PENANG SMART MOBILITY MICRO-SIMULATION MODEL DEVELOPMENT

SURVEY REPORT

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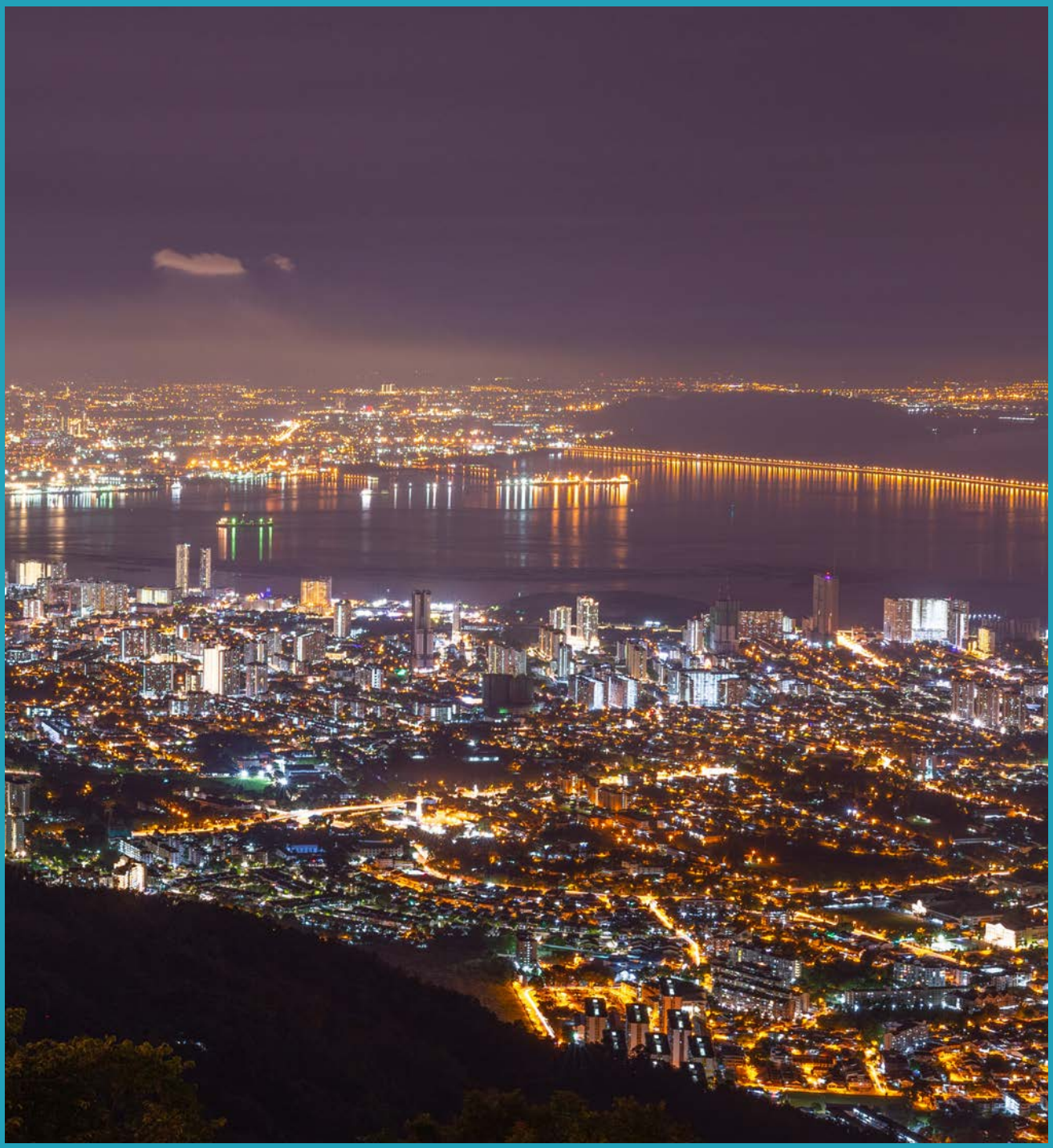

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1.1 BACKGROUND

Ramboll has been engaged through the ASEAN Australia Smart Cities Trust Fund (AASCTF) to conduct a Pilot Project for Penang. This Pilot Project intervention involves the development of a Transport Micro-Simulation Model of the historical centre of Georgetown that can be used to assess future mobility interventions such as public transport, traffic improvements, pedestrianization and cycling improvements.

This Pilot Project involves the development and calibration of the micro-simulation model using PTV Vissim software and testing of a limited set of potential future interventions for Georgetown, as well as training of Digital Penang / MBPP staff in the use of PTV Vissim.

This report outlines the project survey details including survey methodologies and results. Traffic surveys included video Traffic Count surveys, Parking Surveys, and Origin-Destination surveys.

Survey results will be used in the development and calibration of the micro-simulation model to provide an accurate representation of the transportation environment in Georgetown.

1.2 SURVEY OBJECTIVES

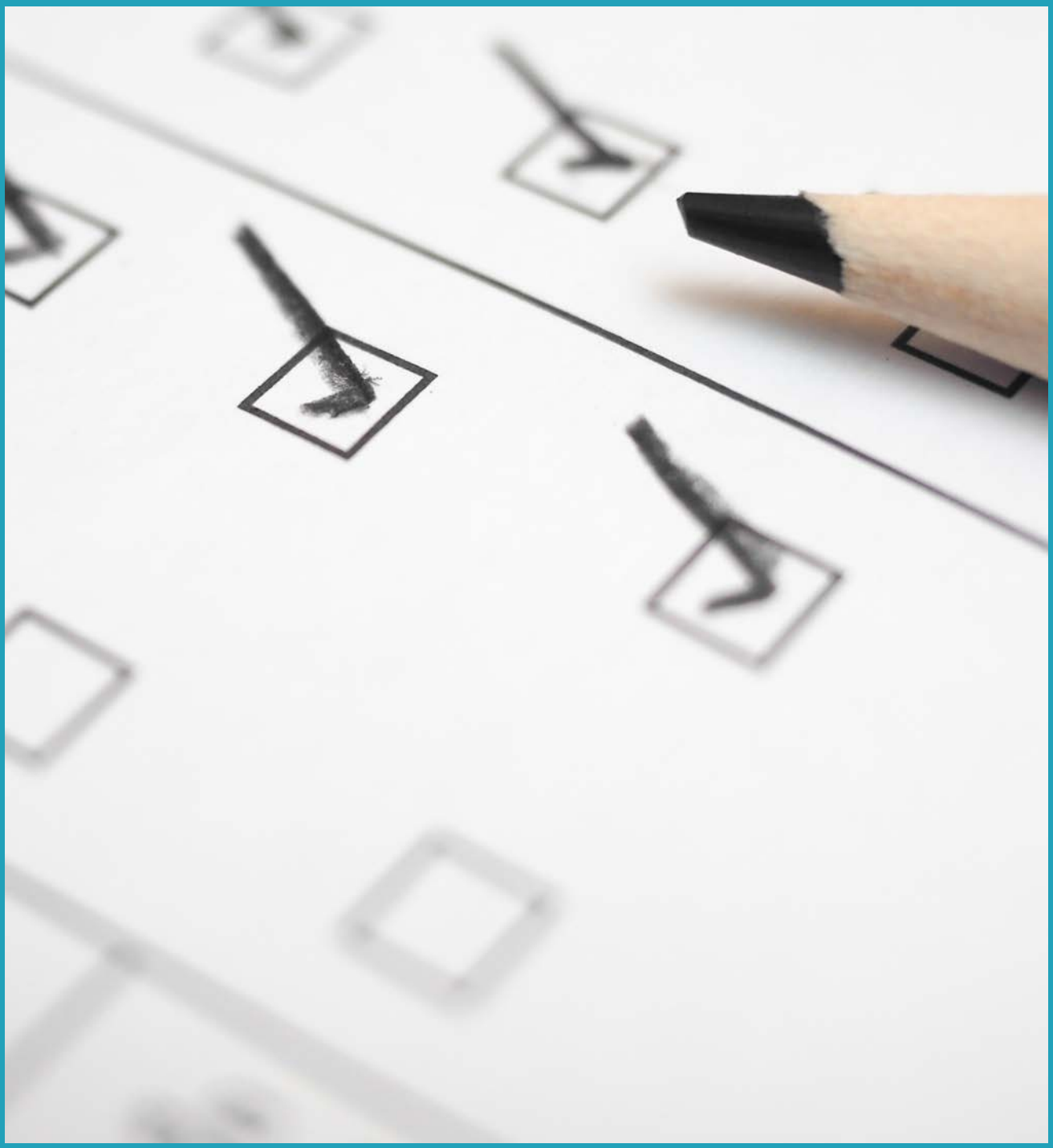
Surveys proposed for this project are intended to establish solid ground for traffic planning and simulation works ahead. Quality survey data is vital to ensure the traffic analysis is based on the real-world situation and reflect what is happening on-site accurately. In order to do this, a detailed survey plan has been proposed and carried out by Ramboll with information presented in the chapters below.

1.3 ORGANISATION OF REPORT

Following this introduction, the report is structured as follows:

- Chapter 2 provides an overview of the survey methodology, including the methodologies for traffic surveys, parking surveys and origin-destination data survey,
- Chapter 3 presents the results from traffic surveys which contains results in classified vehicle count, unclassified pedestrian / cyclist count and junction layout and signal surveys,
- Chapter 4 contains the results from parking surveys including on-street parking occupancy, off-street parking occupancy, and parking dwell time survey,
- Chapter 5 includes the results from origin-destination data survey, including unit matrix and result matrices from the survey,
- Chapter 6 describes how the survey data were utilised from on-site results to model inputs of this study, and
- Chapter 7 provides the next steps of the study.

SURVEY METHODOLOGY



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This chapter outlines the survey methodology for data collection needed to develop the micro-simulation model. On-site traffic surveys have been undertaken in November 2021 by the project sub-contractor, Fox Traffic Sdn. Bhd. In the meantime, the origin-destination data was collected from GPS data provider TomTom for the same duration of the on-site data extraction.

2.1 SURVEY INTRODUCTION

To develop a representative simulation of transportation in Georgetown for this study, accurate and comprehensive multi-modal transport data is required to be collected across the network with a combination of on-site video capture and remote GPS data collection.

Survey data came from two sources for this project, namely video traffic surveys and GPS data collection. On-site video traffic surveys allow us to capture an accurate and highly detailed snapshot of traffic movement around every junction and parking area, disaggregated across each peak period. GPS data collection gives us a 'birds eye view' of movement across the network, aggregated into weeks or months of travel patterns, travel times and speeds across a collective group of user experiences. Bringing these two data sources together gives us an accurate picture of transport patterns to develop and calibrate a simulation model that is representative of on-site conditions.

The following sections describe the details of survey methodology for each type of survey.

2.2 TRAFFIC SURVEYS

For video-based traffic surveys, classified movement counts were conducted during peak morning periods (7:00am to 10:00am) and peak afternoon/evening periods (4:30pm to 7:30pm) for the following dates:

- 9 November 2021 (Tuesday),
- 10 November 2021 (Wednesday), and
- 11 November 2021 (Thursday)

'Classified' refers to counting separately the different vehicle classes including motorbikes, cars, light goods vehicles, heavy goods vehicles, buses etc. The following sections outline the survey specifications for this study.

2.2.1 CLASSIFIED VEHICLE COUNT SURVEYS

The specifications for the classified vehicle count survey are shown in Table 1. All junction surveys were disaggregated into the various classifications for each turning movement at the junction separately.

Table 1: Classified Vehicle Count Survey Specifications

Item	Specifications
Survey Locations	Junctions shown in Figure 1
Survey Classifications	Cars, Taxis, Motorcycles, Light Goods Vehicles & Small Vans, Heavy Goods Vehicles with 3 axles and above, Buses
Aggregation	All counts to be in 15-minute intervals
Queues	Maximum observed queue lengths should be recorded for each junction approach in 15-minute intervals
Signal Phase and Timings	Junction signal phase and timings should be taken from video recordings of the signal for a minimum of continuous 15 minutes in each one-hour of junction survey. Recorded signal phases, timings and videos are required to be submitted.
Survey Days	9 November 2021 (Tuesday), 10 November 2021 (Wednesday), and 11 November 2021 (Thursday);
Survey Time Periods	07:00 – 10:00 and 16:30 – 19:30

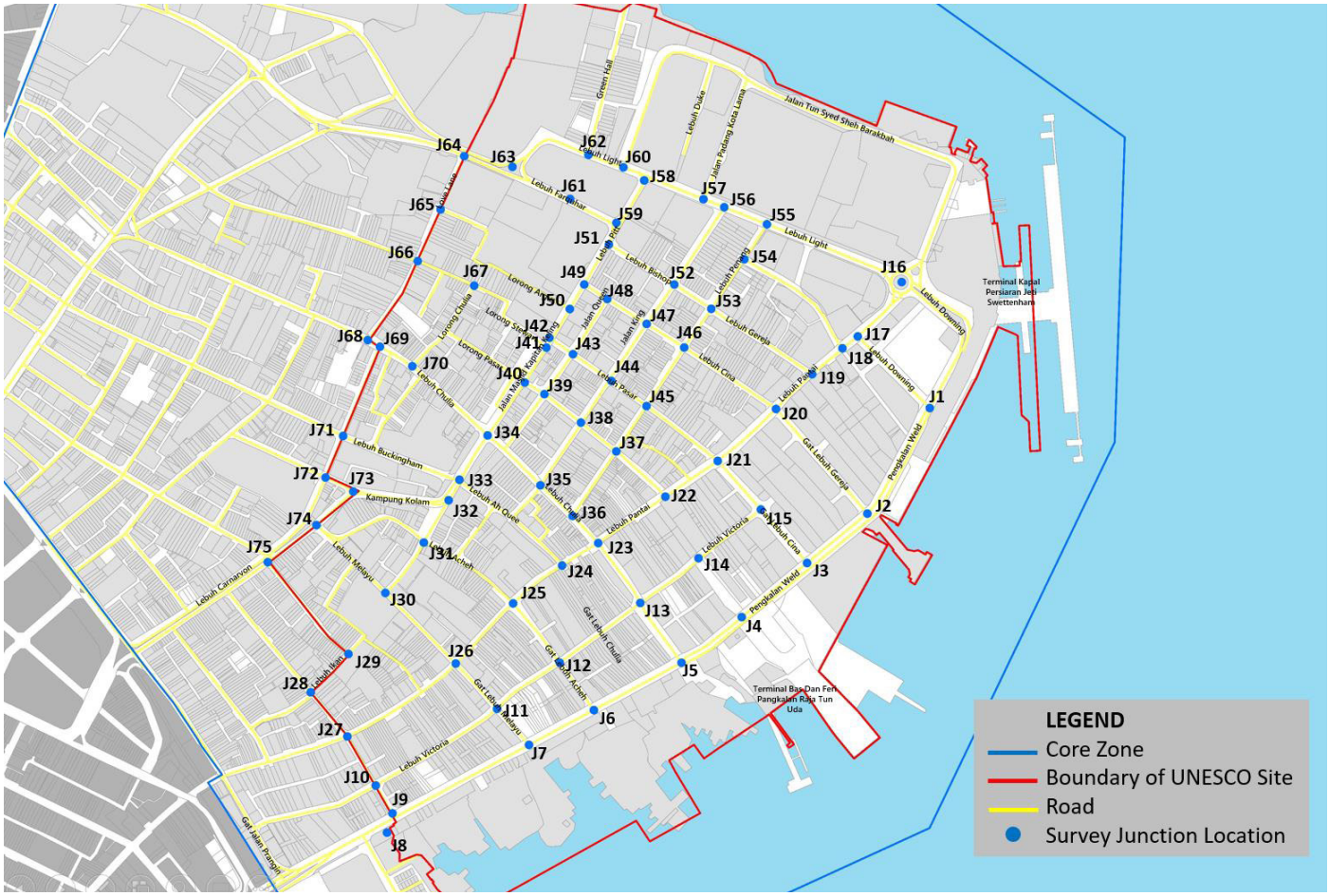


Figure 1: Classified Vehicle Count Survey Junctions

The survey has been carried out from 9 November 2021 to 11 November 2021. It is observed that during this week traffic volume has picked up following the ending of MCO* period in Penang state.

*MCO refers to Movement Control Order, a directive from the Malaysian central government restricting movement of persons within or between states to limit the spread of Covid-19.

2.2.2 UNCLASSIFIED PEDESTRIAN / CYCLIST COUNT SURVEYS

During the same date and time duration of vehicle count survey, number of pedestrians and cyclists crossing the identified junctions was also surveyed to provide a comprehensive picture of the pedestrian and cyclist demand throughout the study area.

Pedestrian and cyclists were recorded at crossing points throughout the road network when they were crossing the street. The number for pedestrians and cyclists is unclassified, which means the results are in single combined class without further differentiation of user profiles (such as students, elderly, etc.). This approach was selected as it provide sufficient basis to evaluate the impact of pedestrian and cyclist movement to an overall traffic network, which suits the purpose of this report.

Further details of the unclassified pedestrian / cyclist survey are presented in Table 2 and Figure 2.

Table 2: Unclassified Pedestrian / Cyclist Count Survey Specifications

Item	Specifications
Survey Locations	Pedestrians and cyclists crossing each arm of junctions shown in Figure 2
Survey Classifications	Single Class
Aggregation	All counts to be in 15-minute intervals
Survey Days	9 November 2021 (Tuesday), 10 November 2021 (Wednesday), and 11 November 2021 (Thursday);
Survey Time Periods	07:00 – 10:00 and 16:30 – 19:30

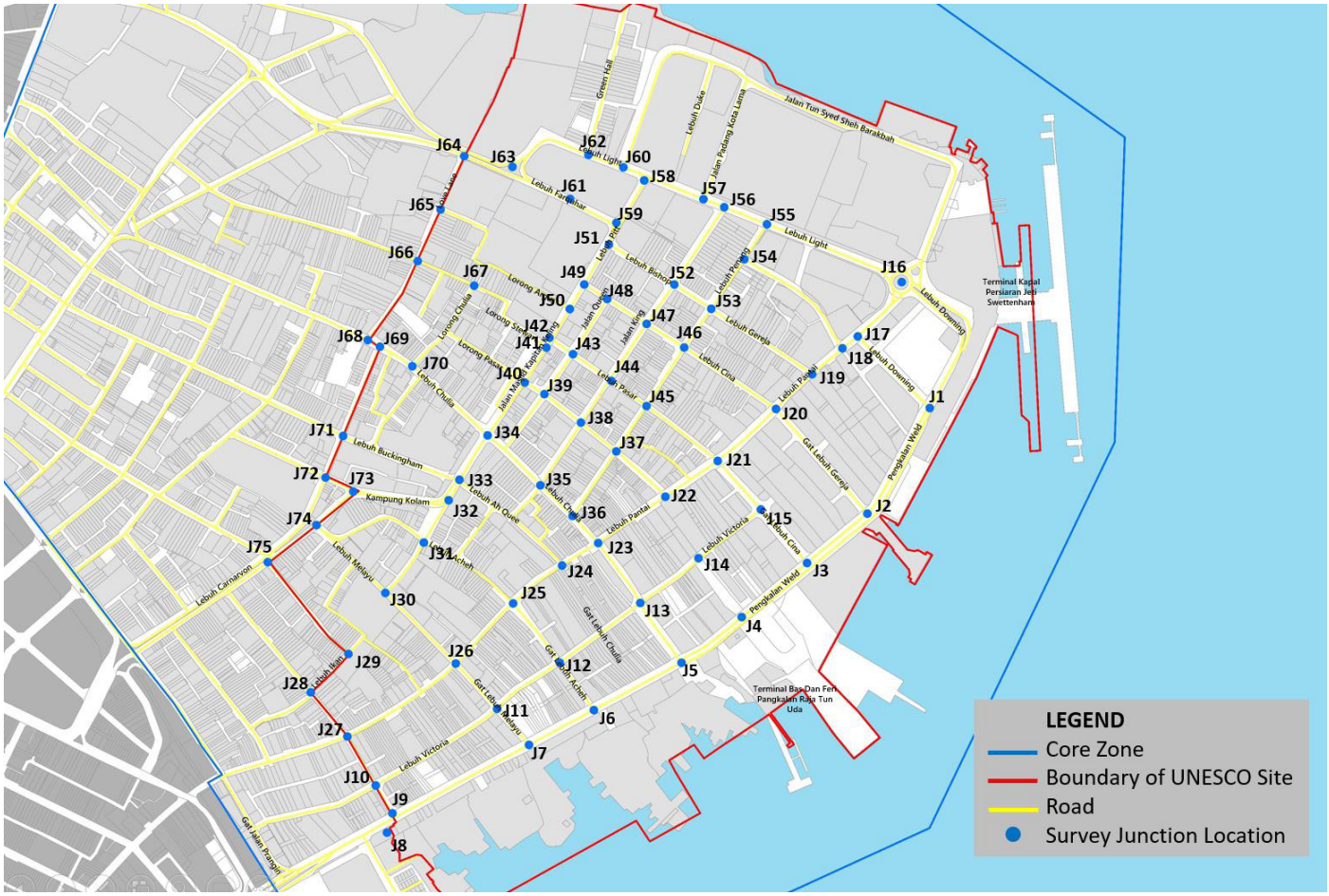


Figure 2: Unclassified Pedestrian / Cyclist Count Survey Junctions

2.2.3 JUNCTION LAYOUT AND SIGNAL SURVEYS

For traffic analysis and modeling, an accurate representation of network inventory is vital to the realistic reproduction of traffic conditions on-site.

As a part of this survey exercise, a full record inventory has been made of existing junction and road layouts, turning movements allowed or banned, traffic signal information, traffic lane configurations, bus stops, internal parking, and public transport facilities, waiting and loading restrictions, and general site layout.

Junction layout and traffic signals have been pre-collected and verified on-site with actual situation during the site works from 9 to 11 November 2021. Figure 3 shows the junction layout before on-site verification.

Figure 3: Junction Layout (Pre-collected before On-site Verification)

In addition, the junction layout and network inventory information also includes the direction of travel along roads within the study which are shown in Figure 4 below.

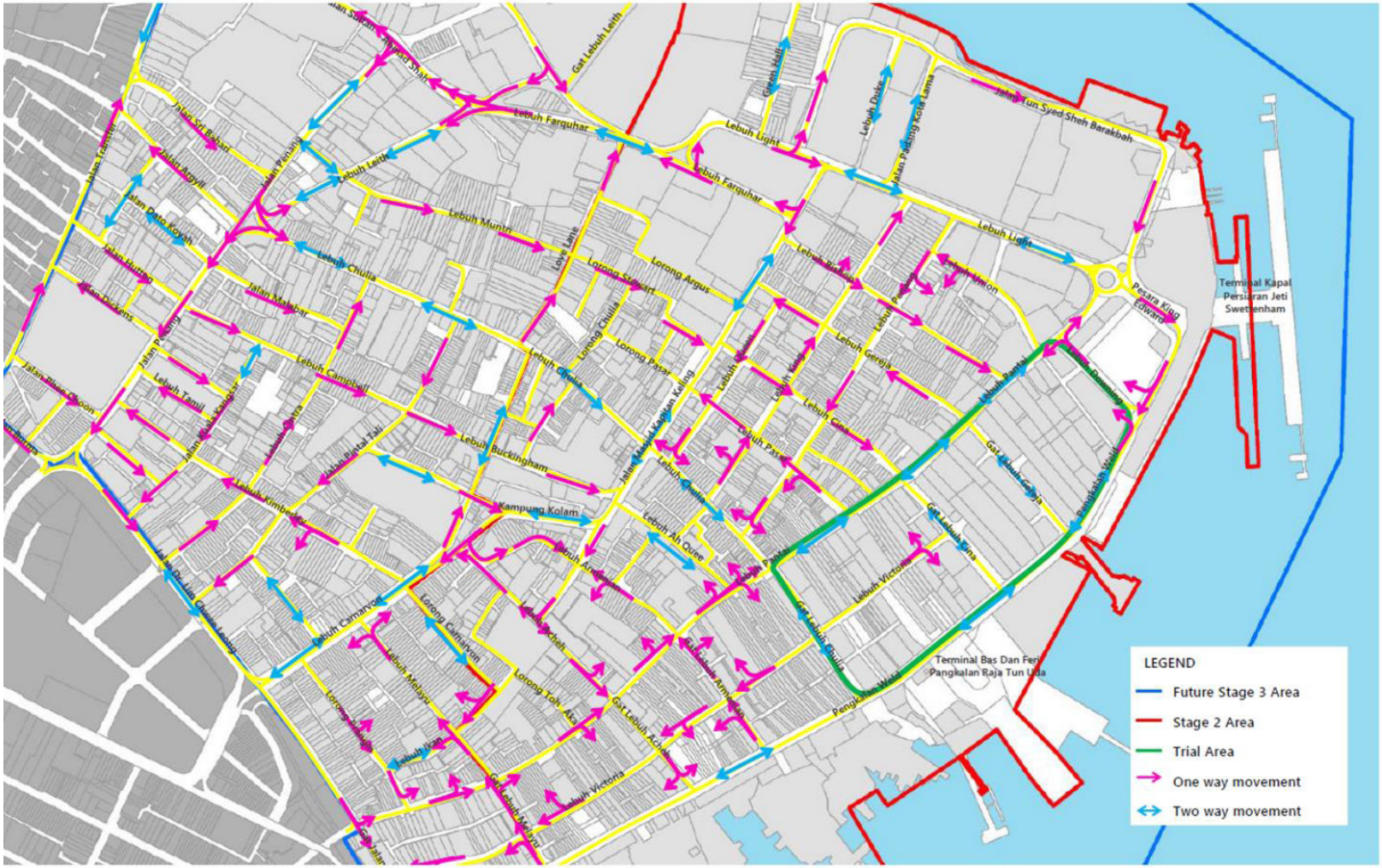


Figure 4: Road Movement Direction

Further survey results with on-site verification are presented in Chapter 3.

2.2.4 QUEUE LENGTH SURVEYS

Together with classified vehicle traffic counts as described in Section 2.2.1, queue length counts were also conducted during the site survey.

Queue length is an important indicator of junction performance in an urban traffic scenario. Vehicle queue is formed from delays at junction including geometry delays and signal delays. It is also a reflection of the reaction time drivers have toward traffic regulations.

Queue length information was collected at the locations shown in Figure 5 during the site survey.

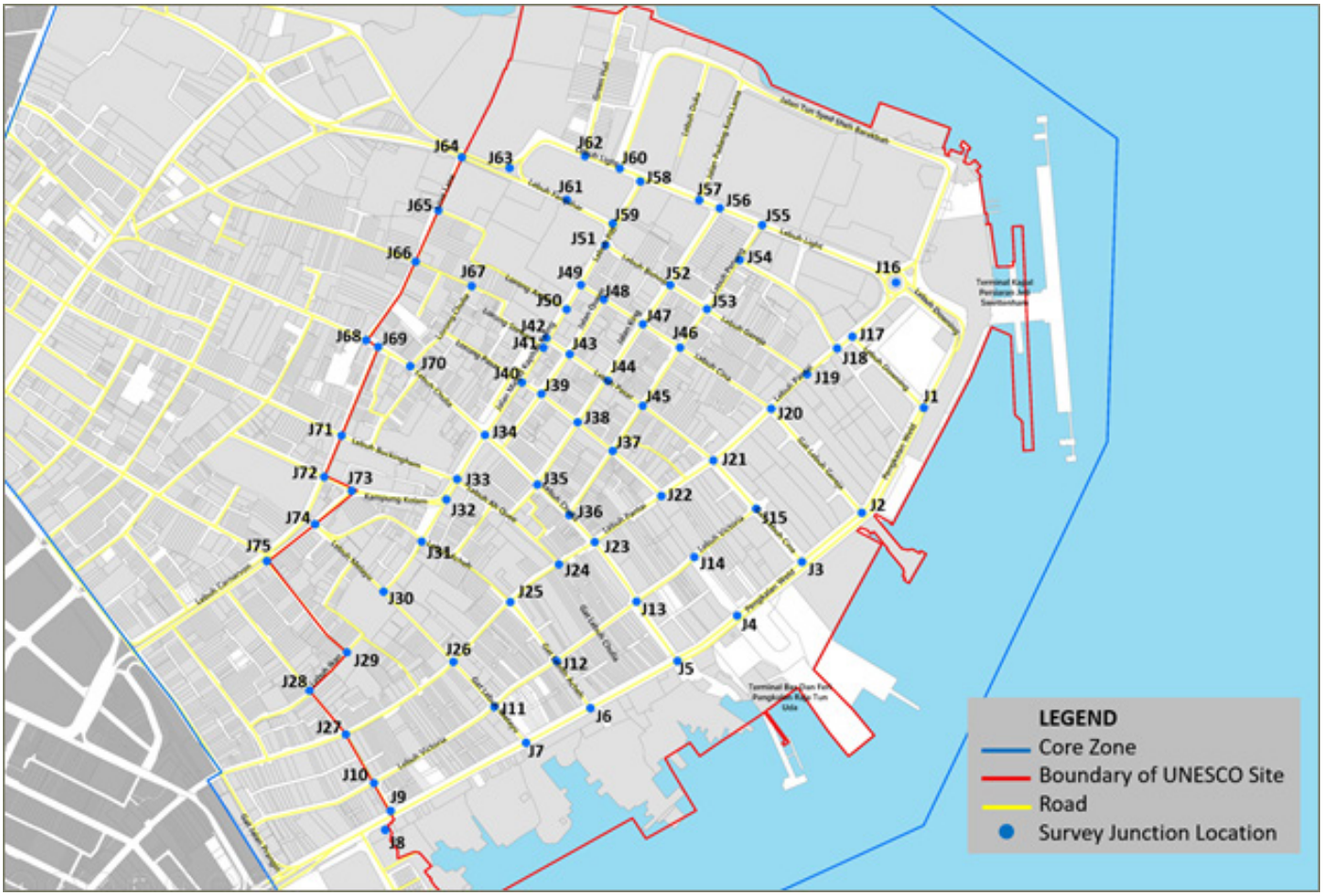


Figure 5: Queue Lenght Survey Junctions

Further survey results and their usage for site calibration were presented in Chapter 3.

2.3 PARKING SURVEYS

Parking surveys have been conducted at both on-street and off-street parking facilities. On-street parking was classified by street and midblock section. Illegal parking was also recorded. The parking surveys were meant to gain an understanding of not just traffic flowing through the historical centre of Georgetown, but also parking behavior within the study area.

For on-street parking, the following information has been captured:

A. On-street Photos by survey team: Car Park Occupancy by one-hour segments of all on-street parking across the survey period.
B. On-street video surveys: Sampled arrival/departure counts and parking dwell time, by vehicle classification, at selected locations, for a period of 15 minutes within each one-hour survey period.

The following figure identifies the on-street (yellow) parking areas included within the parking occupancy survey (A). Selected locations for on-street parking arrival, departure, dwell time survey (B) are also indicated in purple boxes in Figure 6.

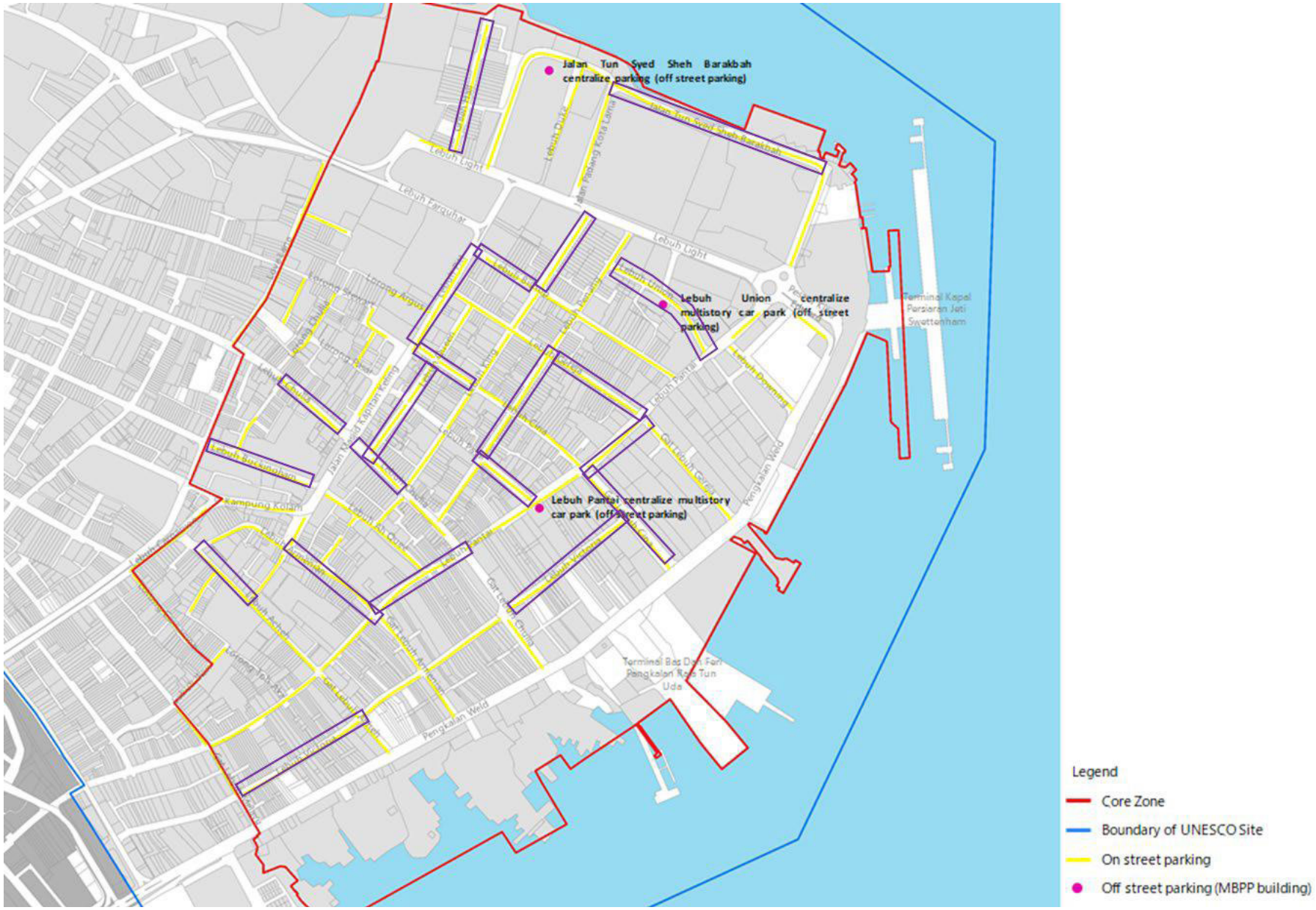


Figure 6: On-street Parking Survey Locations

Parking surveys have been conducted in conjunction with the surrounding junction surveys.

For off-street parking, the following information was collected:

A. Through video recording: Arrival and departure counts, by vehicle classification
B. Car Park Occupancy across the survey period

Figure 7 identifies the off-street parking areas marked in pink points that are to be included within the parking occupancy survey.

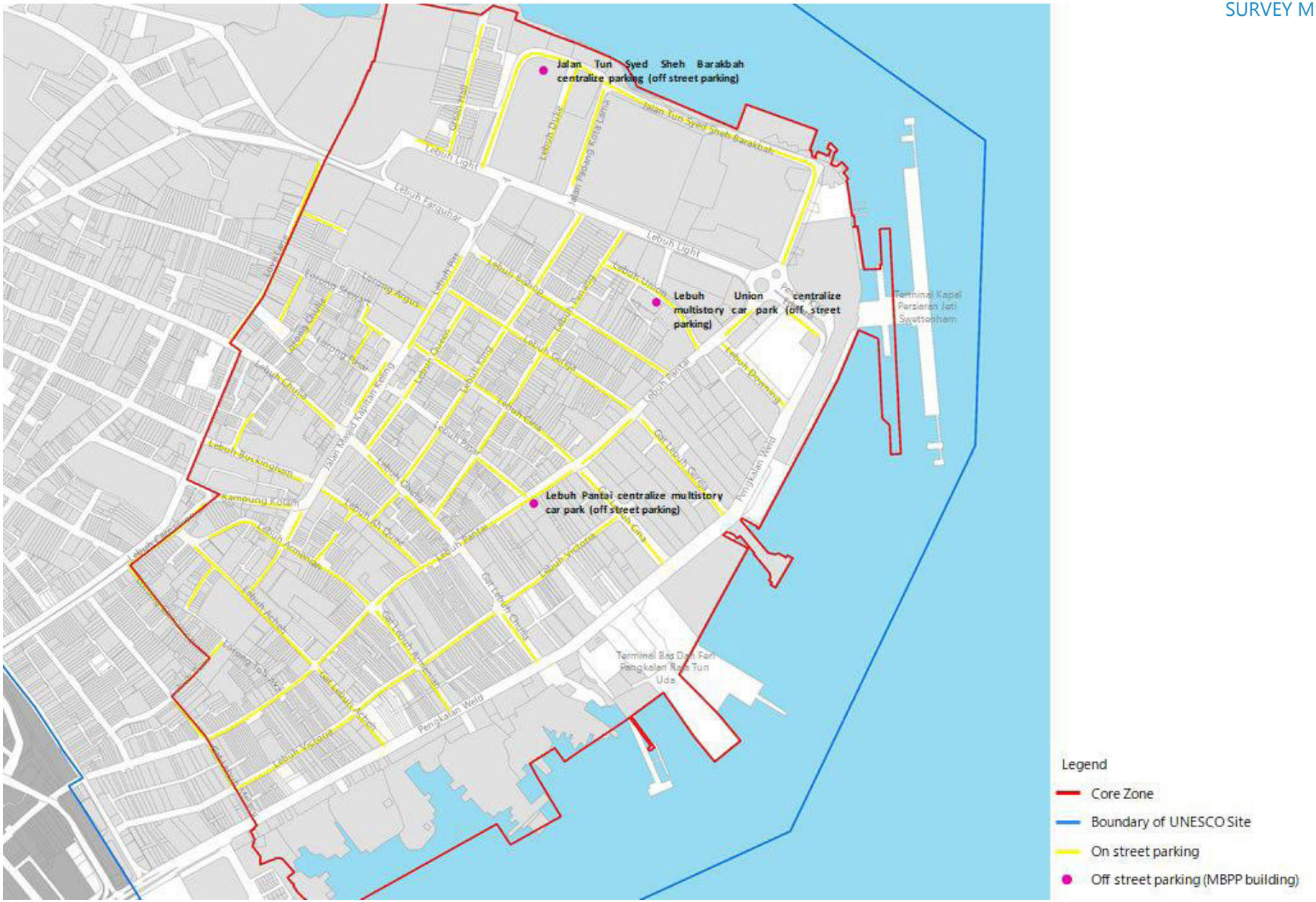


Figure 7: Off-street Parking Survey Locations

Further survey results from parking surveys are presented in Chapter 4.

2.4 ORIGIN-DESTINATION DATA SURVEY

GPS data collected for this study refers to historic data and real time data within the road network based on GPS location of vehicles on-site. This data was collected and aggregated by GPS navigation provider TomTom. There are two types of GPS data to be used for this study, which are travel pattern data and speed data.

Using travel pattern data, in-depth information about the distribution of the motorized traffic from various locations can be extracted to calibrate the transport models and simulations, and to better understand travel patterns.

Through speed data, bottleneck analysis of the road network can be assessed to identify significant speed reductions during peak hours, and to identify potential traffic safety issues.

The GPS data acquired to develop and calibrate the micro-simulation model includes the following components:

- Origin-destination travel pattern data; and
- Travel time and speed data

2.4.1 ORIGIN-DESTINATION TRAVEL PATTERN DATA COLLECTION

Origin-Destination Travel Pattern Data can be used to approximate the travel patterns within the model area for more accurate representation of the on-site condition. To generate this data, results from an online data platform named "TomTom O/D Analysis" was used to provide trip investigation based on a high volume of location data.

TomTom O/D Analysis uses advanced algorithms to analyze anonymized Floating Car Data (FCD) from 600+ million connected devices – providing the project with the authoritative view of what's happening on the road. TomTom gathers real-time FCD by combining measurements of existing infrastructure with signals from anonymous TomTom connected GPS devices. TomTom also archives this data to create a historical traffic database.

All major entry and exit points to the study area were used for collection of origin-destination travel pattern data for this simulation model. An example of the data collection process is shown in Figure 8.

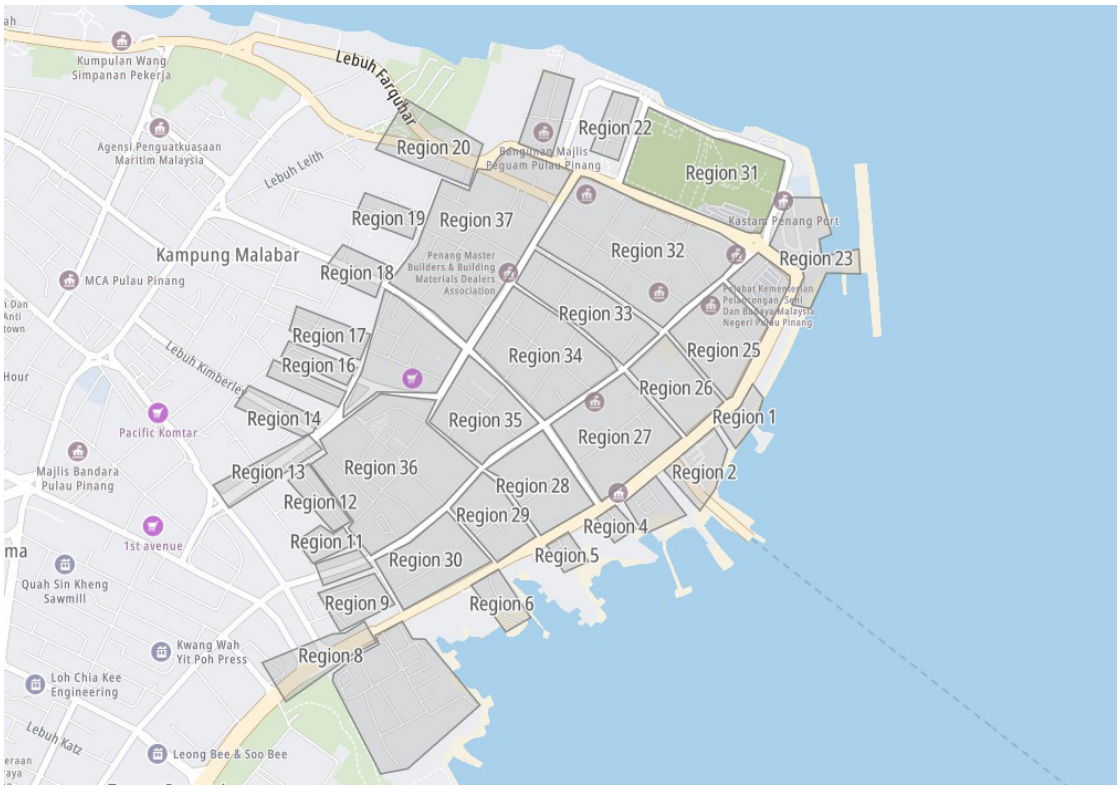


Figure 8: Example of GPS Data Collection Process

2.4.2 TRAVEL TIME & SPEED DATA COLLECTION

Travel Time & Speed Data allows the modeled results to be compared with real-life data for further model calibration. Within this data, two types of analysis are used for this study:

- Route Analysis: to define a specific route and generate average speeds, average travel times and sample size (number of vehicles that traversed a segment).
- Speed & Density Analysis: focused analysis on sample size (number of vehicles that traversed a segment), including speed and density of the sampled vehicles.

Major arterial roads within the study area were used for data collection of travel time and speed information. The travel time and speed data collection occurred at the same time as the traffic survey to ensure consistency between datasets.

Datasets were compiled to aggregate data analysed over one day.

TRAFFIC SURVEYS

Photo: Adobe Stock

3.1 SURVEY TASKS

As described in the survey methodology sections, on-site video-based traffic surveys were conducted during peak morning periods (7:00 am to 10:00 am) and peak afternoon/evening periods (4:30 pm to 7:30 pm) on 9 November 2021 (Tuesday), 10 November 2021 (Wednesday), and 11 November 2021 (Thursday). The survey aimed to produce results for the following tasks:

1. Classified vehicles count surveys
2. Unclassified pedestrian / cyclist count surveys
3. Junction layout and signal surveys

Results from each of the tasks are shown in Section 3.2.1 to Section 3.2.3 below.

3.2 SURVEY RESULTS

3.2.1 CLASSIFIED VEHICLE COUNT SURVEYS

As proposed and presented to the client, traffic counts at existing junctions were conducted to obtain the current background road network demand.

The junction traffic counts were conducted at the following seventy-five locations:

- Junction 1: Pengkalan Road/Lebuh Downing
- Junction 2: Pengkalan Road/Gat Lebuh Gereja
- Junction 3: Pengkalan Road/Gat Lebuh China
- Junction 4: Pengkalan Road/Gat Lebuh Pasar
- Junction 5: Pengkalan Road/Gat Lebuh Chulia
- Junction 6: Pengkalan Road/Gat Lebuh Armenian
- Junction 7: Pengkalan Road/Gat Lebuh Acheh
- Junction 8: Pengkalan Road/Lintasan Pengkalan 1
- Junction 9: Pengkalan Road/Gat Lebuh Melayu
- Junction10: Lebuh Victoria/ Gat Lebuh Melayu
- Junction11: Lebuh Victoria/ Gat Lebuh Acheh
- Junction12: Lebuh Victoria/ Gat Lebuh Armenian
- Junction13: Lebuh Victoria/ Gat Lebuh Chulia
- Junction14: Lebuh Victoria/ Gat Lebuh Pasar
- Junction15: Lebuh Victoria/ Gat Lebuh China
- Junction16: Lebuh Pantai/ Pesara King Edward
- Junction17: Lebuh Pantai/ Lebuh Downing
- Junction18: Beach Street/ Lebuh Union
- Junction19: Beach Street/ Bishop Street
- Junction20: Beach Street/ Gat Lebuh Gereja
- Junction21: Beach Street/ Gat Lebuh China
- Junction22: Beach Street/ Gat Lebuh Pasar
- Junction23: Beach Street/ Gat Lebuh Chulia
- Junction24: Beach Street/ Lebuh Al Quee
- Junction25: Beach Street/ Gat Lebuh Armenian

- Junction26: Beach Street/ Gat Lebuh Acheh
- Junction27: Beach Street/ Gat Lebuh Melayu
- Junction28: Lorong Ikan/ Lebuh Melayu
- Junction29: Lorong Toh Aka/ Lorong Carnavon
- Junction30: Lebuh Acheh/Lebuh Cannon
- Junction31: Lebuh Acheh/Lebuh Armenian
- Junction32: Jalan Masjid Kapitan Keling/Jalan Kampung Kolam
- Junction33: Jalan Masjid Kapitan Keling/Jalan Buckingham
- Junction34: Jalan Masjid Kapitan Keling/Chulia Street
- Junction35: Chulia Street/Lebuh King
- Junction36: Chulia Street/Lebuh penang
- Junction37: Lebuh Pasar/Penang Street
- Junction38: Lebuh Pasar/ Lebuh King
- Junction39: Lebuh Pasar/ Queen Street
- Junction40: Jalan Masjid Kapitan Keling/ Lebuh Pasar
- Junction41: Jalan Masjid Kapitan Keling/ Lorong Stewart
- Junction42: Jalan Masjid Kapitan Keling/ Lebuh China
- Junction43: Lebuh China/Queen Street
- Junction44: Lebuh China/Lebuh King
- Junction45: Lebuh China/Lebuh Penang
- Junction46: Lebuh Gereja /Lebuh Penang
- Junction47: Lebuh King /Church Street
- Junction48: Church Street/Queen Street
- Junction49: Jalan Masjid Kapitan Keling/ Church Street
- Junction50: Jalan Masjid Kapitan Keling/ Lorong Argus
- Junction51: Jalan Masjid Kapitan Keling/ Bishop Street
- Junction52: Bishop Street/Lebuh King
- Junction53: Bishop Street/Lebuh Penang
- Junction54: Lebuh Penang/Lebuh Union
- Junction55: Lebuh Penang/Light Street
- Junction56: Lebuh King/Light Street
- Junction57: Lebuh Light/Jalan Padang Kota Lana
- Junction58: Lebuh Light/Jalan Masjid Kapitan Keling
- Junction59: Jalan Masjid Kapitan Keling/Lebuh Farquhar
- Junction60: Lebuh Light/Jalan Tun Syed Sheh Barakbah
- Junction61: Lebuh Farquhar/Local road
- Junction62: Lebuh Light/Jalan Green Hall
- Junction63: Lebuh Light/ Lebuh Farquhar
- Junction64: Lebuh Light/ Love Ln
- Junction65: Love Ln/Lorong Argus
- Junction66: Love Ln/Mountri Street
- Junction67: Lorong Stewart/Lorong Chulia
- Junction68: Love Ln/Chulia Street
- Junction69: Chulia Street/lebuh Carnavon
- Junction70: Chulia Street/lebuh Chulia
- Junction71: Lebuh Campbell/Lebuh Carnarvon
- Junction72: Pesara Claimant/Lebuh Carnarvon

- Junction73: Jalan Kampung Kolam/Lebuh Carnarvon
- Junction74: Lebuh Carnarvon/Lebuh Acheh
- Junction75: Lebuh Carnarvon/Lebuh Kimberley

The locations of seventy-five surveyed junctions are shown in Figure 9.

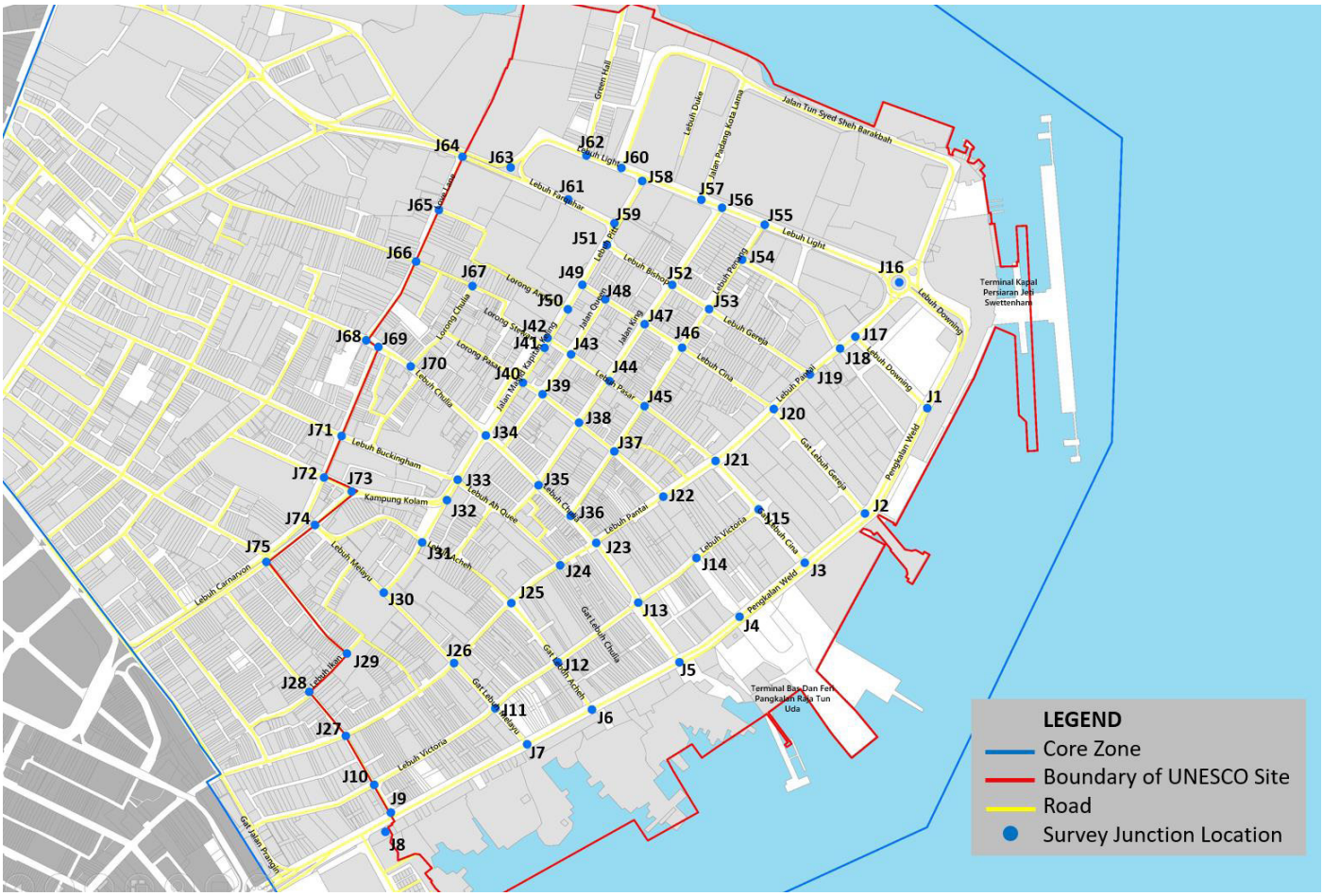


Figure 9: Existing Junctions Surveyed in Study Area

Traffic counts results were analysed to determine the peak 60-minute periods within the morning and evening peak periods. All traffic flows were converted and expressed in Passenger Car Units (PCUs). PCUs are factors that convert different classification of vehicles to be equivalent to a typical car. The following PCU factors were used (in accordance with Malaysian guidelines*) for the junction counts:

- Car: 1.00
- Taxi: 1.00
- Light Goods Vehicles (Lorry Kecil): 2.50
- Heavy Goods Vehicles (Lorry Besar): 3.00
- Bus: 3.00
- Motorcycle: 0.75

The peak hour traffic flows occurred during the times stated in Table 3.

