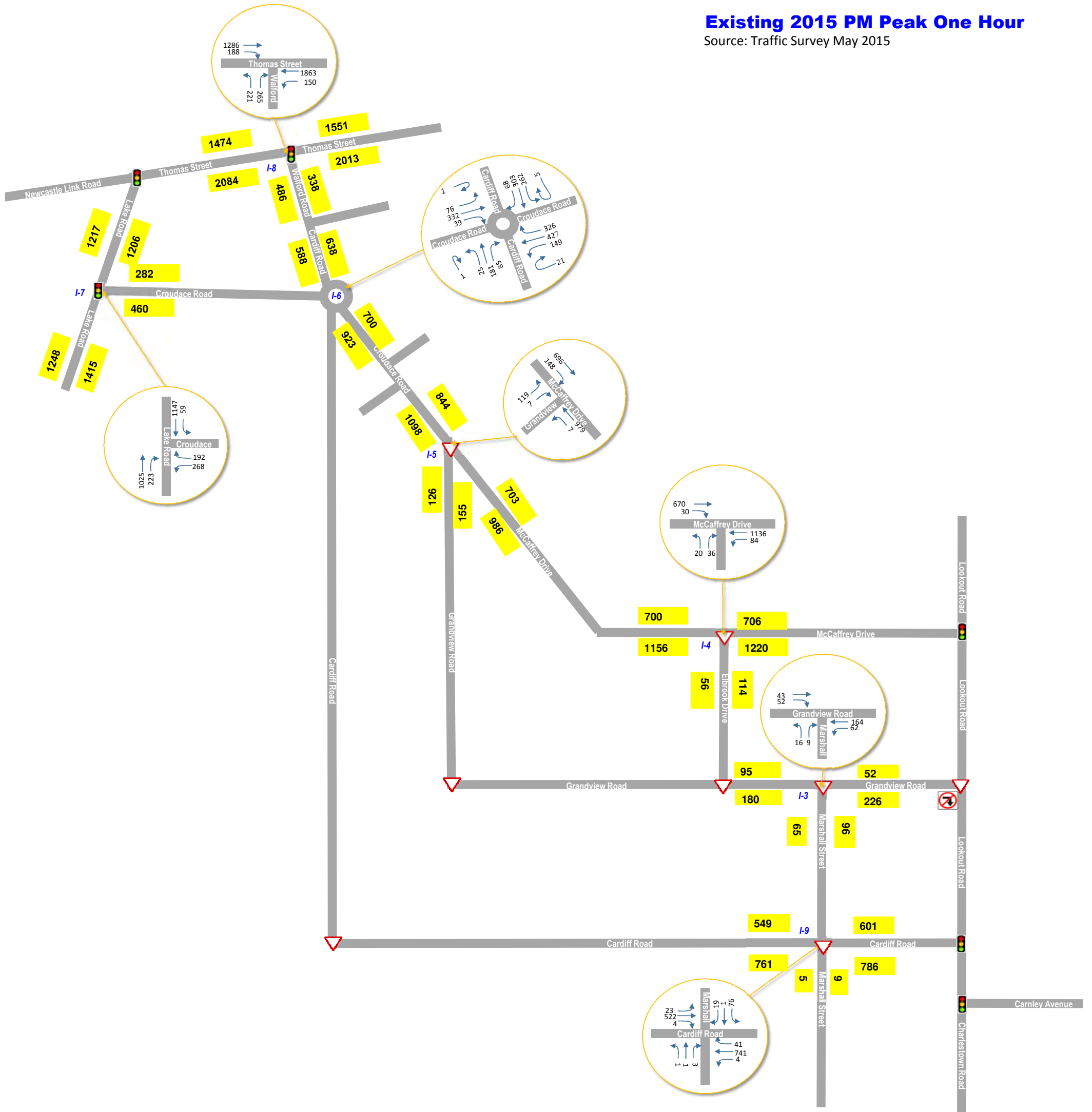


Existing 2014 PM Peak One Hour
 Source: Traffic Survey May and June 2014



Existing 2015 PM Peak One Hour

Source: Traffic Survey May 2015



APPENDIX B

LHTM UPDATES

Appendix B – LHTM OD Traffic Distribution Updates

1 LHTM Updates Using October 2014 Survey Data

The October 2014 survey data set was used to refine LHTM for the study area. Figure B1 below show 10 OD survey locations investigated. Table 1 compares 2014 traffic distributions at 10 OD survey locations compared with October 2014 surveyed daily traffic data.