Table 3: Survey Peak Hour

	Surveyed Time	Peak Hour Traffic
Weekday AM	07:00 to 10:00	08:15 to 09:15 (Traffic flows shown in Figure 10 to 14)
Weekday PM	16:30 to 19:30	17:00 to 18:00 (Traffic flows shown in Figure 15 to 19)

For the respective peak hours within the surveyed timings, the corresponding traffic flow volumes (in PCUs) in the background road network are shown in the following figures.

*Guideline refers to AT (J) 38-2018 Guidelines for Traffic Impact Assessment

Photo: ADB

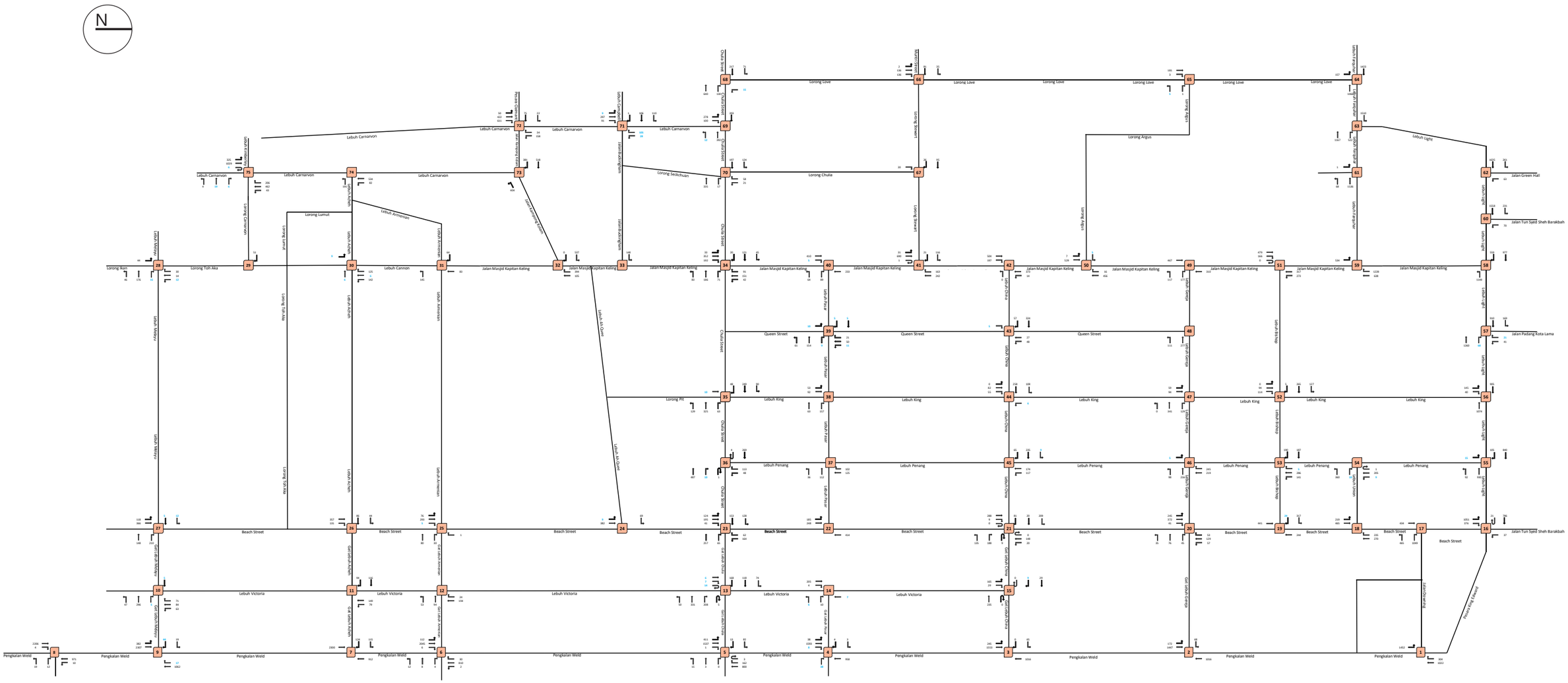


Figure 10: 2021 Existing Traffic Flows (PCUs/Hr) AM Peak – Full

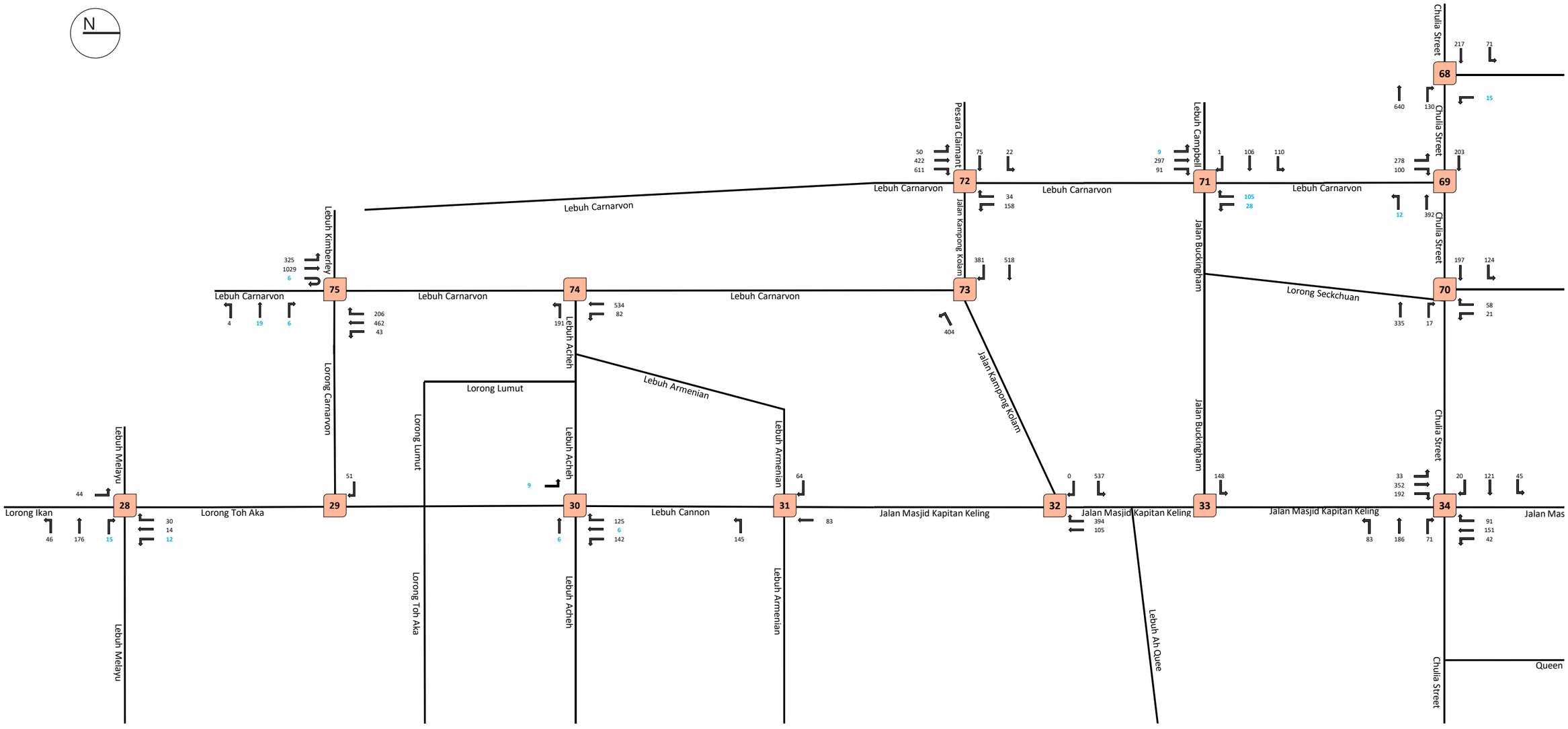


Figure 11: 2021 Existing Traffic Flows (PCUs/Hr) AM Peak – Northwest Section

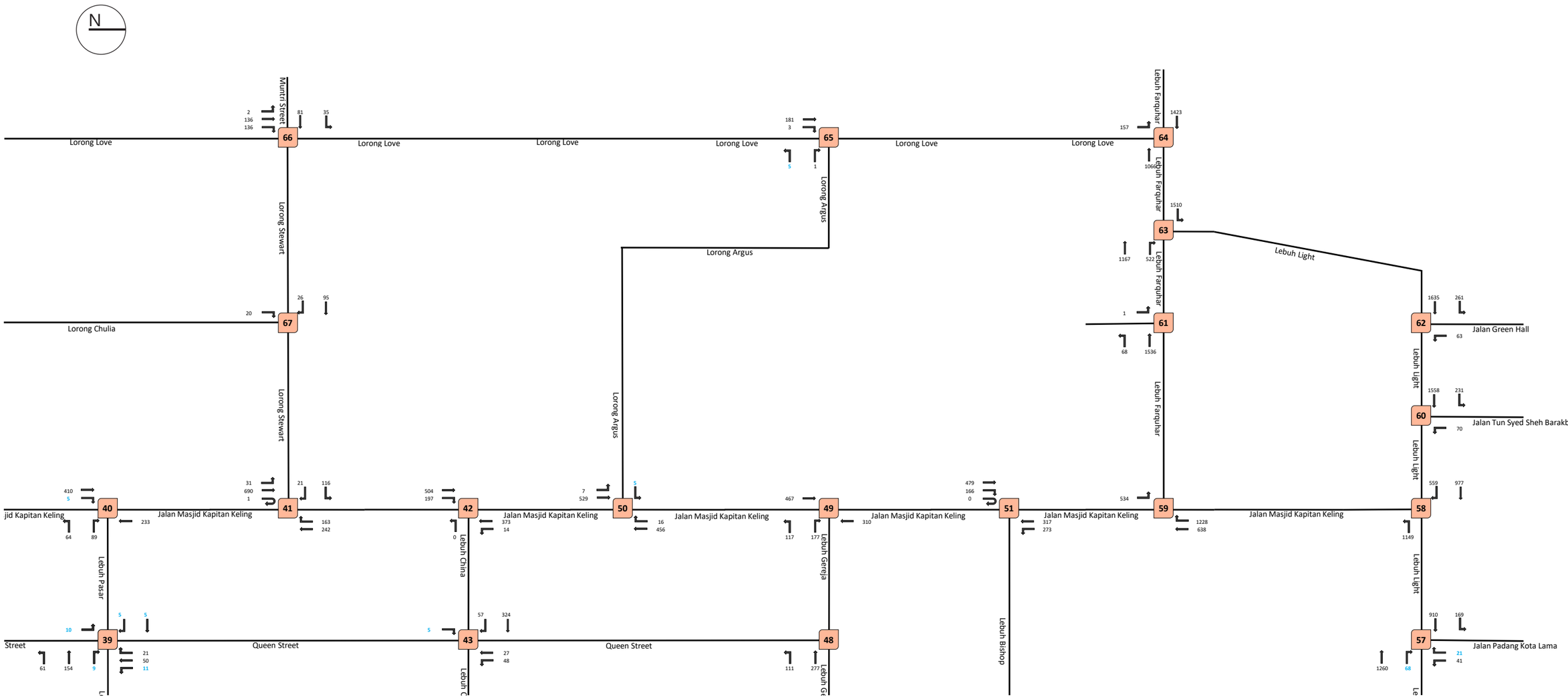


Figure 12: 2021 Existing Traffic Flows (PCUs/Hr) AM Peak – Northeast Section

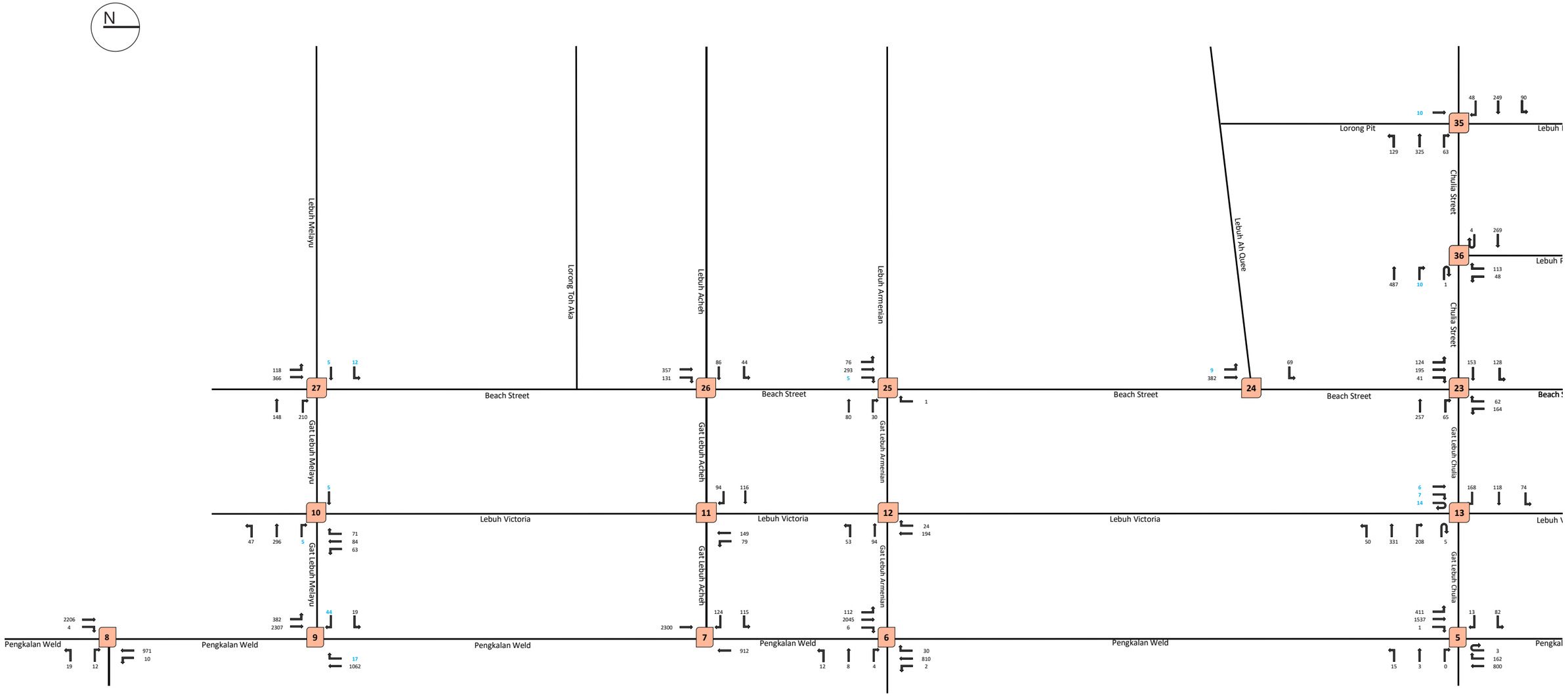


Figure 13: 2021 Existing Traffic Flows (PCUs/Hr) AM Peak – Southwest Section

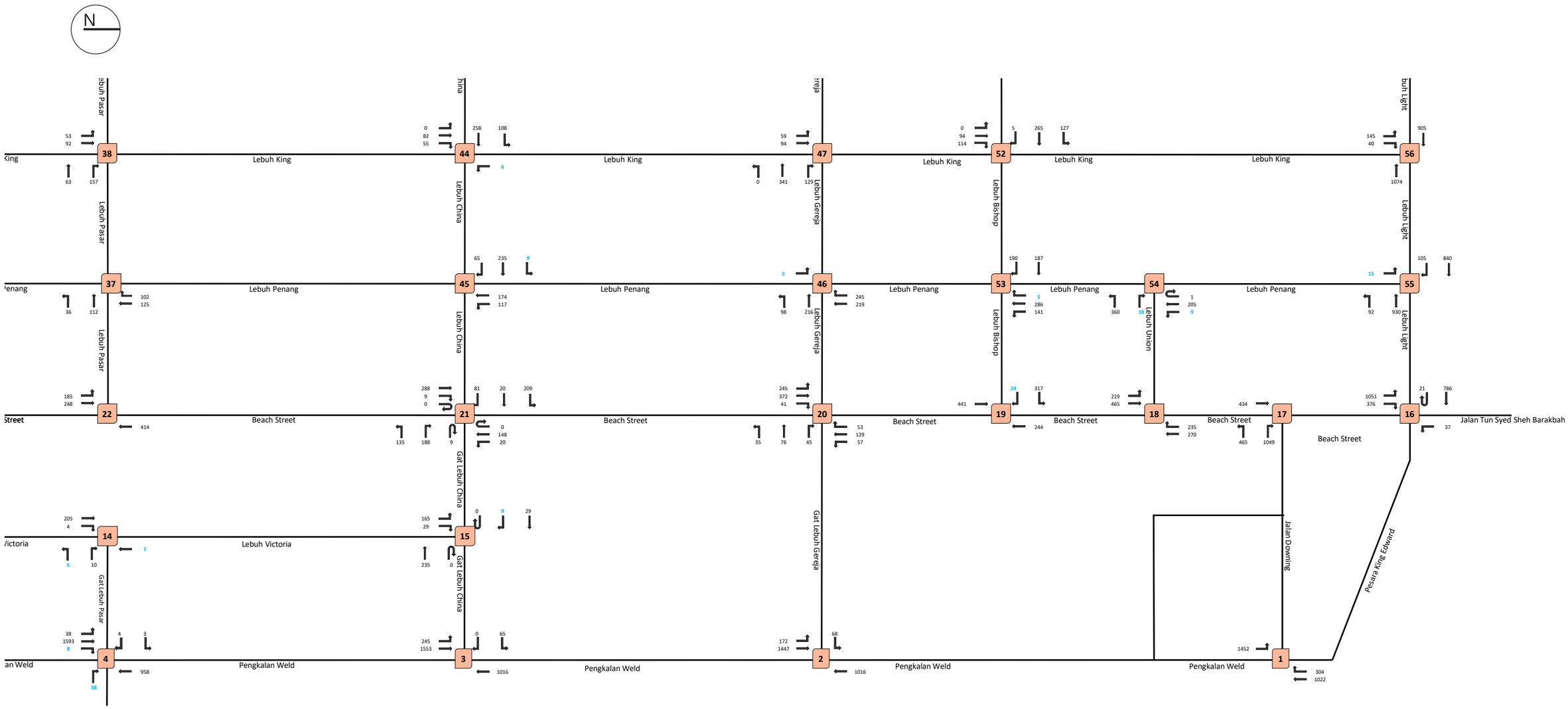


Figure 14: 2021 Existing Traffic Flows (PCUs/Hr) AM Peak – Southeast Section

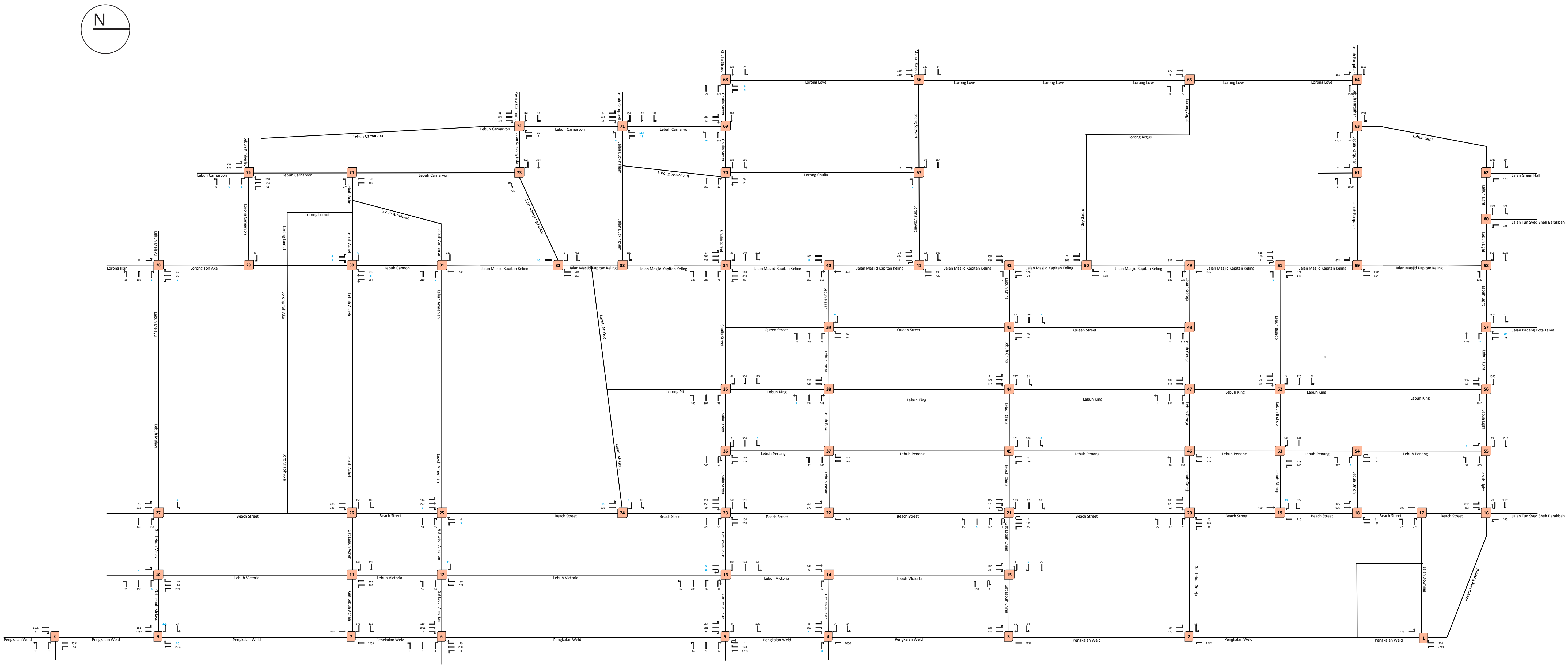


Figure 15: 2021 Existing Traffic Flows (PCUs/Hr) PM Peak – Full

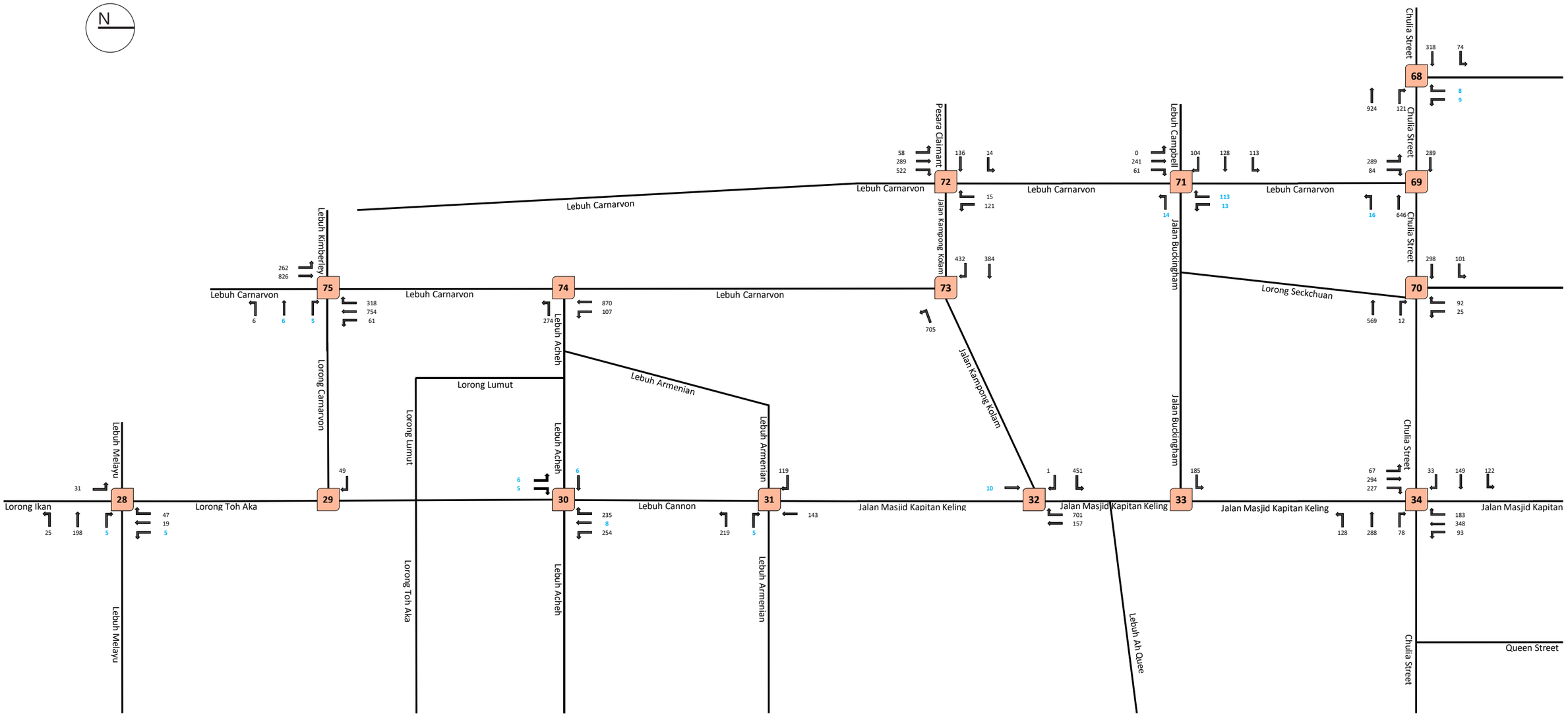


Figure 16: 2021 Existing Traffic Flows (PCUs/Hr) PM Peak – Northwest Section

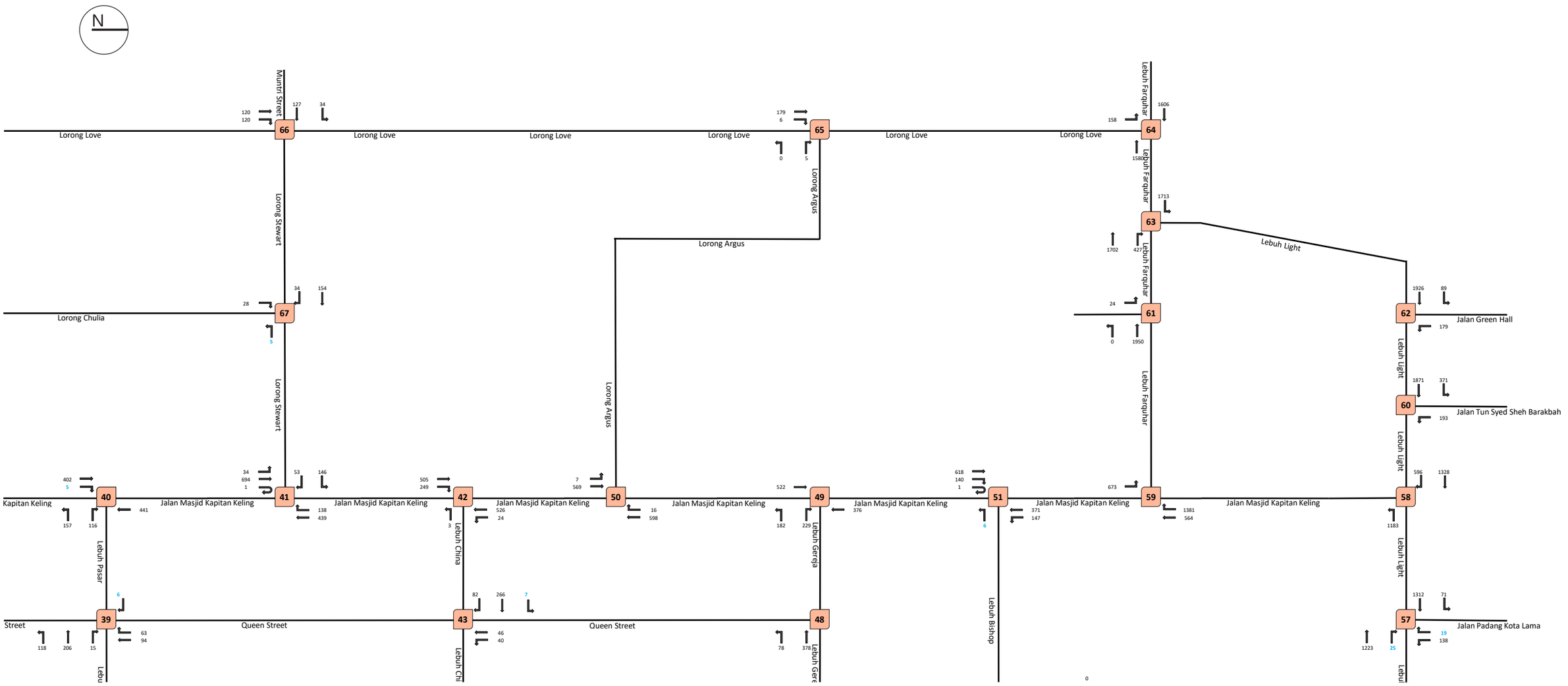


Figure 17: 2021 Existing Traffic Flows (PCUs/Hr) PM Peak – Northeast Section

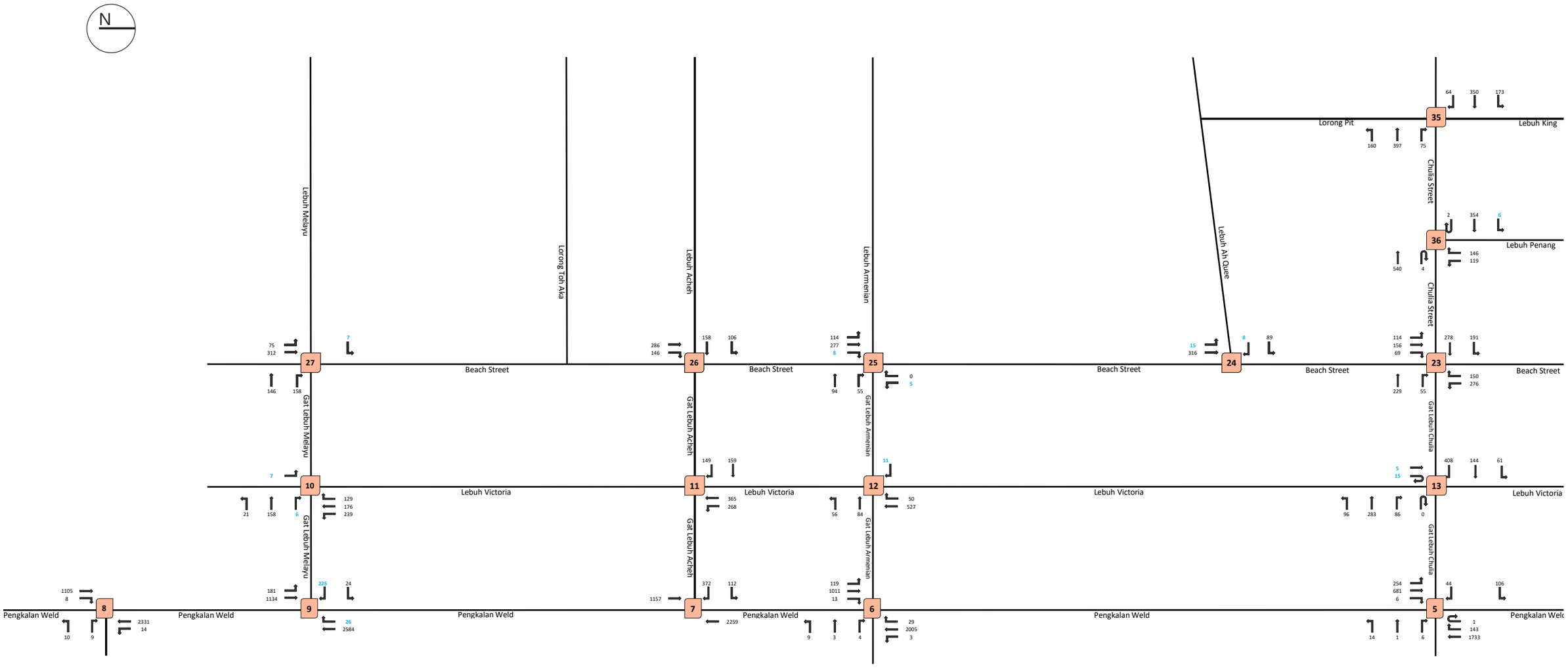


Figure 18: 2021 Existing Traffic Flows (PCUs/Hr) PM Peak – Southwest Section

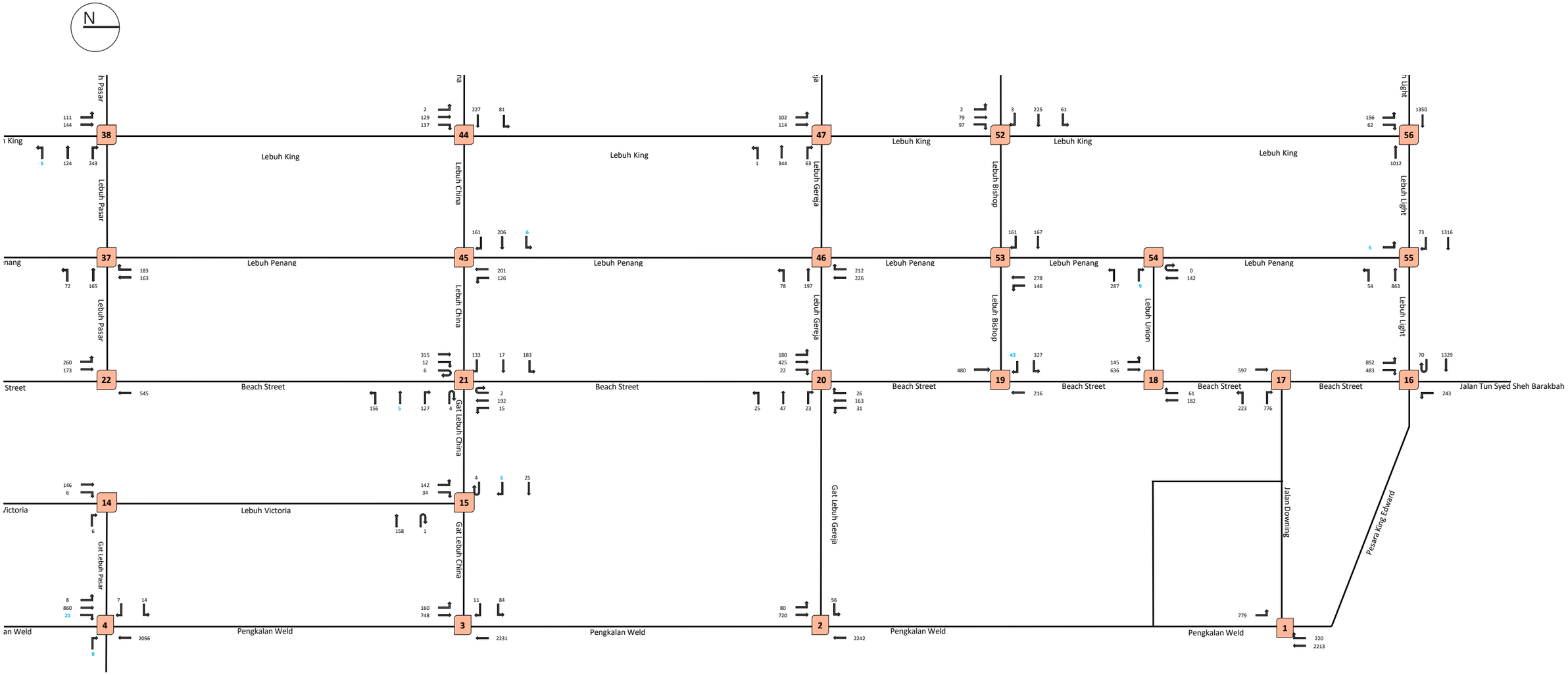


Figure 19: 2021 Existing Traffic Flows (PCUs/Hr) PM Peak – Southeast Section

3.2.2 UNCLASSIFIED PEDESTRIAN / CYCLIST COUNT SURVEYS

Pedestrian and cyclists were recorded at crossing points throughout the road network when they were crossing the street. The number for pedestrians and cyclists is unclassified, which means the results are in single combined class without further differentiation of user profiles (such as students, elderly, etc.). The locations of the seventy-five surveyed junctions are shown in Figure 20.

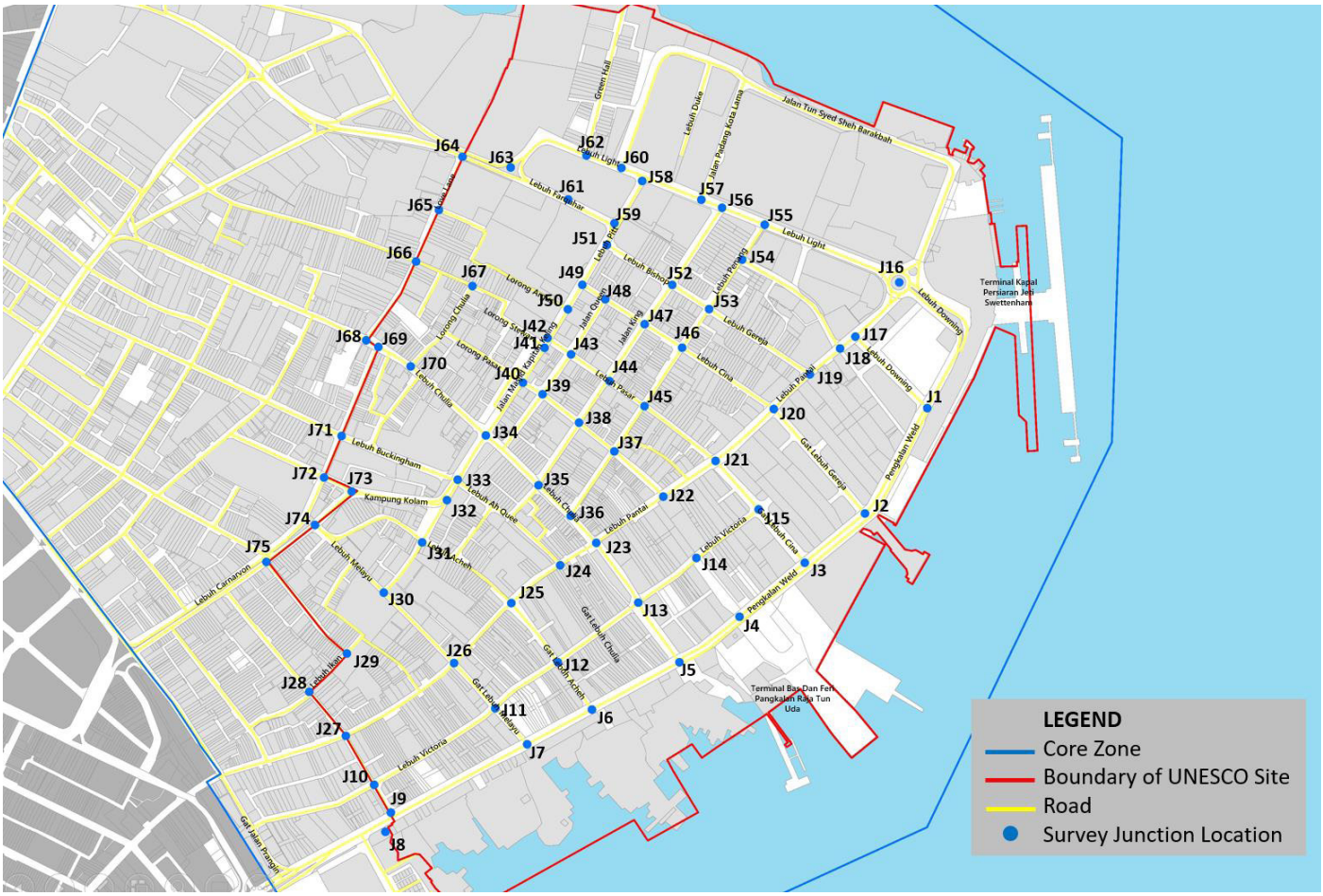


Figure 20: Existing Pedestrian / Cyclist Crossings Surveyed in Study Area

Pedestrian/cyclists count results were analysed to determine the peak 60-minute periods within the morning and evening peak periods. The peak hour pedestrian and cyclist flows follows the same period as traffic flows during the times stated in the table below.

Table 4: Survey Peak Hour (Pedestrian / Cyclist)

	Surveyed Time	Peak Hour Pedestrian / Cyclists
Weekday AM	07:00 to 10:00	08:15 to 09:15 (Flows shown in Figure 21 to 25)
Weekday PM	16:30 to 19:30	17:00 to 18:00 (Flows shown in Figure 26 to 30)

For the respective peak hours within the surveyed timings, the corresponding pedestrian / cyclist flow volumes in the road network are shown in Figures 21 to 30.

Photo: ADB

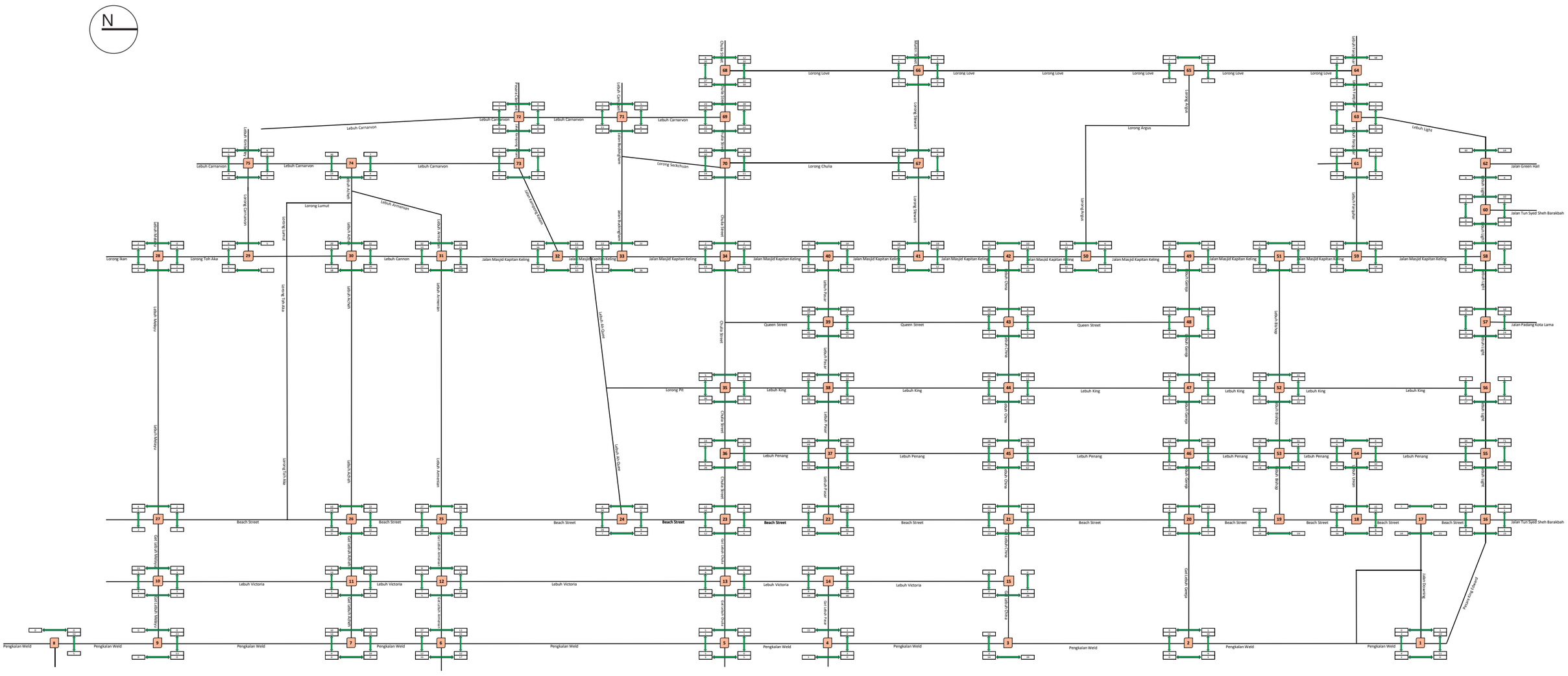


Figure 21: 2021 Existing Pedestrian / Cyclist Flows (Pax/Hr) AM Peak – Full

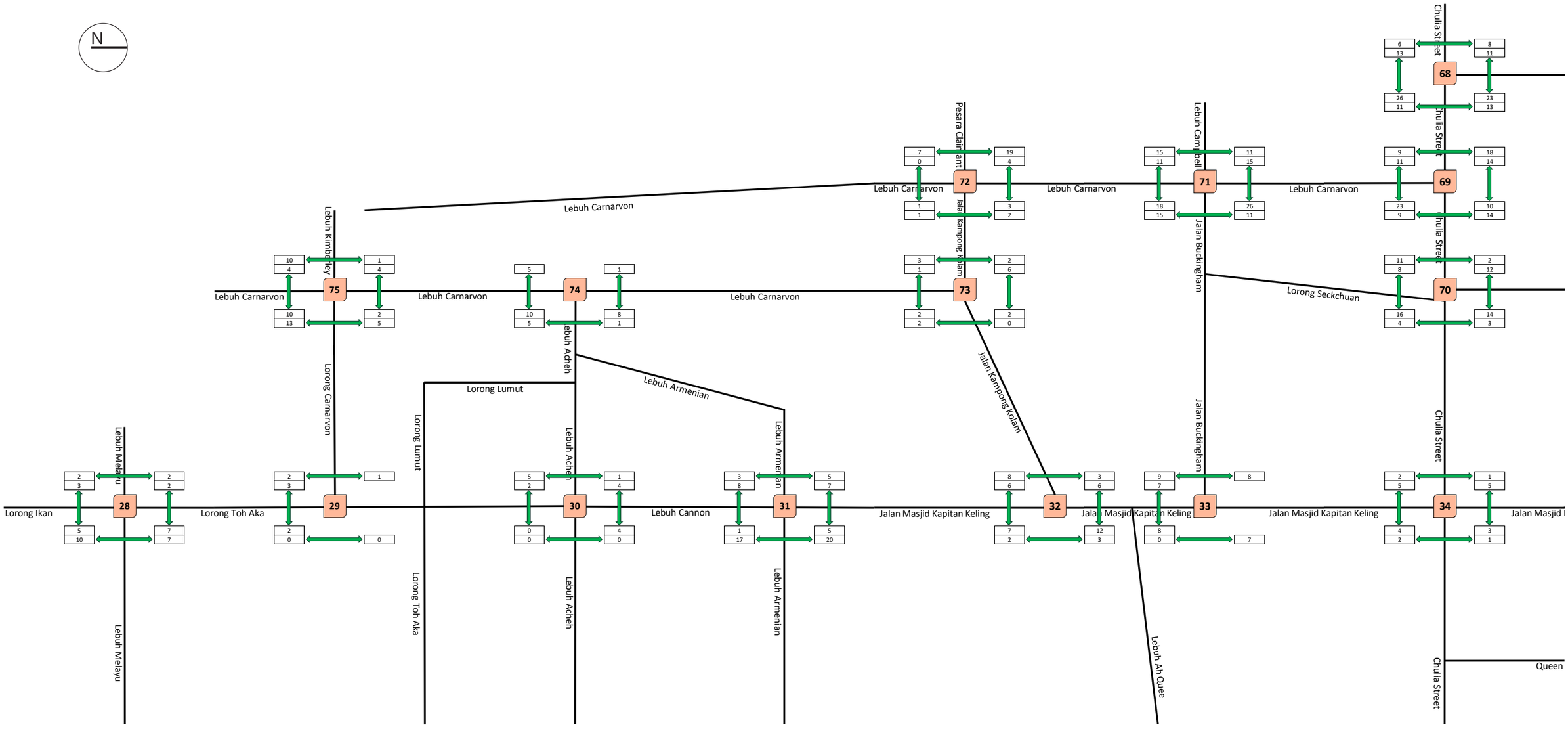


Figure 22: 2021 Existing Pedestrian / Cyclist Flows (Pax/Hr) AM Peak – Northwest Section

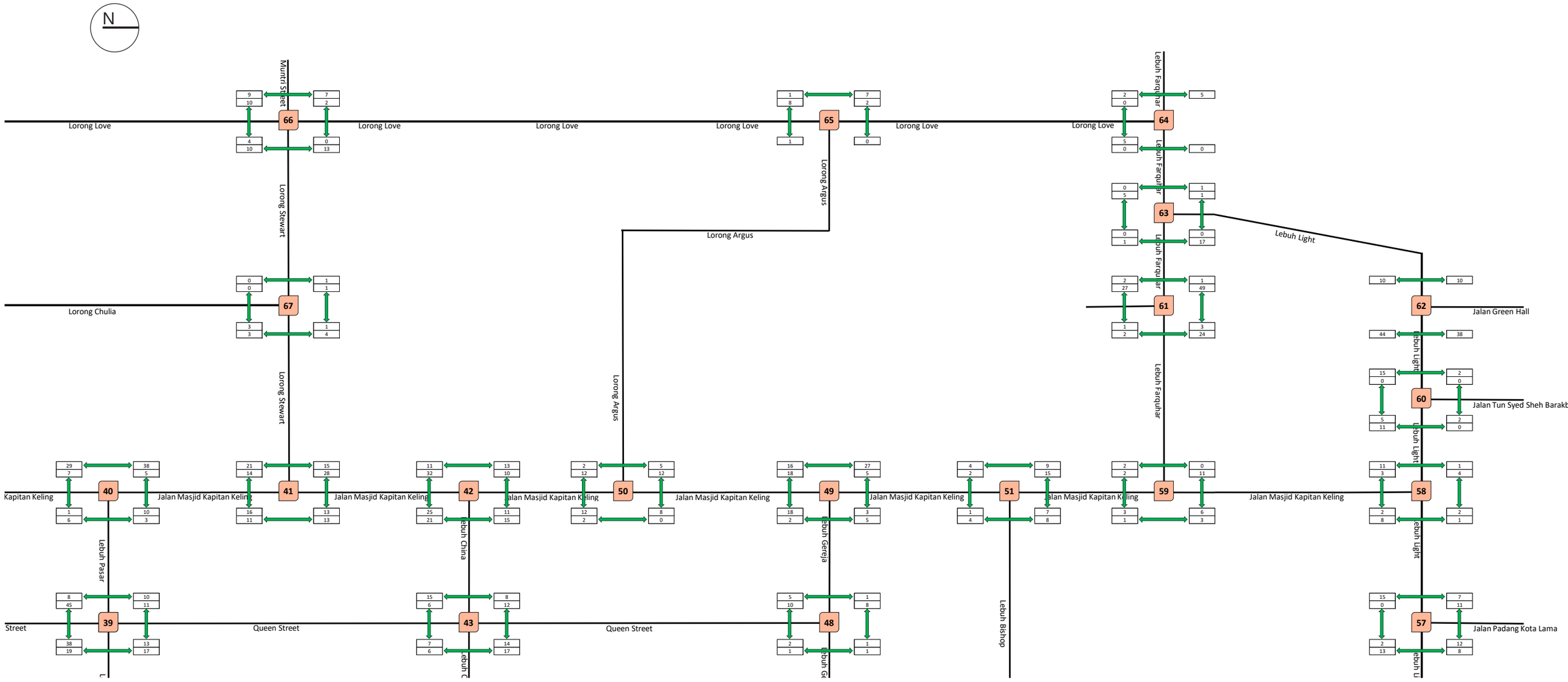


Figure 23: 2021 Existing Pedestrian / Cyclist Flows (Pax/Hr) AM Peak – Northeast Section

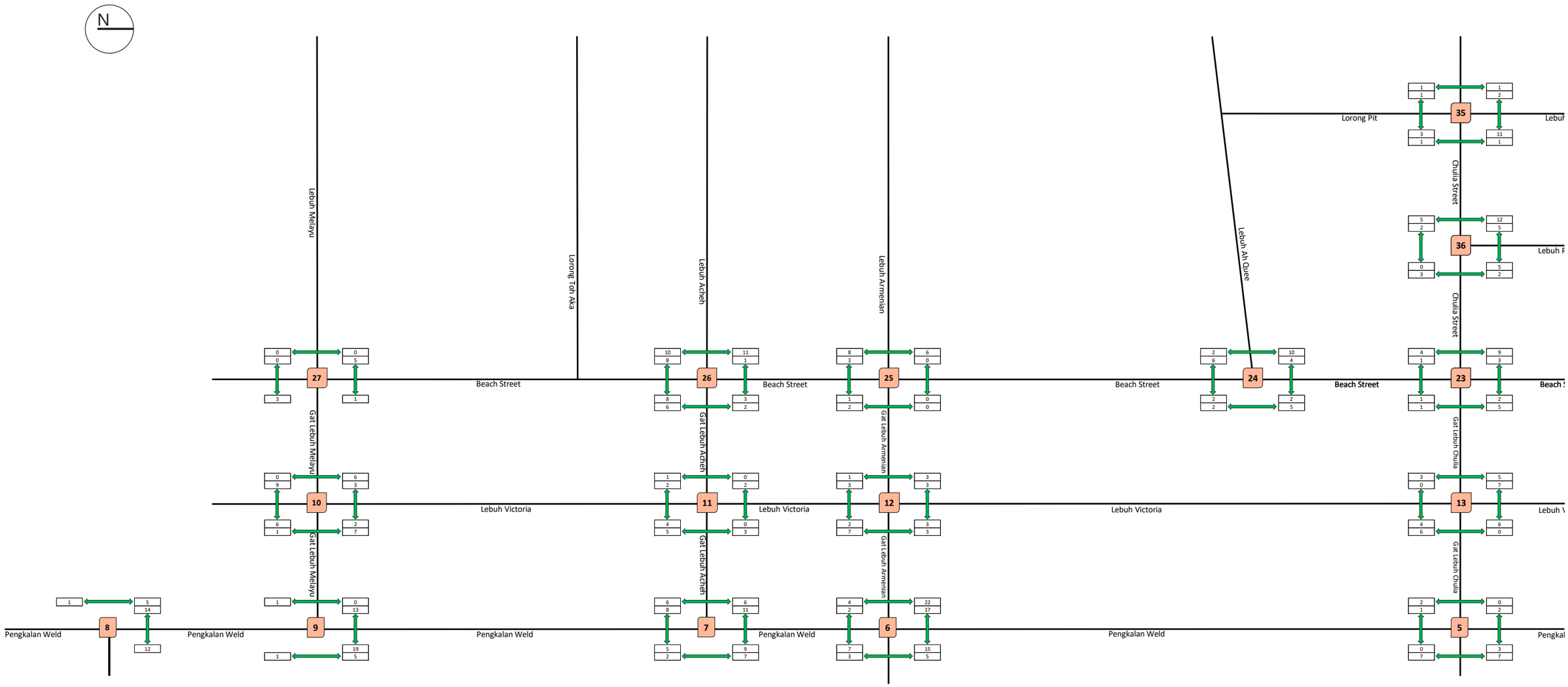


Figure 24: 2021 Existing Pedestrian / Cyclist Flows (Pax/Hr) AM Peak – Southwest Section

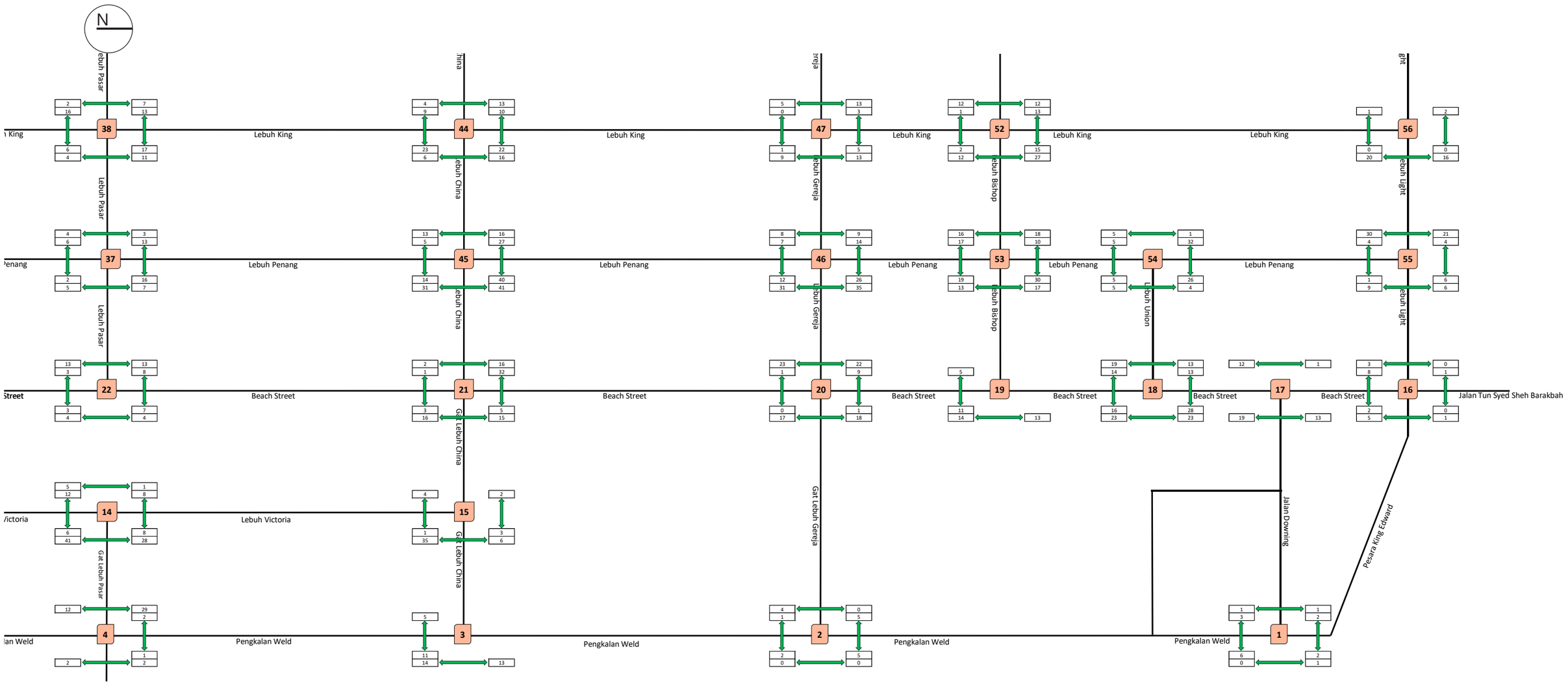


Figure 25: 2021 2021 Existing Pedestrian / Cyclist Flows (Pax/Hr) AM Peak – Southeast Section

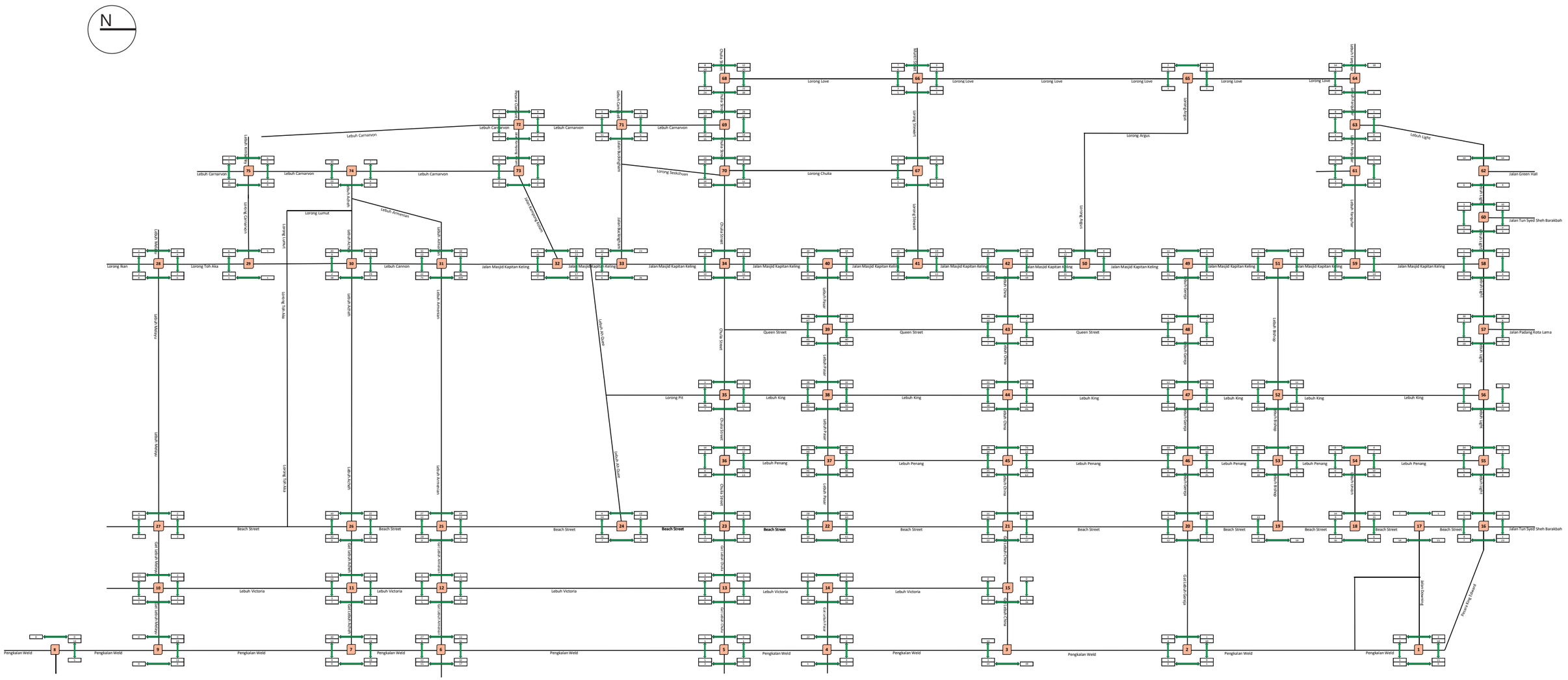


Figure 26: 2021 Existing Pedestrian / Cyclist Flows (Pax/Hr) PM Peak – Full

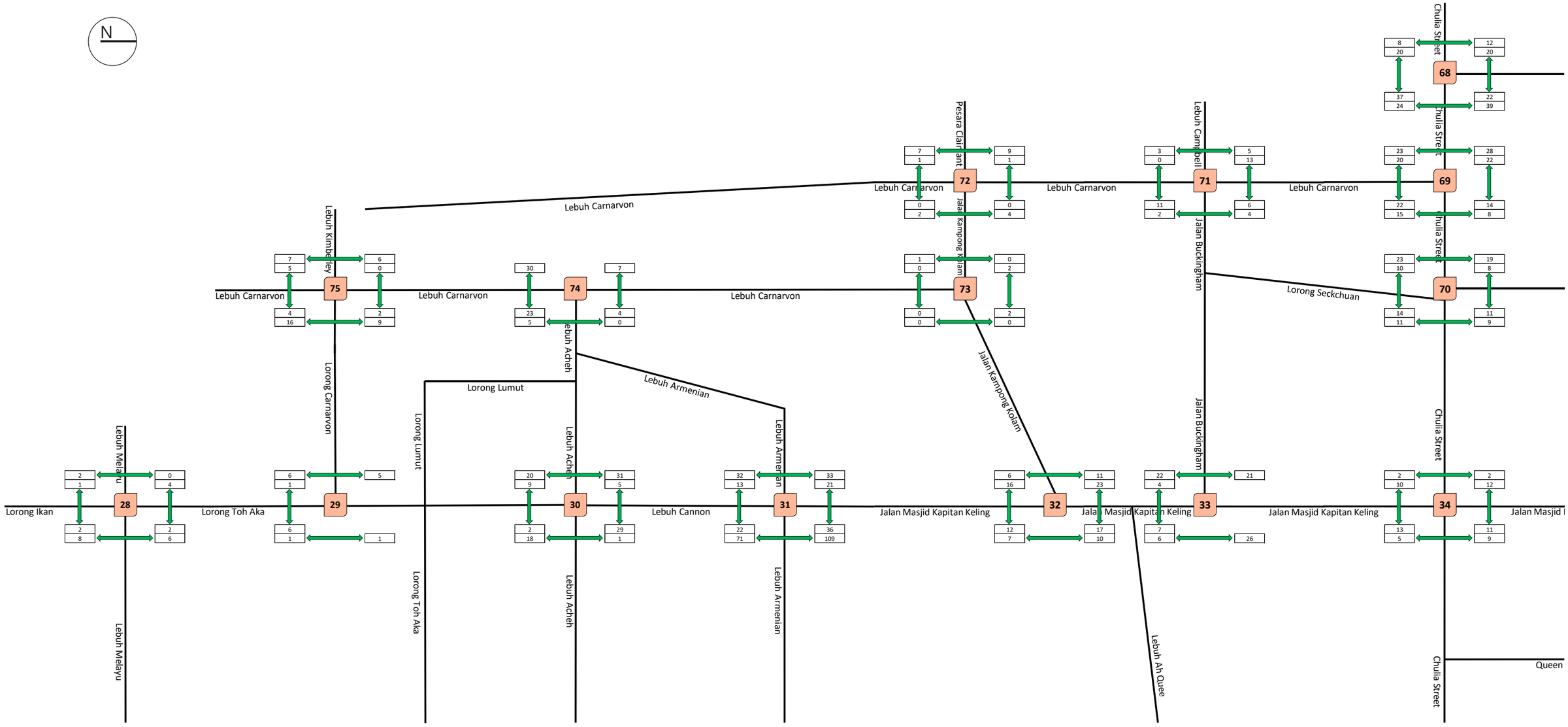


Figure 27: 2021 Existing Pedestrian / Cyclist Flows (Pax/Hr) PM Peak – Northwest Section

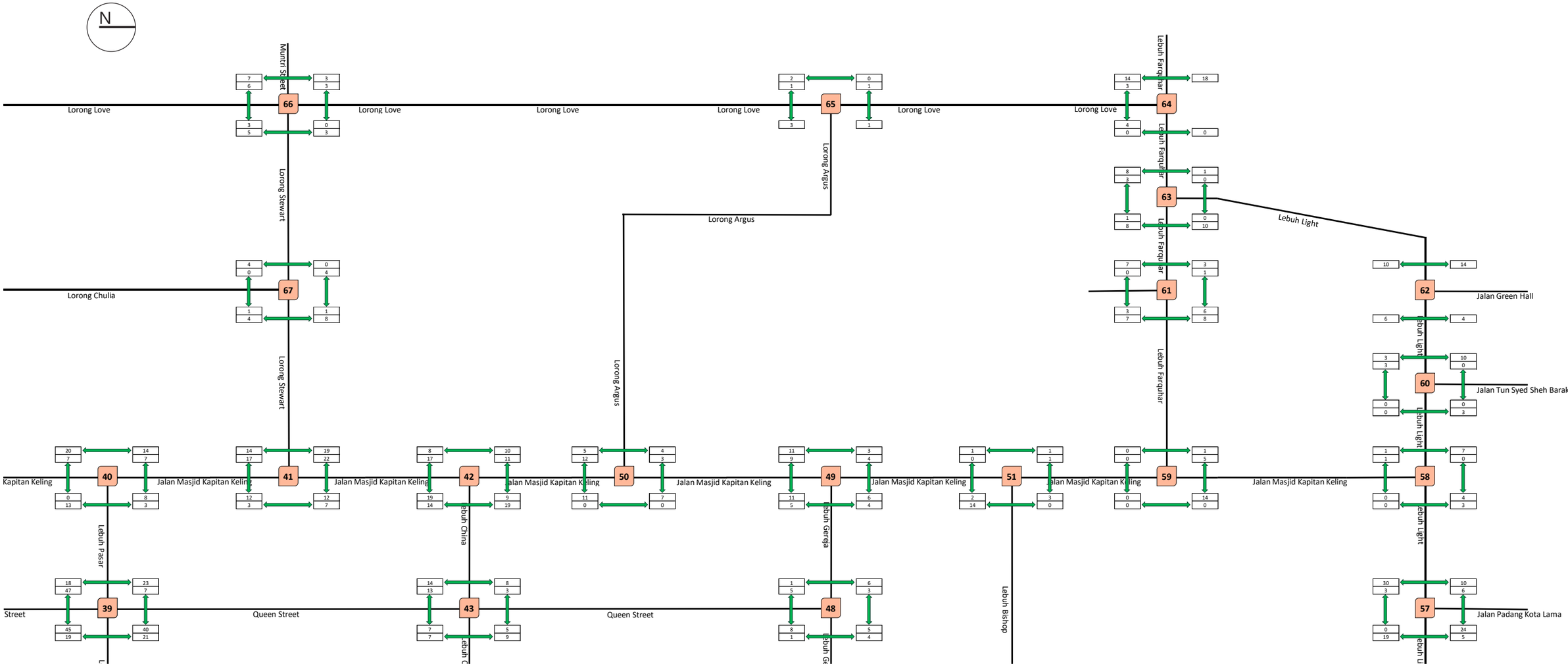


Figure 28: 2021 Existing Pedestrian / Cyclist Flows (Pax/Hr) PM Peak – Northeast Section

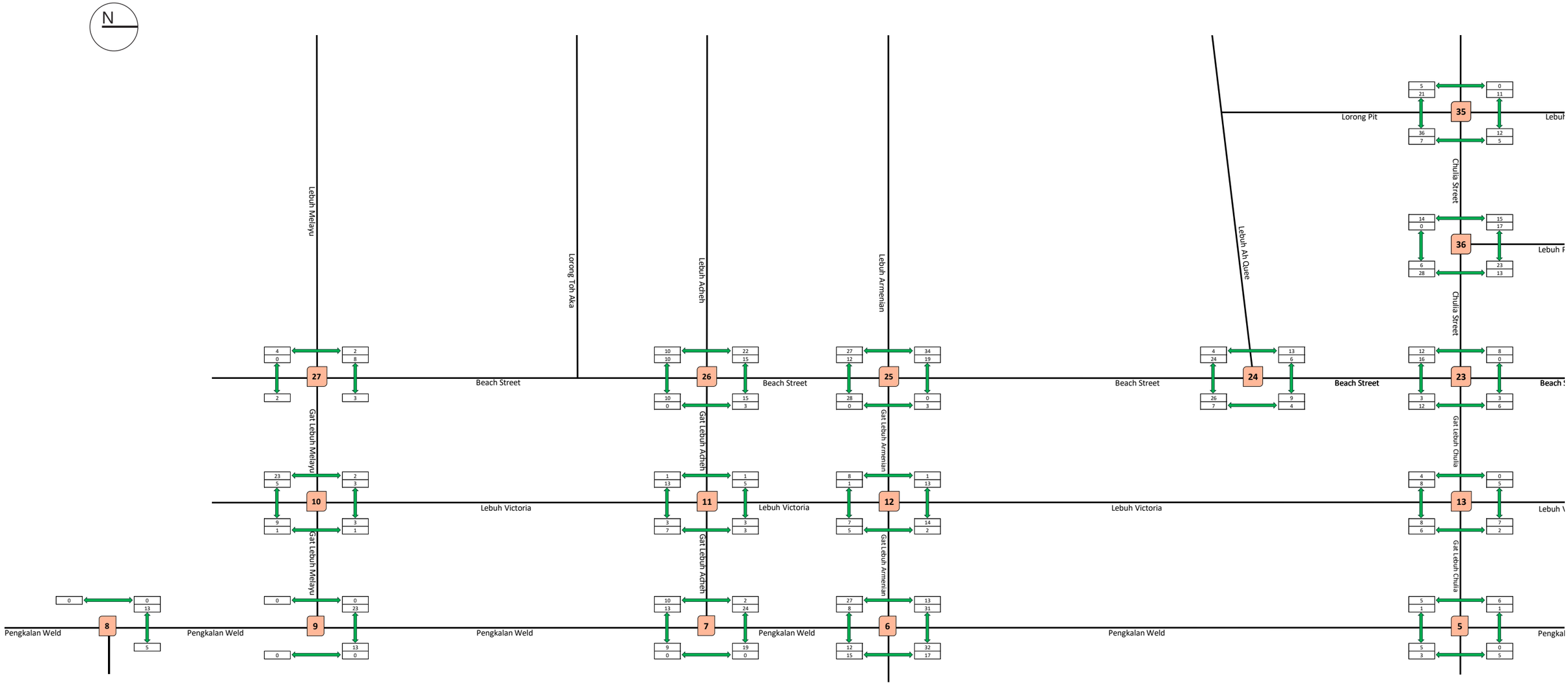


Figure 29: 2021 Existing Pedestrian / Cyclist Flows (Pax/Hr) PM Peak – Southwest Section

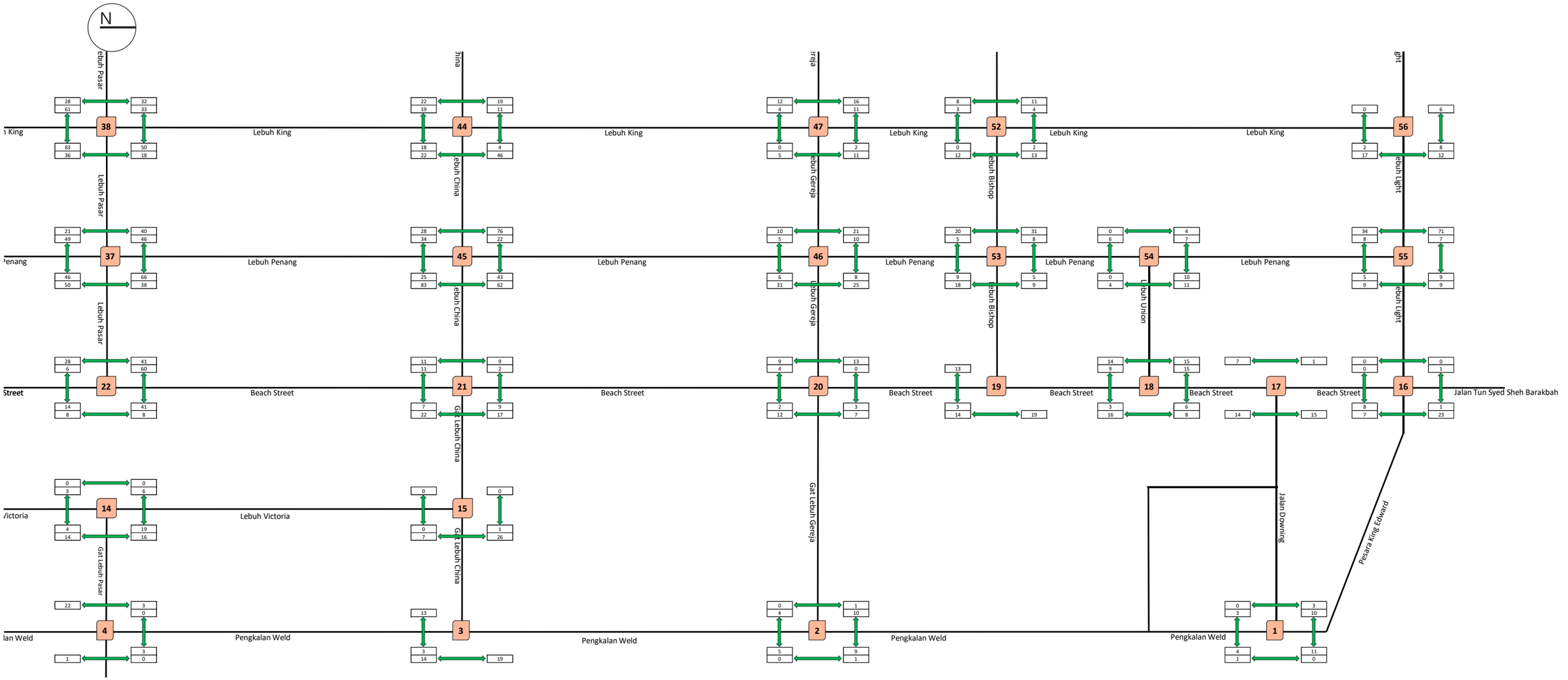


Figure 30: 2021 Existing Pedestrian / Cyclist Flows (Pax/Hr) PM Peak – Southeast Section

3.2.3 JUNCTION LAYOUT AND SIGNAL SURVEYS

As a part of this survey exercise, a full record inventory has been made of existing junction and road layouts, turning movements allowed or banned, traffic signal information, traffic lane configurations, bus stops, internal parking, and public transport facilities, waiting and loading restrictions, and general site layout.

Junction layout and traffic signals after on-site verification with actual situation during the site works from 9 to 11 November 2021 are presented with the following sections.

3.2.3.1 Junction Layout

Junction layout after on-site verification with actual situation during the site works from 9 to 11 November 2021 are presented in Figure 31.

Figure 31: Junction Layout (After On-site Verification)

Further detailed junction layout on individual junction basis is provided in Section 3.3.

3.2.3.2 Junction Signal

Location of signals in the study area are presented in Figure 32.

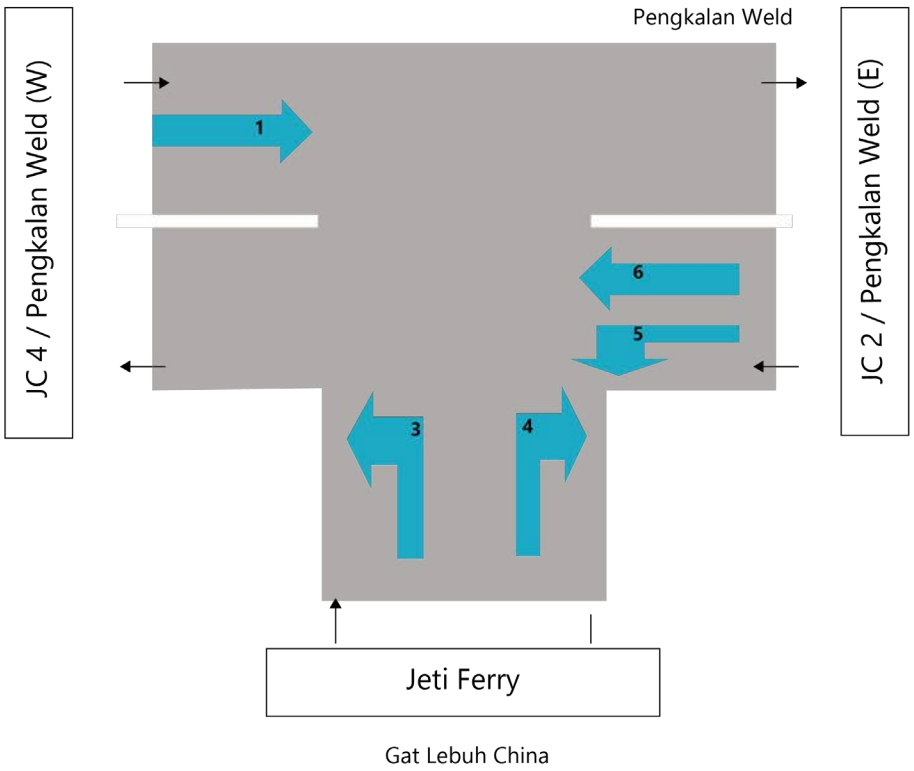
Figure 32: Junction Signal Location

Signal data survey was conducted at 3 locations as indicated in Figure 33.

Figure 33: Surveyed Signalized Junctions

The junction signal for signalized traffic junctions are shown on the next pages.

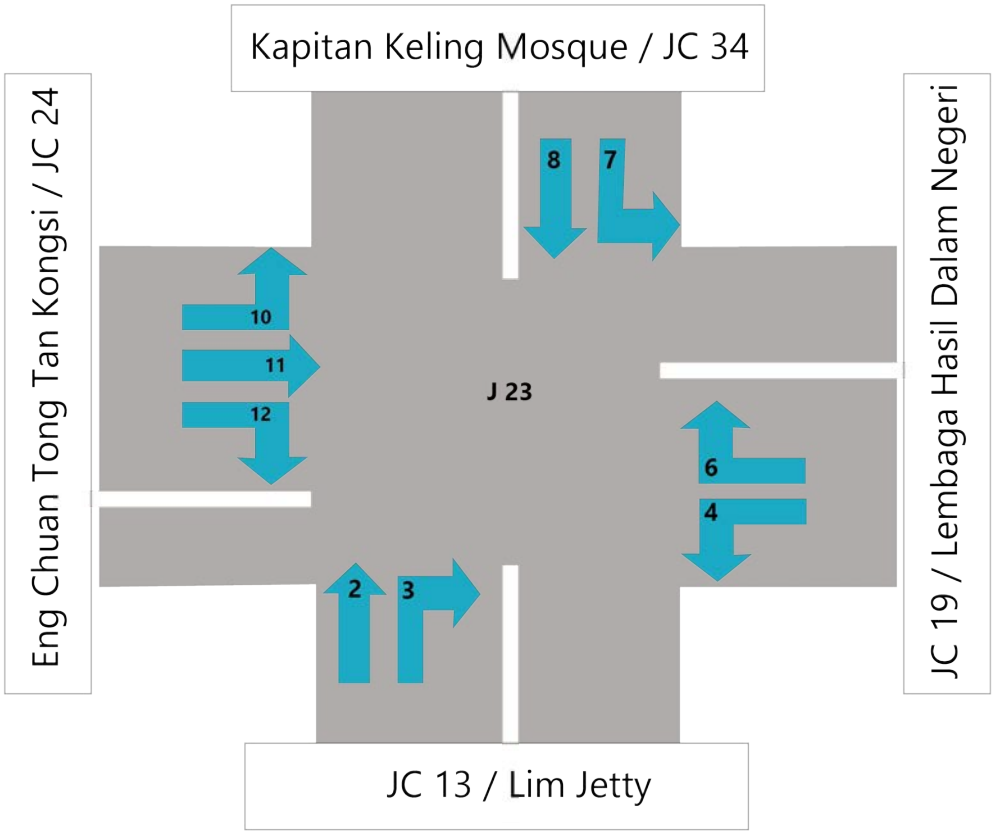
Between Junction 3 & Junction 4



Phase	Movement	Green Time	Amber Time	All Red Time	Total Phase time
A	3,4,5	114	3	3	120
B	1,2	24	3	3	30
Total Signal Time					**150**

Figure 34: Signal Data for Junction between J3 & J4

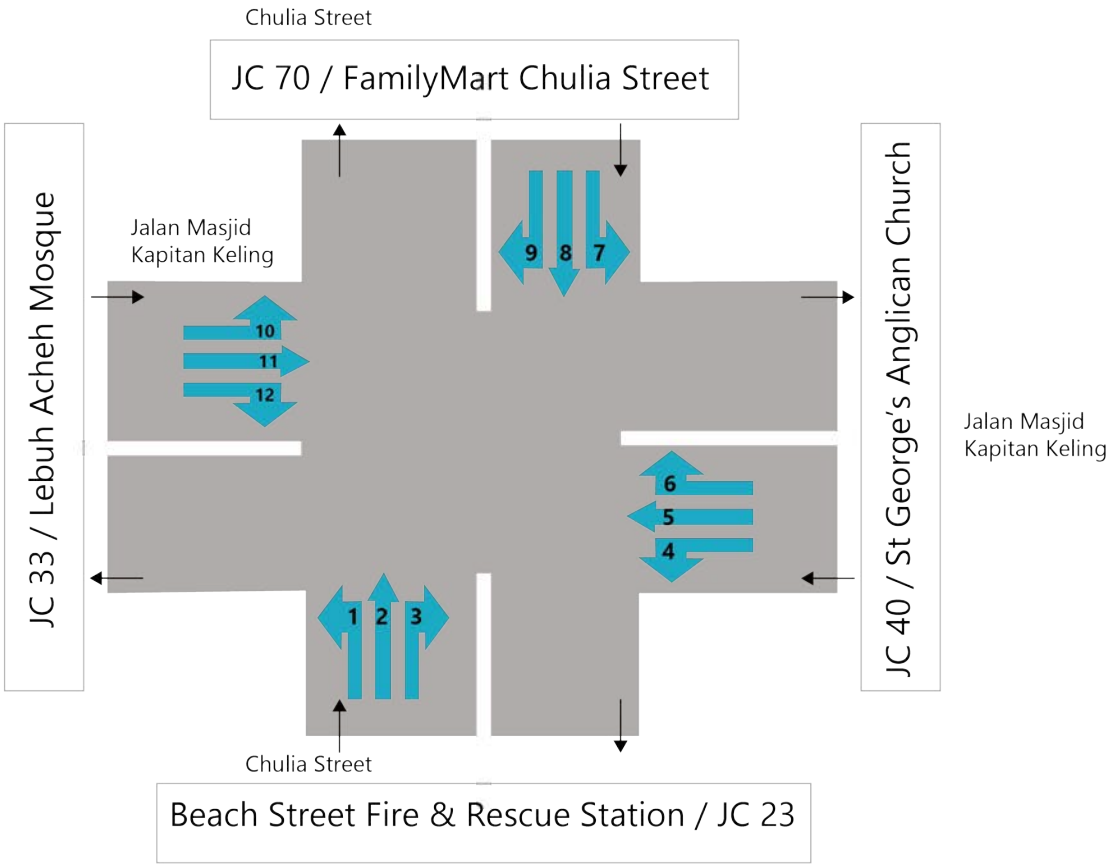
Junction 23:



Phase	Movement	Green Time	Amber Time	All Red Time	Total Phase Time
A	2,3	51	3	3	57
B	4,6	32	3	3	38
C	7,8	45	3	3	51
D	10,11,12	33	3	3	39
Total Signal Time					**185**

Figure 35: Signal Data for Junction 23

Junction 34:



Phase	Movement	Green Time	Amber Time	All Red Time	Total Phase Time
A	1,2,3	49	3	3	55
B	4,5,6	32	3	3	38
C	7,8,9	35	3	3	41
D	10,11,12	38	3	3	44
Total Signal Time					**178**

Figure 36: Signal Data for Junction 34

3.3 SURVEY OBSERVATIONS

Survey observations were made at all junctions on-site together with the traffic surveys. The intention of the survey observation is to document the junction layout observed on-site, forming part of the capacity inputs to the modeling exercise.

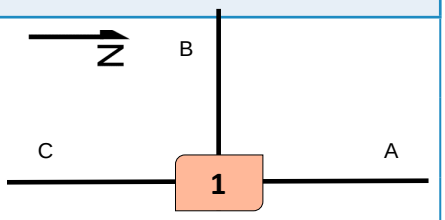
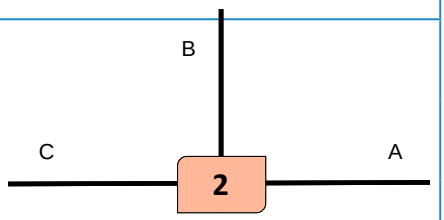
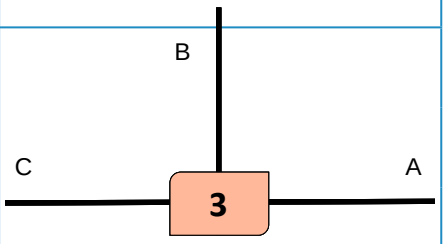
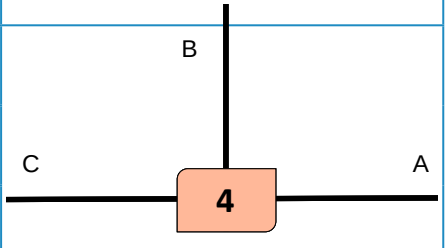
Detailed survey observations are attached in Appendix A of this report.

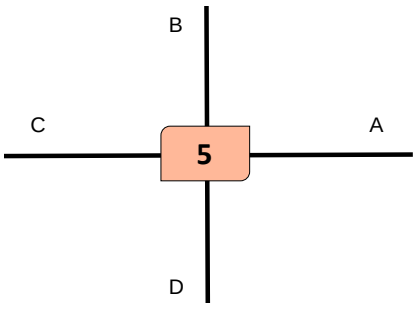
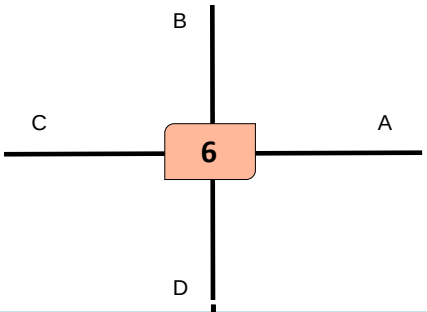
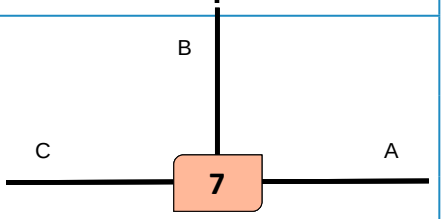
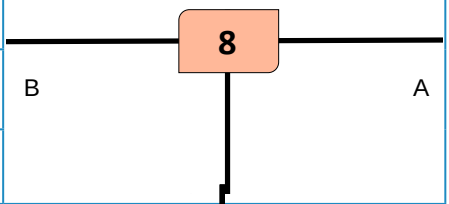
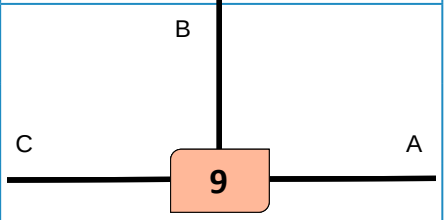
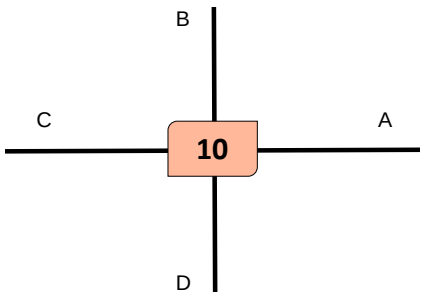
3.4 QUEUE LENGTH SURVEY

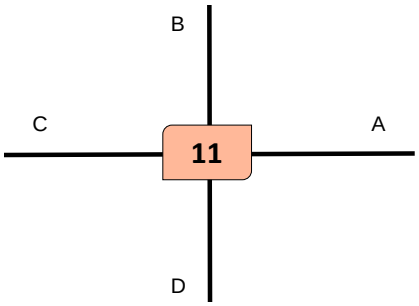
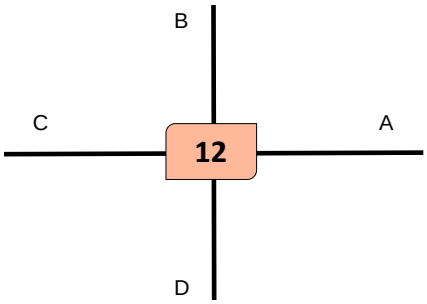
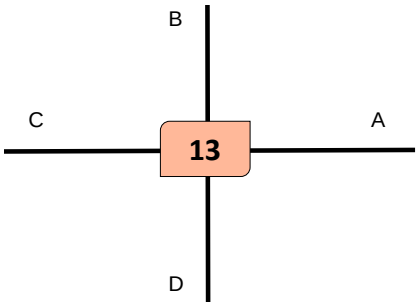
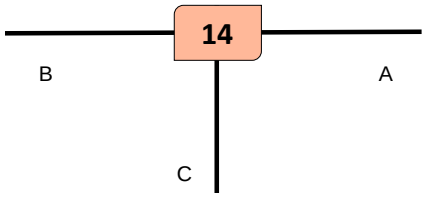
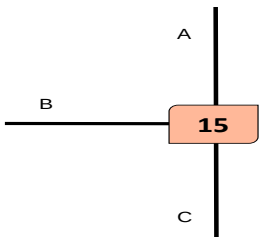
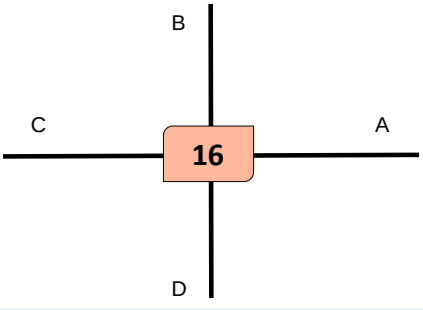
As proposed in the overall survey plan, queue length survey at existing junctions were conducted to obtain the site condition for model verification and calibration.

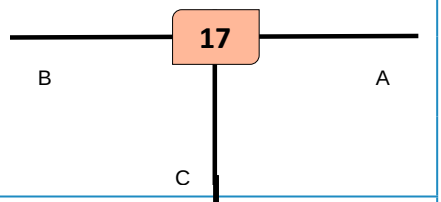
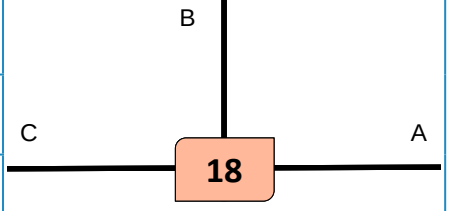
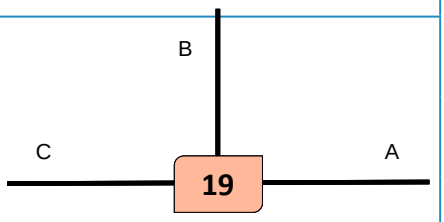
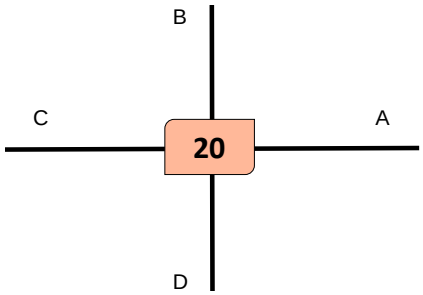
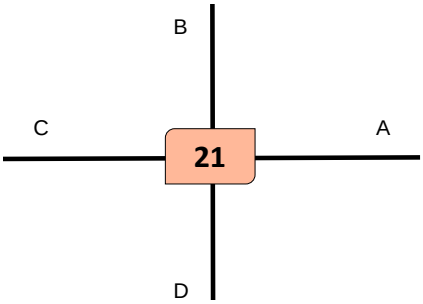
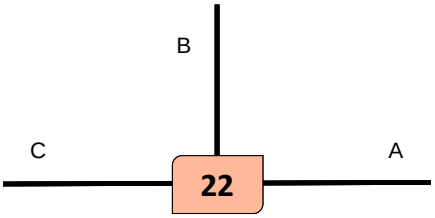
Observed queue length for each junction is presented in the table below.