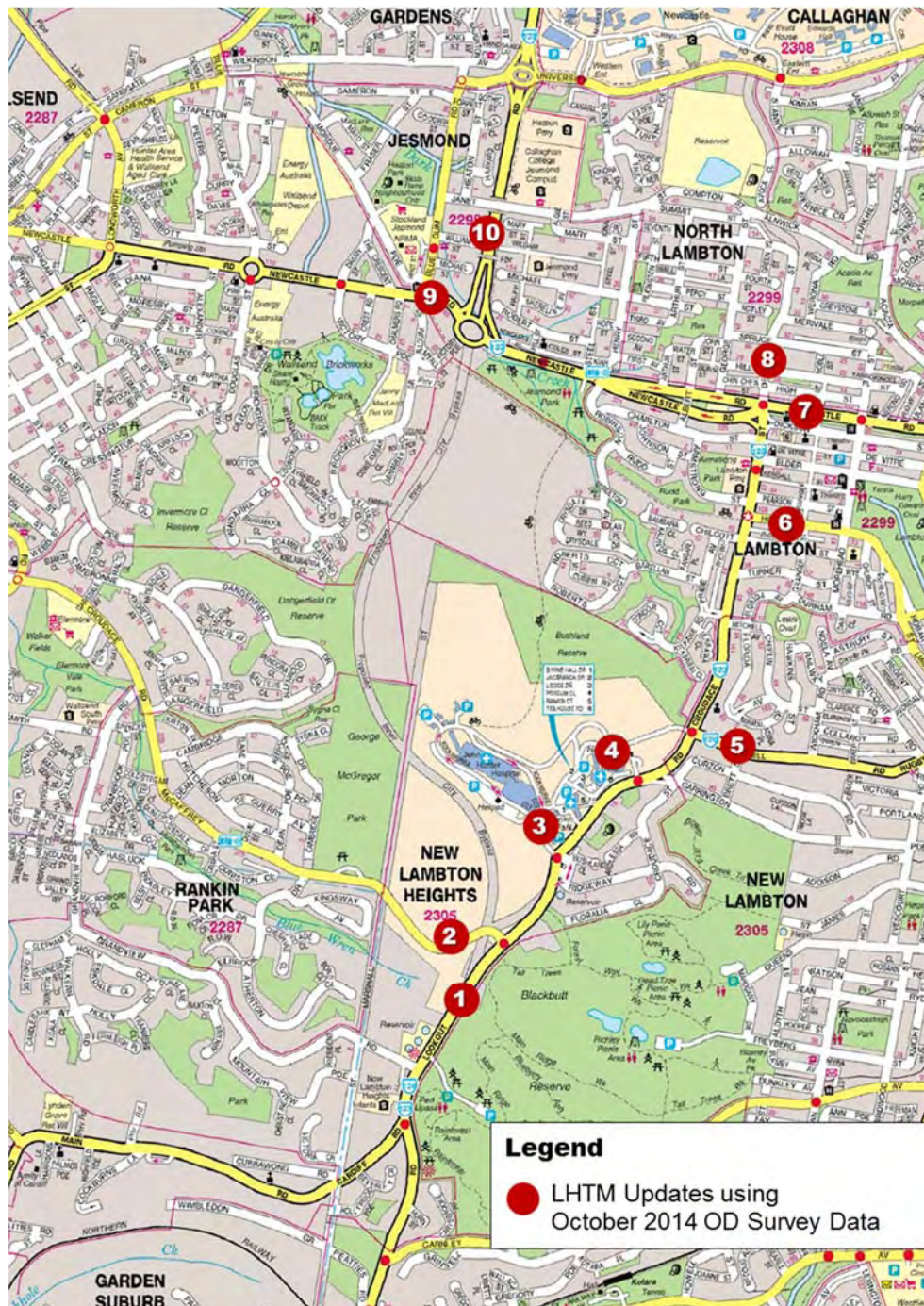


Figure B1 October 2014 OD Survey Data using in LHTM Updates

Table B1 LHTM Updates using October 2014 OD Survey Data (see Figure B1 for Station Locations)