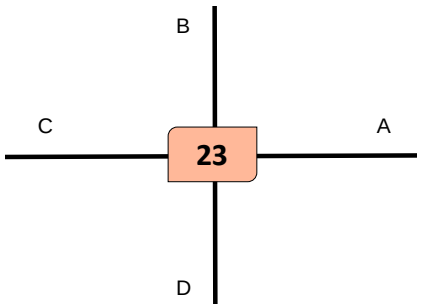
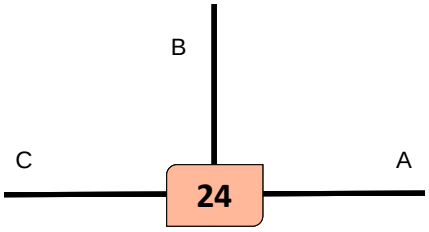
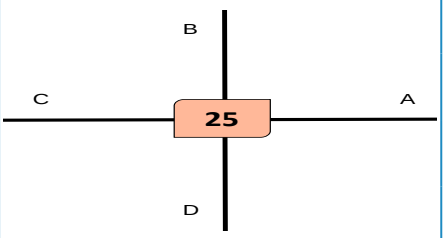
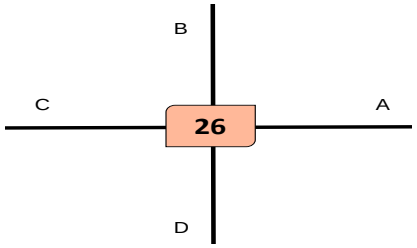
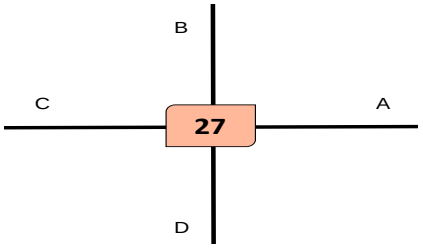
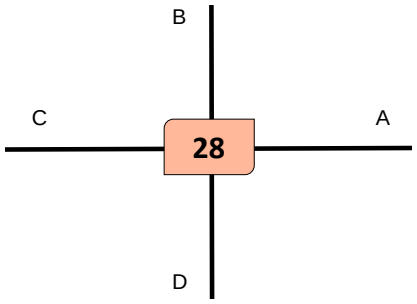
Table 5: Queue Length Survey Results

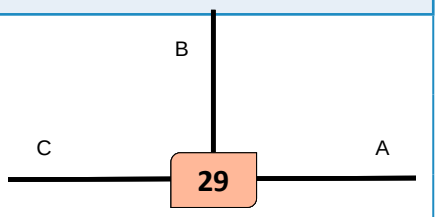
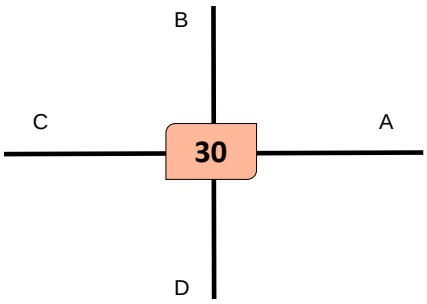
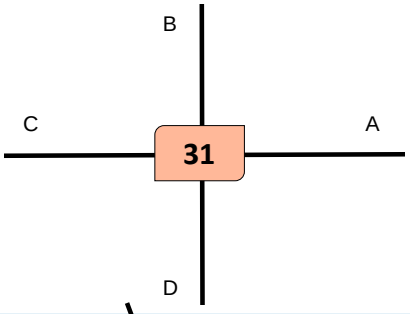
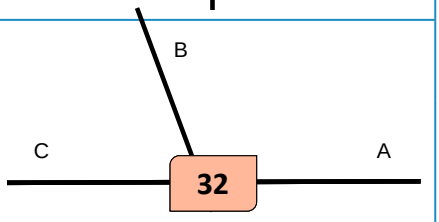
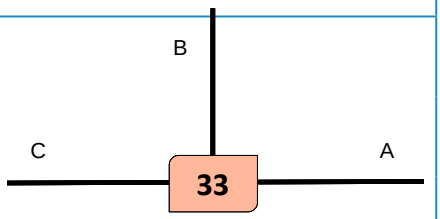
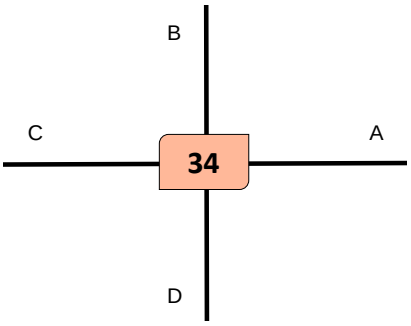
Junction no.	Approach	Road Name (Direction)	Observed Qeue Length AM (m)	Observed Qeue Length PM (m)	Diagram
1	A	Persara King Edward (N)	0	0	
	B	Jalan Downing (W)	0	0	
	C	Pengkalan Weld (S)	0	0	
2	A	Pengkalan Weld (N)	0	0	
	B	Gat Lebuh Gereja (W)	0	0	
	C	Pengkalan Weld (S)	0	0	
3	A	Pengkalan Weld (N)	0	0	
	B	Gat Lebuh China (W)	5	0	
	C	Pengkalan Weld (S)	0	0	
4	A	Pengkalan Weld (N)	0	0	
	B	Gat Lebuh Pasar (W)	0	0	
	C	Pengkalan Weld (S)	0	0	

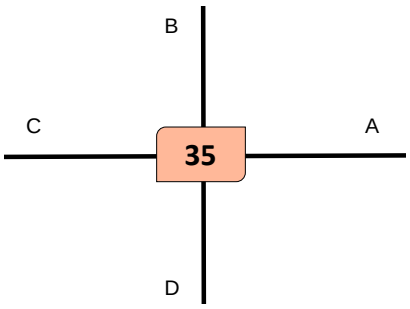
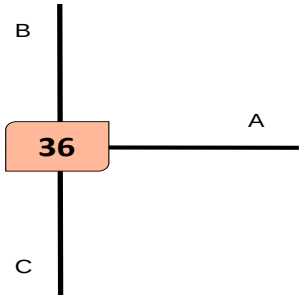
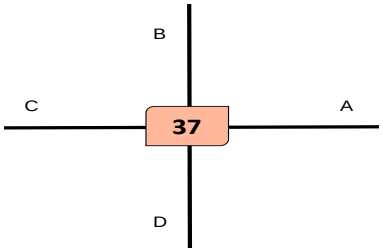
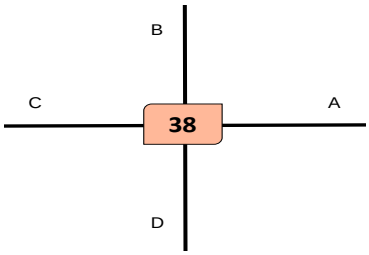
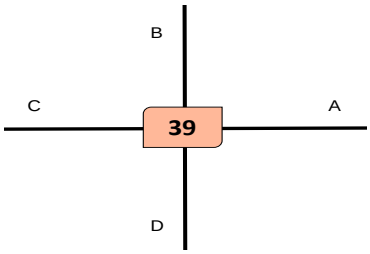
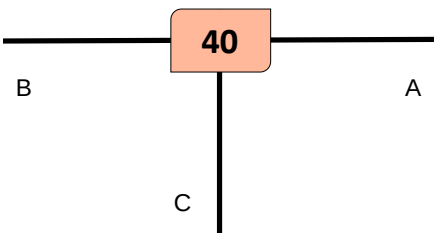
Junction no.	Approach	Road Name (Direction)	Observed Qeue Length AM (m)	Observed Qeue Length PM (m)	Diagram
5	A	Pengkalan Weld (N)	15	55	
	B	Gat Lebuh Chulia (W)	5	20	
	C	Pengkalan Weld (S)	0	35	
	D	Gat Lebuh Chulia (E)	0	0	
6	A	Pengkalan Weld (N)	0	0	
	B	Gat Lebuh Armenian (W)	0	0	
	C	Pengkalan Weld (S)	0	20	
	D	Gat Lebuh Armenian (E)	0	0	
7	A	Pengkalan Weld (N)	0	0	
	B	Gat Lebuh Acheh (W)	5	25	
	C	Pengkalan Weld (S)	0	0	
8	A	Pengkalan Weld (N)	0	0	
	B	Pengkalan Weld (S)	0	0	
	C	Raya Merdeka Hwy (E)	0	10	
9	A	Pengkalan Weld (N)	0	0	
	B	Gat Lebuh Melayu (W)	5	25	
	C	Pengkalan Weld (S)	0	0	
10	A	Lebuh Victoria (N)	0	0	
	B	Gat Lebuh Melayu (W)	0	0	
	C	Lebuh Victoria (S)	0	0	
	D	Gat Lebuh Melayu (E)	0	0	

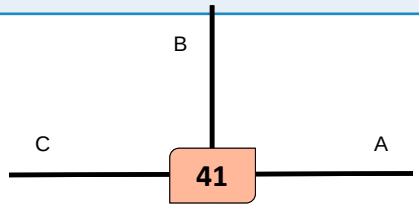
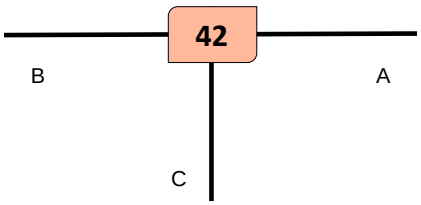
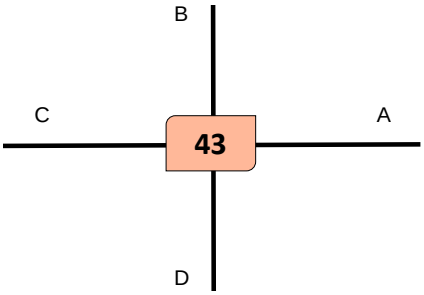
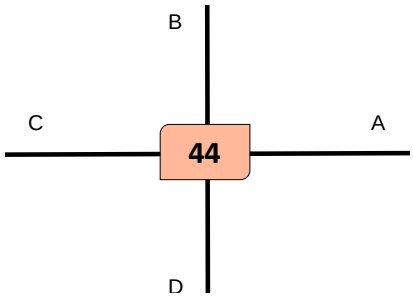
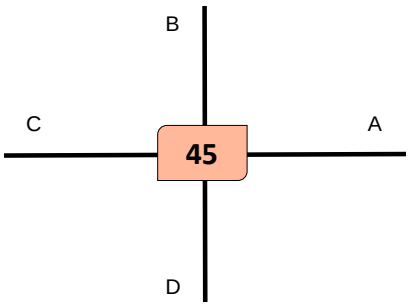
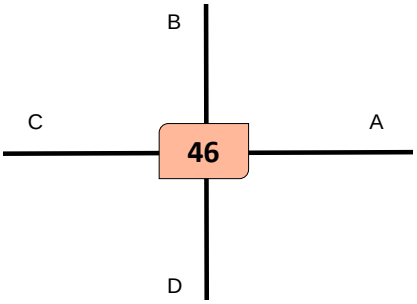
Junction no.	Approach	Road Name (Direction)	Observed Qeue Length AM (m)	Observed Qeue Length PM (m)	Diagram
11	A	Lebuh Victoria (N)	0	0	
	B	Gat Lebuh Acheh (W)	0	0	
	C	Lebuh Victoria (S)	0	0	
	D	Gat Lebuh Acheh (E)	0	0	
12	A	Lebuh Victoria (N)	0	0	
	B	Gat Lebuh Armenian (W)	0	0	
	C	Lebuh Victoria (S)	0	0	
	D	Gat Lebuh Armenian (E)	0	0	
13	A	Gat Lebuh Chulia (E)	0	0	
	B	Lebuh Victoria (N)	0	0	
	C	Gat Lebuh Chulia (W)	0	0	
	D	Lebuh Victoria (S)	0	0	
14	A	Lebuh Victoria (N)	0	0	
	B	Lebuh Victoria (S)	0	0	
	C	Gat Lebuh Pasar (E)	0	0	
15	A	Gat Lebuh China (W)	0	0	
	B	Lebuh Victoria (S)	0	0	
	C	Gat Lebuh China (E)	0	0	
16	A	Jalan Tun Syed Sheh Barakbah (N)	0	0	
	B	Lebuh Light (W)	5	20	
	C	Jalan Tun Syed Sheh Barakbah (S)	5	10	
	D	Lebuh Light (E)	0	0	

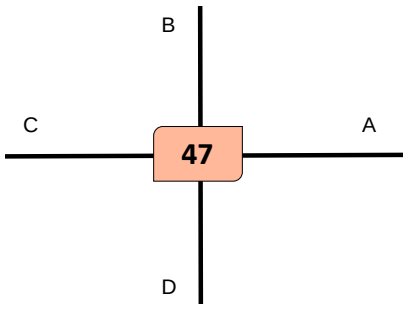
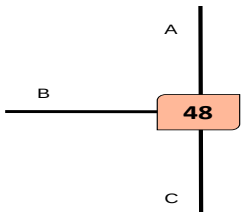
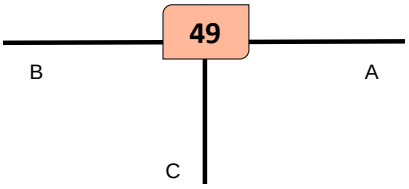
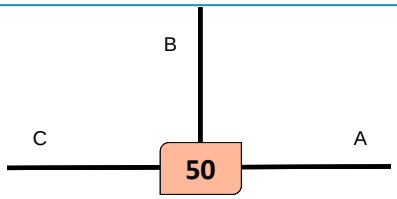
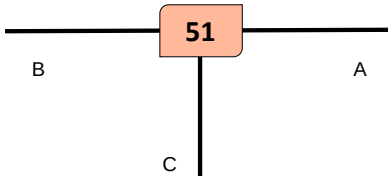
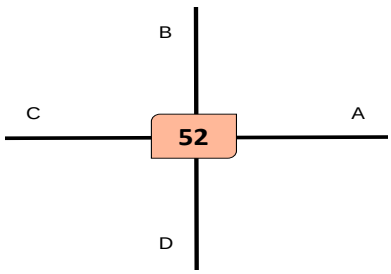
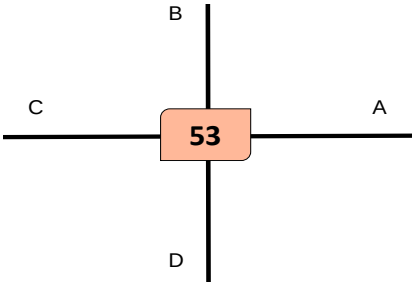
Junction no.	Approach	Road Name (Direction)	Observed Qeue Length AM (m)	Observed Qeue Length PM (m)	Diagram
17	A	Beach Street (N)	0	0	
	B	Beach Street (S)	0	0	
	C	Jalan Downing (W)	0	0	
18	A	Beach Street (N)	0	0	
	B	Lebuh Union (W)	0	0	
	C	Beach Street (S)	0	0	
19	A	Beach Street (N)	0	0	
	B	Lebuh Bishop (W)	0	0	
	C	Beach Street (S)	0	0	
20	A	Beach Street (N)	0	0	
	B	Lebuh Gereja (W)	0	0	
	C	Beach street (S)	0	0	
	D	Gat Lebuh Gereja (E)	0	0	
21	A	Beach Street (N)	0	0	
	B	Lebuh China (W)	0	0	
	C	Beach Street (S)	0	0	
	D	Gat Lebuh China (E)	0	0	
22	A	Beach Street (N)	0	0	
	B	Lebuh Pasar (W)	0	0	
	C	Beach Street (S)	0	0	

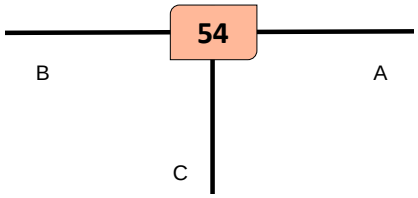
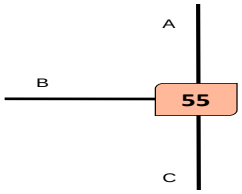
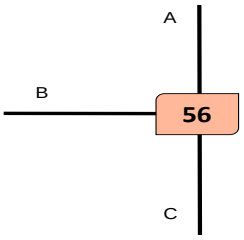
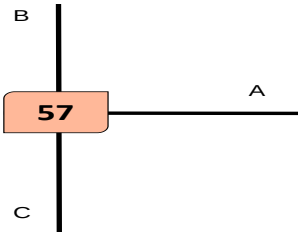
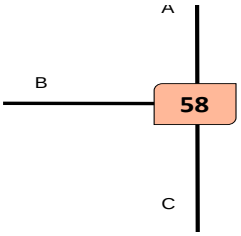
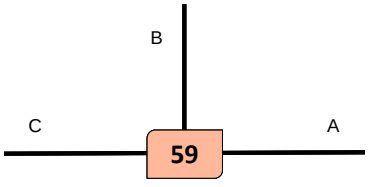
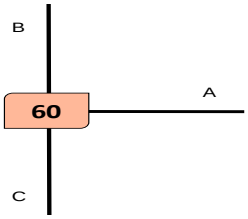
Junction no.	Approach	Road Name (Direction)	Observed Qeue Length AM (m)	Observed Qeue Length PM (m)	Diagram
23	A	Beach Street (N)	10	40	
	B	Chulia Street (W)	20	40	
	C	Beach Street (S)	15	25	
	D	Gat Lebuh Chulia (E)	10	40	
24	A	Beach Street (N)	0	0	
	B	Lebuh Ah Quee (W)	5	5	
	C	Beach Street (S)	0	0	
25	A	Beach Street (N)	0	0	
	B	Lebuh Armenian (W)	0	0	
	C	Beach Street (S)	0	0	
	D	Gat Lebuh Armenian (E)	0	10	
26	A	Beach Street (N)	0	0	
	B	Lebuh Acheh (W)	0	0	
	C	Beach Street (S)	0	0	
	D	Gat Lebuh Acheh (E)	0	0	
27	A	Beach Street (N)	0	0	
	B	Lebuh Melayu(W)	0	0	
	C	Beach Street (S)	0	0	
	D	Gat Lebuh Melayu (E)	0	0	
28	A	Lorong Toh Aka (N)	0	0	
	B	Lorong Melayu (W)	0	0	
	C	Lorong Ikan (S)	0	0	
	D	Lorong Melayu (E)	0	0	

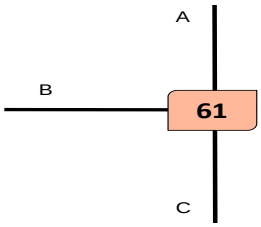
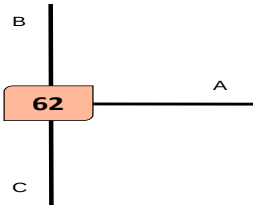
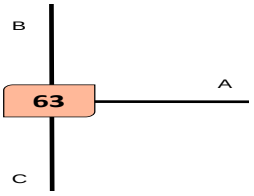
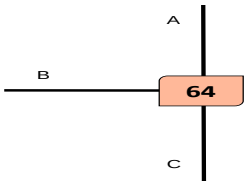
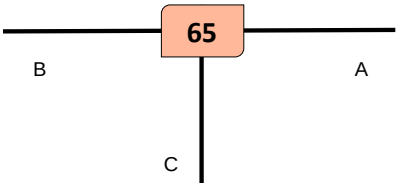
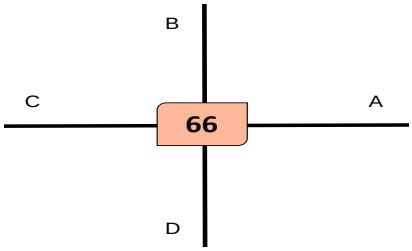
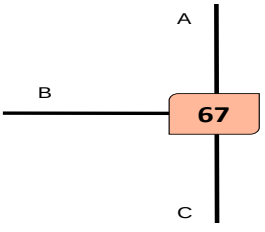
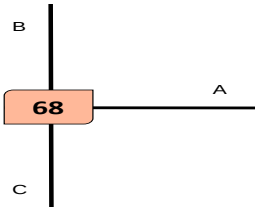
Junction no.	Approach	Road Name (Direction)	Observed Qeue Length AM (m)	Observed Qeue Length PM (m)	Diagram
29	A	Lorong Toh Aka (N)	0	0	
	B	Lorong Carnarvon (W)	0	0	
	C	Lorong Toh Aka (S)	0	0	
30	A	Lebuh Cannon (N)	0	0	
	B	Lebuh Acheh (W)	0	0	
	C	Lebuh Cannon (S)	0	0	
	D	Lebuh Acheh (E)	0	0	
31	A	Jalan Masjid Kapitan Keling (N)	0	0	
	B	Lebuh Armenian (W)	0	5	
	C	Lebuh Cannon (S)	0	0	
	D	Lebuh Armenian (E)	0	5	
32	A	Jalan Masjid Kapitan Keling (N)	0	0	
	B	Jalan Kampong Kolam (SW)	0	0	
	C	Jalan Masjid Kapitan Keling (S)	0	0	
33	A	Jalan Masjid Kapitan Keling (N)	0	0	
	B	Jalan Buckingham (W)	0	5	
	C	Jalan Masjid Kapitan Keling (S)	0	0	
34	A	Jalan Masjid Kapitan Keling (N)	0	25	
	B	Chulia Street (W)	0	50	
	C	Jalan Masjid Kapitan Keling (S)	0	40	
	D	Chulia Street (E)	0	40	

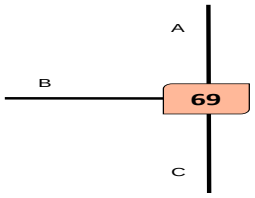
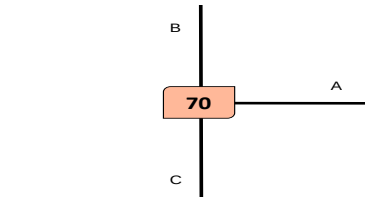
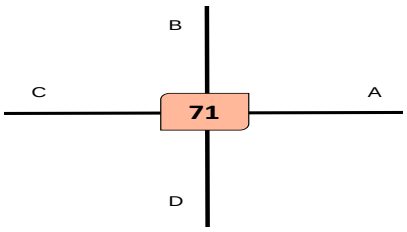
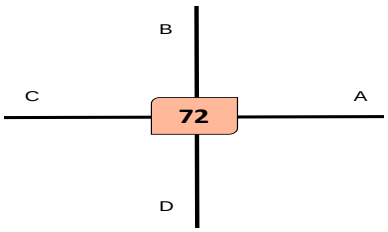
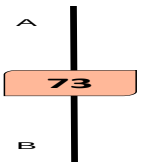
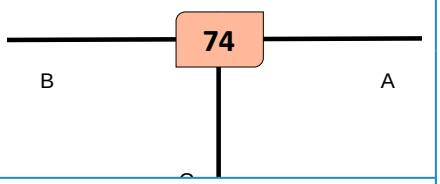
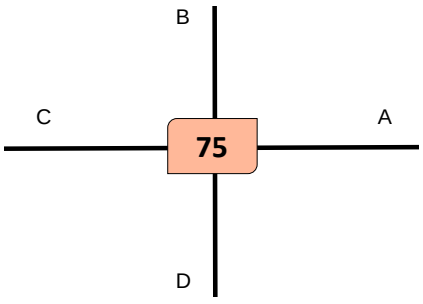
Junction no.	Approach	Road Name (Direction)	Observed Qeue Length AM (m)	Observed Qeue Length PM (m)	Diagram
35	A	Lebuh King (N)	0	0	
	B	Chulia Street (W)	0	0	
	C	Lorong Pit (S)	0	0	
	D	Chulia Street (E)	0	0	
36	A	Lebuh Penang (N)	5	10	
	B	Chulia Street (W)	0	0	
	C	Chulia Street (E)	0	0	
37	A	Lebuh Penang (N)	0	0	
	B	Lebuh Pasar (W)	0	0	
	C	Lebuh Penang (S)	0	0	
	D	Lebuh Pasar (E)	0	10	
38	A	Lebuh King (N)	0	0	
	B	Lebuh Pasar (W)	0	0	
	C	Lebuh King (S)	5	10	
	D	Lebuh Pasar (E)	0	0	
39	A	Queen Street (N)	0	10	
	B	Lebuh Pasar (W)	0	0	
	C	Queen Street (S)	0	0	
	D	Lebuh Pasar (E)	0	0	
40	A	Jalan Masjid Kapitan Keling (N)	0	0	
	B	Jalan Masjid Kapitan Keling (S)	0	0	
	C	Lebuh Pasar (E)	5	3	
	D	Lorong Ikan (S)	0	0	

Junction no.	Approach	Road Name (Direction)	Observed Qeue Length AM (m)	Observed Qeue Length PM (m)	Diagram
41	A	Jalan Masjid Kapitan Keling (N)	0	0	
	B	Lorong Stewart	5	20	
	C	Jalan Masjid Kapitan Keling (S)	0	15	
42	A	Lebuh China (E)	0	0	
	B	Jalan Masjid Kapitan Keling (N)	0	0	
	C	Jalan Masjid Kapitan Keling (S)	0	15	
43	A	Queen Street (N)	0	0	
	B	Lebuh China (W)	0	0	
	C	Queen Street (S)	0	0	
	D	Lebuh China (E)	0	0	
44	A	Lebuh King (N)	0	0	
	B	Lebuh China (W)	0	0	
	C	Lebuh King (S)	0	0	
	D	Lebuh China (E)	0	0	
45	A	Lebuh Penang (N)	5	10	
	B	Lebuh China (W)	0	0	
	C	Lebuh Penang (S)	0	0	
	D	Lebuh China (E)	0	0	
46	A	Lebuh Penang (N)	0	0	
	B	Lebuh Gereja (W)	0	0	
	C	Lebuh Penang (S)	0	0	
	D	Lebuh Gereja (E)	5	10	

Junction no.	Approach	Road Name (Direction)	Observed Qeue Length AM (m)	Observed Qeue Length PM (m)	Diagram
47	A	Lebuh King (N)	0	0	
	B	Lebuh Gereja (W)	0	0	
	C	Lebuh King (S)	5	10	
	D	Lebuh Gereja (E)	0	0	
48	A	Lebuh Gereja (W)	0	0	
	B	Queen Street (S)	0	0	
	C	Lebuh Gereja (E)	0	0	
49	A	Jalan Masjid Kapitan Keling (N)	0	0	
	B	Jalan Masjid Kapitan Keling (S)	0	0	
	C	Lebuh Gereja (E)	0	35	
50	A	Jalan Masjid Kapitan Keling (N)	0	0	
	B	Lorong Argus (W)	0	0	
	C	Jalan Masjid Kapitan Keling (S)	0	0	
51	A	Jalan Masjid Kapitan Keling (N)	0	0	
	B	Jalan Masjid Kapitan Keling (S)	0	5	
	C	Lebuh Bishop (E)	0	0	
52	A	Lebuh King (N)	0	0	
	B	Lebuh Bishop (W)	0	0	
	C	Lebuh King (S)	0	0	
	D	Lebuh Bishop (E)	0	0	
53	A	Lebuh Penang (N)	0	5	
	B	Lebuh Bishop (W)	0	0	
	C	Lebuh Penang (S)	0	0	
	D	Lebuh Bishop (E)	0	0	

Junction no.	Approach	Road Name (Direction)	Observed Qeue Length AM (m)	Observed Qeue Length PM (m)	Diagram
54	A	Lebuh Penang (N)	0	0	
	B	Lebuh Penang (S)	0	0	
	C	Lebuh Union (E)	0	5	
55	A	Lebuh Light (W)	0	0	
	B	Lebuh Penang (S)	0	0	
	C	Lebuh Light (E)	0	0	
56	A	Lebuh Light (W)	0	0	
	B	Lebuh King (S)	0	5	
	C	Lebuh Light (E)	0	0	
57	A	Jalan Padang Kota Lama (N)	0	0	
	B	Lebuh Light (W)	0	0	
	C	Lebuh Light (E)	0	0	
58	A	Lebuh Light (W)	0	0	
	B	Jalan Masjid Kapitan Keling (S)	0	0	
	C	Lebuh Light (E)	0	0	
59	A	Jalan Masjid Kapitan Keling (N)	0	0	
	B	Lebuh Farquhar (W)	0	0	
	C	Jalan Masjid Kapitan Keling (S)	0	0	
60	A	Jalan Tun Syed Sheh Barakbah (N)	0	10	
	B	Lebuh Light (W)	0	0	
	C	Lebuh Light (E)	0	0	

Junction no.	Approach	Road Name (Direction)	Observed Qeue Length AM (m)	Observed Qeue Length PM (m)	Diagram
61	A	Lebuh Farquhar (W)	0	0	
	B	Lebuh Farquhar (S)	0	0	
	C	Lebuh Farquhar (E)	0	30	
62	A	Jalan Geen Hall (N)	0	10	
	B	Lebuh Light (W)	0	30	
	C	Lebuh Light (E)	0	0	
63	A	Lebuh Light (N)	0	0	
	B	Lebuh Farquhar (W)	0	0	
	C	Lebuh Farquhar (E)	0	0	
64	A	Lebuh Farquhar (W)	0	0	
	B	Lorong Love (S)	10	20	
	C	Lebuh Farquhar (E)	0	0	
65	A	Lorong Love (N)	0	0	
	B	Lorong Love (S)	0	0	
	C	Lorong Argus (E)	0	0	
66	A	Lorong Love (N)	0	0	
	B	Muntri Street (W)	0	10	
	C	Lorong Love (S)	0	0	
	D	Lorong Stewart (E)	0	0	
67	A	Lorong Stewart (W)	0	0	
	B	Lorong Chulia (S)	0	0	
	C	Lorong Stewart (E)	0	0	
68	A	Lorong Love (N)	0	0	
	B	Chulia Street (W)	0	0	
	C	Chulia Street (E)	0	0	

Junction no.	Approach	Road Name (Direction)	Observed Qeue Length AM (m)	Observed Qeue Length PM (m)	Diagram
69	A	Chulia Street (W)	0	0	
	B	Lebuh Carnarvon (S)	0	20	
	C	Chulia Street (E)	0	0	
70	A	Lorong Chulia (N)	0	0	
	B	Chulia Street (W)	0	0	
	C	Chulia Street (E)	0	0	
71	A	Lebuh Carnarvon (N)	0	0	
	B	Lebuh Campbell (W)	0	0	
	C	Lebuh Carnarvon (S)	0	0	
	D	Jalan Buckingham (E)	0	0	
72	A	Lebuh Carnarvon (N)	0	0	
	B	Pesara Claimant (W)	0	0	
	C	Lebuh Carnarvon (S)	0	0	
	D	Jalan Kampong Kolam (E)	0	0	
73	A	Jalan Kampong Kolam (W)	0	0	
	B	Jalan Kampong Kolam (E)	0	0	
74	A	Lebuh Carnarvon (N)	0	0	
	B	Lebuh Carnarvon (S)	0	0	
	C	Lebuh Acheh (E)	0	0	
75	A	Lebuh Carnarvon (N)	0	0	
	B	Lebuh Kimberley (W)	0	0	
	C	Lebuh Carnarvon (S)	0	0	
	D	Lorong Carnarvon (E)	0	0	

Traffic demand in Penang during the survey period was reduced due to the ongoing Covid-19 pandemic. Residents of Penang as well as tourists have become more cautious around travel during this pandemic period. This has resulted in lower traffic demand on the road-network and in turn has reduced queue lengths often observed in Georgetown.

Photo: ADB

PARKING SURVEYS

Photo: Adobe Stock

4.1 SURVEY TASKS

Parking surveys were conducted at both on-street and off-street parking facilities. On-street parking was classified by street and midblock section. Illegal parking was also recorded.

The parking data collected were categorized into the following three tasks:

1. On-street parking occupancy survey
2. Off-street parking occupancy survey
3. Parking dwell time survey

Results of the respective tasks are shown in the sections below.

4.2 SURVEY RESULTS

4.2.1 ON-STREET PARKING OCCUPANCY

On-street parking surveys were conducted between junctions along the road sections highlighted in both yellow and purple in Figure 37.

Figure 37: On-street Parking Occupancy Survey Locations

The entire study area was divided into 4 areas for the survey to be conducted over a three-day period. For each of the surveyed road section between junctions, occupancy data were collected every hour to understand the number of vehicles occupying the parking space at the given time.

Results reported in the table below are showing the maximum and average of the on street parking occupancy. Abbreviations for the content in table is as below:

C - Car;
LGV - Light Good Vehicle;
HGV - Heavy Good Vehicle;
B - BUS;
M - Motorcycle;
Left - Parking on left side of the road while traveling form Junction X to Junction Y;
Right - Parking on right side of the road while traveling form Junction X to Junction Y.

Table 6: On-street Parking Occupancy Survey Results

Junction 23 to Junction 22		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	2	0	0	0	1	5	0	0	0	0
	Max	5	0	0	0	2	6	0	0	0	1
PM Peak	Average	11	0	0	0	4	10	2	0	0	1
	Max	8	0	0	0	6	10	3	0	0	1
Junction 22 to Junction 21		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	4	0	0	0	6	7	0	0	0	5
	Max	4	0	0	0	17	9	0	0	0	10
PM Peak	Average	5	0	0	0	17	11	0	0	0	7
	Max	5	0	0	0	18	10	1	0	0	9
Junction 21 to Junction 20		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	8	0	0	0	11	8	0	0	0	0
	Max	9	0	0	0	21	9	1	0	0	0
PM Peak	Average	12	0	0	0	26	12	0	0	0	0
	Max	10	0	0	0	27	12	0	0	0	0
Junction 17 to Junction 16		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	0	0	0	0	7	6	0	0	0	4
	Max	0	0	0	0	11	5	0	0	0	10
PM Peak	Average	4	0	0	0	5	3	0	0	0	5
	Max	10	0	0	0	9	4	0	0	0	10
Junction 16 to Junction A		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	2	0	0	0	0	8	0	0	0	0
	Max	6	0	0	0	0	9	0	0	0	1
PM Peak	Average	1	0	0	0	0	3	0	0	0	0
	Max	1	0	0	0	0	4	0	0	0	0

Junction 1 to Junction 17		Left					Right				
		C	LGV	HGV	B	M	C	LGV	HGV	B	M
AM Peak	Average	4	0	0	0	17	2	0	0	0	36
	Max	4	0	0	0	24	2	0	0	0	63
PM Peak	Average	6	0	0	0	13	2	0	0	0	26
	Max	5	0	0	0	25	2	0	0	0	50
Junction 5 to Junction 13		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	4	1	0	0	0	5	0	0	0	2
	Max	6	1	0	0	0	11	0	0	0	2
PM Peak	Average	8	0	0	0	0	8	0	0	0	1
	Max	9	0	0	0	0	10	0	0	0	1
Junction 13 to Junction 14		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	6	2	0	0	0	10	0	0	0	3
	Max	9	2	0	0	0	11	0	1	0	6
PM Peak	Average	6	1	0	0	0	12	0	0	0	1
	Max	7	1	0	0	1	12	0	0	0	1
Junction 14 to Junction 15		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	1	0	0	0	0	8	0	0	0	0
	Max	3	0	0	0	0	7	0	0	0	0
PM Peak	Average	9	0	0	0	0	11	1	0	0	0
	Max	10	0	0	0	1	10	1	0	0	0
Junction 21 to Junction 15		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	8	0	0	0	3	0	0	0	0	0
	Max	10	0	0	0	8	0	0	0	0	0
PM Peak	Average	9	0	0	0	9	0	0	0	0	0
	Max	10	0	0	0	10	0	0	0	0	0
Junction 15 to Junction 3		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	7	0	0	0	0	7	0	0	0	1
	Max	10	0	0	0	0	10	0	0	0	4
PM Peak	Average	10	0	0	0	0	9	0	0	0	4
	Max	11	0	0	0	1	10	0	0	0	4
Junction 2 to Junction 20		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	22	0	0	0	1	11	0	0	0	0
	Max	20	0	0	0	2	14	0	0	0	1
PM Peak	Average	18	0	0	0	0	19	0	0	0	1
	Max	17	0	0	0	0	12	0	0	0	1
Junction 62 - End		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	11	0	0	0	6	21	1	0	0	9
	Max	12	0	0	0	11	27	2	0	0	18
PM Peak	Average	17	0	0	0	22	24	2	0	0	15
	Max	13	0	0	0	20	24	2	0	0	13

Junction 58 - Junction 57		Left					Right				
		C	LGV	HGV	B	M	C	LGV	HGV	B	M
AM Peak	Average	13	0	0	0	8	12	0	0	0	0
	Max	13	0	0	0	16	17	0	0	0	0
PM Peak	Average	26	0	0	0	27	31	0	0	0	3
	Max	17	1	0	0	25	17	0	0	0	3
Junction 57 - End		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	3	1	0	0	7	11	0	0	0	0
	Max	7	1	0	0	10	28	0	0	0	0
PM Peak	Average	10	1	0	0	5	15	0	0	0	0
	Max	8	1	0	0	4	16	0	0	0	0
Junction 57 - Junction 56		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	7	0	0	0	1	0	0	0	0	1
	Max	12	0	0	0	2	0	0	0	0	2
PM Peak	Average	15	0	0	0	0	6	0	0	0	0
	Max	12	0	0	0	0	7	0	0	0	0
Junction 56 - End		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	25	0	0	0	7	7	0	0	0	9
	Max	54	0	0	0	10	13	0	0	0	10
PM Peak	Average	61	0	0	0	7	16	1	0	0	6
	Max	56	0	0	0	10	19	1	0	0	5
Junction 56 - Junction 16		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	0	0	0	0	2	11	0	0	0	7
	Max	1	0	0	0	3	20	1	0	0	8
PM Peak	Average	3	0	0	0	1	53	0	0	0	2
	Max	5	0	0	0	2	57	1	0	0	5
Junction 51 - Junction49		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	2	0	0	0	0	1	0	0	0	0
	Max	4	1	0	0	0	4	0	0	0	0
PM Peak	Average	4	0	0	0	4	1	0	0	0	0
	Max	4	0	0	0	4	2	0	0	0	0
Junction 49 - Junction50		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	2	0	0	0	2	3	0	0	0	0
	Max	6	0	0	0	3	7	0	0	0	0
PM Peak	Average	4	0	0	0	2	4	0	0	0	0
	Max	5	0	0	0	2	9	0	0	0	0
Junction 50 - Junction42		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	2	0	0	0	7	1	0	0	0	6
	Max	2	0	0	0	11	2	0	0	0	6
PM Peak	Average	0	0	0	0	4	3	0	0	0	8
	Max	0	0	0	0	8	4	0	0	0	8

Junction 34 -Junction70		Left					Right				
		C	LGV	HGV	B	M	C	LGV	HGV	B	M
AM Peak	Average	2	0	0	0	3	7	0	0	0	0
	Max	4	0	0	0	6	13	0	0	0	1
PM Peak	Average	9	0	0	0	8	13	0	0	0	2
	Max	12	0	0	0	12	15	1	0	0	2
Lorong Steward		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	1	0	0	0	0	2	0	0	0	1
	Max	2	0	0	0	0	2	0	0	0	2
PM Peak	Average	9	1	0	0	0	3	0	0	0	1
	Max	10	2	0	0	0	3	0	0	0	2
Junction 50 - End		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	4	0	0	0	0	0	0	0	0	0
	Max	8	0	0	0	0	0	0	0	0	0
PM Peak	Average	7	0	0	0	0	0	0	0	0	0
	Max	9	0	0	0	0	0	0	0	0	0
A to B Lorong Muda		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	0	0	0	0	5	3	0	0	0	0
	Max	0	0	0	0	7	3	0	0	0	0
PM Peak	Average	0	0	0	0	2	5	0	0	0	0
	Max	0	0	0	0	4	8	0	0	0	0
C to D		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	1	0	0	0	6	14	0	0	0	1
	Max	3	0	0	0	6	17	0	0	0	1
PM Peak	Average	9	0	0	0	2	22	0	0	0	0
	Max	14	1	0	0	2	21	0	0	0	0
Lebuh Klang		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	3	0	0	0	4	6	0	0	0	1
	Max	4	0	0	0	4	5	0	0	0	1
PM Peak	Average	5	0	0	0	4	6	0	0	0	1
	Max	6	0	0	0	5	6	0	0	0	3
Junction 67 -Junction70		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	6	1	0	0	4	5	0	0	0	1
	Max	9	1	0	0	4	7	0	0	0	3
PM Peak	Average	7	0	0	0	2	8	0	0	0	2
	Max	7	0	0	0	3	7	0	0	0	3
Junction 68 -Junction66		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	0	0	0	0	2	16	0	0	0	13
	Max	1	0	0	0	2	18	0	0	0	8
PM Peak	Average	3	0	0	0	5	15	0	0	0	16
	Max	4	0	0	0	6	20	0	0	0	11

Junction 66 -Junction65		Left					Right				
		C	LGV	HGV	B	M	C	LGV	HGV	B	M
AM Peak	Average	9	0	0	0	5	0	0	0	0	1
	Max	13	0	0	0	5	0	0	0	0	1
PM Peak	Average	11	0	0	0	5	0	0	0	0	1
	Max	11	0	0	0	6	0	0	0	0	1
Junction 65- End		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	4	0	0	0	0	0	1	0	0	1
	Max	3	0	0	0	0	0	1	0	0	1
PM Peak	Average	4	0	0	0	0	0	0	0	0	1
	Max	4	0	0	0	1	0	0	0	0	2
Junction 65 -Junction64		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	7	0	0	0	1	0	0	0	0	0
	Max	12	0	0	0	1	0	0	0	0	0
PM Peak	Average	5	0	0	0	0	0	0	0	0	0
	Max	5	0	0	0	0	0	0	0	0	0
Junction 59 to Junction52		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	5	0	0	0	1	5	0	0	0	7
	Max	11	0	0	0	1	8	0	0	0	10
PM Peak	Average	13	0	0	0	8	13	0	0	0	11
	Max	11	0	0	0	9	18	0	0	0	13
Junction 52 to Junction 53		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	6	0	0	0	8	8	0	0	0	1
	Max	6	1	0	0	10	8	0	0	0	3
PM Peak	Average	10	0	0	0	8	9	0	0	0	4
	Max	8	0	0	0	9	8	0	0	0	5
Junction 53 to Junction 19		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	5	0	0	0	2	16	0	0	0	7
	Max	5	0	0	0	5	23	0	0	0	8
PM Peak	Average	15	1	0	0	11	23	0	0	0	18
	Max	10	1	0	0	12	21	0	0	0	21
Junction 18 to Junction 54		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	10	0	0	0	11	15	0	0	0	10
	Max	10	0	0	0	20	20	0	0	0	13
PM Peak	Average	18	0	0	0	9	19	0	0	0	7
	Max	13	0	0	0	17	19	0	0	0	13
Junction 55 to Junction 54		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	3	0	0	0	6	5	0	0	0	0
	Max	3	0	0	0	8	7	0	0	0	0
PM Peak	Average	4	0	0	0	8	8	0	0	0	0
	Max	3	0	0	0	9	8	0	0	0	0

Junction 54 to Junction 53		Left					Right				
		C	LGV	HGV	B	M	C	LGV	HGV	B	M
AM Peak	Average	4	0	0	0	5	7	1	0	0	1
	Max	5	1	0	0	8	10	1	0	0	2
PM Peak	Average	5	0	0	0	7	9	0	0	0	1
	Max	6	0	0	0	7	11	0	0	0	2
Junction 53 to Junction 46		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	6	0	0	0	2	4	0	0	0	5
	Max	5	0	0	0	3	8	0	0	0	5
PM Peak	Average	7	0	0	0	1	11	0	0	0	4
	Max	6	0	0	0	1	11	0	0	0	5
Junction 46 to Junction 45		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	8	0	0	0	4	10	0	0	0	3
	Max	12	0	0	0	4	16	0	0	0	4
PM Peak	Average	13	0	0	0	8	19	0	0	0	4
	Max	10	0	0	0	6	18	0	0	0	3
Junction 45 toJunction 37		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	2	0	0	0	1	6	0	0	0	2
	Max	3	0	0	0	2	10	0	0	0	2
PM Peak	Average	6	1	0	0	4	11	0	0	0	8
	Max	5	1	0	0	5	11	0	0	0	7
Junction 37 to Junction 36		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	5	0	0	0	2	6	0	0	0	5
	Max	7	1	0	0	4	12	0	0	0	9
PM Peak	Average	16	1	0	0	5	15	0	0	0	8
	Max	11	2	0	0	5	12	0	0	0	12
Junction 23 to Junction 22		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	2	0	0	0	3	6	0	0	0	1
	Max	5	0	0	0	3	9	0	0	0	3
PM Peak	Average	11	0	0	0	6	9	2	0	0	1
	Max	9	0	0	0	7	10	4	0	0	4
Junction 22 to Junction 21		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	5	0	0	0	8	7	0	0	0	6
	Max	4	0	0	0	21	9	0	0	0	12
PM Peak	Average	4	0	0	0	20	9	1	0	0	10
	Max	4	0	0	0	21	9	2	0	0	15
Junction 21 to Junction 20		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	7	0	0	0	19	8	0	0	0	0
	Max	8	0	0	0	27	10	1	0	0	0
PM Peak	Average	11	0	0	0	30	12	0	0	0	1
	Max	8	0	0	0	26	13	0	0	0	2

Junction 20 to Junction 46		Left					Right				
		C	LGV	HGV	B	M	C	LGV	HGV	B	M
AM Peak	Average	14	3	0	0	6	9	4	1	0	5
	Max	15	2	0	0	9	14	5	2	0	8
PM Peak	Average	20	2	0	0	7	15	3	0	0	11
	Max	17	2	0	0	5	15	4	0	0	10
Junction 46 to Junction 47		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	6	0	0	0	0	5	0	0	0	0
	Max	8	0	0	0	0	10	0	0	0	0
PM Peak	Average	8	0	0	0	0	9	0	0	0	0
	Max	8	0	0	0	0	9	0	0	0	0
Junction 47 to Junction 48		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	4	0	0	0	2	7	0	0	0	1
	Max	7	0	0	0	3	12	0	0	0	2
PM Peak	Average	6	0	0	0	2	12	1	0	0	0
	Max	6	0	0	0	3	12	1	0	0	1
Junction 48 to Junction 49		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	2	0	0	0	1	2	0	0	0	0
	Max	3	0	0	0	4	4	0	0	0	0
PM Peak	Average	3	0	0	0	2	3	0	0	0	0
	Max	3	0	0	0	2	4	0	0	0	0
Junction 42 to Junction 43		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	1	0	0	0	1	1	0	0	0	0
	Max	2	0	0	0	1	4	0	0	0	0
PM Peak	Average	3	0	0	0	1	4	0	0	0	0
	Max	3	0	0	0	2	4	1	0	0	0
Junction 43 to Junction 44		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	2	0	0	0	0	1	0	0	0	1
	Max	5	0	0	0	1	2	0	0	0	2
PM Peak	Average	7	0	0	0	4	8	0	0	0	2
	Max	5	0	0	0	3	6	0	0	0	2
Junction 44 to Junction 45		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	5	0	0	0	5	5	0	0	0	0
	Max	5	0	0	0	6	8	0	0	0	0
PM Peak	Average	9	0	0	0	4	8	0	0	0	3
	Max	6	0	0	0	6	8	1	0	0	4
Junction 45 to Junction 21		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	8	0	0	0	4	10	2	0	0	4
	Max	9	1	0	0	7	14	2	0	0	11
PM Peak	Average	15	0	0	0	8	15	1	0	0	6
	Max	9	0	0	0	9	16	1	0	0	9

Junction 22 to Junction 37		Left					Right				
		C	LGV	HGV	B	M	C	LGV	HGV	B	M
AM Peak	Average	12	0	0	0	3	4	1	0	0	0
	Max	21	0	0	0	5	5	1	0	0	1
PM Peak	Average	21	0	0	0	10	12	1	0	0	3
	Max	18	0	0	0	7	10	1	0	0	4
Junction 35 to Junction 38		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	5	0	0	0	2	8	0	0	0	3
	Max	5	0	0	0	4	11	1	0	0	4
PM Peak	Average	19	0	0	0	9	15	0	0	0	8
	Max	15	0	0	0	12	13	0	0	0	7
Junction 38 to Junction 44		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	2	1	0	0	0	5	0	0	0	4
	Max	6	1	0	0	0	9	0	0	0	7
PM Peak	Average	10	2	0	0	2	9	0	0	0	6
	Max	6	2	0	0	2	9	0	0	0	6
Junction 44 to Junction 47		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	7	1	0	0	3	8	0	0	0	0
	Max	14	2	0	0	4	13	0	0	0	1
PM Peak	Average	19	0	0	0	5	15	0	0	0	4
	Max	17	0	0	0	7	14	0	0	0	5
Junction 47 to Junction 52		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	10	0	0	0	1	6	0	0	0	2
	Max	14	0	0	0	2	7	0	0	0	3
PM Peak	Average	16	0	0	0	0	8	0	0	0	0
	Max	14	0	0	0	0	8	0	0	0	0
Junction 52 to Junction 56		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	24	0	0	0	1	18	1	0	0	10
	Max	27	0	0	0	2	25	1	0	0	17
PM Peak	Average	26	0	0	0	2	23	1	0	0	10
	Max	28	0	0	0	4	28	1	0	0	17
Junction 48 to Junction 43		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	4	0	0	0	2	15	0	0	0	0
	Max	8	0	0	0	2	25	0	0	0	1
PM Peak	Average	8	0	0	0	4	21	0	0	0	2
	Max	10	0	0	0	5	25	0	0	0	3
Junction 43 to Junction 39		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	2	0	0	0	4	7	0	0	0	3
	Max	3	0	0	0	4	11	0	0	0	4
PM Peak	Average	5	0	0	0	3	15	0	0	0	7
	Max	6	0	0	0	3	12	0	0	0	8

Junction 34 to Junction 35		Left					Right				
		C	LGV	HGV	B	M	C	LGV	HGV	B	M
AM Peak	Average	0	0	0	0	2	4	0	0	0	0
	Max	0	0	0	0	3	7	0	0	0	0
PM Peak	Average	1	0	0	0	6	7	0	0	0	2
	Max	2	1	0	0	7	8	0	0	0	2
Junction 35 to Junction 23		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	6	0	0	0	1	8	1	0	0	2
	Max	11	0	0	0	4	9	2	0	0	5
PM Peak	Average	9	0	0	0	5	14	1	0	0	6
	Max	11	0	0	0	6	16	1	0	0	7
Junction 39 to End		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	7	0	0	0	4	9	0	0	0	13
	Max	6	0	0	0	5	11	0	0	0	10
PM Peak	Average	9	0	0	0	10	16	0	0	0	9
	Max	7	0	0	0	12	12	0	0	0	8
Junction 71 to Junction C		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	1	0	0	0	1	7	0	0	0	6
	Max	1	0	0	0	2	10	0	0	0	6
PM Peak	Average	0	0	0	0	0	5	0	0	0	2
	Max	0	0	0	0	0	6	0	0	0	4
Junction C to Junction 32		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	1	0	0	0	0	9	0	0	0	0
	Max	2	0	0	0	0	13	0	0	0	0
PM Peak	Average	7	0	0	0	0	15	0	0	0	1
	Max	8	0	0	0	0	15	0	0	0	2
Junction D to Junction C		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	4	0	0	0	0	6	1	0	0	0
	Max	5	0	0	0	0	6	1	0	0	0
PM Peak	Average	5	0	0	0	0	6	0	0	0	0
	Max	5	0	0	0	0	6	0	0	0	0
Junction 31 to Junction 73		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	0	0	0	0	0	3	0	0	0	2
	Max	0	0	0	0	0	5	0	0	0	4
PM Peak	Average	0	0	0	0	0	7	0	0	0	2
	Max	1	0	0	0	0	9	0	0	0	3
Junction 73 to´Junction 74		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	5	0	0	0	5	0	0	0	0	1
	Max	6	0	0	0	6	0	0	0	0	3
PM Peak	Average	5	0	0	0	4	0	0	0	0	0
	Max	4	0	0	0	4	1	0	0	0	0

Junction 74 to Junction 75		Left					Right				
		C	LGV	HGV	B	M	C	LGV	HGV	B	M
AM Peak	Average	11	0	0	0	2	2	0	0	0	0
	Max	9	0	0	0	7	5	1	0	0	0
PM Peak	Average	8	0	0	0	8	0	0	0	0	0
	Max	7	0	0	0	6	0	0	0	0	0
Junction 75 to Junction 29		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	18	3	0	0	6	4	1	0	0	2
	Max	18	3	0	0	5	5	1	0	0	4
PM Peak	Average	20	2	0	0	7	6	1	0	0	3
	Max	17	2	0	0	4	5	2	0	0	4
Junction 29 to Junction 28		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	9	0	0	0	0	0	0	0	0	0
	Max	11	0	0	0	1	0	0	0	0	0
PM Peak	Average	9	0	0	0	0	0	0	0	0	0
	Max	10	0	0	0	1	0	0	0	0	0
Junction 27 to Junction 28		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	1	0	0	0	0	4	0	0	0	3
	Max	1	0	0	0	1	9	0	0	0	5
PM Peak	Average	4	0	0	0	1	6	1	0	0	1
	Max	3	0	0	0	1	7	1	0	0	2
Junction 27 to Junction 26		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	21	2	0	0	4	8	2	0	0	2
	Max	22	3	0	0	5	8	2	0	0	4
PM Peak	Average	20	2	0	0	3	11	2	0	0	13
	Max	20	2	0	0	6	11	2	0	0	20
Junction 26 to Junction 25		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	9	0	0	0	5	5	1	0	0	1
	Max	14	0	0	0	4	13	2	0	0	3
PM Peak	Average	18	0	0	0	2	13	2	0	0	1
	Max	19	0	0	0	3	15	2	0	0	2
Junction 25 to Junction 24		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	4	1	0	0	2	1	2	0	0	1
	Max	8	1	0	0	5	2	2	0	0	2
PM Peak	Average	9	2	0	0	2	8	2	0	0	5
	Max	11	3	0	0	5	7	3	0	0	5
Junction 24 to Junction 23		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	3	0	0	0	0	5	0	0	0	0
	Max	5	1	0	0	0	7	0	0	0	0
PM Peak	Average	5	0	0	0	0	5	0	0	0	0
	Max	5	0	0	0	0	7	1	0	0	0

Junction 13 to Junction 12		Left					Right				
		C	LGV	HGV	B	M	C	LGV	HGV	B	M
AM Peak	Average	9	1	0	0	0	2	0	0	0	3
	Max	16	1	0	0	1	2	0	0	0	4
PM Peak	Average	15	1	0	0	0	8	0	0	0	4
	Max	16	1	0	0	0	9	0	0	0	4
Junction 12 to Junction 11		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	1	0	0	0	0	3	0	0	0	1
	Max	2	0	0	0	1	5	0	0	0	2
PM Peak	Average	3	0	0	0	0	8	1	0	0	4
	Max	3	1	0	0	1	8	1	0	0	7
Junction 11 to Junction 10		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	8	1	0	0	2	22	2	0	0	3
	Max	10	1	0	0	3	22	2	0	0	3
PM Peak	Average	12	2	0	0	1	25	2	0	0	7
	Max	10	1	1	0	3	24	2	0	0	6
Junction 10 to Junction 27		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	0	0	0	0	0	6	0	0	0	1
	Max	0	1	0	0	0	6	0	0	0	2
PM Peak	Average	1	0	0	0	0	7	0	0	0	1
	Max	3	0	0	0	0	7	1	0	0	2
Junction 6 to Junction 12		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	9	0	0	0	3	2	1	0	0	2
	Max	9	0	0	0	2	2	1	0	0	4
PM Peak	Average	10	0	0	0	6	7	1	0	0	0
	Max	10	0	0	0	5	9	1	0	0	0
Junction 12 to Junction 25		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	4	1	0	0	1	6	0	0	0	0
	Max	5	1	0	0	1	10	0	0	0	0
PM Peak	Average	11	1	0	0	3	15	0	0	0	0
	Max	11	1	0	0	4	15	0	0	0	1
Junction 25 to Junction E		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	0	0	0	0	0	1	0	0	0	0
	Max	1	0	0	0	1	3	0	0	0	1
PM Peak	Average	3	0	0	0	0	0	0	0	0	0
	Max	4	0	0	0	0	1	0	0	0	1
Junction E to Junction F		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	1	0	0	0	1	1	0	0	0	0
	Max	2	0	0	0	2	2	0	0	0	0
PM Peak	Average	4	0	0	0	1	5	0	0	0	1
	Max	4	0	0	0	2	6	0	0	0	2

Junction E to Junction 31		Left					Right				
		C	LGV	HGV	B	M	C	LGV	HGV	B	M
AM Peak	Average	1	0	0	0	1	4	0	0	0	0
	Max	2	0	0	0	4	5	0	0	0	0
PM Peak	Average	4	0	0	0	0	4	0	0	0	1
	Max	4	0	0	0	0	4	0	0	0	1
Junction 31 to Junction 30		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	4	0	0	0	1	2	0	0	0	0
	Max	5	0	0	0	1	2	0	0	0	0
PM Peak	Average	12	0	0	0	1	3	0	0	0	0
	Max	12	0	0	0	2	2	0	0	0	0
Junction 30 to Junction G		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	0	0	0	0	0	2	0	0	0	0
	Max	0	0	0	0	0	2	0	0	0	0
PM Peak	Average	0	0	0	0	0	5	0	0	0	1
	Max	0	0	0	0	1	7	0	0	0	1
Junction 74 to Junction 31		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	11	0	0	0	0	0	0	0	0	0
	Max	11	0	0	0	0	0	0	0	0	0
PM Peak	Average	11	0	0	0	0	3	0	0	0	1
	Max	12	0	0	0	0	3	0	0	0	1
Junction 30 to Junction 26		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	9	0	0	0	8	5	0	0	0	0
	Max	14	0	0	0	10	6	0	0	0	0
PM Peak	Average	17	0	0	0	6	5	0	0	0	2
	Max	20	0	0	0	7	6	0	0	0	4
Junction 26 to Junction 11		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	1	0	0	0	1	7	0	0	0	1
	Max	2	0	0	0	1	8	0	0	0	1
PM Peak	Average	1	0	0	0	0	9	0	0	0	3
	Max	1	0	0	0	0	9	0	0	0	5
Junction 11 to Junction 7		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	0	0	0	0	1	2	0	0	0	1
	Max	0	0	0	0	2	4	0	0	0	1
PM Peak	Average	0	0	0	0	3	3	0	0	0	1
	Max	0	0	0	0	5	4	0	0	0	1
Junction G to Junction H		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	9	1	0	0	0	0	0	0	0	1
	Max	9	1	0	0	1	1	0	0	0	3
PM Peak	Average	8	1	0	0	0	1	0	0	0	2
	Max	9	1	0	0	1	1	0	0	0	3

Junction I to Junction 29		Left					Right				
		C	LGV	HGV	B	M	C	LGV	HGV	B	M
AM Peak	Average	2	0	0	0	1	0	0	0	0	0
	Max	2	0	0	0	1	0	0	0	0	0
PM Peak	Average	3	0	0	0	1	0	0	0	0	0
	Max	4	1	0	0	2	0	0	0	0	0
Junction 32 to Junction 31		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	3	0	0	0	1	5	0	0	0	0
	Max	6	0	0	0	2	7	0	0	0	1
PM Peak	Average	4	0	0	0	0	8	0	0	0	0
	Max	5	0	0	0	0	9	0	0	0	0
Junction 33 to Junction J		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	0	0	0	0	1	2	0	0	0	0
	Max	1	0	0	0	2	6	0	0	0	0
PM Peak	Average	8	0	0	0	1	5	0	0	0	1
	Max	7	0	0	0	2	6	0	0	0	2
Junction H to Junction 24		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	4	0	0	0	4	3	0	0	0	0
	Max	4	0	0	0	5	4	0	0	0	1
PM Peak	Average	5	0	0	0	1	10	0	0	0	1
	Max	6	0	0	0	2	11	0	0	0	1
Junction 35 to Junction H		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	0	0	0	0	0	0	0	0	0	1
	Max	1	0	0	0	0	0	0	0	0	2
PM Peak	Average	7	0	0	0	0	9	0	0	0	2
	Max	5	0	0	0	0	9	0	0	0	4
Junction G to Junction 74		**Left**					**Right**				
		C	**LGV**	**HGV**	**B**	**M**	**C**	**LGV**	**HGV**	**B**	**M**
AM Peak	Average	7	0	0	0	2	0	0	0	0	0
	Max	7	0	0	0	3	0	0	0	0	0
PM Peak	Average	6	1	0	0	1	0	0	0	0	0
	Max	7	1	0	0	2	0	0	0	0	0

4.2.2 OFF-STREET PARKING OCCUPANCY

Off-street parking occupancy surveys were conducted at three large off-site parking facilities within the study area, namely Lebuh Pantai Multi-storey Parking, Tun Syed Off-Street Parking, Union Off-Street Parking locations. The locations were shown in Figure 38.

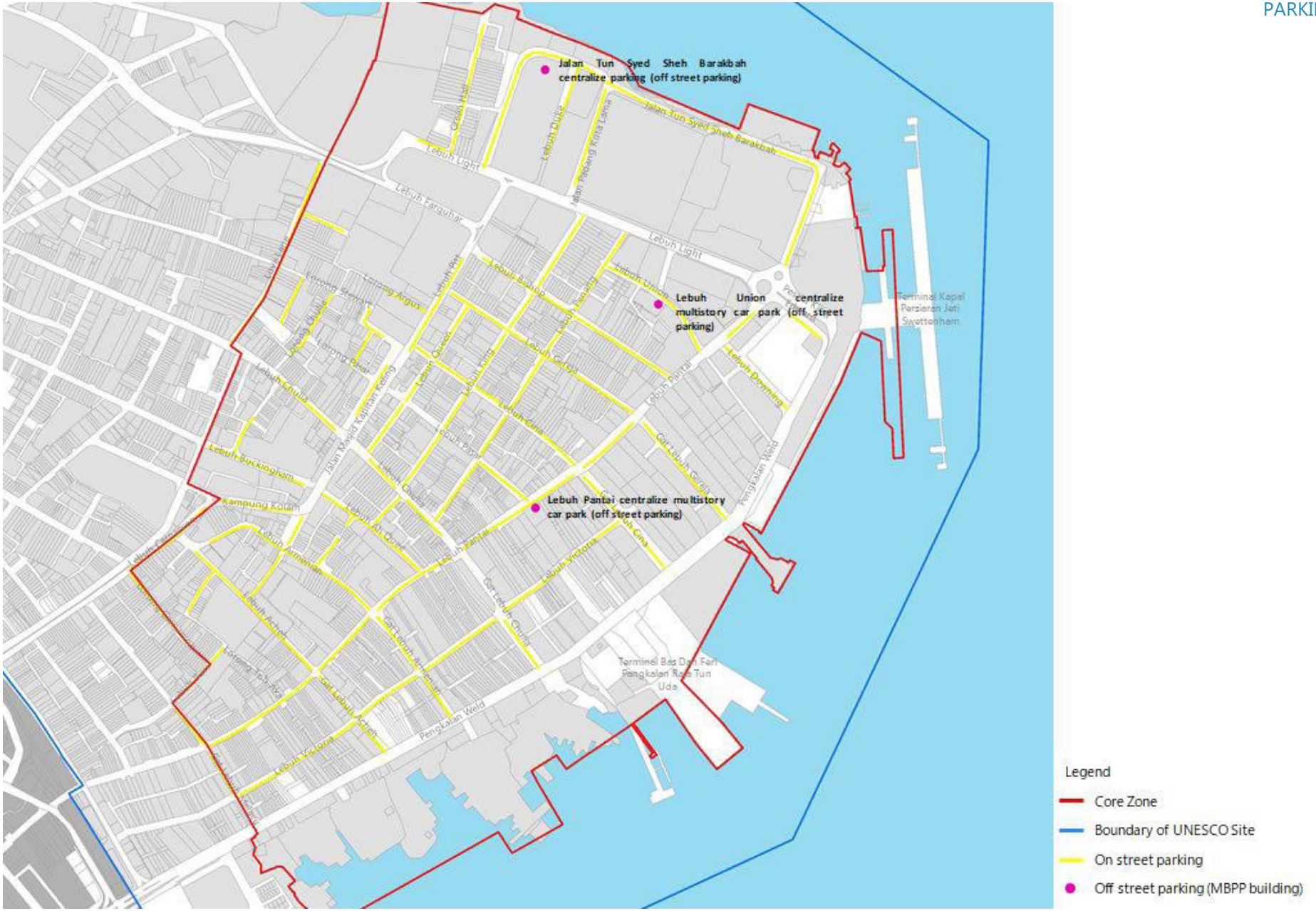


Figure 38: Off-street Parking Survey Locations

Different to on-street parking, off-street parking sites have defined ingress and egress points, which makes it possible to monitor the parking occupancy throughout the survey period with one reference occupancy counts at the beginning of the survey period, and continuous counting of vehicles entering and exiting the parking facility. Thus, the results reported in Tables 7 to 9 below show the number of vehicle entering, leaving, or remaining in the car park.

Table 7: Lebuh Pantai Multi-storey Parking

AM Peak	IN				OUT				OCCUPANCY			
	Car	Van	Lorry	MC	Car	Van	Lorry	MC	Car	Van	Lorry	MC
8:00	8	0	0	2	1	0	0	0	13	0	0	3
9:00	28	1	0	6	2	0	0	1	39	1	0	8
10:00	31	0	0	1	3	0	0	1	67	1	0	8

AM Peak	IN				OUT				OCCUPANCY			
	Car	Van	Lorry	MC	Car	Van	Lorry	MC	Car	Van	Lorry	MC
17:30	14	0	0	1	40	0	0	3	71	1	0	4
18:30	3	0	0	2	33	0	0	4	41	1	0	2
19:30	2	0	0	1	22	0	0	2	21	1	0	1

Table 8: Tun Syed Off Street Parking

AM Peak	IN				OUT				OCCUPANCY			
	Car	Van	Lorry	MC	Car	Van	Lorry	MC	Car	Van	Lorry	MC
8:00	26	0	0	38	0	0	0	1	28	1	2	37
9:00	21	0	0	30	3	0	0	1	46	1	2	66
10:00	3	0	0	0	2	1	0	3	47	0	2	63

AM Peak	IN				OUT				OCCUPANCY			
	Car	Van	Lorry	MC	Car	Van	Lorry	MC	Car	Van	Lorry	MC
17:30	1	0	0	1	9	0	0	15	16	0	2	15
18:30	0	0	0	1	11	0	0	11	5	0	2	5
19:30	0	0	0	0	3	0	0	5	2	0	2	0

Table 9: Union Off Street Parking

AM Peak	IN				OUT				OCCUPANCY			
	Car	Van	Lorry	MC	Car	Van	Lorry	MC	Car	Van	Lorry	MC
8:00	31	0	0	3	0	0	0	1	35	0	0	3
9:00	90	0	0	0	1	0	0	1	124	0	0	2
10:00	46	0	0	0	1	0	0	1	169	0	0	1

AM Peak	IN				OUT				OCCUPANCY			
	Car	Van	Lorry	MC	Car	Van	Lorry	MC	Car	Van	Lorry	MC
17:30	3	0	0	6	30	0	0	1	119	0	0	1
18:30	0	0	0	1	52	0	0	2	67	0	0	0
19:30	0	0	0	0	50	0	0	0	17	0	0	0

4.2.3 PARKING DWELL TIME SURVEY

On-street parking is prevalent in many parts of Georgetown. The movement of vehicles into and out of on-street parking locations is a major contributor to regular congestion. Therefore, it is important for the micro-simulation model to survey the average time of dwell for vehicles utilising the on-street parking. This provides an insight into the behaviour of vehicle parking and the turnaround rate for the parking facility.

Road sections marked in purple in Figure 39 were pre-identified as popular sections for the parking dwell time survey to take place. The road sections were labelled from DP1 to DP21.

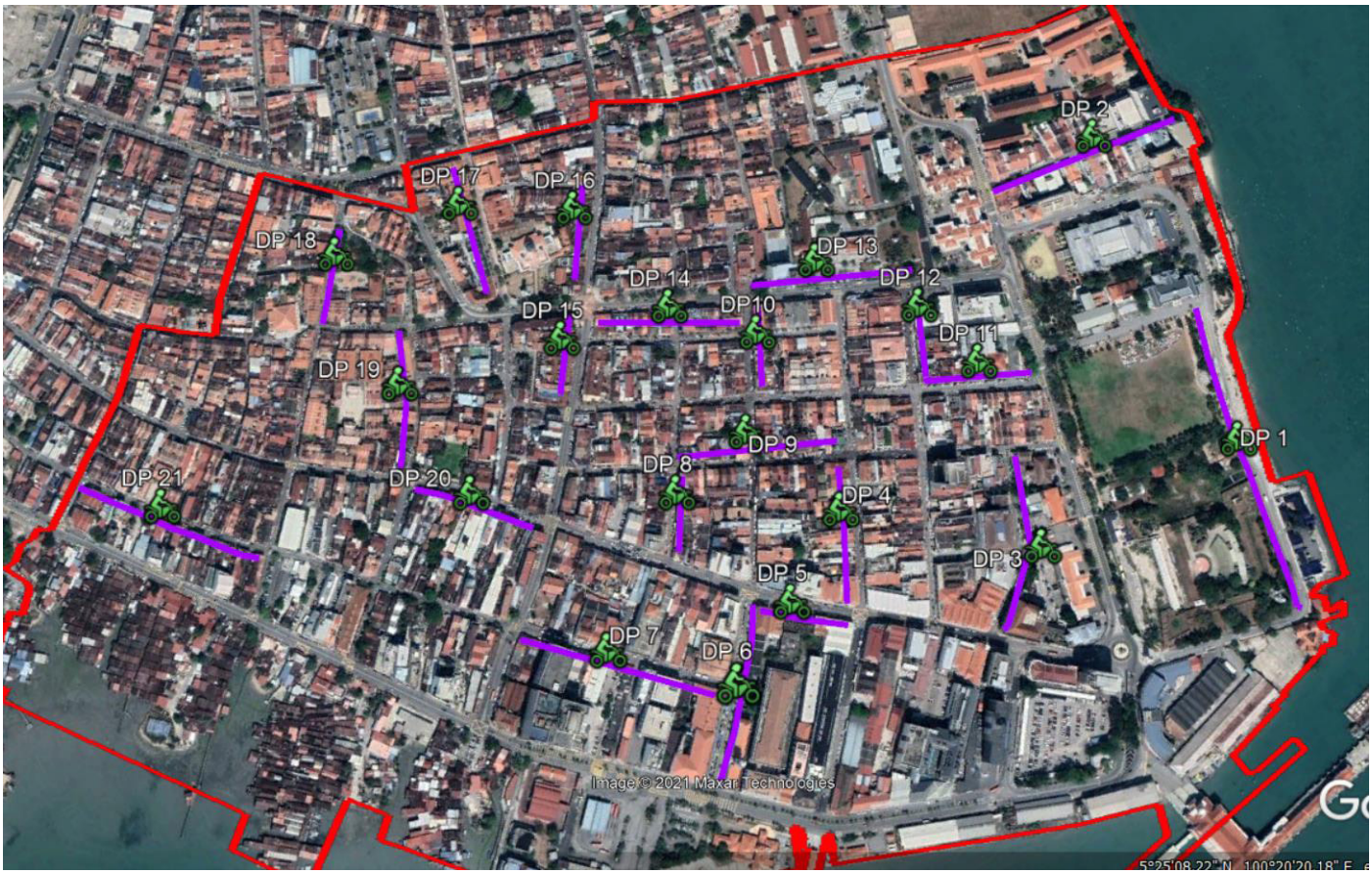


Figure 39: Parking Dwell Time Survey Locations

Due to site constraints dwell time parking surveys for location-6 required two camera locations to view accurate dwell time results. Therefore two cameras were setup. One was located at J21 towards J15 and other was located at J3 towards J15 Results for parking dwell time survey are shown in the table below.

Table 10: Parking Dwell Time Survey Results

Location	Parking Dwell Time (Average) hh:mm:ss	Standard Deviation
DP1	00:00:57	0.001423627
DP2	00:02:48	0.002659139
DP3	00:02:24	0.002374612
DP4	00:01:06	0.001725286
DP5	00:00:48	0.011774317
DP6 (start cam)	00:00:44	0.004050309
DP6 (end cam)	00:02:10	0.020866345
DP7	00:04:01	0.00308549
DP8	00:01:33	0.001934816
DP9	00:01:54	0.001611781
DP10	00:00:30	0.001211326
DP11	00:04:50	0.036085224
DP12	00:01:03	0.001702346
DP13	00:00:31	0.001151509
DP14	00:02:58	0.002703913
DP15	00:00:05	0.001152124
DP16	00:00:40	0.005782647
DP17	00:03:43	0.003185964
DP18	00:16:49	0.195185765
DP19	00:02:30	0.002608574
DP20	00:00:54	0.001700805
DP21	00:01:15	0.001764388

Photo: ADB

ORIGIN-DESTINATION DATA SURVEY

Photo: Adobe Stock

Origin-Destination Travel Pattern Data can be used to approximate the travel patterns within the model area for more accurate representation of the on-site conditions. All major entry and exit points to the study area were used for collection of origin-destination travel pattern data for this survey. Details of the origin-destination survey are shown in the sections below.

5.1 SURVEY ZONING SYSTEM

The zoning system that is adopted for the study area is as shown in Figure 40. The zones are in reference to collection of travel pattern data type as referenced in Section 2.4.1 of the report. Zones were selected to represent the entry and exit points of traffic models, where traffic arrives and departs the network. Traffic will flow from one to another, on occasions spending time in parking spaces.

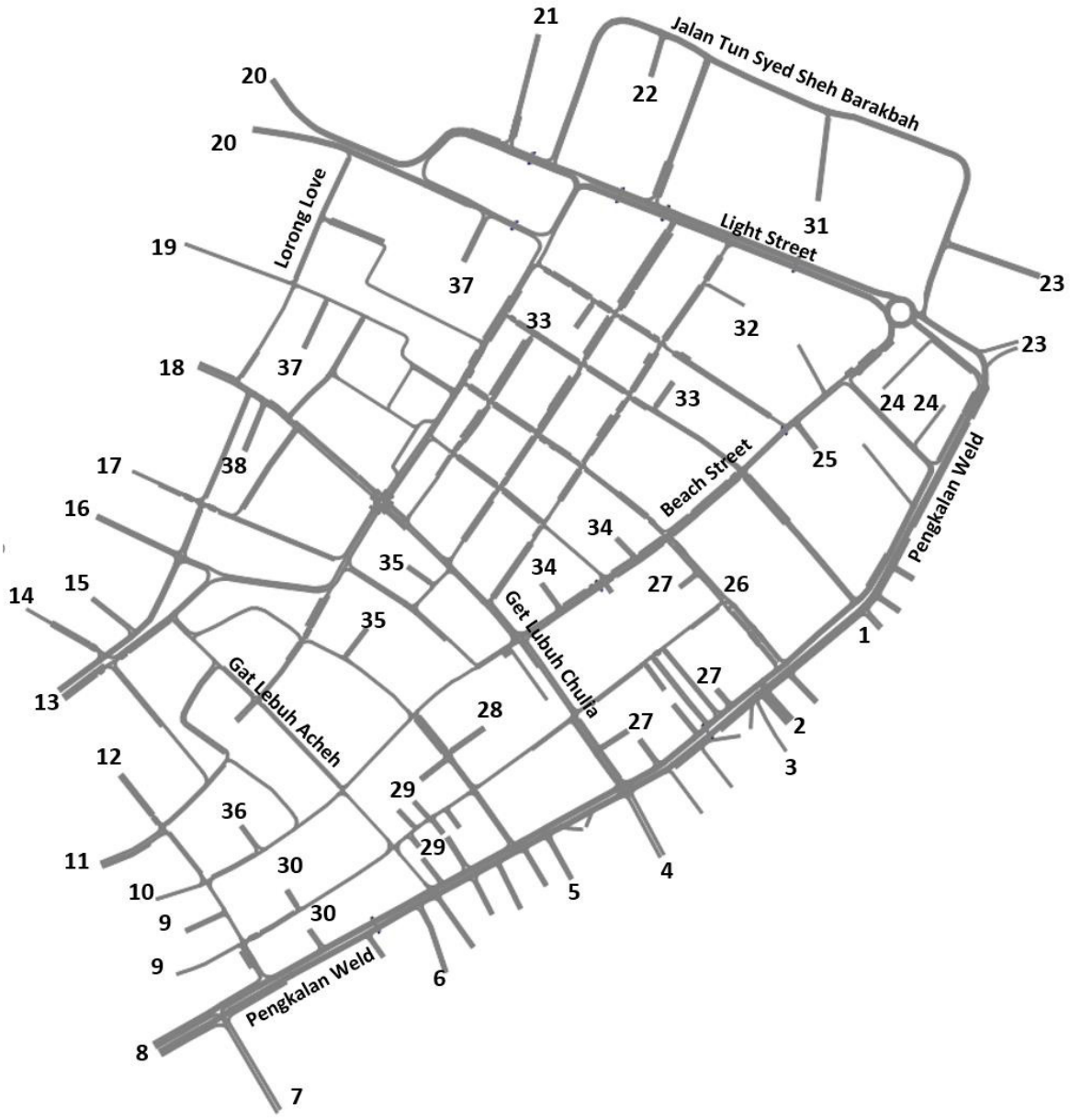


Figure 40: Survey Zoning System

Table 11: Zone Numbering and Description

Zone Number	Zone Description
1	Jalan Gereja
2	Exit from Ferry Terminal
3	Entry to Ferry Terminal
4	Local Road
5	Local Road
6	Road to Tan Jetty Thai Food
7	Raya Merdeka Highway
8	Pengkalan Road
9	Lebuh Victoria Road
10	Lebuh Pantai
11	Lorong Ikan
12	Lebuh Melayu
13	Lebuh Carnarvon
14	Lebuh Kimberley
15	Lorong Ngah Aboo
16	Pesara Claimant
17	Lebuh Campbell
18	Chulia Street
19	Muntri Street
20	Lebuh Farquhar
21	Jalan Green Hall
22	Lebuh Duke
23	Access to Cruise Terminal
24	Private Car Park Access
25	Access to Local Roads
26	Access to Pusaka Warison
27	Access to Local Roads
28	Access to Local Roads
29	Access to Local Roads
30	Access to Local Roads
31	Access to Local Roads
32	Lebuh Union
33	Access to Local Roads
34	Access to Local Roads
35	Access to Local Roads
36	Access to Local Roads
37	Access to Local Roads
38	Lorong Cheapside

5.2 ORIGIN-DESTINATION SURVEY UNIT MATRIX

The representative unit matrix from the TomTom data that was utilized in the matrix estimation and correction procedure is as given below in Table 12 with each row title representing an origin and each column title representing a destination.

Unit matrix is required to represent the connectivity between zones. A value of 0 means there would not be any traffic flow between the pair of origin and destination, either due to inaccessibility or no demand. A value of one means the origin and destination pair is feasible.

These correspond with the zone locations shown in Figure 40 and Table 11.

Table 12: Unit Matrix (with row title representing an origin and column title representing a destination)

Zone	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	1	1	0	0	0	0	1	0	0	0	0	1	0
2	0	0	1	1	0	0	0	1	0	0	0	0	1	1	1	0	0	1	0	1	1	1	1	1	1	1	1	0	0	0	0	1	0	1	0	1	1	1
3	1	1	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	1	0	1	1	0	0	1	0	0	1	0	0	0	0	1	0	1	0	0	1	0
4	0	0	1	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	1	1	0	1	0	1	1	0
5	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	1	0	1	0	1	0	0	0	1	1	1	0	0	1	0	0	1	0	0	1	0	0	0
6	0	0	0	0	0	0	1	1	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	0
7	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1
8	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
9	0	0	0	0	1	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0	1	0	0	1	0	0	0
10	1	1	1	0	1	0	1	1	0	0	1	1	1	1	1	0	0	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
11	0	1	0	0	0	0	0	1	0	0	0	1	1	1	1	0	0	1	0	1	1	1	0	0	1	1	1	0	0	1	0	1	0	0	1	1	1	1
12	0	1	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	1	1	1	0	0	0	0	1	1	1	0	0	1	1	1	1	0	1	1	1
13	0	1	1	1	0	0	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	0	1	0	0	0	0	1	1	1	0	0	0	1	0	0	1	1	1	0	1	0	1	0	0	1	1	0	1	1	0	0	1	0	1	0	1	1	1
15	0	0	1	0	0	1	1	1	0	0	0	0	1	1	0	1	1	1	0	1	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	1	1	1
16	0	0	0	0	1	0	1	1	0	1	0	0	1	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0	1	1	0	1	0	1	1	1	1	1
17	0	1	0	1	0	0	1	1	0	0	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1
18	1	1	1	0	1	0	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	0	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
19	0	1	1	1	0	1	1	1	0	0	0	1	1	1	0	1	1	1	0	1	0	0	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	0
20	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
21	0	1	1	0	1	1	1	1	0	1	1	0	1	0	1	0	0	1	1	1	0	1	1	1	1	1	0	0	1	0	1	1	1	0	0	0	1	0
22	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	1	0	1	1	0	1	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0
23	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	1	1
24	0	1	1	1	1	0	1	1	0	0	0	1	1	1	0	0	0	1	0	1	1	1	1	0	1	0	1	1	0	1	1	1	0	1	1	1	1	1
25	0	1	1	1	0	0	1	1	0	0	1	0	1	1	1	0	0	1	1	1	1	0	0	1	0	1	1	0	0	0	1	1	0	0	1	1	1	0
26	0	0	1	0	0	0	1	1	0	0	0	0	1	1	0	0	0	1	0	1	1	0	1	0	1	0	1	0	1	1	1	1	1	1	1	0	1	0
27	0	1	1	1	0	0	1	1	0	0	0	1	1	1	1	0	1	1	1	1	0	0	1	1	1	0	0	0	0	1	1	1	1	1	1	0	1	0
28	0	1	0	0	1	0	1	1	1	0	0	1	1	1	1	1	0	1	1	1	1	0	0	0	1	1	1	0	1	1	0	1	1	0	1	1	1	1
29	1	1	0	0	0	0	1	1	0	0	0	0	1	1	0	0	1	1	0	1	1	0	1	1	0	0	1	1	0	0	1	1	0	1	1	1	1	0
30	0	1	0	0	0	0	1	1	1	1	0	0	1	1	1	0	1	1	0	1	0	0	1	0	1	0	1	0	1	0	1	1	1	1	0	0	1	0
31	0	1	1	0	0	1	1	1	0	0	0	0	1	0	0	0	0	1	0	1	1	1	1	0	1	0	1	0	0	0	0	0	1	1	0	1	0	0
32	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	0	0	1	1	1	1	0
33	0	1	0	0	0	0	1	1	0	0	0	0	1	0	1	0	0	1	0	1	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	1
34	0	1	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	1	1	0	0	0	0	1	1	1	0	0	1	0	1	1	0	1	1	1	0
35	0	1	0	0	0	0	1	1	0	0	1	0	1	1	0	0	1	1	0	1	0	0	0	0	1	1	1	0	1	1	0	1	0	1	0	1	1	1
36	0	0	0	1	0	0	1	1	0	0	0	1	1	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	1
37	1	1	1	1	1	0	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
38	0	1	1	0	1	0	1	1	0	1	1	1	1	1	1	0	1	1	0	1	1	0	1	0	0	1	1	1	1	0	0	1	1	1	1	0	1	0

5.3 ORIGIN-DESTINATION SURVEY RESULT MATRIX

TomTom data extracted for the AM peak between 7:00am and 10:00am during Tuesday, Wednesday, and Thursday of November 2021 (consistent with the on-site traffic survey time period) is as shown in Table 13.

Table 13: TomTom Matrix

Zone	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
1	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	1	8	2	0	1	0	1	1	1	0	0	0	0	1	0	0	0	0	1	0
2	0	0	6	2	0	0	0	47	0	0	0	0	4	2	1	0	0	8	0	107	2	1	3	1	6	1	1	0	0	0	0	15	0	3	0	1	9	2
3	1	3	0	0	0	0	1	10	0	0	0	0	2	1	0	0	0	2	0	10	1	0	0	2	0	0	1	0	0	0	0	2	0	1	0	0	3	0
4	0	0	1	0	0	0	4	14	0	0	0	0	1	0	0	0	0	0	0	3	0	0	0	1	0	0	0	0	0	0	1	3	0	1	0	1	4	0
5	0	0	0	0	0	0	13	8	0	1	0	0	0	0	0	1	0	1	0	2	0	0	0	1	3	1	0	0	2	0	0	2	0	0	2	0	0	0
6	0	0	0	0	0	0	20	13	0	1	1	0	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	2	0	3	0
7	1	2	1	5	6	14	0	293	4	1	2	0	12	9	1	1	3	6	8	50	9	3	1	18	26	9	32	10	15	5	8	37	6	4	3	0	24	2
8	19	51	16	20	16	15	94		33	28	8	43	255	144	30	18	24	131	28		136	65	40	206	253	121	251	76	288	120	57	536	91	140	79	73	421	92
9	0	0	0	0	1	1	5	16	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	4	0	1	0	0	2	0	0	0
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12	0	1	0	0	0	0	0	7	0	0	0	0	14	2	0	0	0	0	1	5	1	0	0	0	0	1	1	1	0	0	1	5	2	2	0	1	2	3
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15	0	0	1	0	0	2	3	11	0	0	0	0	3	2	0	1	1	1	0	1	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	1	1	3
16	0	0	0	0	1	0	4	8	0	1	0	0	3	5	8	0	1	2	0	1	0	0	0	0	0	0	0	0	1	3	0	3	0	2	1	1	2	1
17	0	6	0	1	0	0	10	81	0	0	1	5	38	28	46	5	0	23	2	23	1	3	0	2	7	1	7	3	2	0	0	6	2	4	6	12	9	35
18	1	10	12	0	1	0	11	76	2	1	0	4	20	15	6	2	4	0	3	40	1	0	0	4	5	1	10	7	2	0	2	7	6	9	10	12	26	12
19	0	3	2	1	0	1	2	19	0	0	0	1	7	5	0	2	1	3	0	27	0	0	1	1	2	2	1	0	0	0	1	16	8	4	1	3	22	0
20	12	236	33	15	10	6	280		1	4	19	17	85	38	13	6	7	94	23	0	111	33	52	64	166	40	87	19	21	9	65	322	80	85	32	42	324	20
21	0	6	3	0	2	1	35	87	0	3	1	0	1	0	1	0	0	1	1	16	0	3	1	5	1	1	0	0	1	0	12	9	3	0	0	0	2	0
22	0	0	0	0	1	0	0	11	0	0	0	0	0	0	0	0	1	2	0	4	1	0	1	1	0	1	0	0	0	0	1	2	0	0	0	0	0	0
23	0	0	1	0	0	0	6	55	0	0	0	0	0	0	0	0	0	1	1	10	0	0	0	0	1	0	2	1	0	0	0	0	0	0	0	0	1	1
24	0	2	3	3	2	0	10	50	0	0	0	1	2	2	0	0	0	5	0	72	3	3	1	0	4	0	4	2	0	1	1	12	0	3	1	1	11	1
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26	0	0	1	0	0	0	3	21	0	0	0	0	1	1	0	0	0	1	0	24	2	0	1	0	5	0	1	0	1	1	1	4	4	1	3	0	7	0
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28	0	1	0	0	1	0	8	55	1	0	0	1	7	3	1	1	0	4	1	7	2	0	0	0	2	2	3	0	4	1	0	5	1	0	3	1	1	1
29	1	2	0	0	0	0	4	66	0	0	0	0	4	3	0	0	1	1	0	10	1	0	1	2	0	0	3	1	0	0	1	9	0	3	3	1	1	0
30	0	1	0	0	0	0	3	33	1	1	0	0	4	1	1	0	1	1	0	2	0	0	1	0	2	0	2	0	1	0	1	3	1	3	0	0	1	0
31	0	2	2	0	0	1	8	26	0	0	0	0	1	0	0	0	0	2	0	15	1	1	1	0	1	0	1	0	0	0	0	0	2	1	0	1	0	0
32	2	5	2	1	1	3	17	82	0	0	0	1	7	6	1	0	2	11	5	212	6	5	2	3	8	1	3	0	1	0	0	0	0	2	2	3	22	0
33	0	1	0	0	0	0	1	14	0	0	0	0	6	0	1	0	0	4	0	10	1	0	1	0	2	0	1	0	0	0	0	0	0	0	0	0	1	1
34	0	2	0	0	0	0	0	21	0	0	0	0	8	8	0	0	0	6	1	19	0	0	0	0	1	1	1	0	0	3	0	4	3	0	1	1	2	0
35	0	1	0	0	0	0	4	19	0	0	1	0	22	14	0	0	2	22	0	9	0	0	0	0	1	1	3	0	1	2	0	2	0	2	0	2	2	2
36	0	0	0	1	0	0	1	49	0	0	0	1	28	17	0	1	0	3	0	5	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	1	1
37	4	29	4	1	1	0	30	100	2	0	4	2	10	5	0	1	4	12	6	349	7	4	4	2	10	6	8	3	1	1	9	12	9	3	2	6	0	3
38	0	9	2	0	1	0	5	45	0	1	1	2	34	19	1	0	2	8	0	11	4	0	2	0	0	2	4	1	2	0	0	6	3	3	3	0	7	0

Photo: ADB

SURVEY DATA UTILISATION

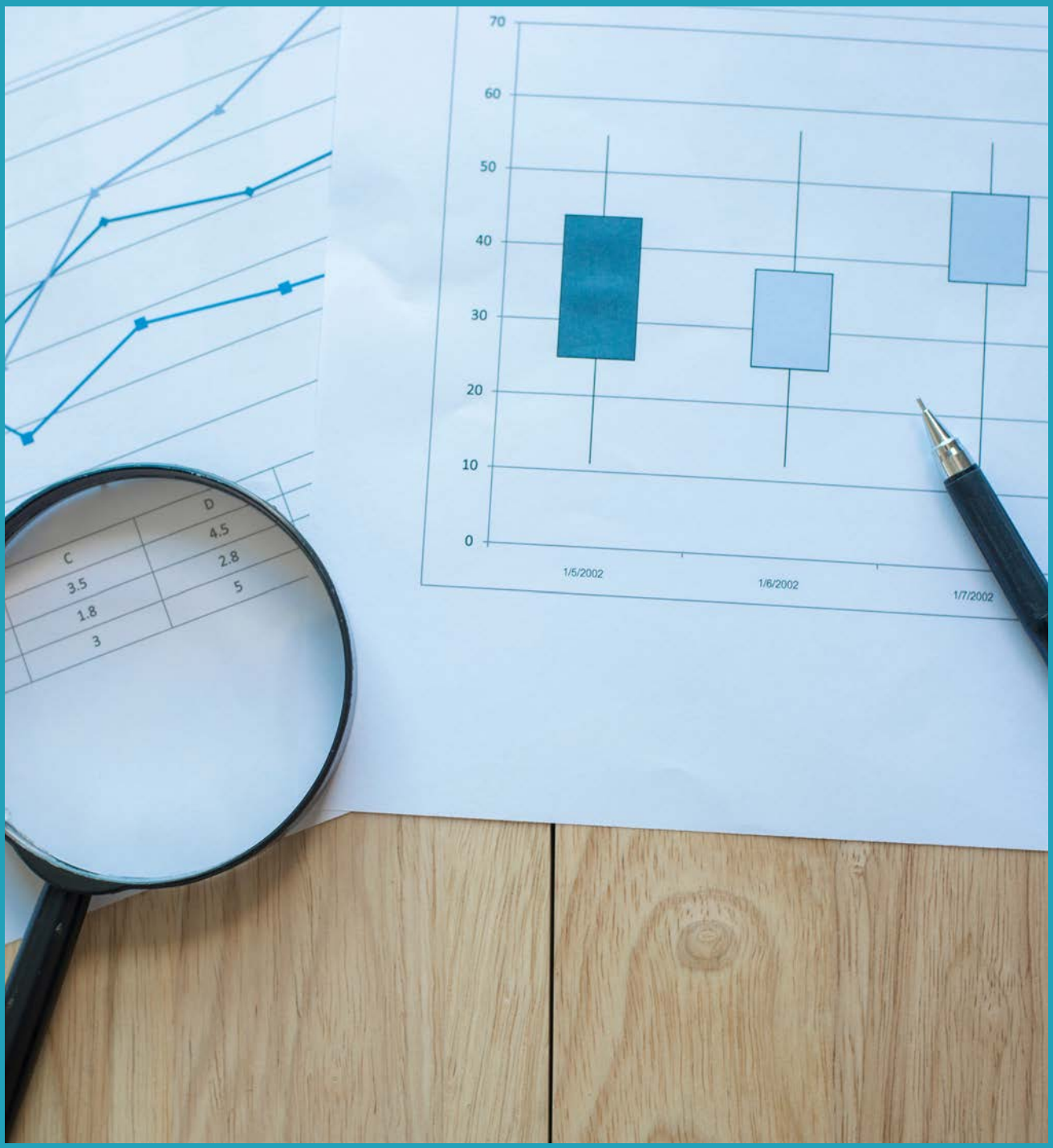

Photo: Adobe Stock

6.1 DATA UTILIZATION INTRODUCTION

Site data collected are to be further processed into the format accepted in traffic analysis and modelling. These steps as documented below follow the typical method of how data is utilised for large-scale urban area simulation projects, with customisation made for Penang's on-site conditions.

Data collected are separated into capacity data and survey data. The types of data contained in each category are summarised in Figure 41.

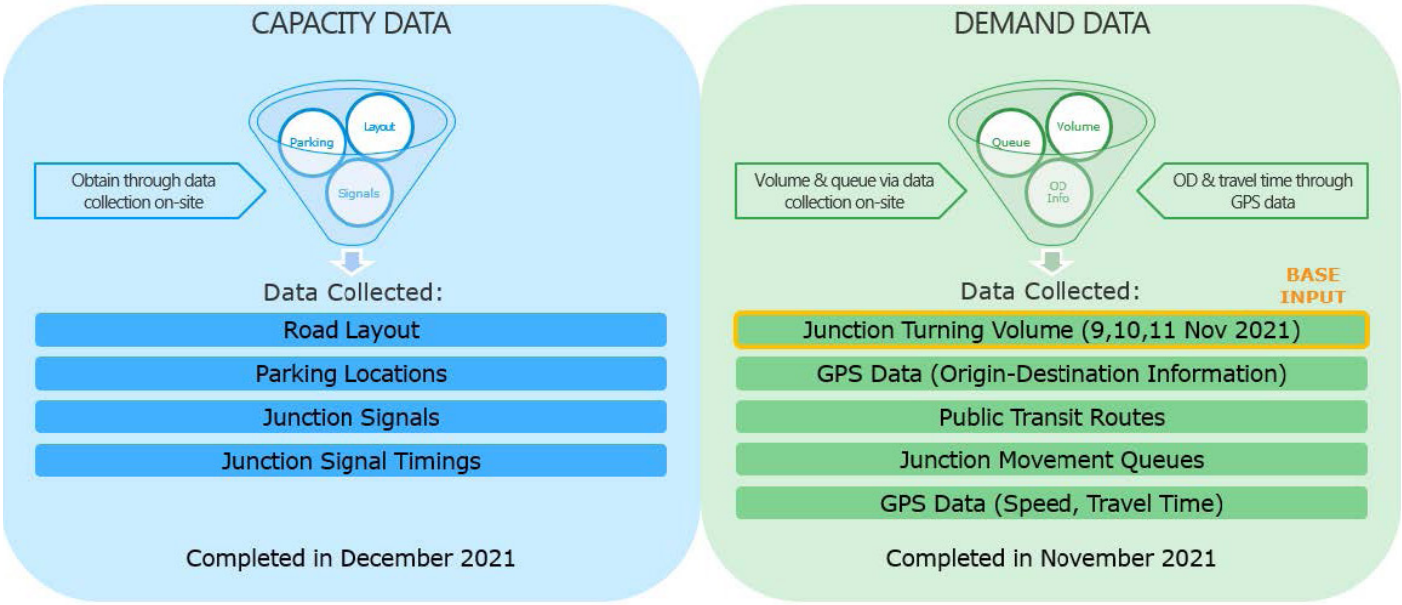

Figure 41: Data Categories

6.2 DATA CONVERSION PROCESS

Raw data collected from site surveys contained three hours of information, and were collected in specific classifications, in individual movements.

In order to complete a complex and dynamic traffic simulation model, the raw data needs to be processed and consolidated into hourly peak data consisting of model classes and with combined movement between zones. The following steps are included to complete the process:

1. Conversion of individual vehicle classed to PCU
2. Identify peak hours during the survey period
3. Produce movement diagram from individual junctions
4. Compare movements recorded with allowable ones in road layout
5. Check flow balance between upstream and downstream junctions
6. Consolidate turn-by-turn movements to OD table

For each of the tasks involved, the following section details the key considerations when completing each step.

6.2.1 CONVERSION TO PCU

Traffic count results were analysed to determine the peak 60-minute periods within the morning and evening peak periods. All traffic flows were converted and expressed in Passenger Car Units (PCUs). PCUs are factors that convert different classification of vehicles to be equivalent to a typical car. The following PCU factors were used (in accordance with Malaysian guidelines) for the junction counts:

- Car: 1.00
- Taxi: 1.00
- Light Goods Vehicles (Lorry Kecil): 2.50
- Heavy Goods Vehicles (Lorry Besar): 3.00
- Bus: 3.00
- Motorcycle: 0.75

Traffic flows from different vehicle types need to be converted into Passenger Car Unit (PCU) to be comparable. This step is usually done with Excel spreadsheet calculations with an example shown below.

	Mode						Total PCU
	Car	Taxi	LGV	HGV	Bus	Motorcycle	
Count	626	1	32	0	24	231	952
PCU Factor	1	1	2.5	3	3	0.75	
Total PCUs	626	1	80	0	72	173.25	

Figure 42: Example of PCU Conversion

: *PCU refers to Passenger Car Unit. PCUs are factors that convert different classification of vehicles to be equivalent to a typical car.

6.2.2 IDENTIFY PEAK HOURS

Peak hour is defined as the one-hour period within the survey duration with the highest total amount of traffic among all vehicle movements at all junctions in the network.

Peak hour is identified by adding all vehicle movement counts (per 15-min interval) in PCU values together and picking out the period with highest volume.

As an example, J42 AM hourly traffic is shown below. It can be inferred from the below Figure 43 that peak hour is in between 8 AM to 9 AM.

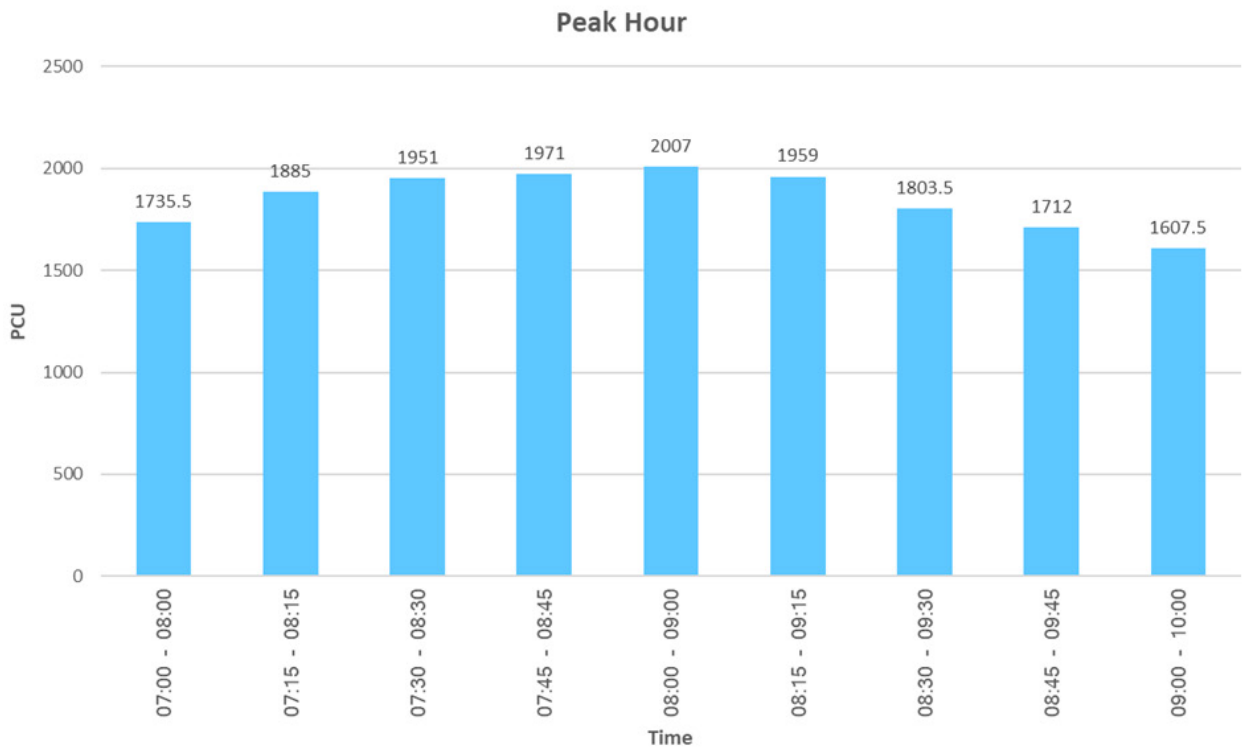

Figure 43: Example of Peak Hour Identification

6.2.3 PRODUCE MOVEMENT DIAGRAM

Once peak hours are identified, the vehicle movements are put in a diagram to show the spatial relations between movements. Movement diagrams produced from this survey have been included in Chapter 3 of this report.

6.2.4 COMPARE WITH ROAD LAYOUT

Data collected on-site contains all vehicle movements happening on-site, regardless of whether the movement is allowed by traffic regulations or not. In order to identify irregular movements, the data collected needs to be compared on individual basis with on-site layout. If any irregularities were discovered, it is to be further studied with either verifying on the counts or modifying the network layout (should the movements occur consistently and in large quantities).

6.2.5 CHECK FLOW BALANCE

Flow between two consecutive junctions is compared to ensure upstream and downstream junctions have consistent flows between themselves.

As an example, J41 and J42 traffic counts are taken and flow balance between the junctions are compared as shown in Figure 44.

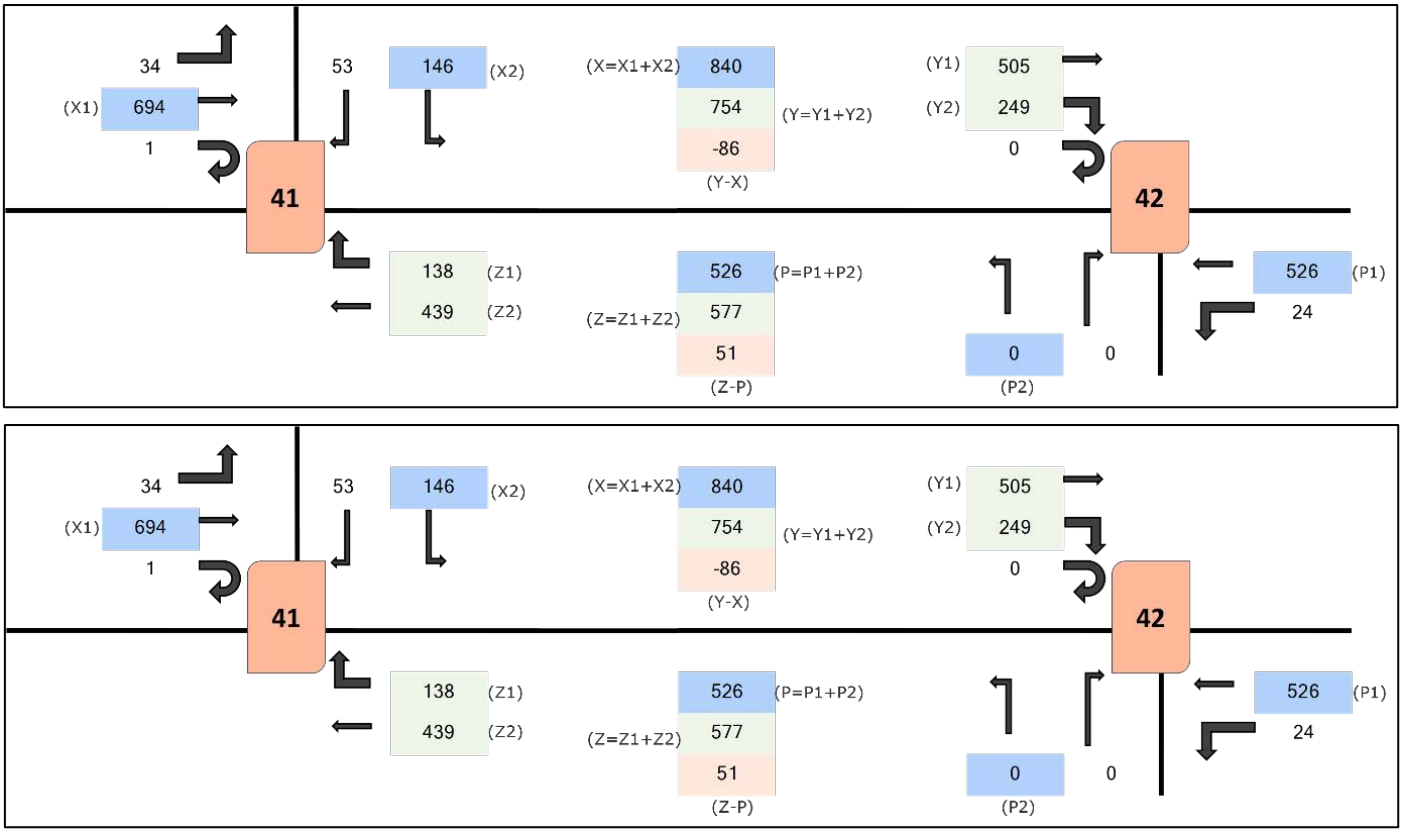

Figure 44: Example of Flow Balance Comparison

Traffic coming out from junction 41 east bound (694+146= 840) is compared with traffic coming to junction 42 east bound (505+ 249= 754). A difference of 86 is observed in east bound direction. Similarly for west bound a difference of 51 is observed.

6.2.6 CONSOLIDATE TO OD TABLE

After flow balance, as a final step OD demand is derived from the turning movement data from the surveys and also from TomTom data using matrix estimation in VISSIM.

Figure 45 shows an example of OD demand. Zone 3 is highlighted in below image and details are explained.

Zone	1	2	3	4	5	Total
1	0	441	219	447	91	**1198**
2	448	0	408	324	143	**1323**
3	499	334	0	145	62	**1040**
4	57	343	141	0	123	**664**
5	294	291	284	240	0	**1109**
Total	**1298**	**1409**	**1052**	**1156**	**419**	

Figure 45: Example of OD Table Data Source

Sum total of zone 3 highlighted in yellow is originating trips from zone 3 to other zones and cell highlighted in green color is destination trips to zone 3 from other zones.

NEXT STEPS

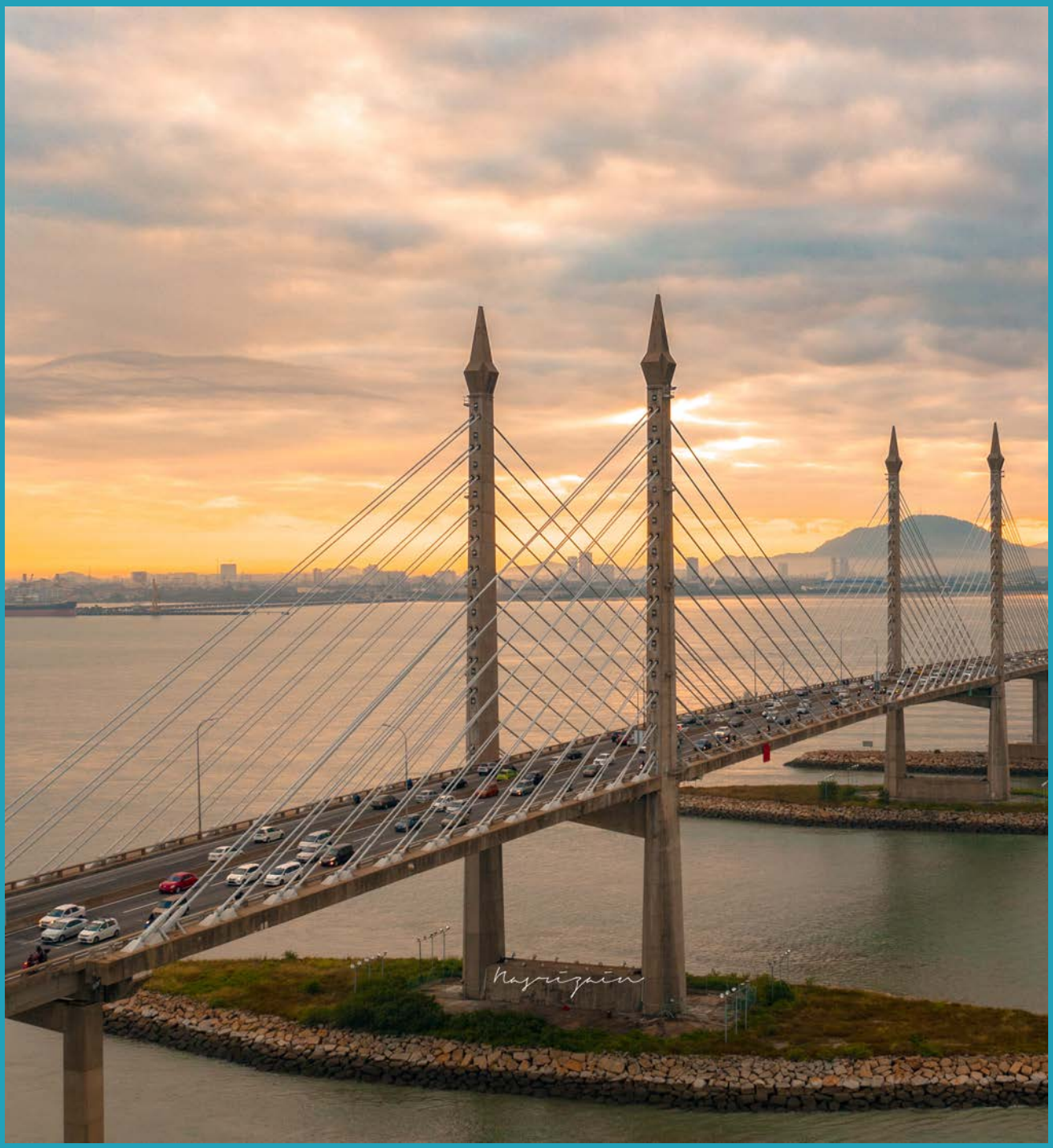

Photo: Adobe Stock

7.1 NEXT MODEL STAGES

With the survey and data processing being completed following the on-site surveys conducted in November 2021 during the progressive re-opening of Malaysia, the Stage 1 micro-simulation model will be calibrated, and scenario testing will commence.