Station ID	To/From	Two-way distribution		Station ID	To/From	Two-way distribution		Station ID	To/From	Two-way distribution		Station ID	To/From	Two-way distribution		Station ID	To/From	Two-way distribution	
		Observed	Modelled			Observed	Modelled			Observed	Modelled			Observed	Modelled			Observed	Modelled
1	1			2	1	52%	51%	3	1	44%	45%	4	1	0%	1%	5	1	40%	42%
	2	21%	21%		2		2		20%	20%	2		0%	2%	2		34%	34%	
	3	14%	14%		3	16%	16%		3				3	0%	1%		3	14%	15%
	4	0%	0%		4	0%	0%		4	0%	0%		4				4	6%	0%
	5	12%	12%		5	25%	27%		5	13%	14%		5	45%	46%		5		
	6	2%	2%		6	1%	2%		6	1%	1%		6	2%	1%		6	0%	0%
	7	18%	20%		7	4%	4%		7	8%	7%		7	22%	23%		7	0%	1%
	8	4%	3%		8	0%	0%		8	1%	1%		8	3%	1%		8	0%	1%
	9	5%	6%		9	0%	0%		9	5%	4%		9	8%	8%		9	3%	3%
	10	23%	22%		10	0%	0%		10	7%	7%		10	19%	19%		10	2%	4%
Total	100%	100%	Total	100%	100%	Total	100%	100%	Total	100%	100%	Total	100%	100%	Total	100%	100%		
6	1	13%	11%	7	1	20%	20%	8	1	51%	46%	9	1	6%	6%	10	1	29%	27%
	2	4%	4%		2	2%	2%		2	2%	1%		2	0%	0%		2	0%	0%
	3	2%	1%		3	3%	3%		3	4%	3%		3	2%	1%		3	3%	3%
	4	0%	0%		4	1%	0%		4	2%	0%		4	0%	0%		4	1%	0%
	5	0%	1%		5	0%	0%		5	1%	2%		5	1%	1%		5	1%	2%
	6				6	0%	0%		6	10%	12%		6	6%	7%		6	5%	8%
	7	2%	0%		7				7	20%	23%		7	50%	54%		7	18%	19%
	8	6%	7%		8	2%	3%		8				8	1%	1%		8	0%	0%
	9	41%	41%		9	55%	57%		9	8%	9%		9				9	43%	41%
	10	31%	35%		10	17%	16%		10	2%	3%		10	35%	31%		10		
Total	100%	100%	Total	100%	100%	Total	100%	100%	Total	100%	100%	Total	100%	100%	Total	100%	100%		

1. Lookout Road, south of McCaffrey Drive
2. McCaffrey Drive, west of Lookout Road
3. Kookaburra Circuit, west of Lookout Road (hospital access)
4. Jacaranda Drive, west of Lookout Road (hospital access)
5. Russell Road, west of Brett Street
6. Howe Street, west of Grainger Street
7. Newcastle Road, east of Croudace Street
8. Dent Street, north of Newcastle Road
9. Newcastle Road - west of Inner City Bypass
10. Inner City Bypass, north of Newcastle Road

2 LHTM Updates Using May 2015 Survey Data

The May 2015 survey data was used to further refine the model for southern section between McCaffrey Drive and Carnley Avenue. Figure B2 below show 15 OD surveys and mid-block traffic counts locations investigated in May 2015 survey.

Table B2 summarises further model update results for southern section between McCaffrey Drive and Carnley Avenue (ID1 to ID 7 in Figure B2). The modelled 2014 traffic distributions at key OD stations are compared with May 2015 surveyed traffic distribution. Traffic distributions for the northern section (ID 8 to ID 15 in Figure B2) remain unchanged.