The Stage 1 micro-simulation report will contain information on the process and use of data in the model calibration and scenario testing.

Upon the acceptance of the Stage 1 micro-simulation model report, Stage 2 will commence which will include simulation of a wider area of Georgetown encompassing the full UNESCO World Heritage area.

On completion of Stage 2, Ramboll will conduct a PTV accredited training courses on the use of VISSIM software for MBPP and Digital Penang in order for the micro-simulation model to be used for ongoing testing of changes to transport within Georgetown beyond the conclusion of this Pilot Project.

7.2 NEXT DELIVERABLE STAGES

With the above model stages, the following future deliverables will be produced and submitted as part of this project.

Table 14: Deliverable Stages

Deliverable	Contents
Stage 1 Base Model Calibration Report (D2A)	Interim Technical Deliverable – This report documents the model development and calibration and is a formal documentation of the models accuracy and reflectiveness of real world conditions
Stage 1 Scenario Testing Report (D2B)	Stage 1 Final Deliverable – This report documents the simulation of the scenario testing and comparison of the base calibrated (real world) model to the future proposed interventions to evaluate their improvement.
Stage 2 Base Model Calibration Report (D3A)	Interim Technical Deliverable (Stage 2) – This report documents the model development and calibration and is a formal documentation of the models accuracy and reflectiveness of real world conditions for the larger Stage 2 area
Stage 2 Scenario Testing Report (D3B)	Stage 2 Final Deliverable – This report documents the simulation of the scenario testing for Stage 2 and comparison of the base calibrated (real world) model to the future proposed interventions to evaluate their improvement.
Final Report (D4) and Project Evaluation (D5)	Compilation of Stage 1 and Stage 2 work above

APPENDICES

Photo: Adobe Stock

APPENDIX 1: SURVEY OBSERVATIONS

A.1.0 EXPLANATION OF SYMBOLOGY

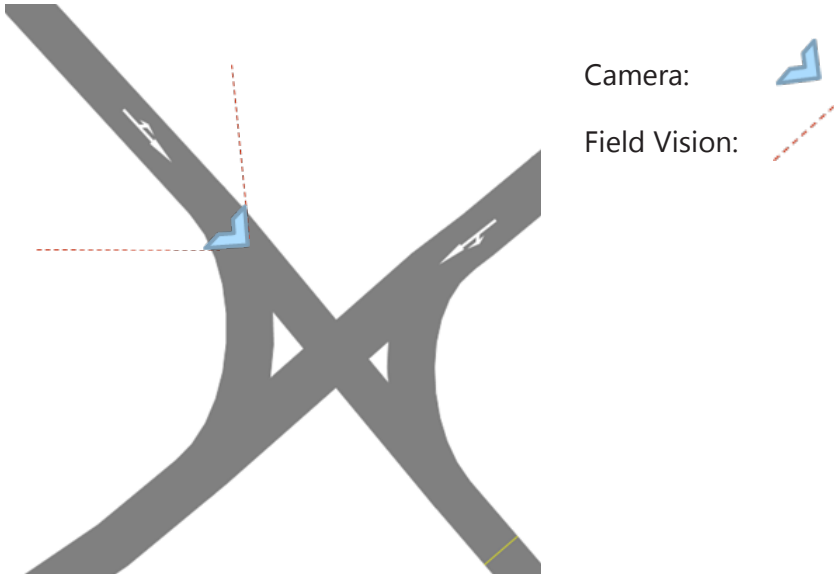

Figure 46: Explanation of symbology

A.1.1 JUNCTION 1: PENGKALAN WELD / LEBUH DOWNING

Junction 1 is a unsignalized T-junction, and the layout is shown in the figure below, followed by the photos taken during site survey. Short queues were observed on approaches of the junction.

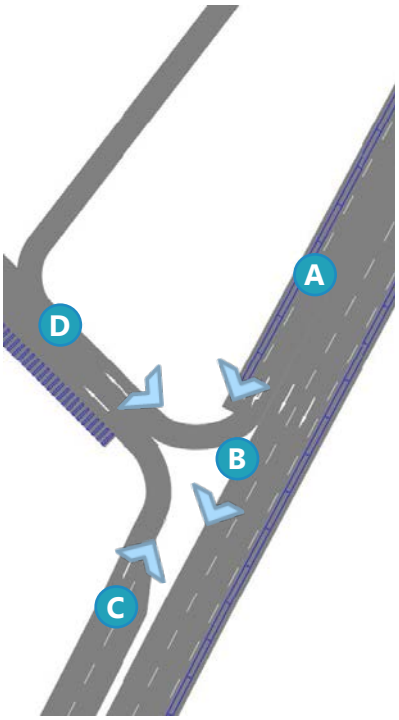

Figure 47: Junction 1 Layout

Figure 48: Junction 1 Trafic Condition

A.1.2 JUNCTION 2: PENGKALAN WELD / GAT LEBUH GEREJA

Junction 2 is a unsignalized T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

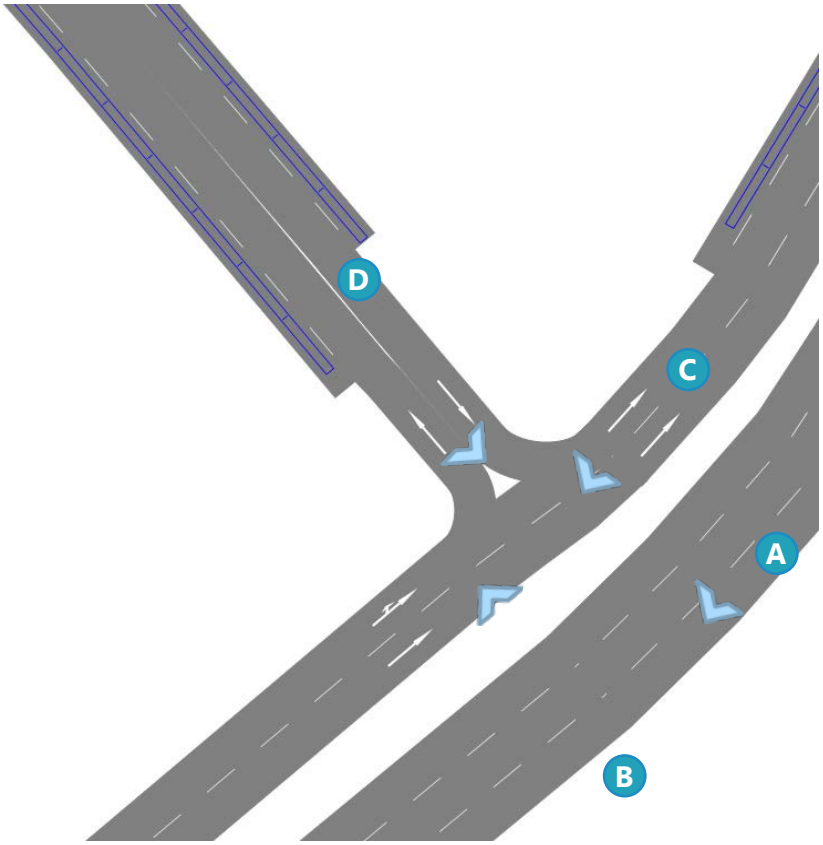

Figure 49: Junction 2 Layout

Figure 50: Junction 2 Traffic Condition

A.1.3 JUNCTION 3: PENGKALAN WELD / GAT LEBUH CHINA

Junction 3 is a unsignalized Double T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

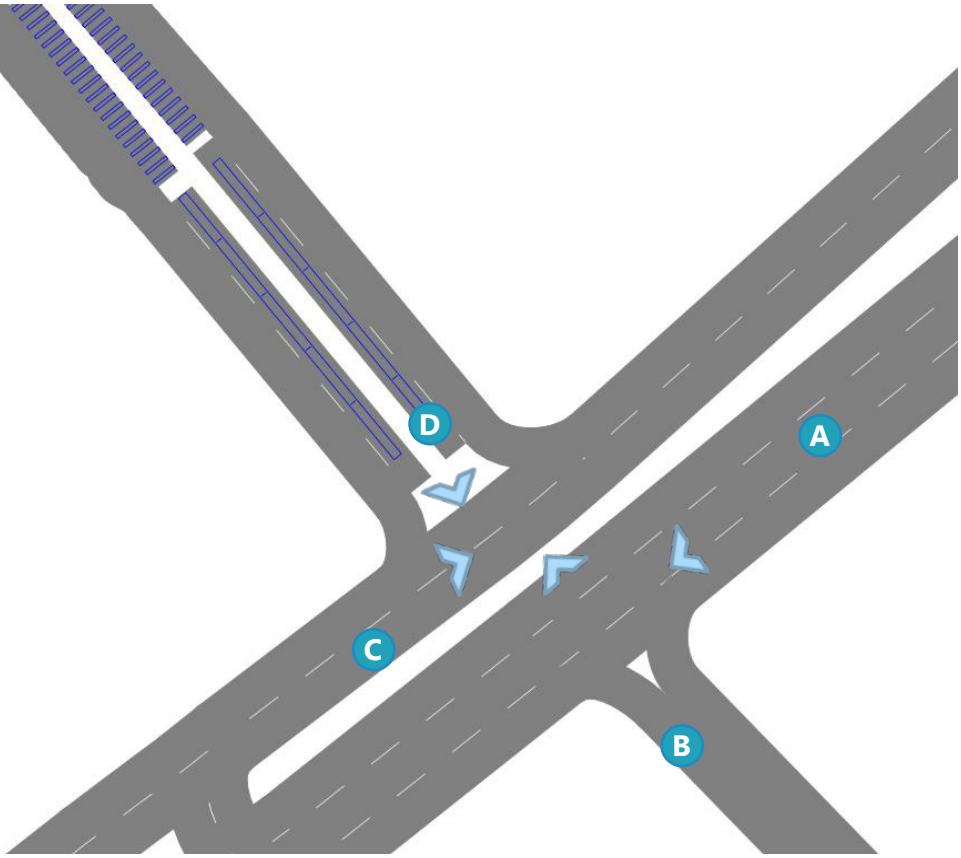

Figure 51: Junction 3 Layout

Figure 52: Junction 3 Traffic Condition

A.1.4 JUNCTION 4: PENGKALAN WELD / GAT LEBUH PASAR

Junction 4 is a signalised cross junction and the layout is shown in the figure below, followed by the site photos. Medium queues were observed at east approach of the junction and short queues were observed at the other approaches of the junction.

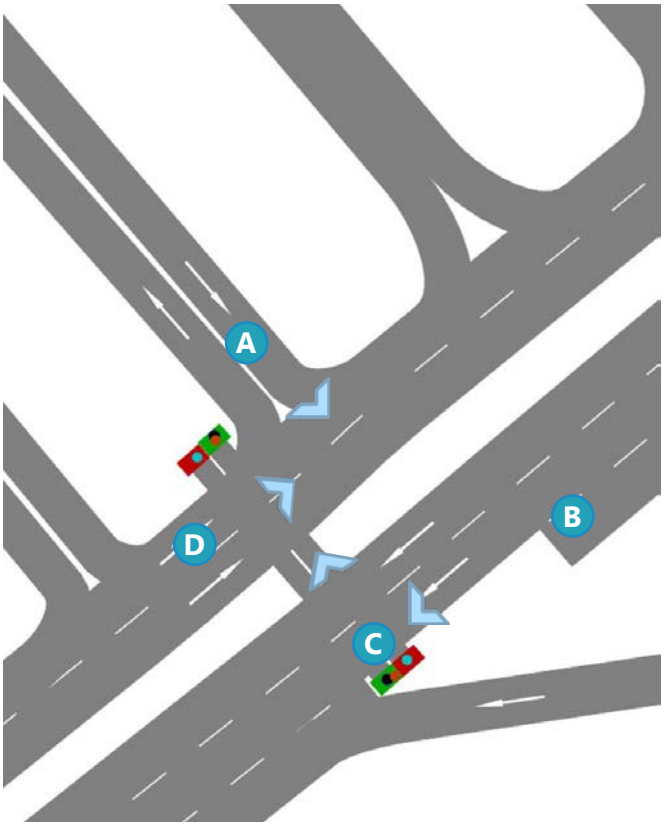

Figure 53: Junction 4 Layout

Figure 54: Junction 4 Traffic Condition

A.1.5 JUNCTION 5: PENGKALAN WELD / GAT LEBUH CHULIA

Junction 5 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on the approaches of the junction.

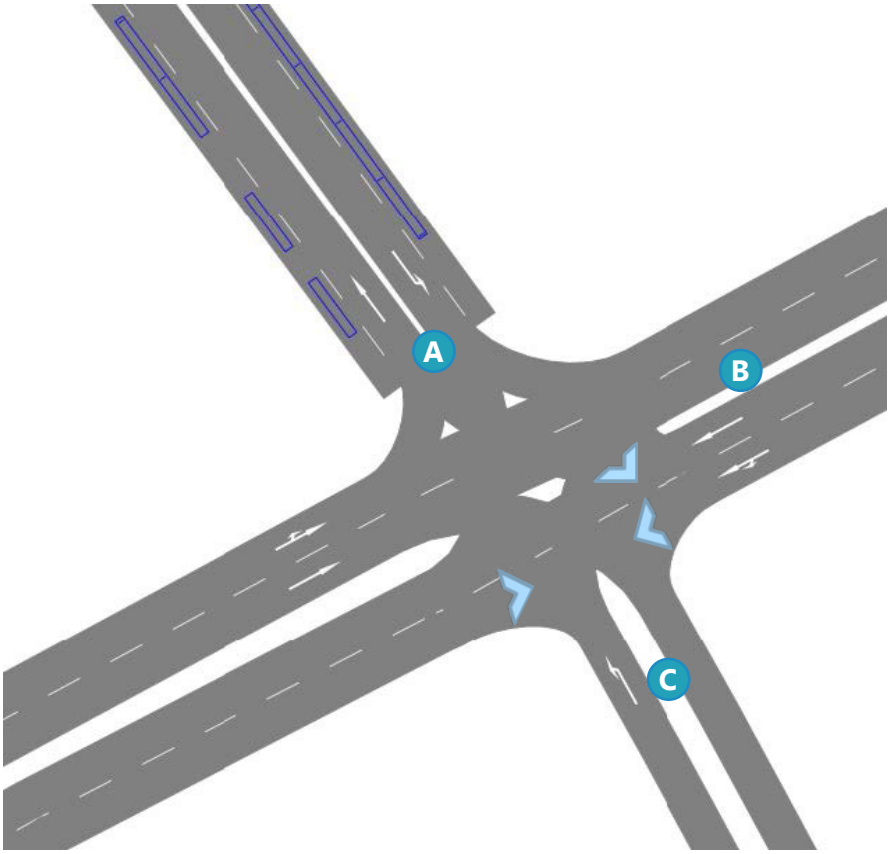

Figure 55: Junction 5 Layout

Figure 56: Junction 5 Traffic Condition

A.1.6 JUNCTION 6: PENGKALAN WELD / GAT LEBUH ARMENIAN

Junction 6 is a unsignalized Double-T junction and the layout is shown in the figure below, followed by the site photos. Long queues were observed at east approach of the junction during the morning and evening peak.

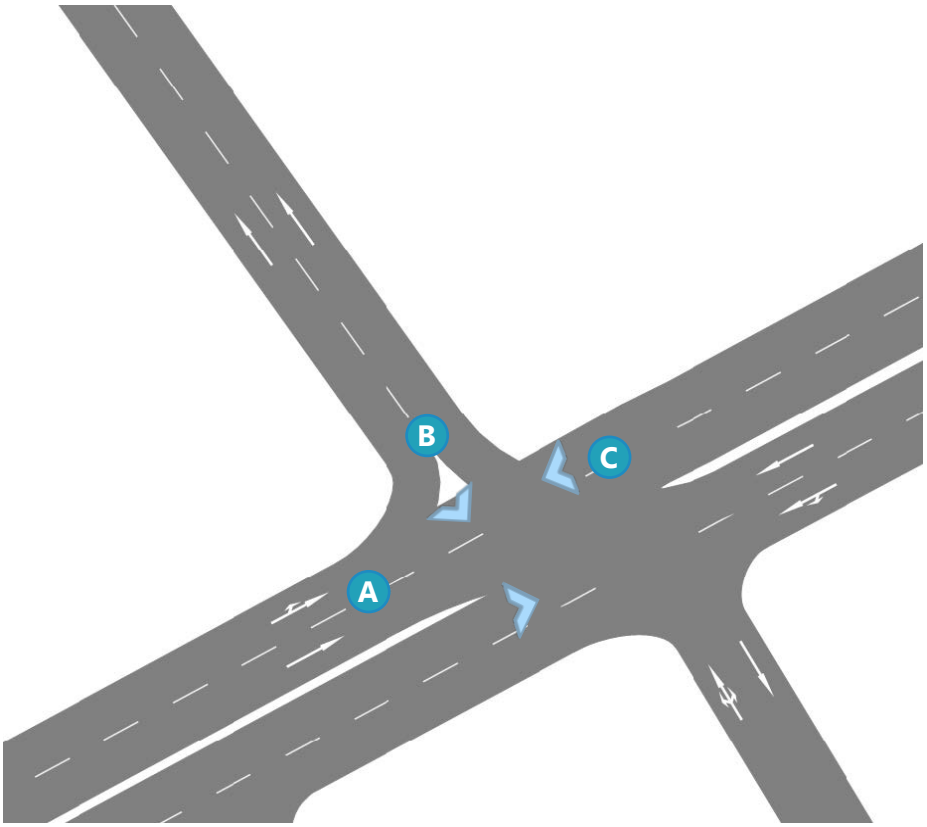

Figure 57: Junction 6 Layout

Figure 58: Junction 6 Traffic Condition

A.1.7 JUNCTION 7: PENGKALAN WELD / GAT LEBUH ACHEH

Junction 7 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Medium queues were observed on all approaches of the junction.

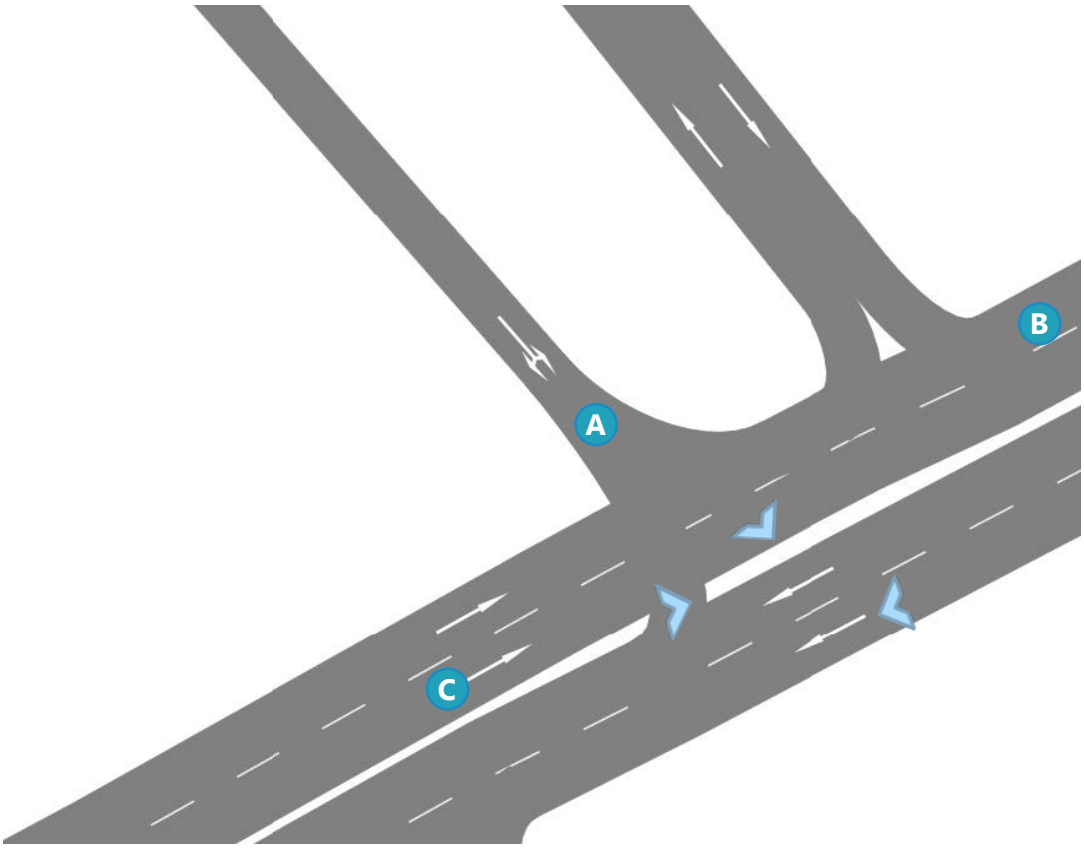

Figure 59: Junction 7 Layout

Figure 60: Junction 7 Traffic Condition

A.1.8 JUNCTION 8: PENGKALAN WELD / RAYA MERDEKA HIGHWAY

Junction 8 is a signalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

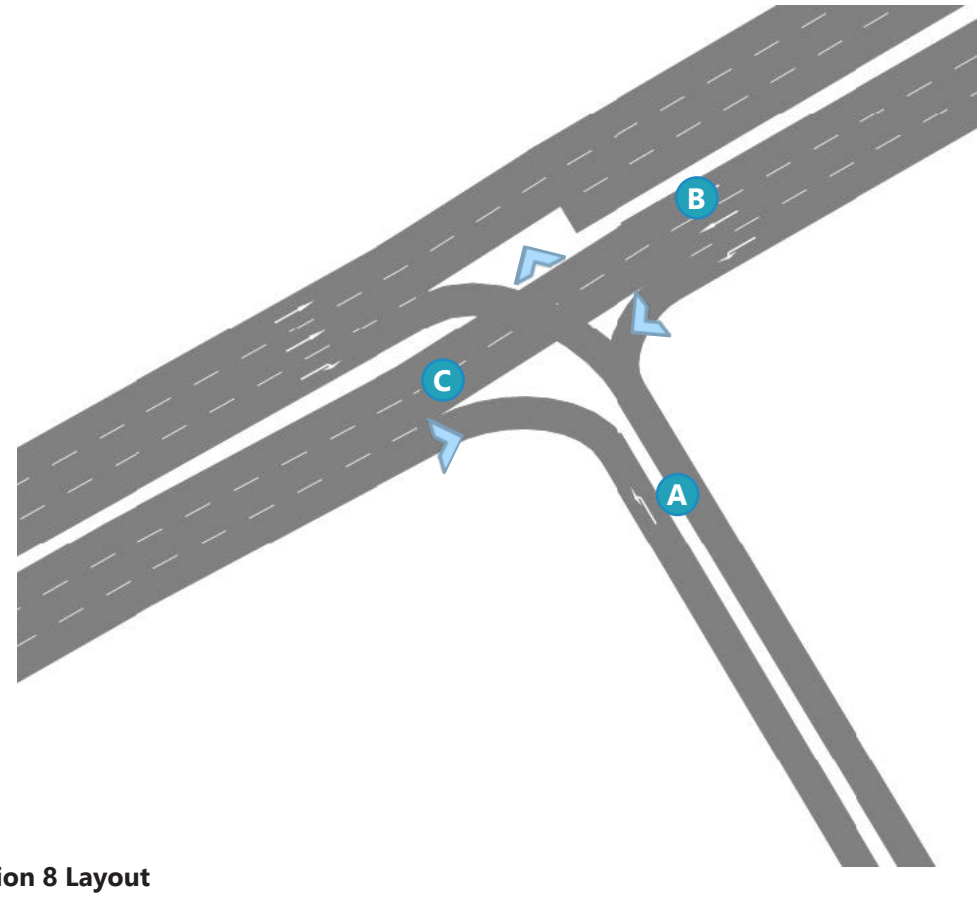

Figure 61: Junction 8 Layout

Figure 62: Junction 8 Traffic Condition

A.1.9 JUNCTION 9: PENGKALAN WELD / GAT LEBUH MELAYU

Junction 9 is a signalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction

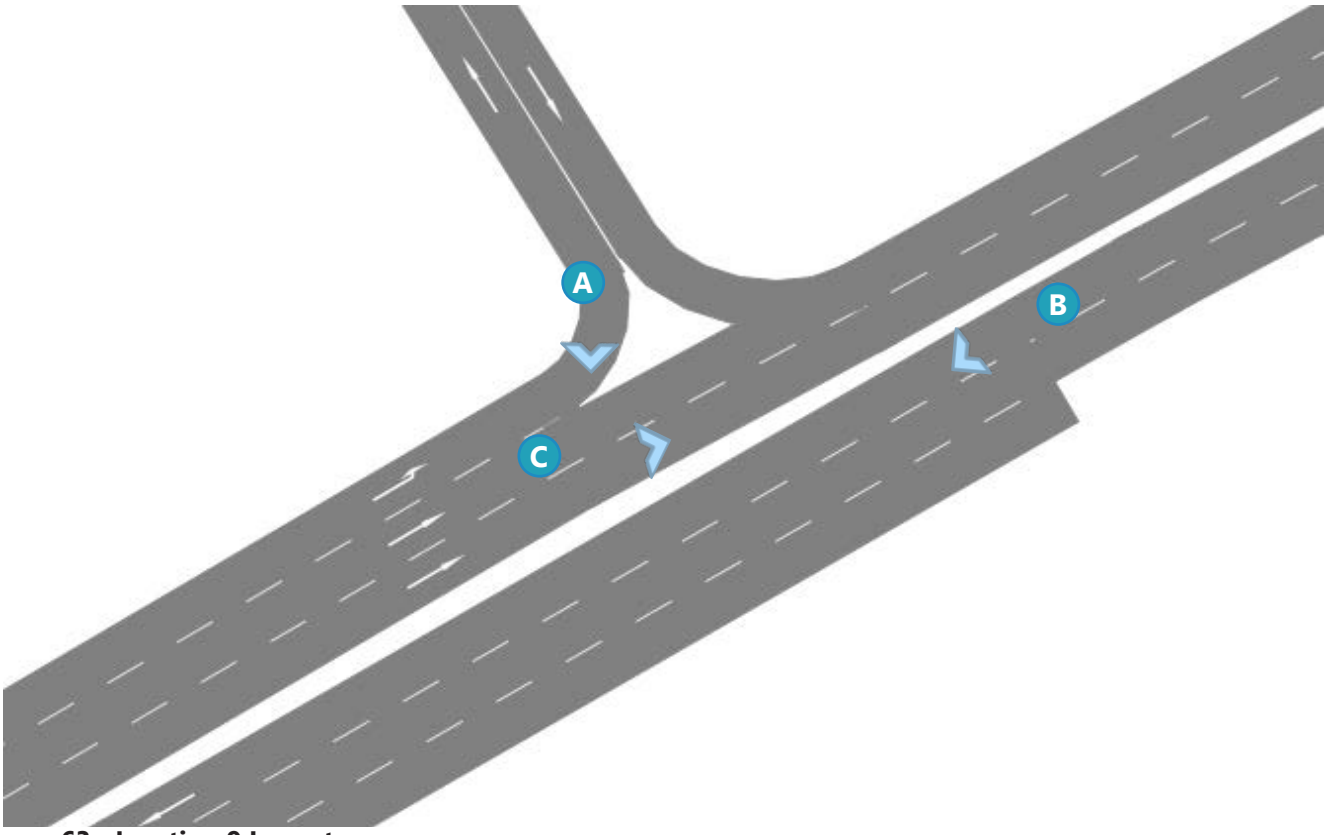

Figure 63: Junction 9 Layout

Figure 64: Junction 9 Traffic Condition

A.1.10 JUNCTION 10: LEBUH VICTORIA / GAT LEBUH MELAYU

Junction 10 is a unsignalized cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction during the morning and evening peak.

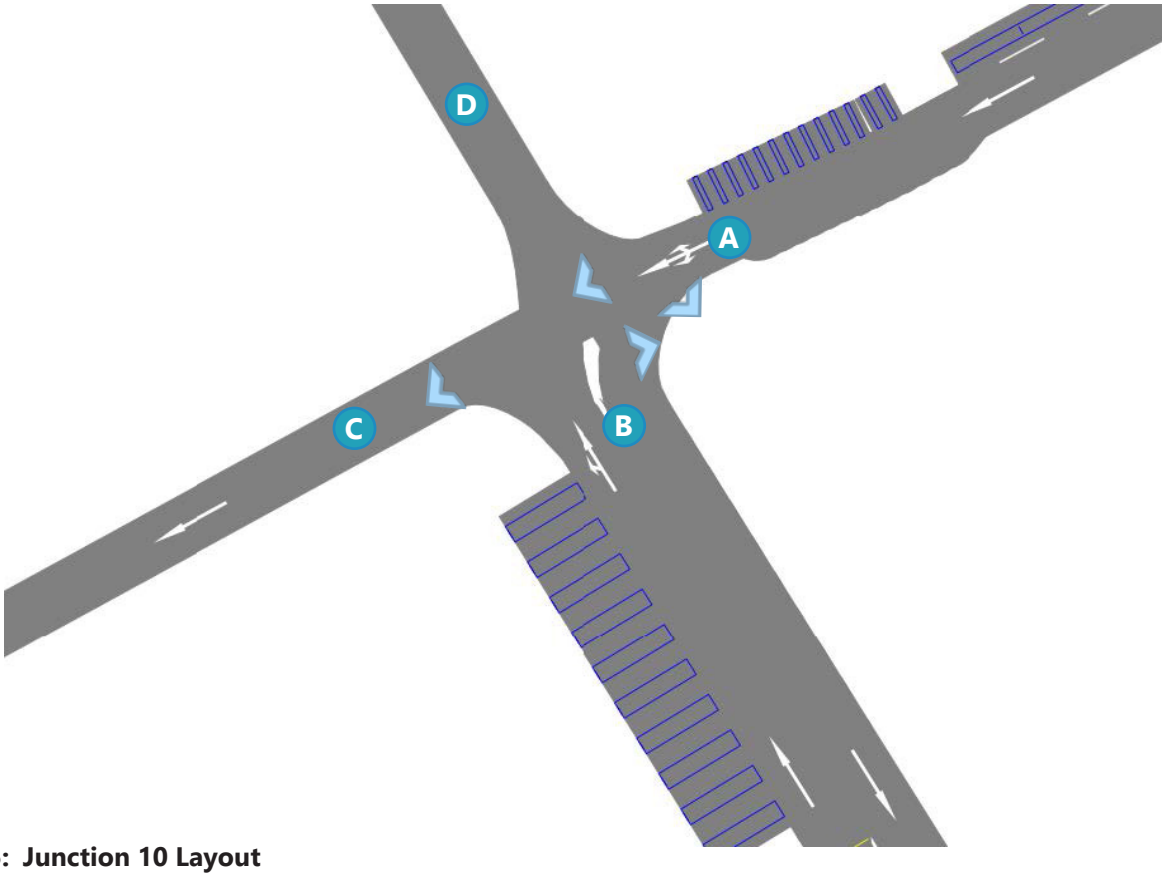

Figure 65: Junction 10 Layout

Figure 66: Junction 10 Traffic Condition

A.1.11 JUNCTION 11: LEBUH VICTORIA / GAT LEBUH ACHEH

Junction 11 is a unsignalized cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

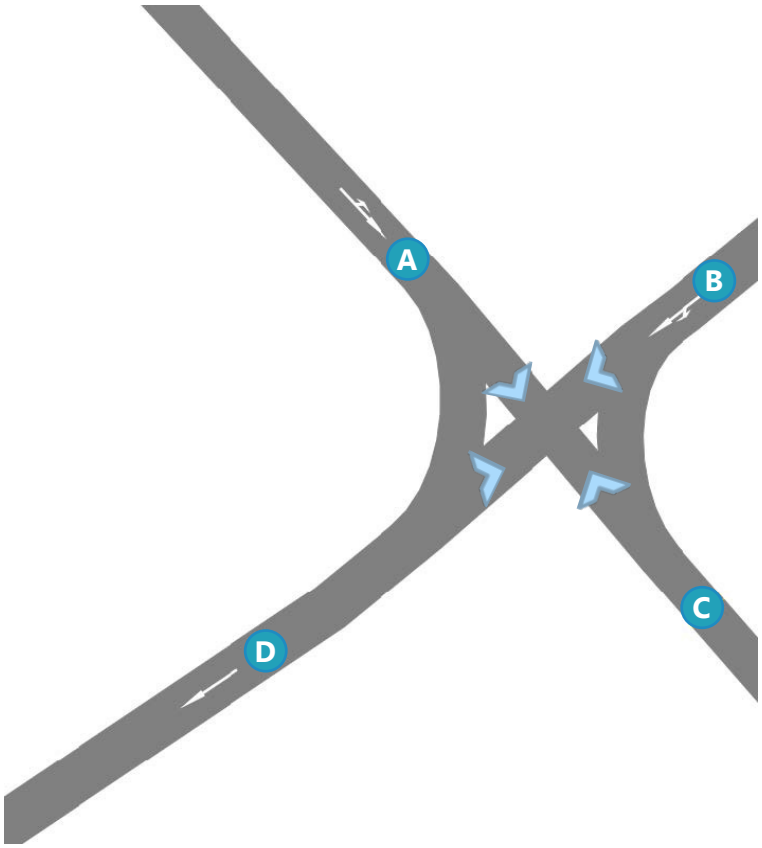

Figure 67: Junction 11 Layout

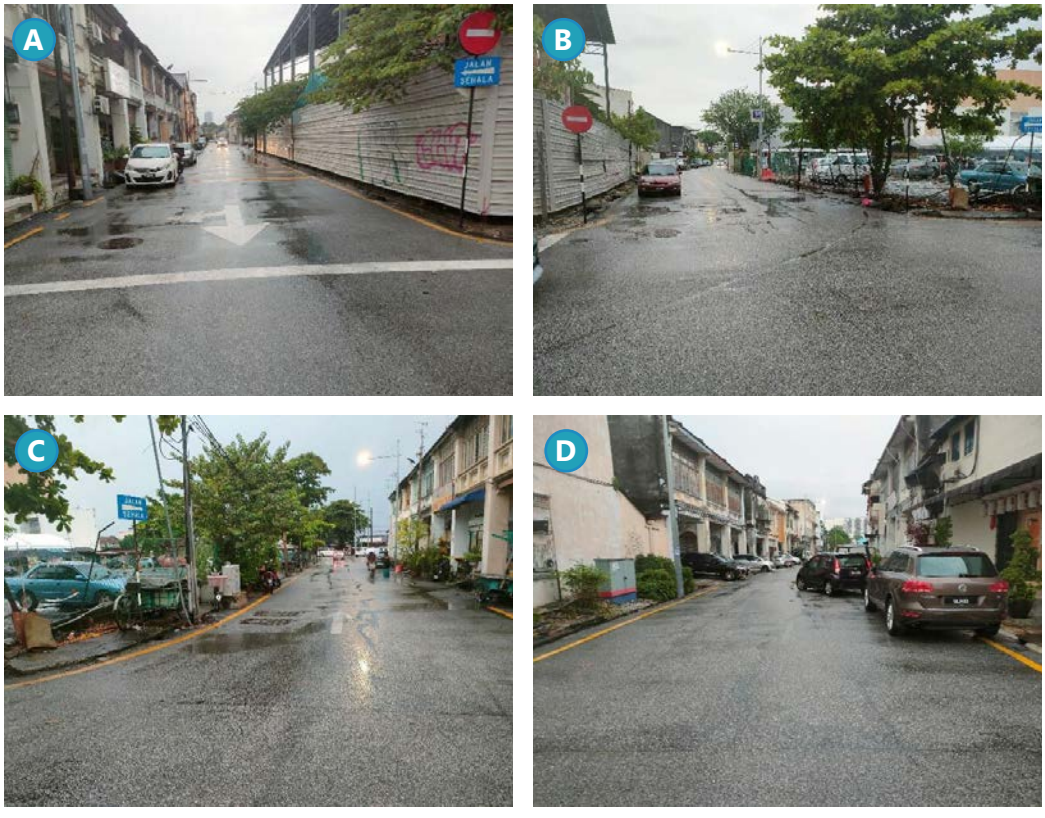

Figure 68: Junction 11 Traffic Condition

A.1.12 JUNCTION 12: LEBUH VICTORIA / GAT LEBUH ARMENIAN

Junction 12 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

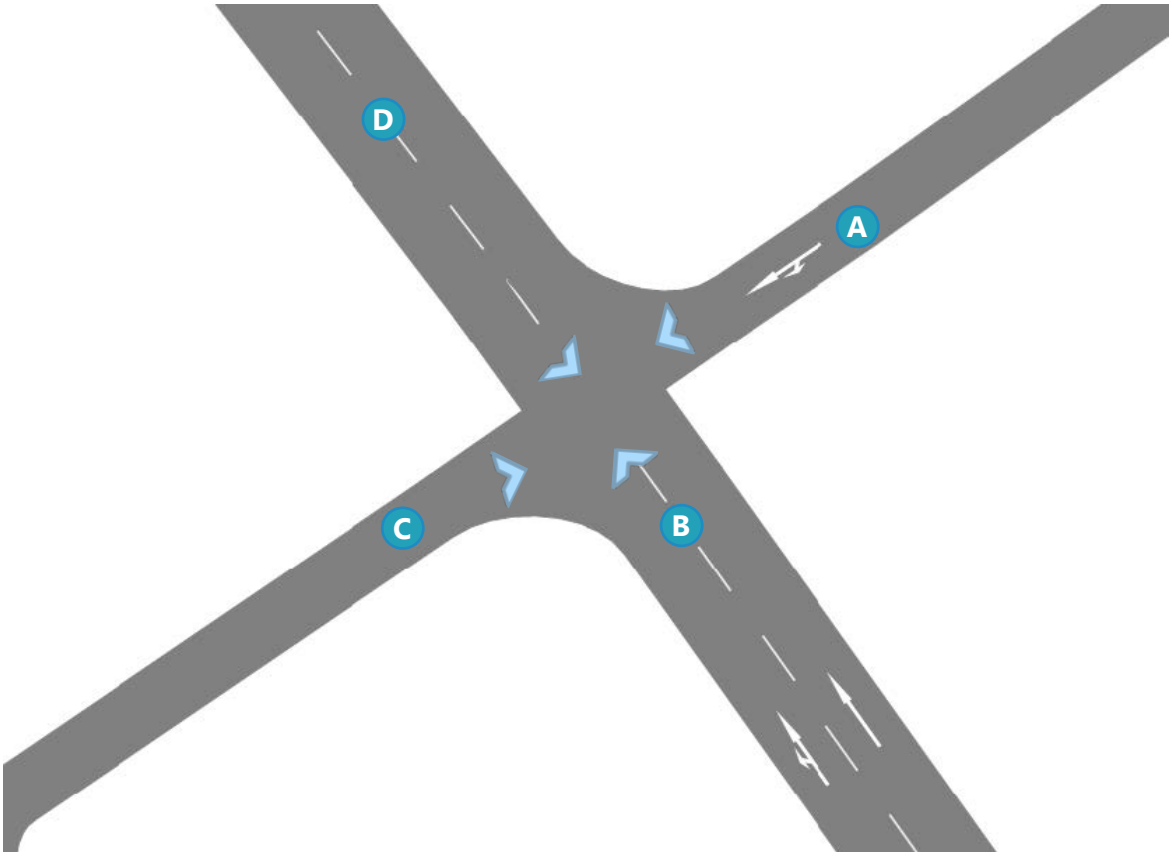

Figure 69: Junction 12 Layout

Figure 70: Junction 12 Traffic Condition

A.1.13 JUNCTION 13: LEBUH VICTORIA / GAT LEBUH CHULIA

Junction 13 is a unsignalized cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

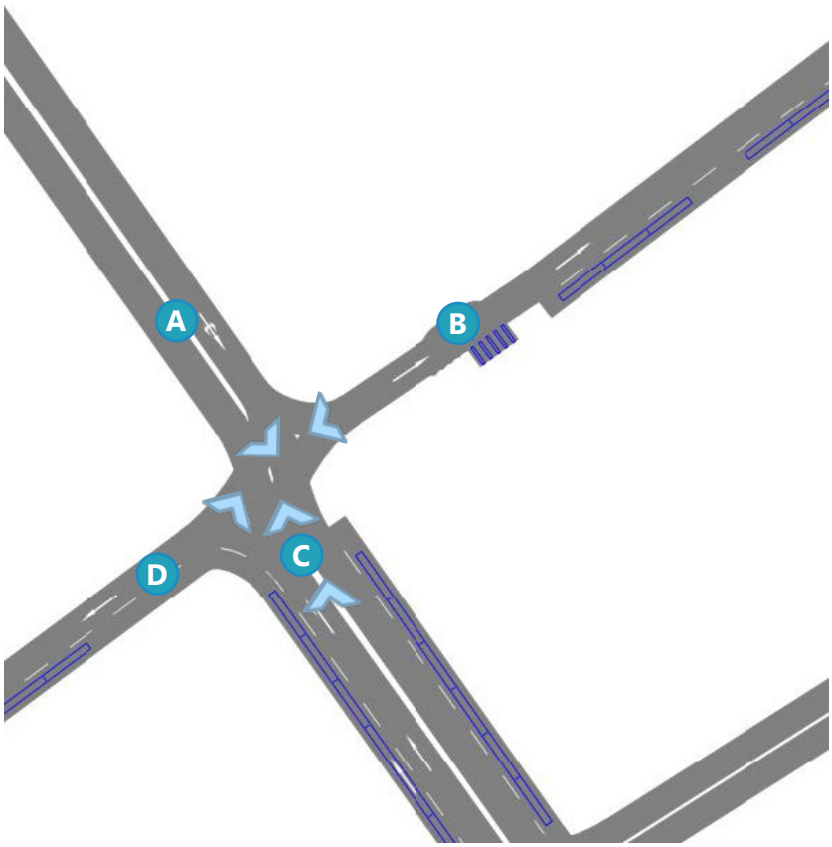

Figure 71: Junction 13 Layout

Figure 72: Junction 13 Traffic Condition

A.1.14 JUNCTION 14: LEBUH VICTORIA / GAT LEBUH PASAR

Junction 14 is a unsignalized T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

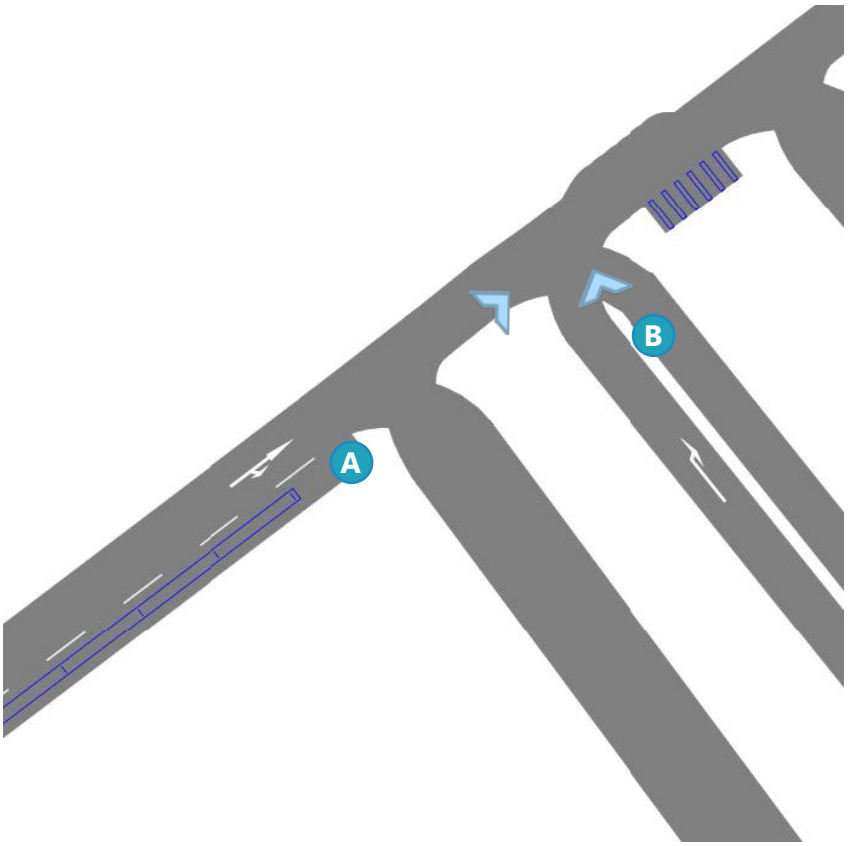

Figure 73: Junction 14 Layout

Figure 74: Junction 14 Traffic Condition

A.1.15 JUNCTION 15: LEBUH VICTORIA / GAT LEBUH CHINA

Junction 15 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

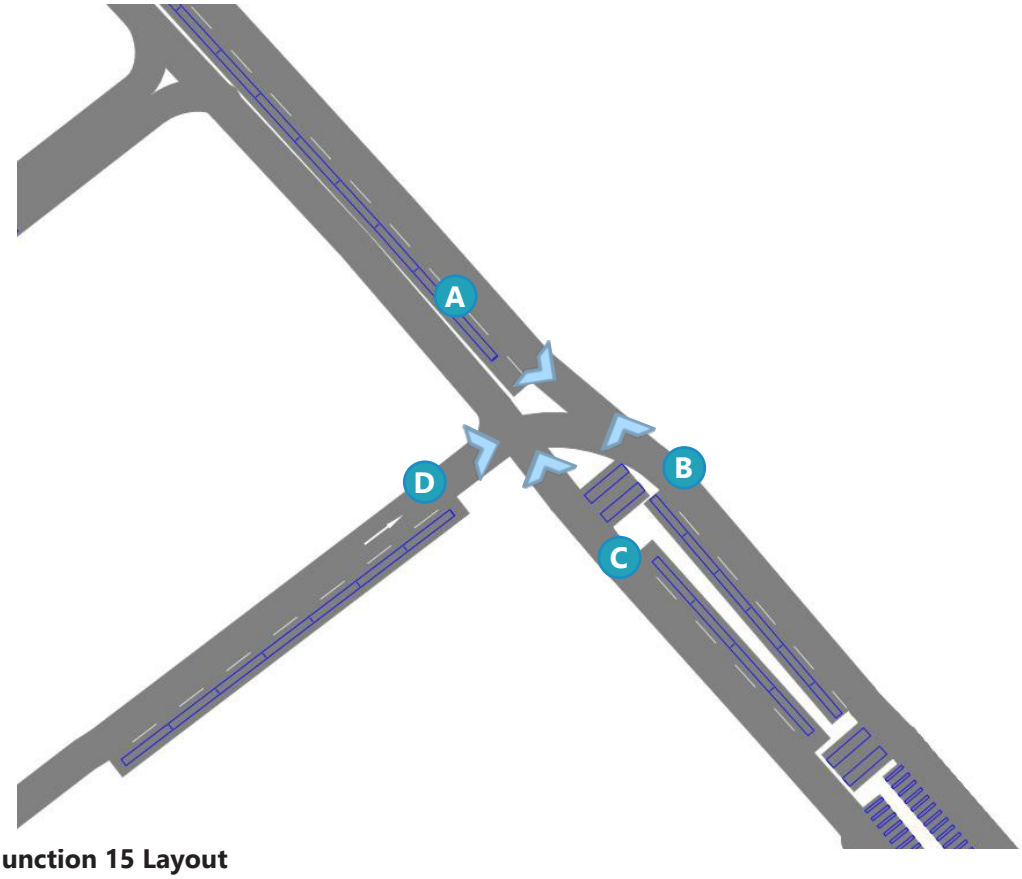

Figure 75: Junction 15 Layout

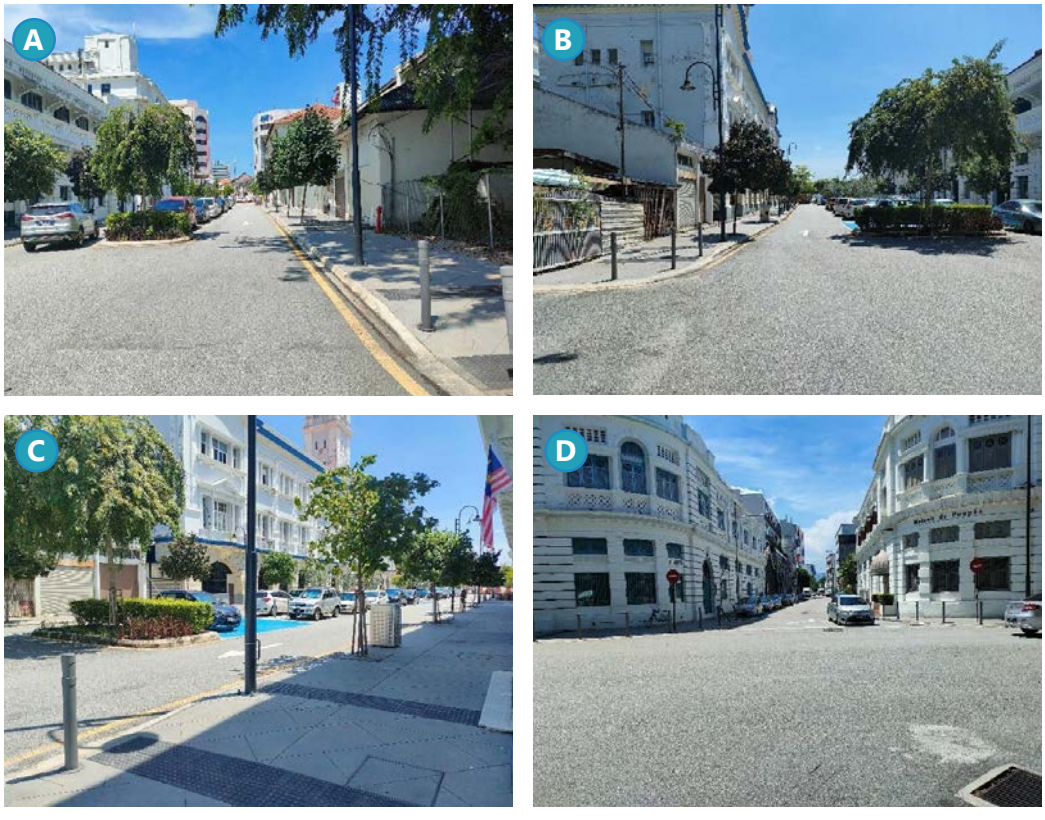

Figure 76: Junction 15 Traffic Condition

A.1.16 JUNCTION 16: BEACH STREET / PESARA KING EDWARD

Junction 16 is a unsignalized roundabout junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

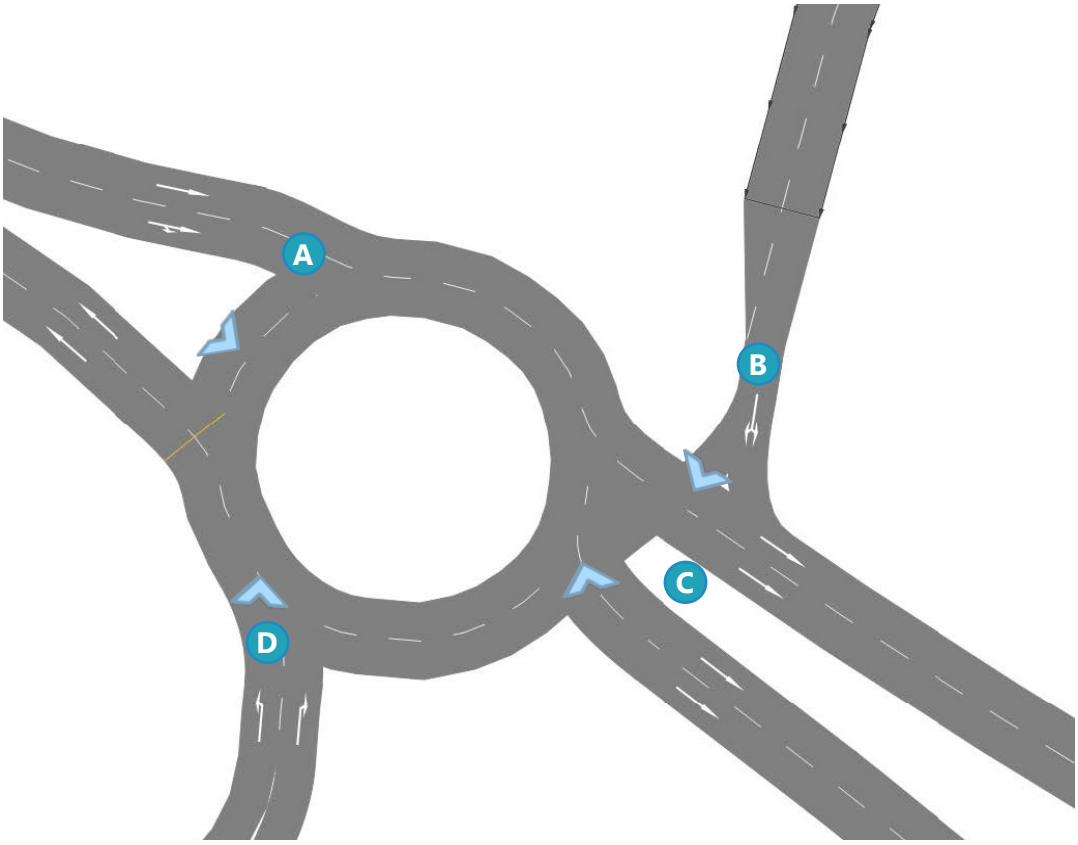

Figure 77: Junction 16 Layout

Figure 78: Junction 16 Traffic Condition

A.1.17 JUNCTION 17: BEACH STREET / LEBUH DOWNING

Junction 17 is a unsignalized T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

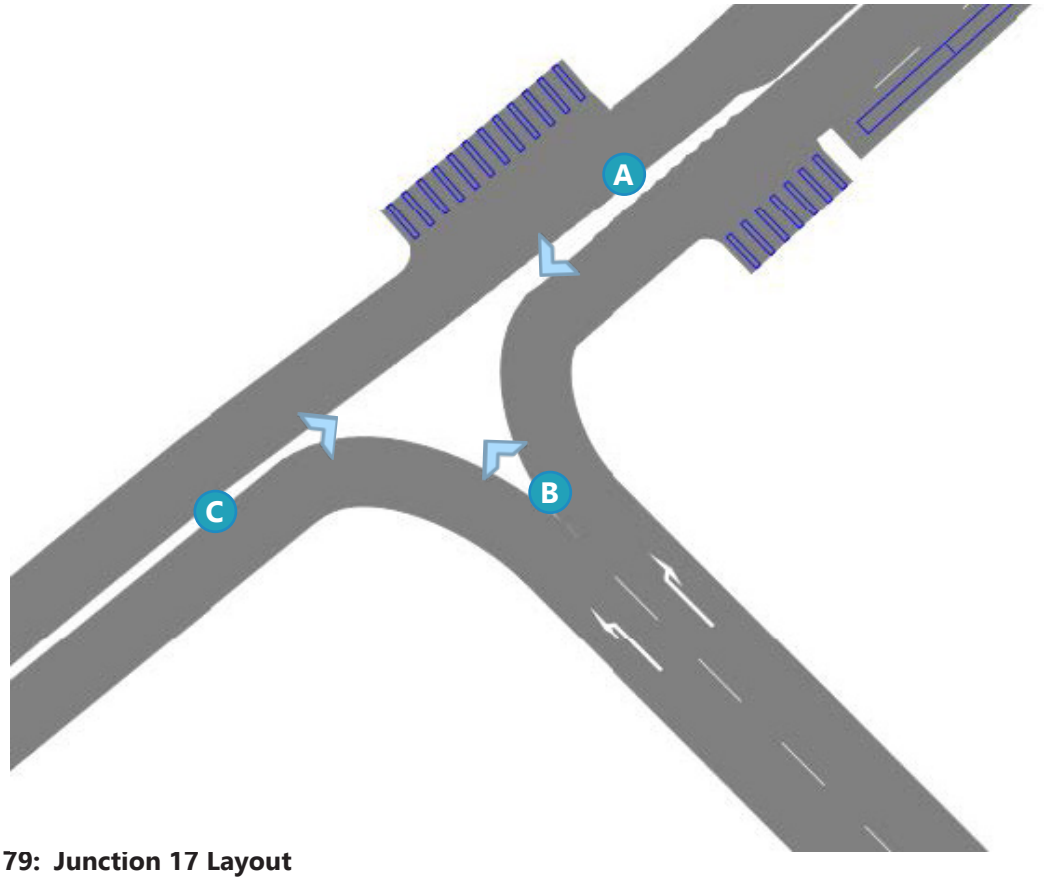

Figure 79: Junction 17 Layout

Figure 80: Junction 17 Traffic Condition

A.1.18 JUNCTION 18: BEACH STREET / LEBUH UNION

Junction 18 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

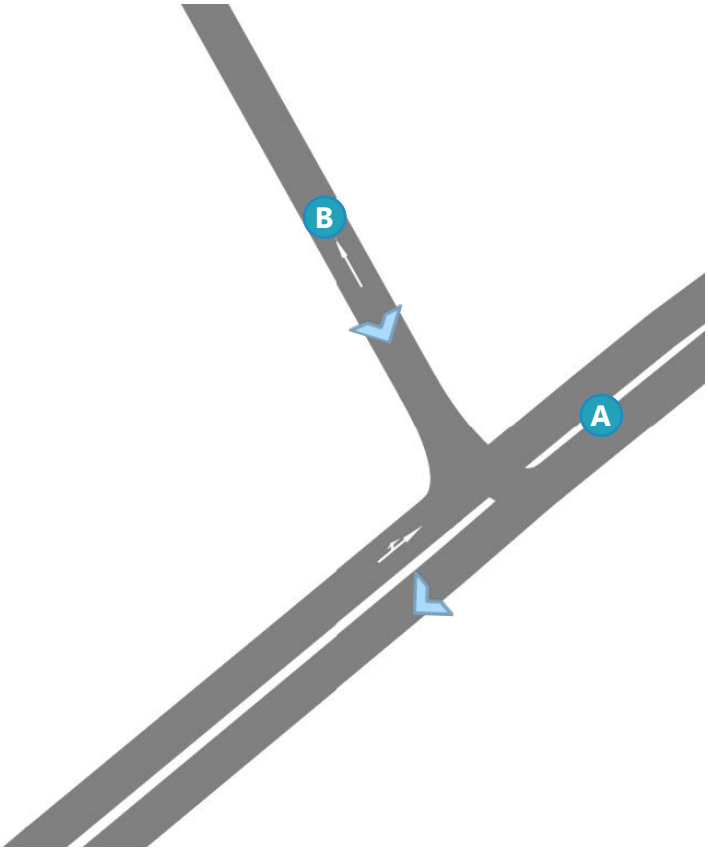

Figure 81: Junction 18 Layout

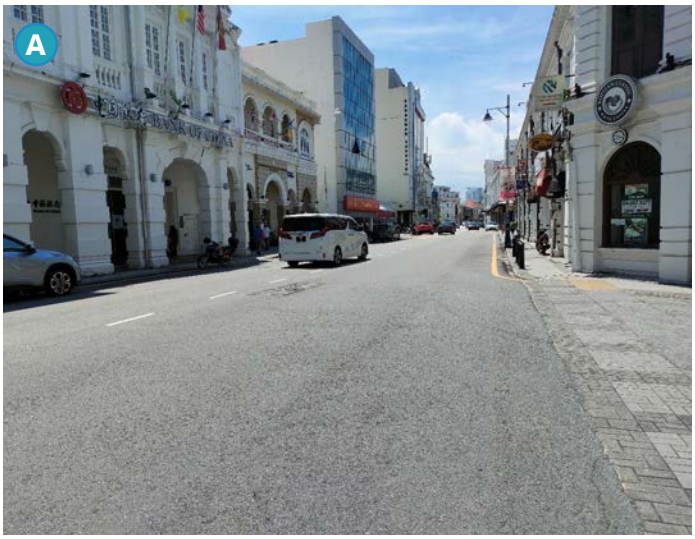

Figure 82: Junction 18 Traffic Condition

A.1.19 JUNCTION 19: BEACH STREET / BISHOP STREET

Junction 19 is a signalised double T-signalized T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

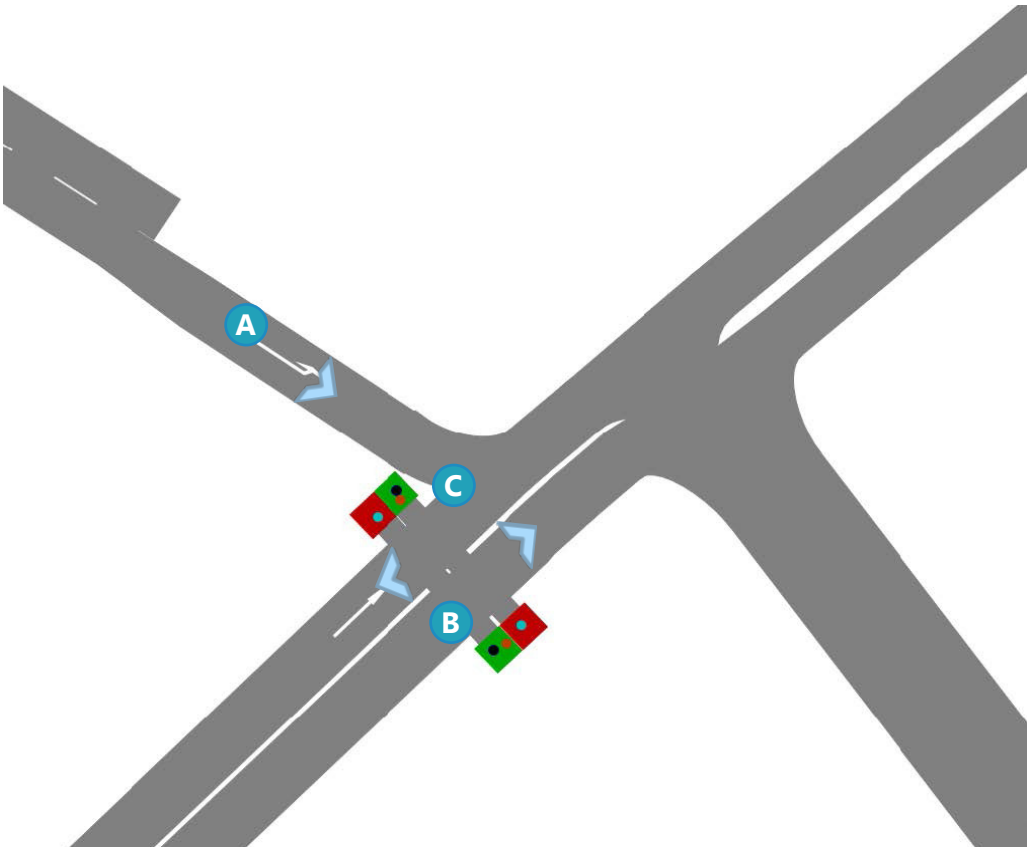

Figure 83: Junction 19 Layout

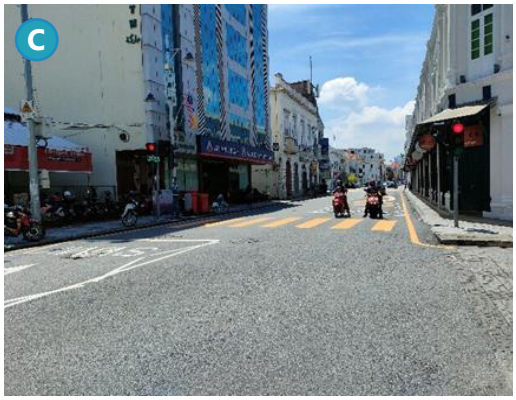

Figure 84: Junction 19 Traffic Condition

A.1. 20 JUNCTION 20: BEACH STREET / GAT LEBUH GEREJA

Junction 20 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Junction 20 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

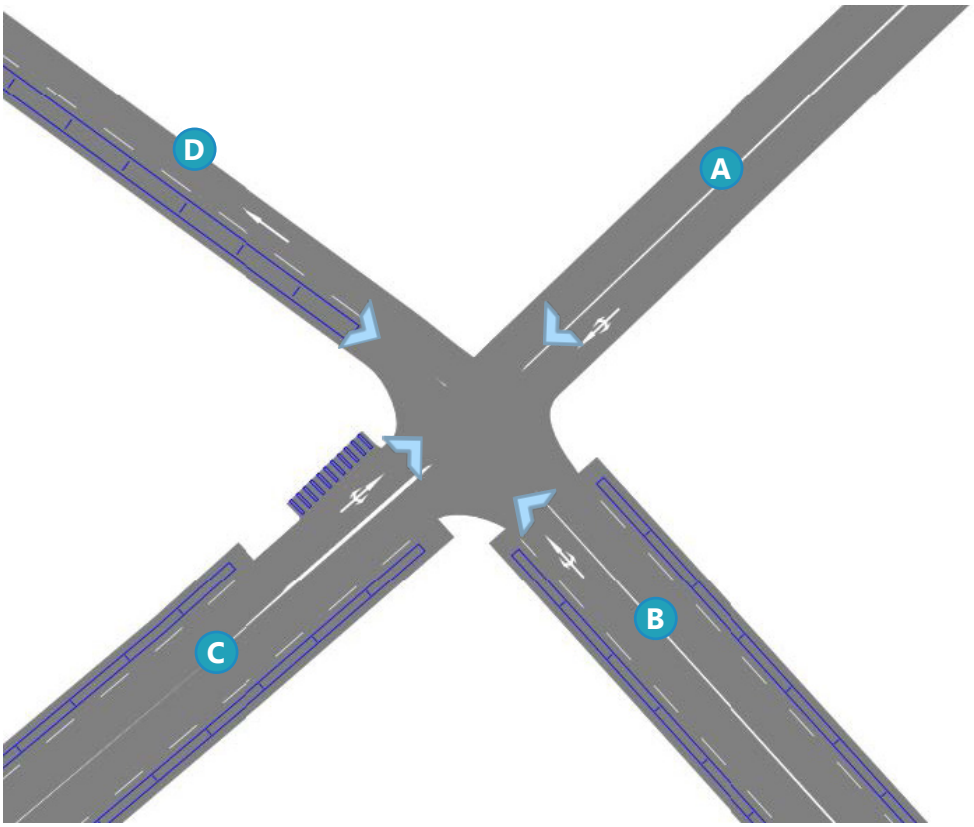

Figure 85: Junction 20 Layout

Figure 86: Junction 20 Traffic Condition

A.1.21 JUNCTION 21: BEACH STREET / GAT LEBUH CHINA

Junction 21 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

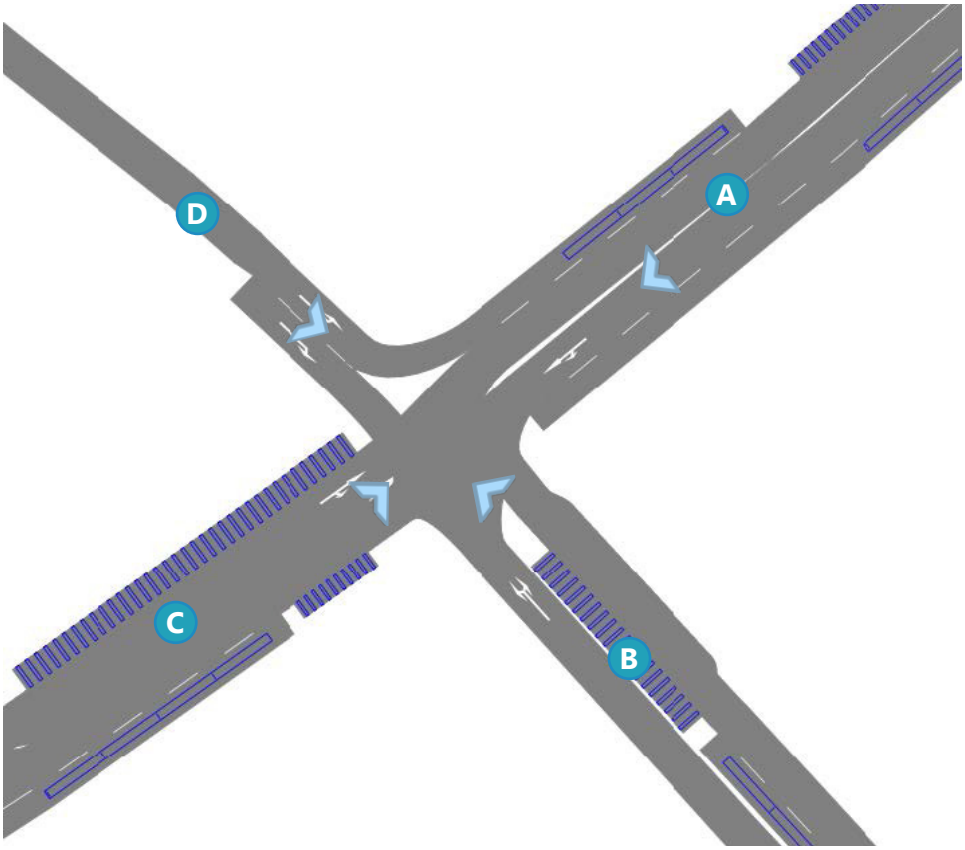

Figure 87: Junction 21 Layout

Figure 88: Junction 21 Traffic Condition

A.1.22 JUNCTION 22: BEACH STREET / LEBUH PASAR

Junction 22 is a signalised T-junction and the layout is shown in the figure below, followed by the site photos. Medium-length queues were observed on approaches of the junction.

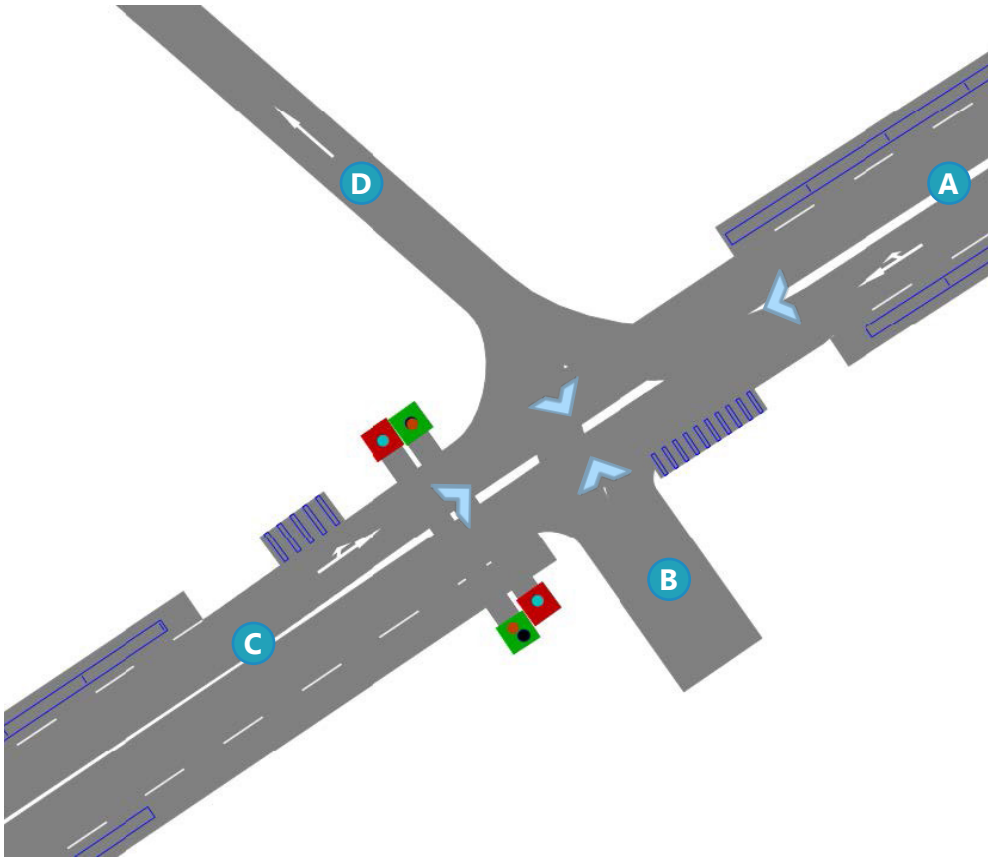

Figure 89: Junction 22 Layout

Figure 90: Junction 22 Traffic Condition

A.1.23 JUNCTION 23: BEACH STREET / GAT LEBUH CHULIA

Junction 23 is a signalised cross junction and the layout is shown in the figure below, followed by the site photos. Medium-length queues were observed on approaches of the junction.

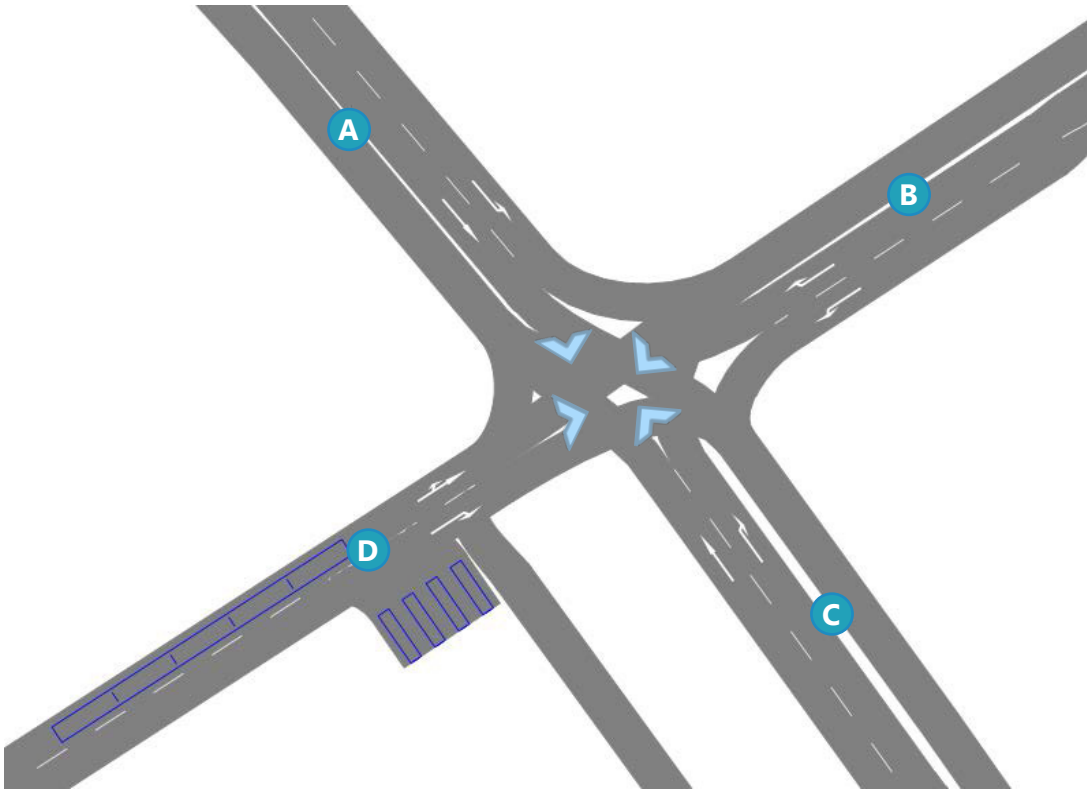

Figure 91: Junction 23 Layout

Figure 92: Junction 23 Traffic Condition

A.1.24 JUNCTION 24: BEACH STREET / LEBUH AH QUEE

Junction 24 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Medium-length queues were observed on approaches of the junction.

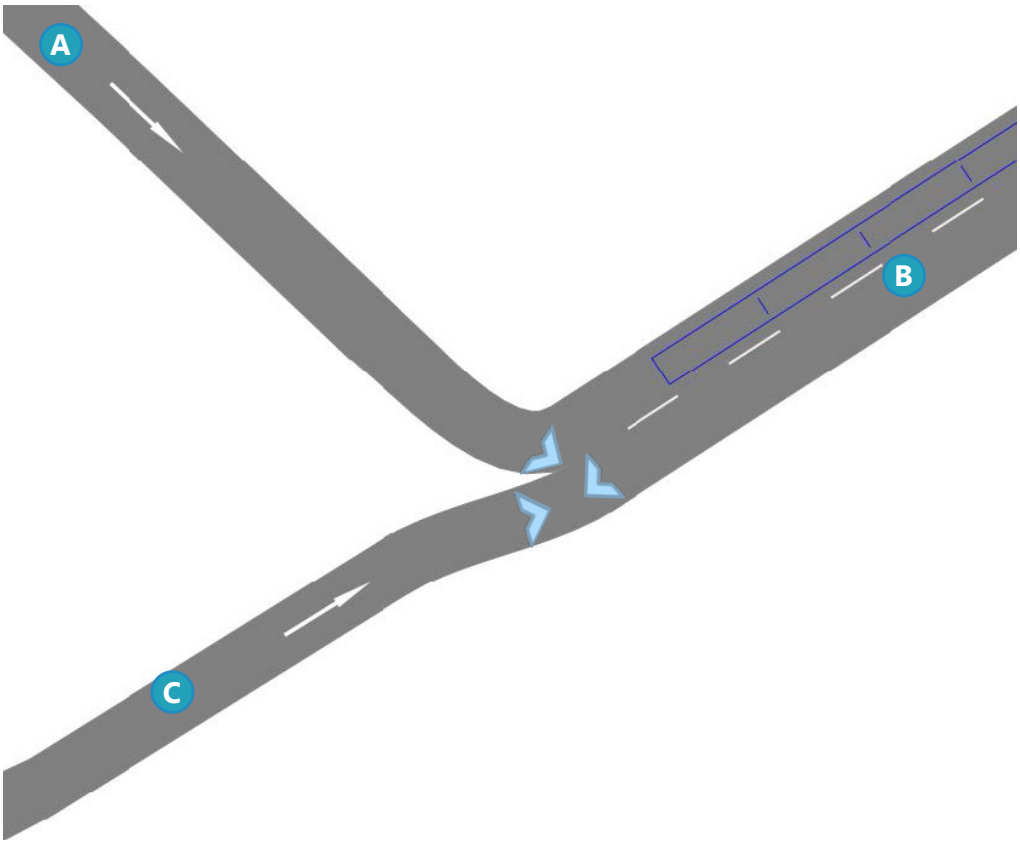

Figure 93: Junction 24 Layout

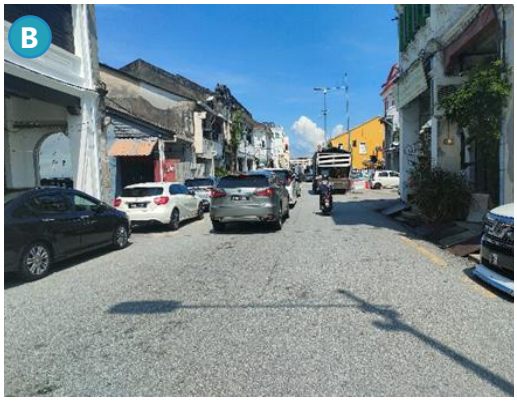

Figure 94: Junction 24 Traffic Condition

A.1.25 JUNCTION 25: BEACH STREET / GAT LEBUH ARMENIAN

Junction 25 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Medium-length queues were observed on approaches of the junction.

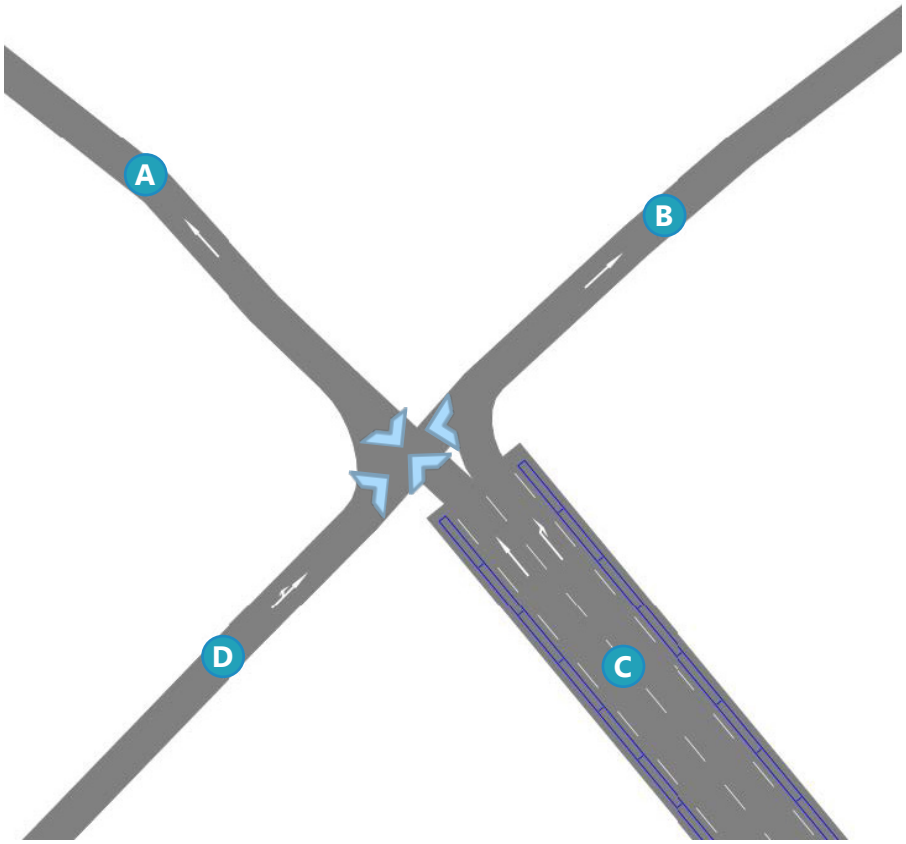

Figure 95: Junction 25 Layout

Figure 96: Junction 25 Traffic Condition

A.1.26 JUNCTION 26: BEACH STREET / GAT LEBUH ACHEH

Junction 26 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

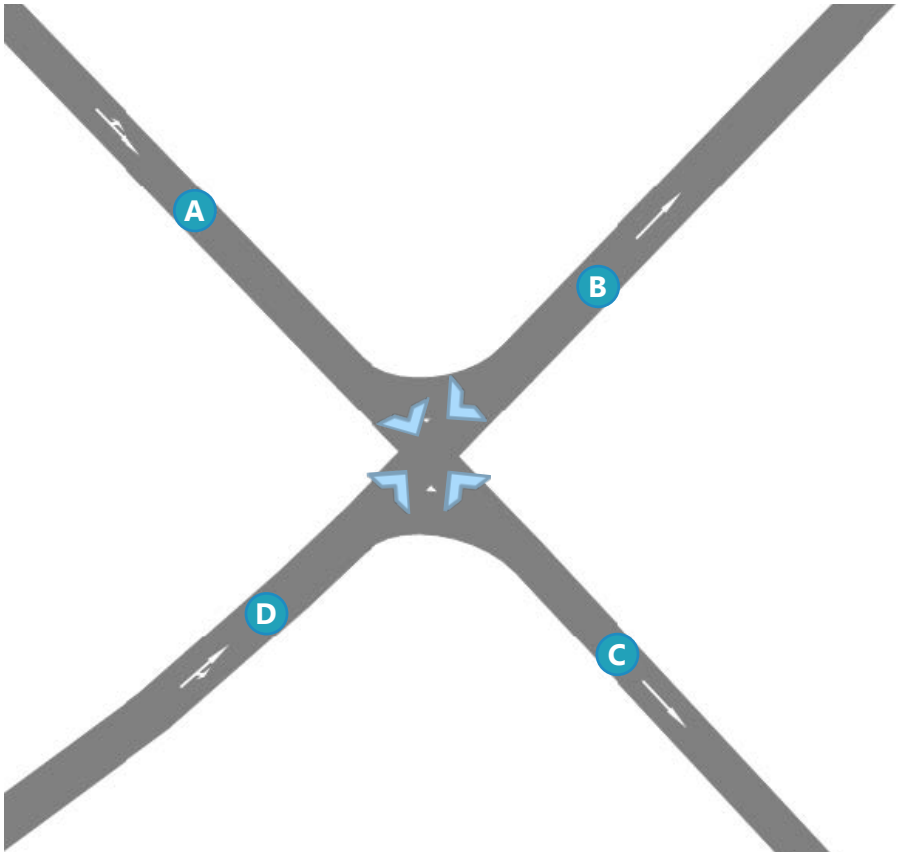

Figure 97: Junction 26 Layout

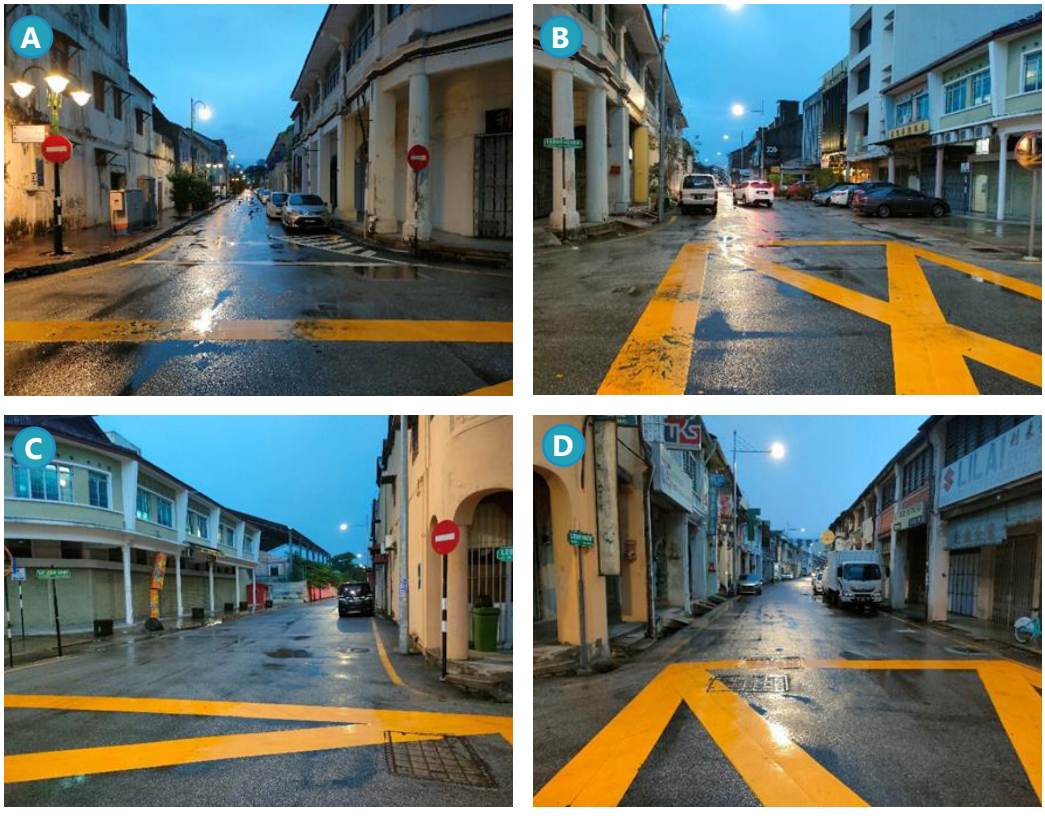

Figure 98: Junction 26 Traffic Condition

A.1.27 JUNCTION 27: BEACH STREET / GET LEBUH MELAYU

Junction 27 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

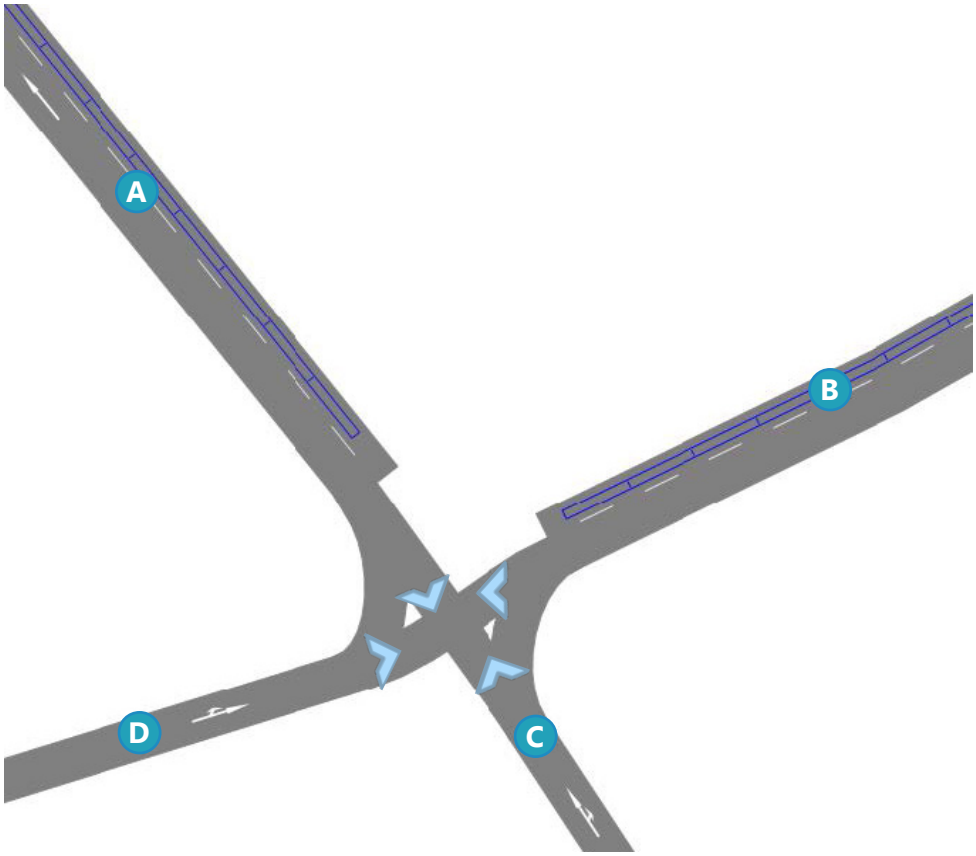

Figure 99: Junction 27 Layout

Figure 100: Junction 27 Traffic Condition

A.1.28 JUNCTION 28: GET LEBUH MELAYU / LORONG TOH AKA

Junction 28 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction..

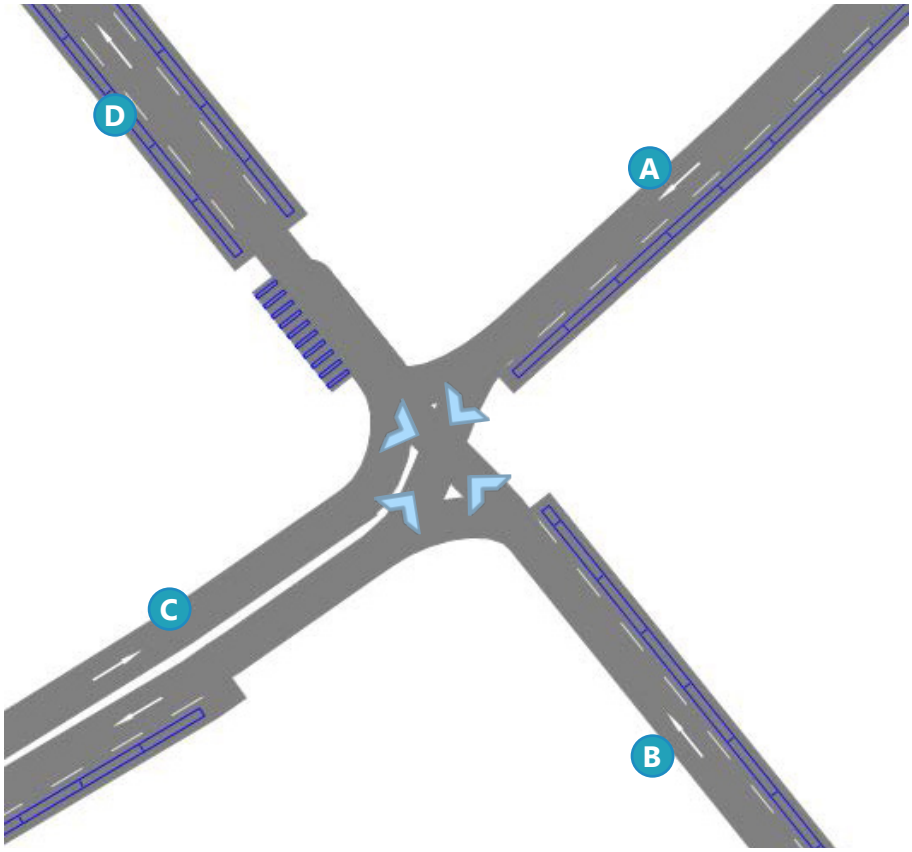

Figure 101: Junction 28 Layout

Figure 102: Junction 28 Traffic Condition

A.1.29 JUNCTION 29: LORONG TOH AKA / LORONG CARNAVON

Junction 29 is a signalised cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction during the morning and evening peak.

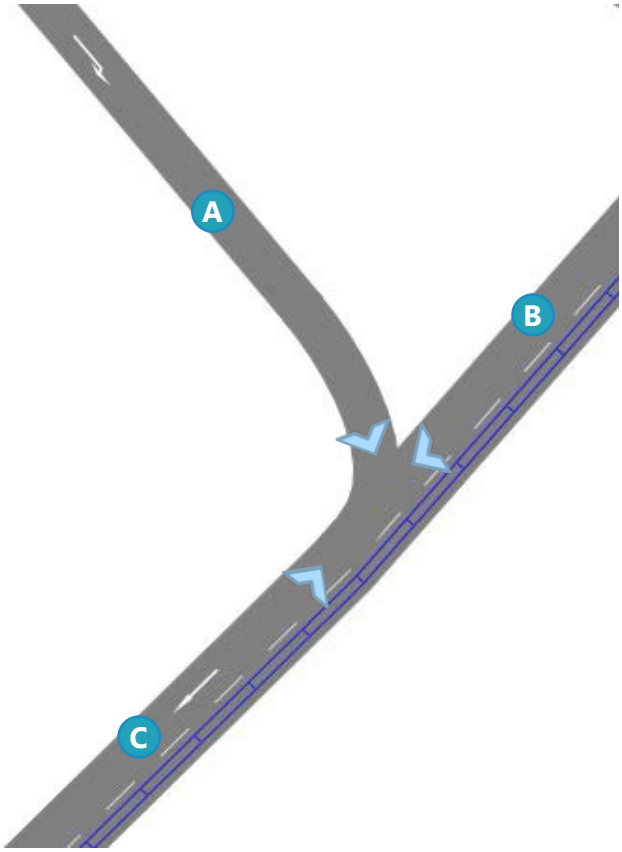

Figure 103: Junction 29 Layout

Figure 104: Junction 29 Traffic Condition

A.1.30 JUNCTION 30: GAT LEBUH ACHEH / LEBUH CARNAVON

Junction 30 is a unsingalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

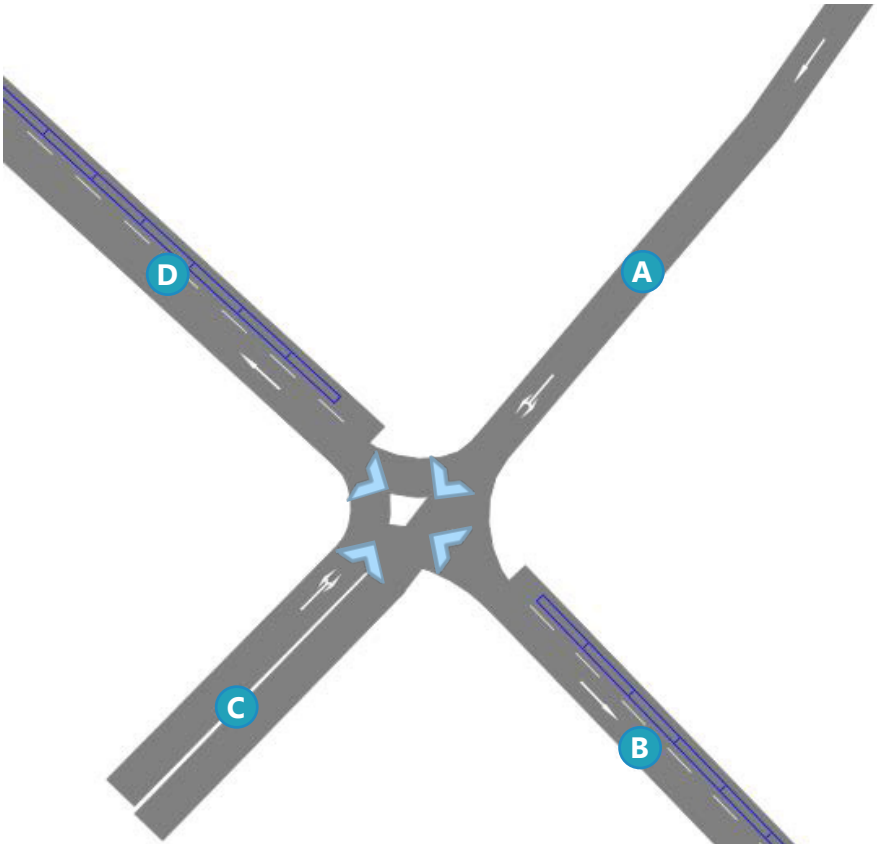

Figure 105: Junction 30 Layout

Figure 106: Junction 30 Traffic Condition

A.1.31 JUNCTION 31: GAT LEBUH ARMENIAN / LORONG CARNAVON

Junction 31 is a unsignalised double T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

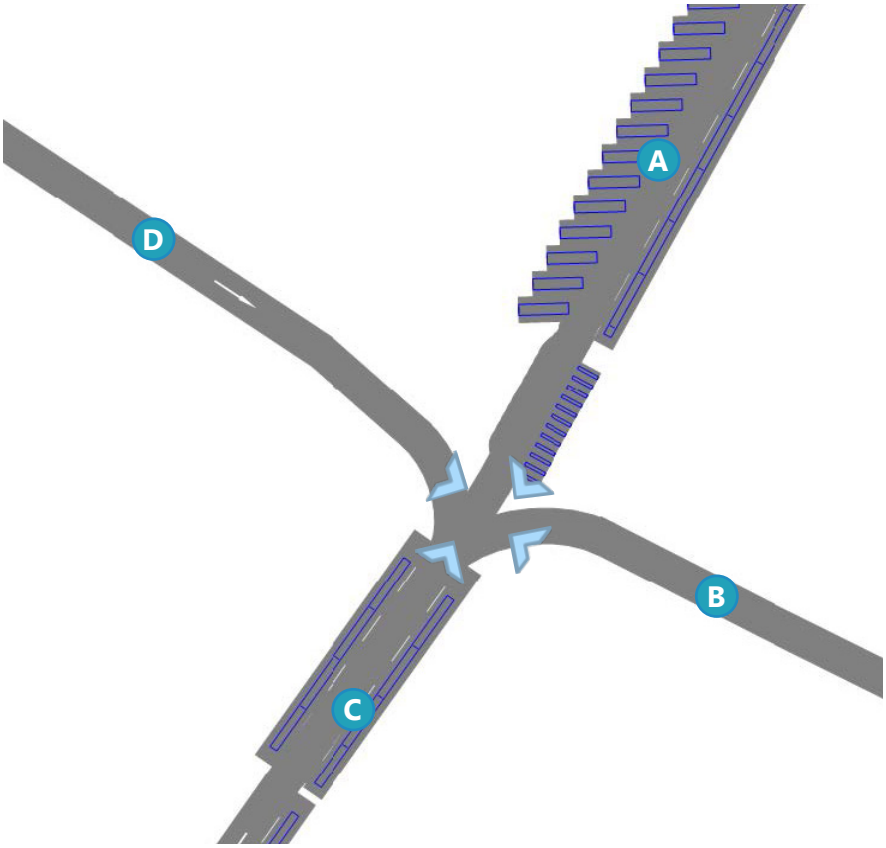

Figure 107: Junction 31 Layout

Figure 108: Junction 31 Traffic Condition

A.1.32 JUNCTION 32: JALAN MASJID KAPITAN KELING / JALAN MASJID KAPITAN KELING

Junction 32 is a unsignalised Y-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

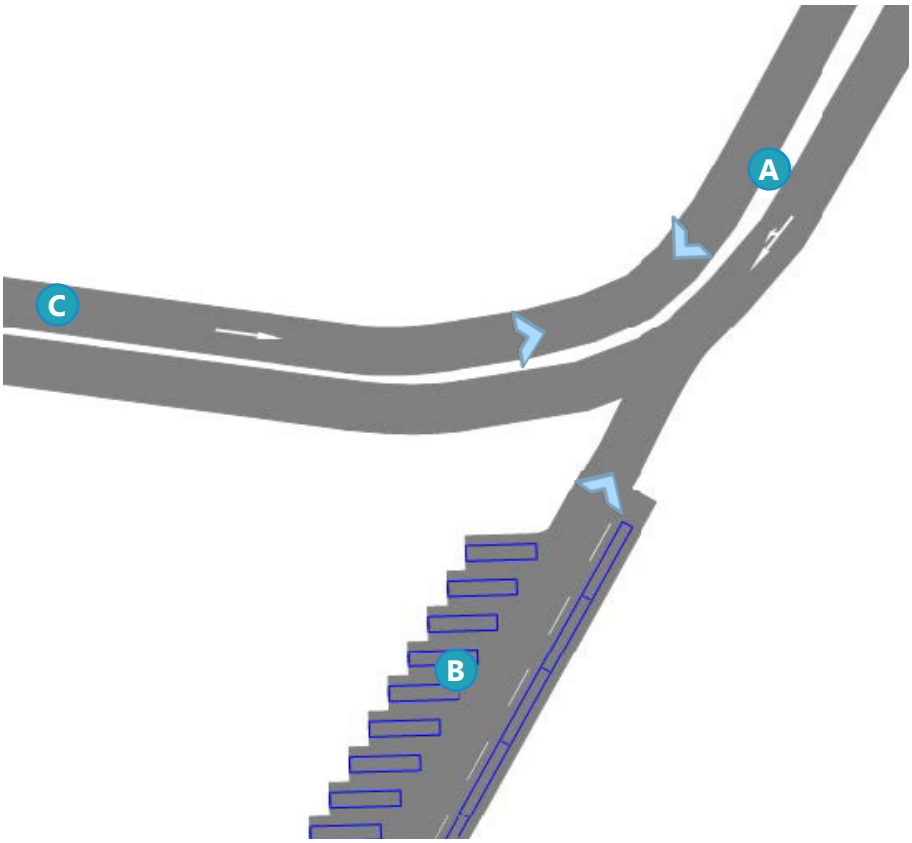

Figure 109: Junction 32 Layout

Figure 110: Junction 32 Traffic Condition

A.1.33 JUNCTION 33: JALAN MASJID KAPITAN KEELING/ LEBUH AH QUEE

Junction 33 is a unsignalized double T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

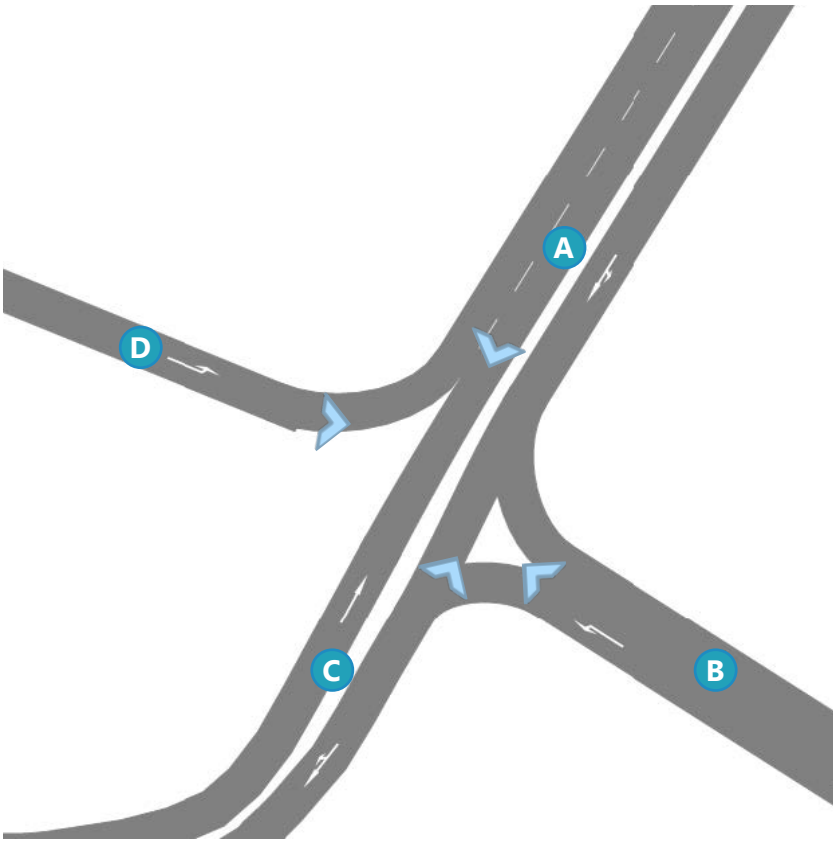

Figure 111: Junction 33 Layout

Figure 112: Junction 33 Traffic Condition

A.1.34 JUNCTION 34: JALAN MASJID KAPITAN KELING / CHULIA STREET

Junction 34 is a signalised cross junction, and the layout is shown in the figure below, followed by the site photos. Long queues were observed on approaches of the junction.