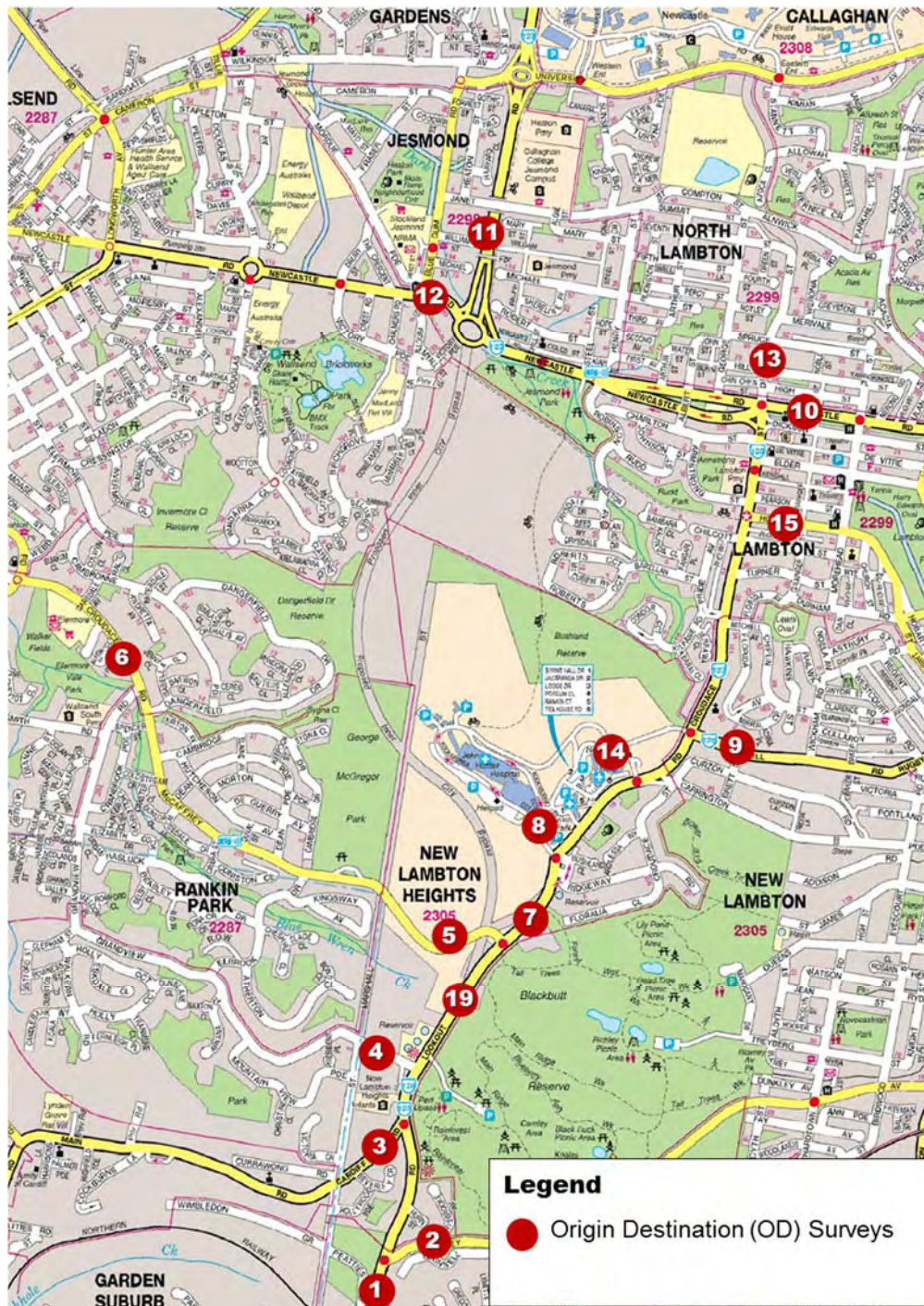


Figure B2 The 15 OD Surveyed Locations Investigated

Table B2 LHTM Updates using May 2015 OD Survey Data (see Figure B2 for Station Locations)

Station ID	To/From	Two-way distribution		Station ID	To/From	Two-way distribution		Station ID	To/From	Two-way distribution		Station ID	To/From	Two-way distribution	
		Observed	Modelled			Observed	Modelled			Observed	Modelled			Observed	Modelled
1	1			2	1	72%	71%	3	1	27%	27%	4	1	17%	17%
	2	30%	28%		2				2	23%	24%		2	11%	10%
	3	7%	7%		3	15%	17%		3				3	2%	0%
	4	1%	1%		4	1%	1%		4	0%	0%		4		
	5	14%	15%		5	7%	8%		5	1%	1%		5	2%	0%
	6	14%	13%		6	7%	8%		6	0%			6	0%	0%
	8	8%	8%		8	2%	1%		8	8%	9%		8	8%	7%
	9	3%	2%		9	0%	0%		9	20%	20%		9	38%	36%
	10	11%	11%		10	0%	0%		10	13%	12%		10	11%	13%
	11	17%	16%		11	1%	1%		11	3%	2%		11	5%	8%
	12	3%	3%		12	1%	1%		12	1%	0%		12	1%	0%
	13	4%	4%		13	0%	0%		13	2%	3%		13	2%	3%
	14	0%	0%		14	0%	0%		14	0%	0%		14	0%	0%
	15	1%	1%		15	0%	0%		15	2%	2%		15	3%	1%

Station ID	To/From	Two-way distribution		Station ID	To/From	Two-way distribution		Station ID	To/From	Two-way distribution	
		Observed	Modelled			Observed	Modelled			Observed	Modelled
5	1	37%	35%	6	1	44%	34%	7	1	54%	56%
	2	8%	9%		2	8%	8%		2	2%	1%
	3	0%	0%		3	0%	0%		3	16%	15%
	4	0%	0%		4	0%	0%		4	3%	4%
	5				5	0%	89%		5	25%	23%
	6	0%	91%		6				6	0%	20%
	8	19%	19%		8	19%	19%		7		
	9	28%	27%		9	22%	22%				
	10	5%	6%		10	3%	3%				
	11	1%	0%		11	0%	0%				
	12	0%	0%		12	1%	0%				
	13	1%	0%		13	0%	0%				
	14	0%	0%		14	0%	0%				
	15	2%	2%		15	2%	1%				

1. Charlestown Road, south of Cardiff Road
2. Carnley Avenue, east of Charlestown Road
3. Cardiff Road, west of Lookout Road
4. Grandview Road, west of Lookout Road
5. McCaffrey Drive, west of Lookout Road
6. Croudace Road, west of Grandview Road
7. Lookout Road, north of McCaffrey Drive