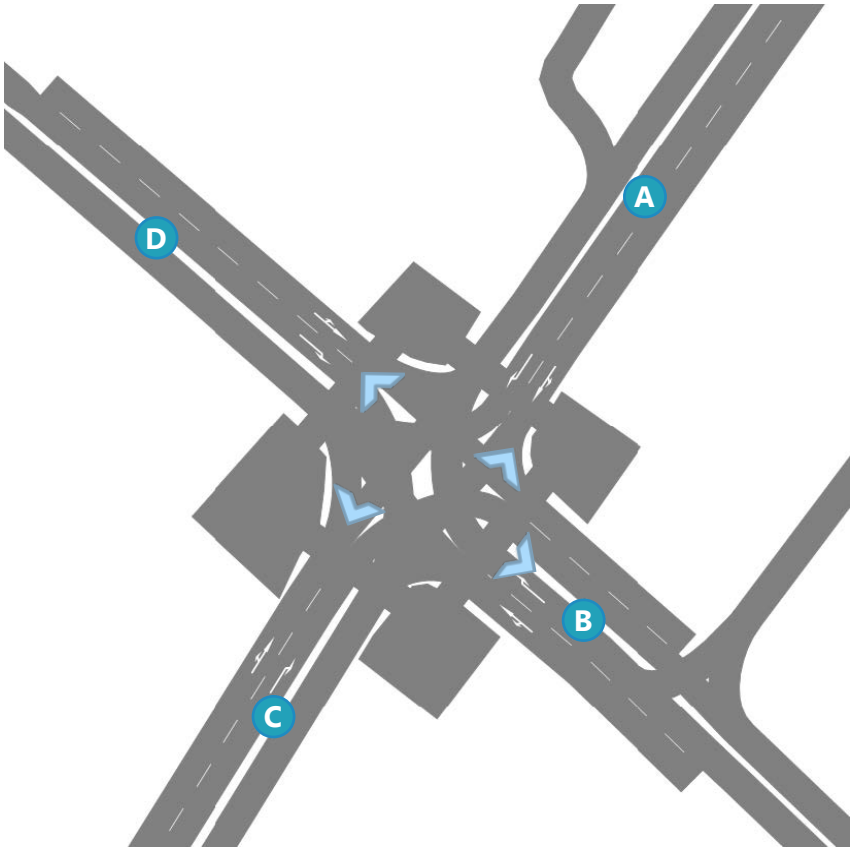

Figure 113: Junction 34 Layout

Figure 114: Junction 34 Traffic Condition

A.1.35 JUNCTION 35: LEBUH KING / CHULIA STREET

Junction 35 is a unsignalised Cross-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

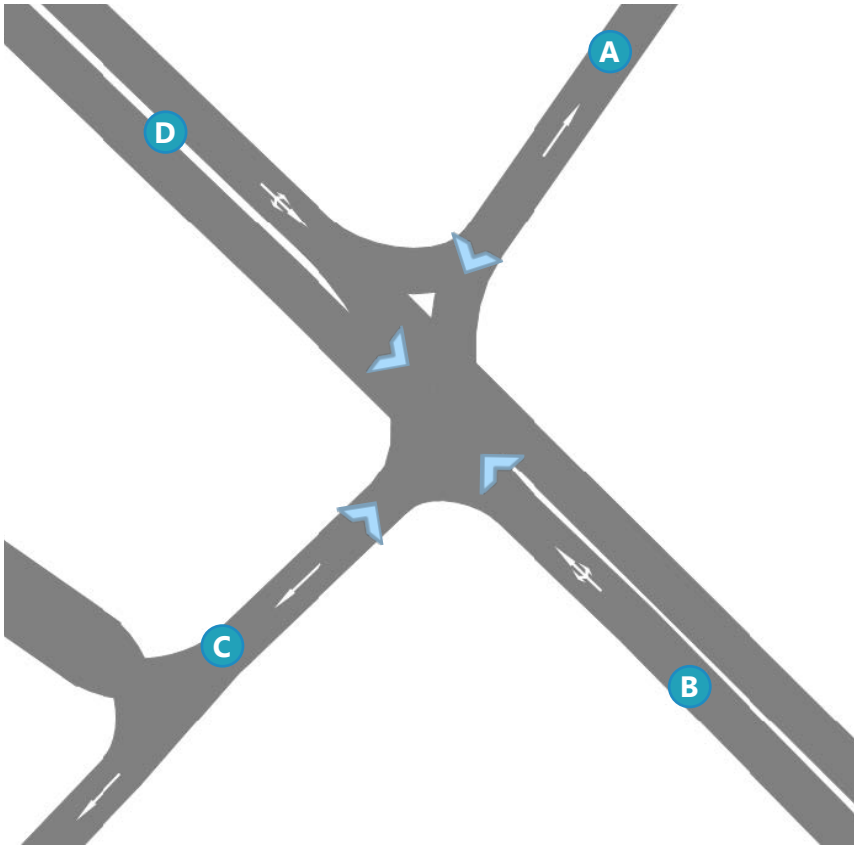

Figure 115: Junction 35 Layout

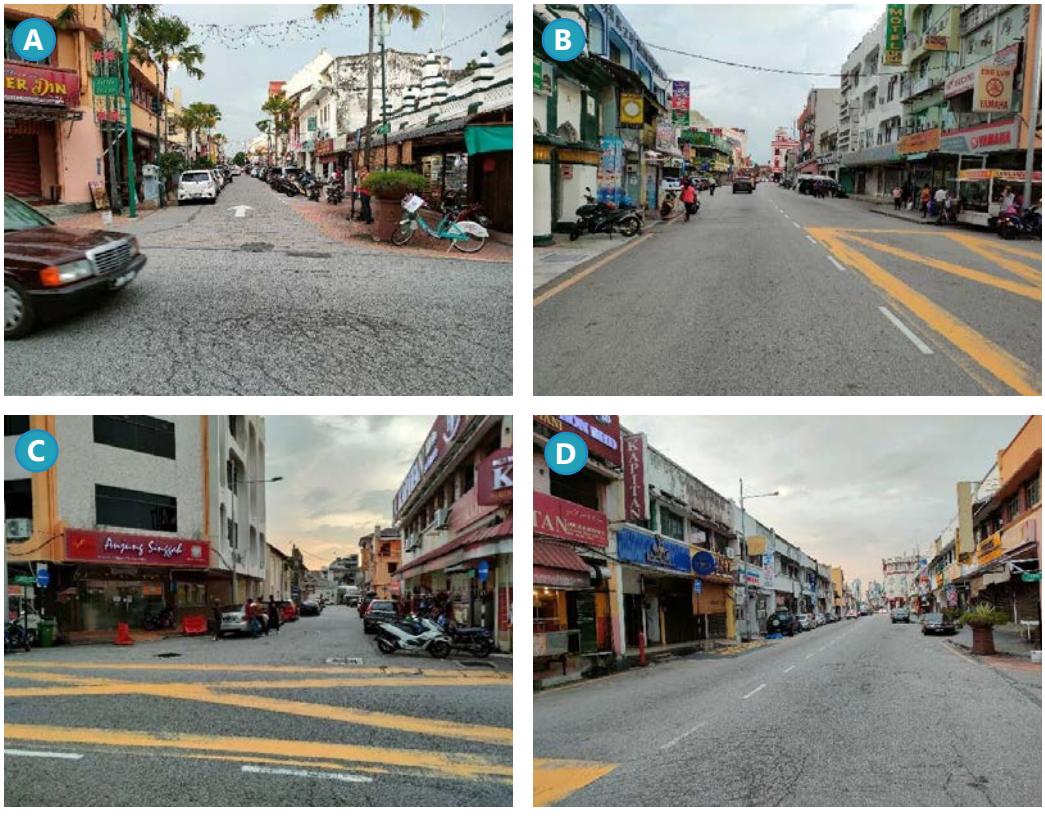

Figure 116: Junction 35 Traffic Condition

A.1.36 JUNCTION 36: PENANG STREET / CHULIA STREET

Junction 36 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short-length queues were observed on approaches of the junction.

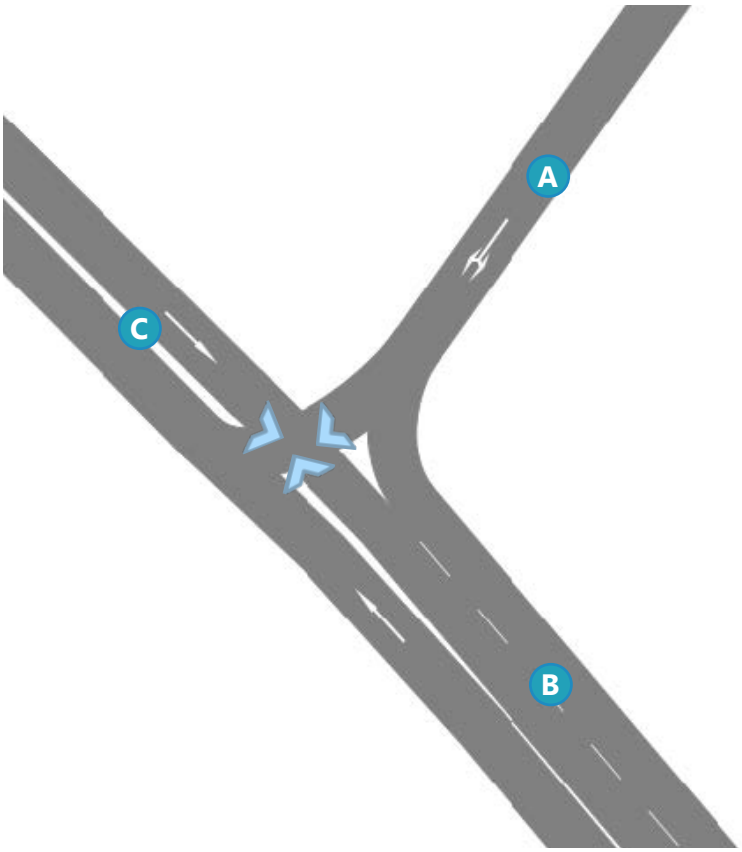

Figure 117: Junction 36 Layout

Figure 118: Junction 36 Traffic Condition

A.1.37 JUNCTION 37: PENANG STREET / LEBUH PASAR

Junction 37 is a unsignalized Cross-junction and the layout is shown in the figure below, followed by the site photos. Medium-length queues were observed on approaches of the junction.

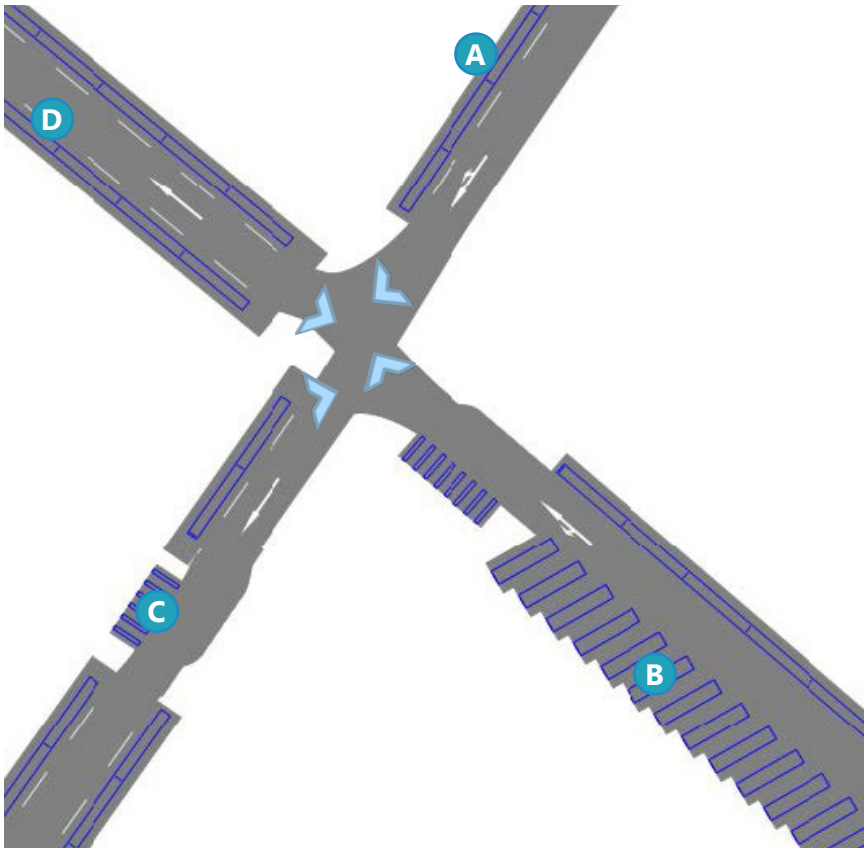

Figure 119: Junction 37 Layout

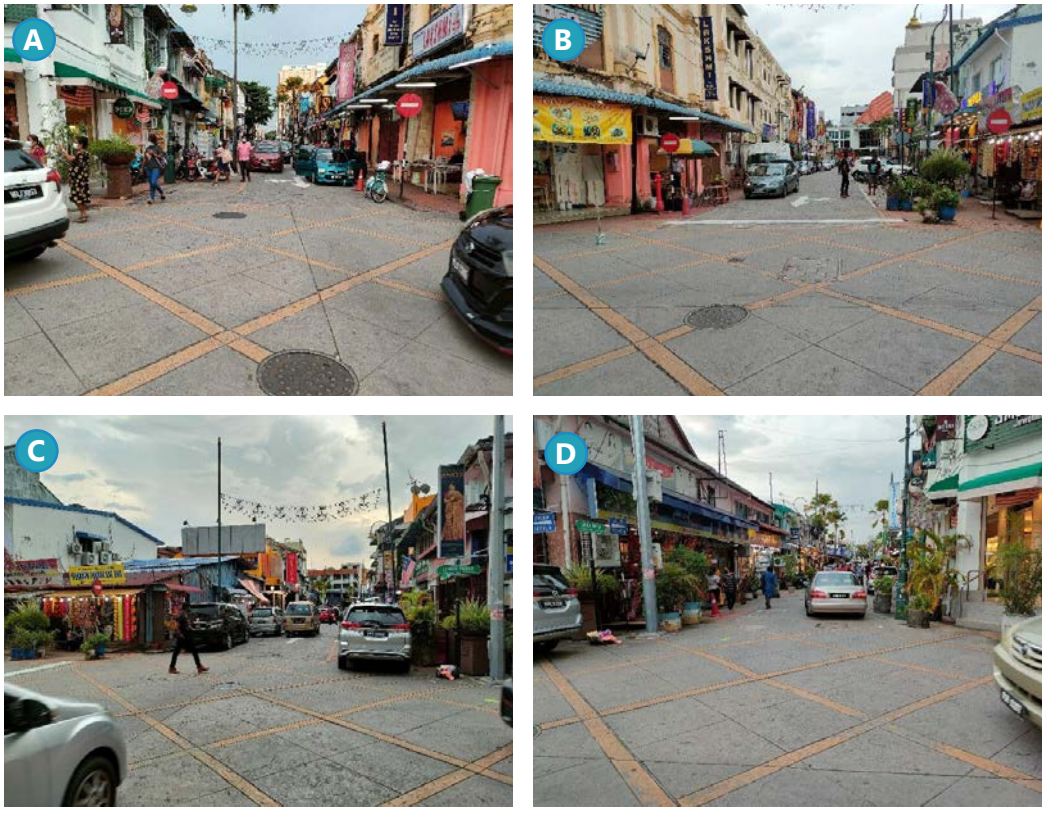

Figure 120: Junction 37 Traffic Condition

A.1.38 JUNCTION 38: LEBUH KING / LEBUH PASAR

Junction 38 is a unsignalised Cross junction and the layout is shown in the figure below, followed by the site photos. Medium-length queues were observed on approaches of the junction.

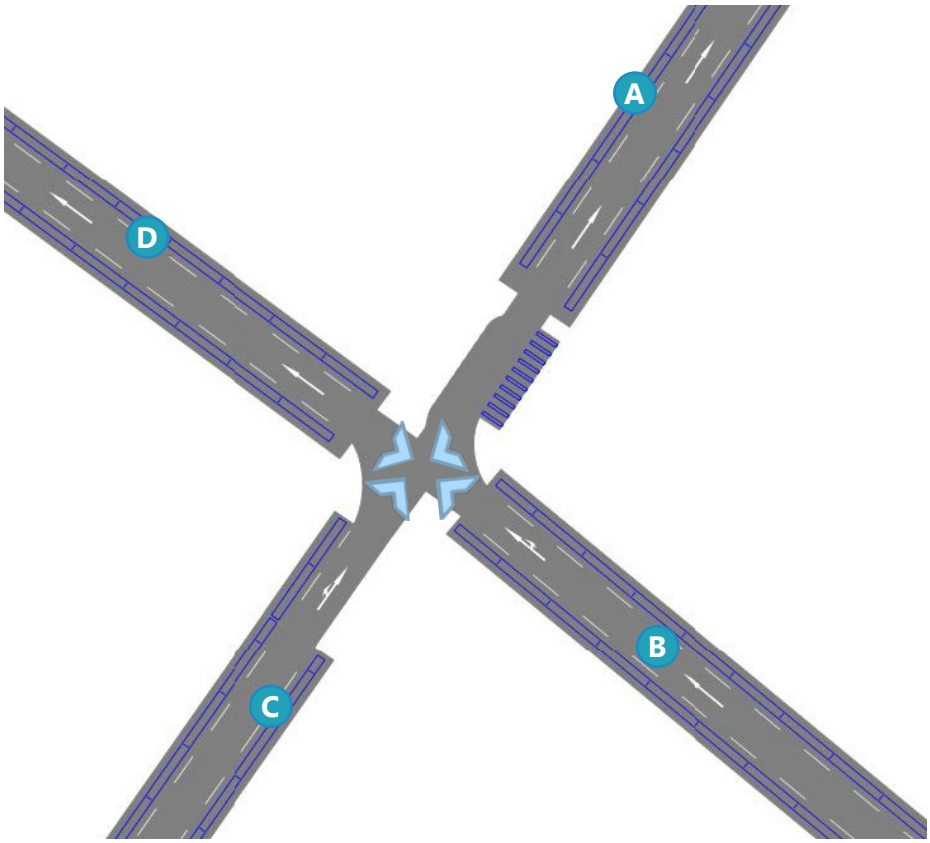

Figure 121: Junction 38 Layout

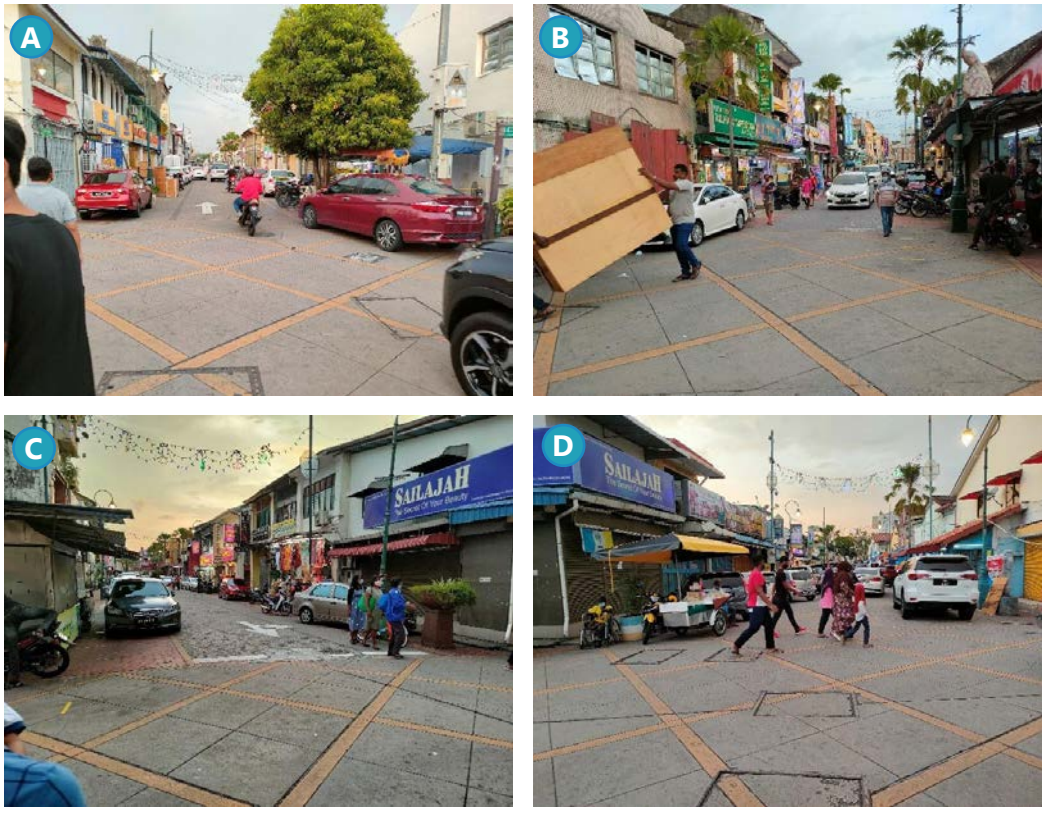

Figure 122: Junction 38 Traffic Condition

A.1.39 JUNCTION 39: LEBUH PASIR / QUEEN STREET

Junction 39 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Medium-length queues were observed on approaches of the junction.

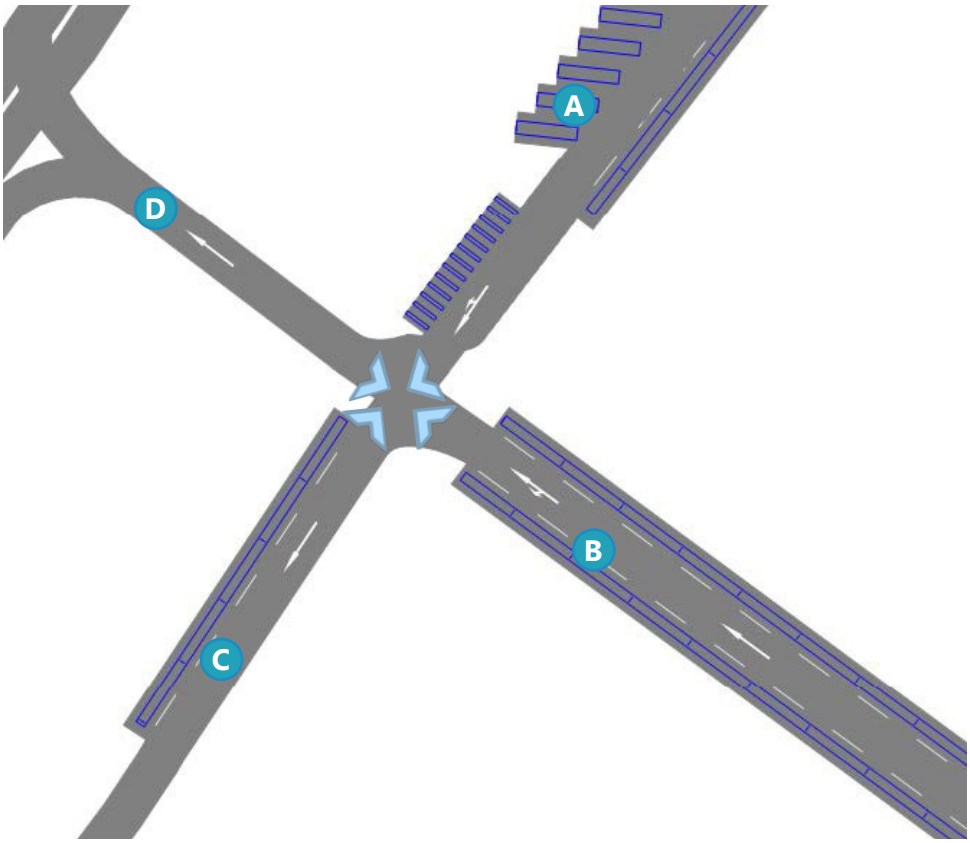

Figure 123: Junction 39 Layout

Figure 124: Junction 39 Traffic Condition

A.1.40 JUNCTION 40: LEBUH PASIR / JALAN MASJID KAPITAN KELING

Junction 40 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Medium-length queues were observed on approaches of the junction.

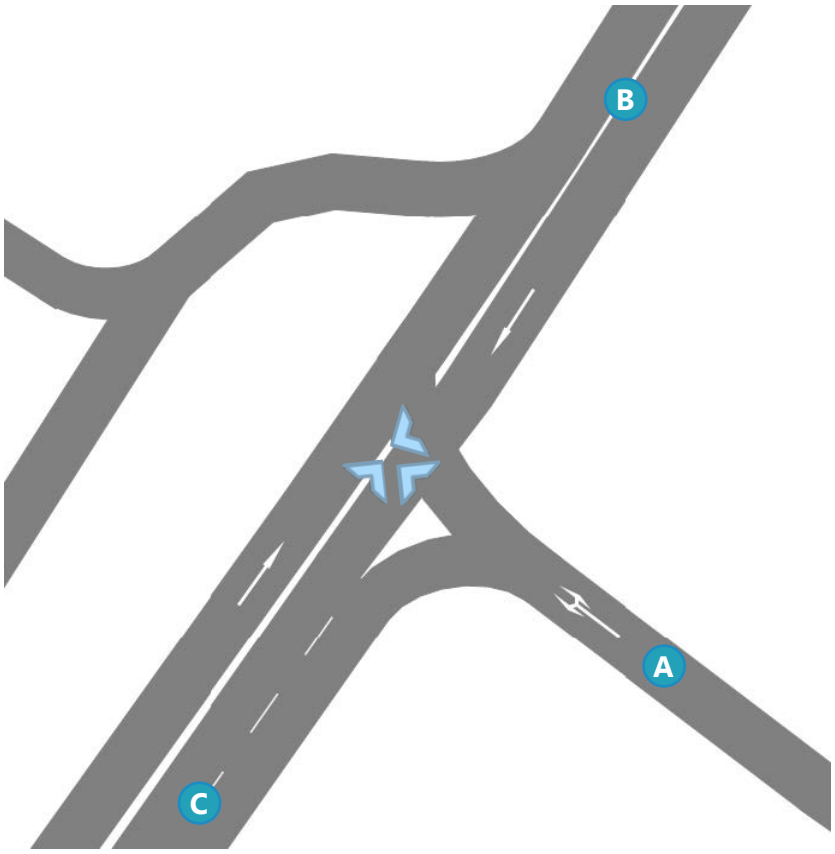

Figure 125: Junction 40 Layout

Figure 126: Junction 40 Traffic Condition

A.1.41 JUNCTION 41: LORONG STEWART / JALAN MASJID KAPITAN KELING

Junction 41 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Medium length queues were observed on approaches of the junction.

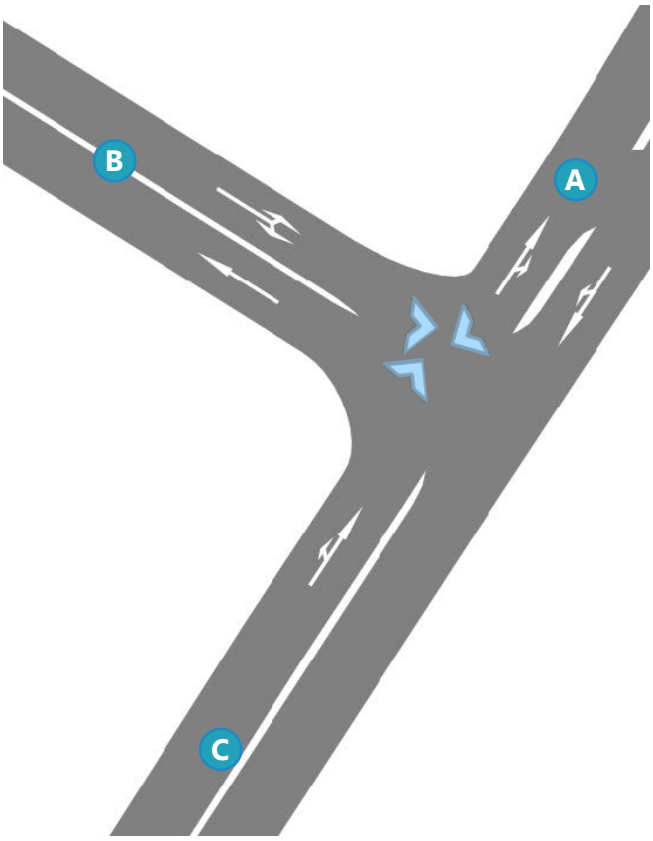

Figure 127: Junction 41 Layout

Figure 128: Junction 41 Traffic Condition

A.1.42 JUNCTION 42: LEBUH CHINA / JALAN MASJID KAPITAN KELING

Junction 42 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

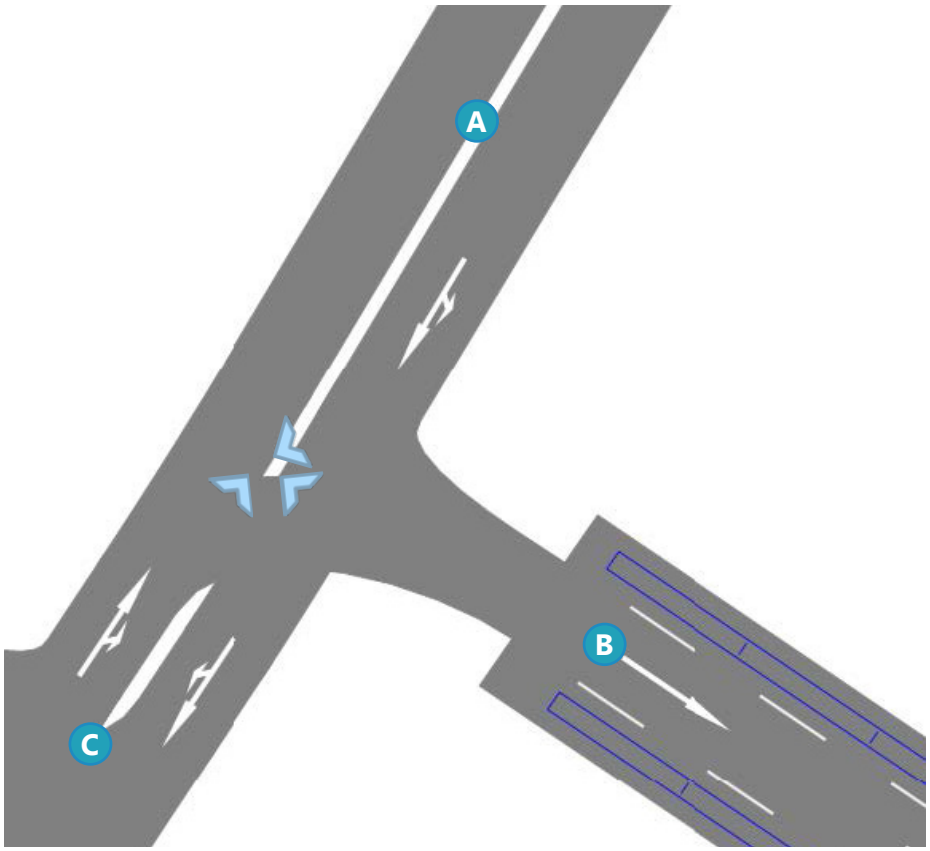

Figure 129: Junction 42 Layout

Figure 130: Junction 42 Traffic Condition

A.1.43 JUNCTION 43: LEBUH CHINA / QUEEN STREET

Junction 43 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

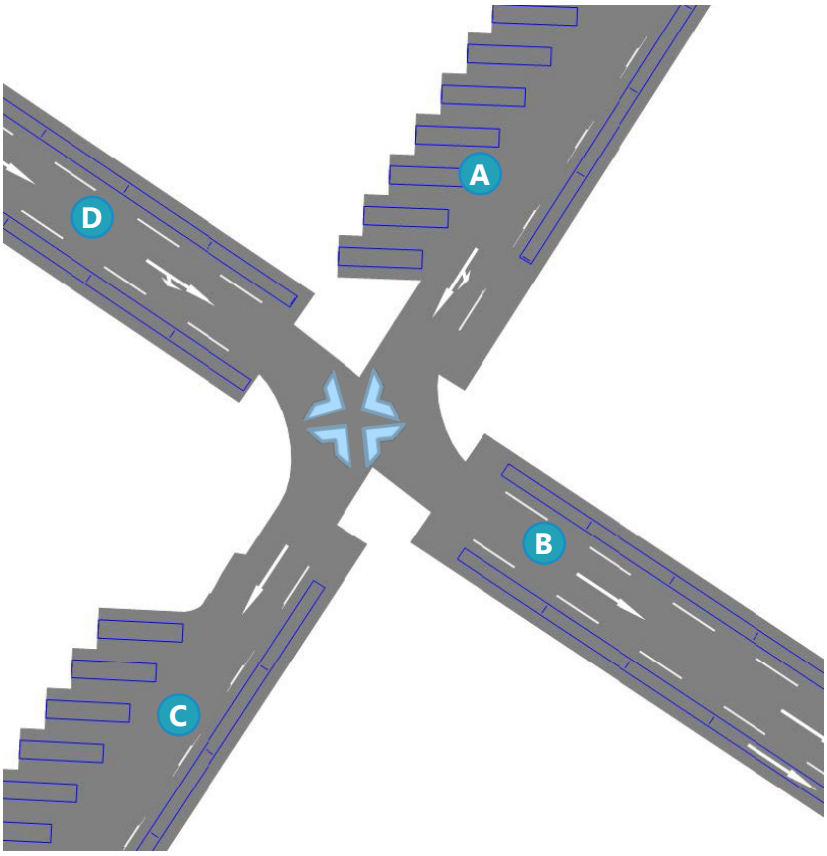

Figure 131: Junction 43 Layout

Figure 132: Junction 43 Traffic Condition

A.1.44 JUNCTION 44: LEBUH CHINA / LEBUH KING

Junction 44 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

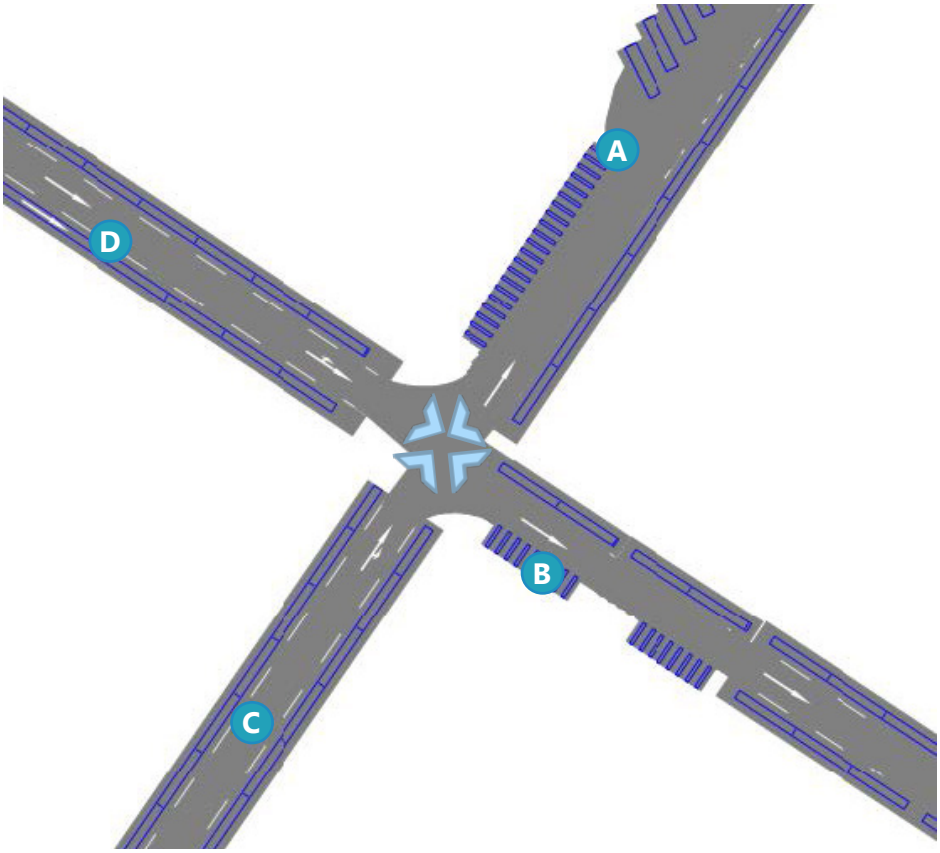

Figure 133: Junction 44 Layout

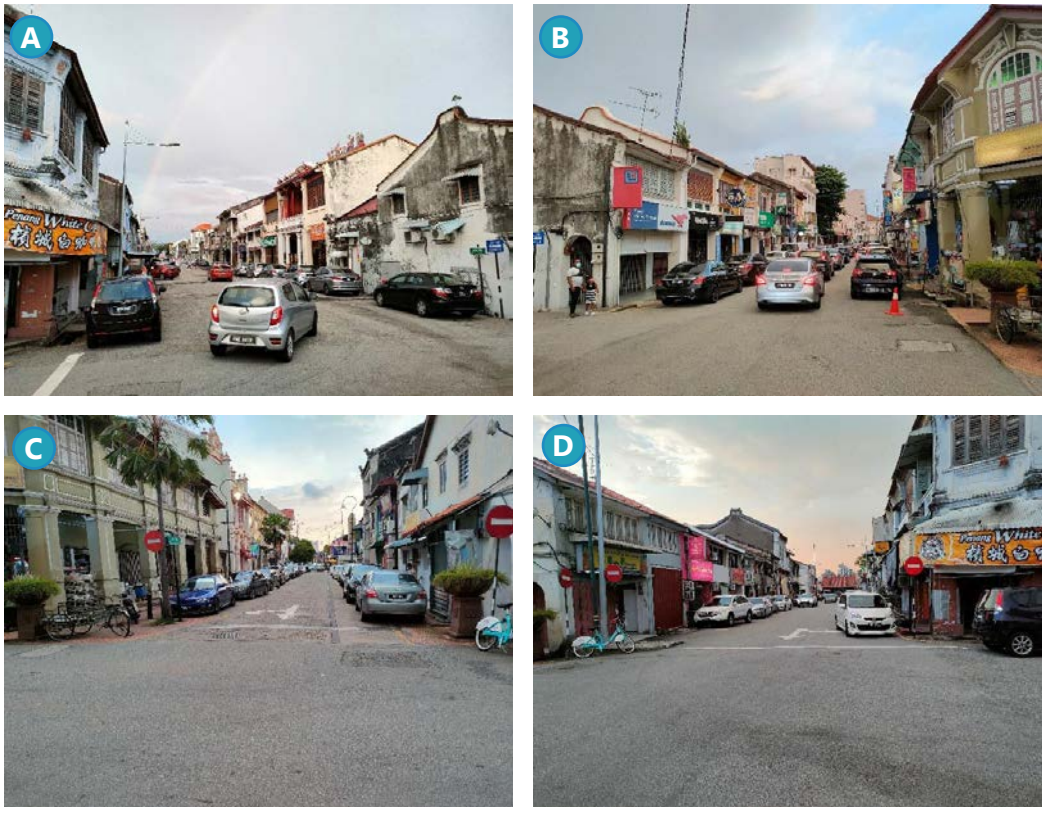

Figure 134: Junction 44 Traffic Condition

A.1.45 JUNCTION 45: LEBUH CHINA / PENANG STREET

Junction 45 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Medium-length queues were observed on approaches of the junction.

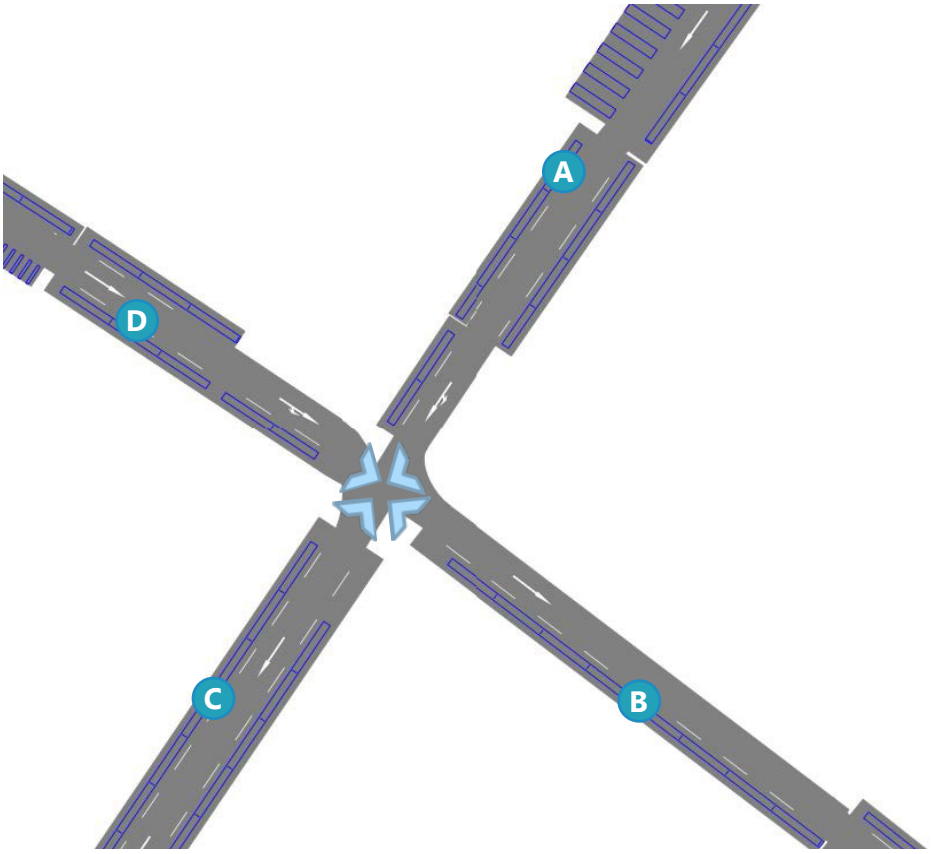

Figure 135: Junction 45 Layout

Figure 136: Junction 45 Traffic Condition

A.1.46 JUNCTION 46: CHURCH STREET / PENANG STREET

Junction 46 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

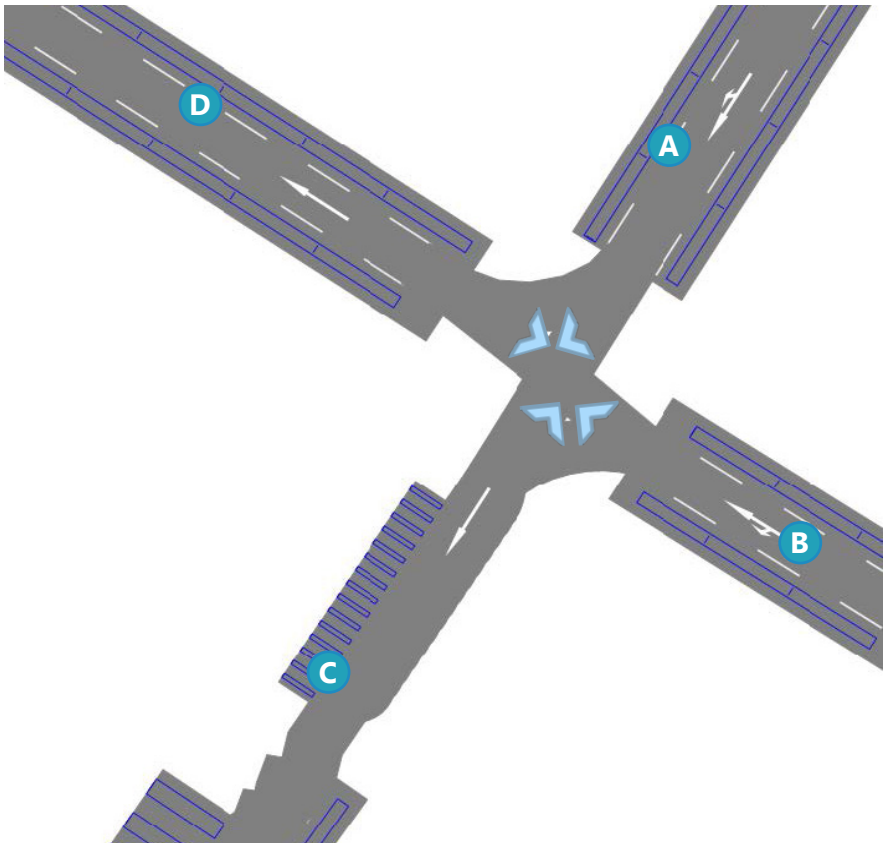

Figure 137: Junction 46 Layout

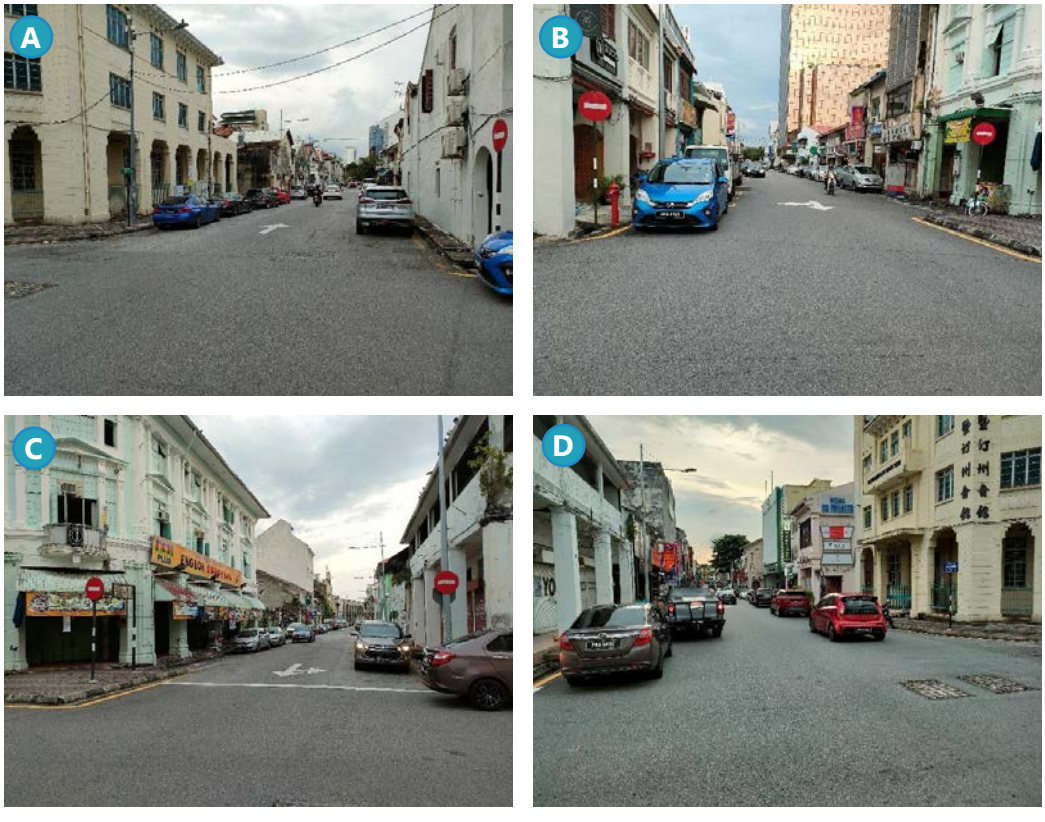

Figure 138: Junction 46 Traffic Condition

A.1.47 JUNCTION 47: CHURCH STREET / LEBUH KING

Junction 47 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

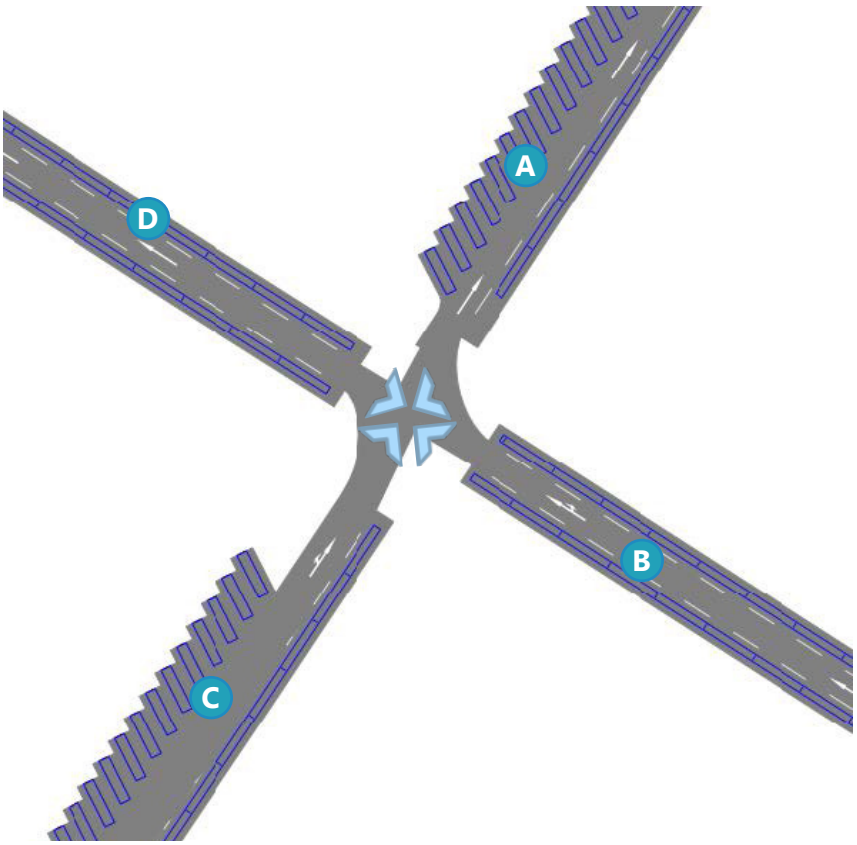

Figure 139: Junction 47 Layout

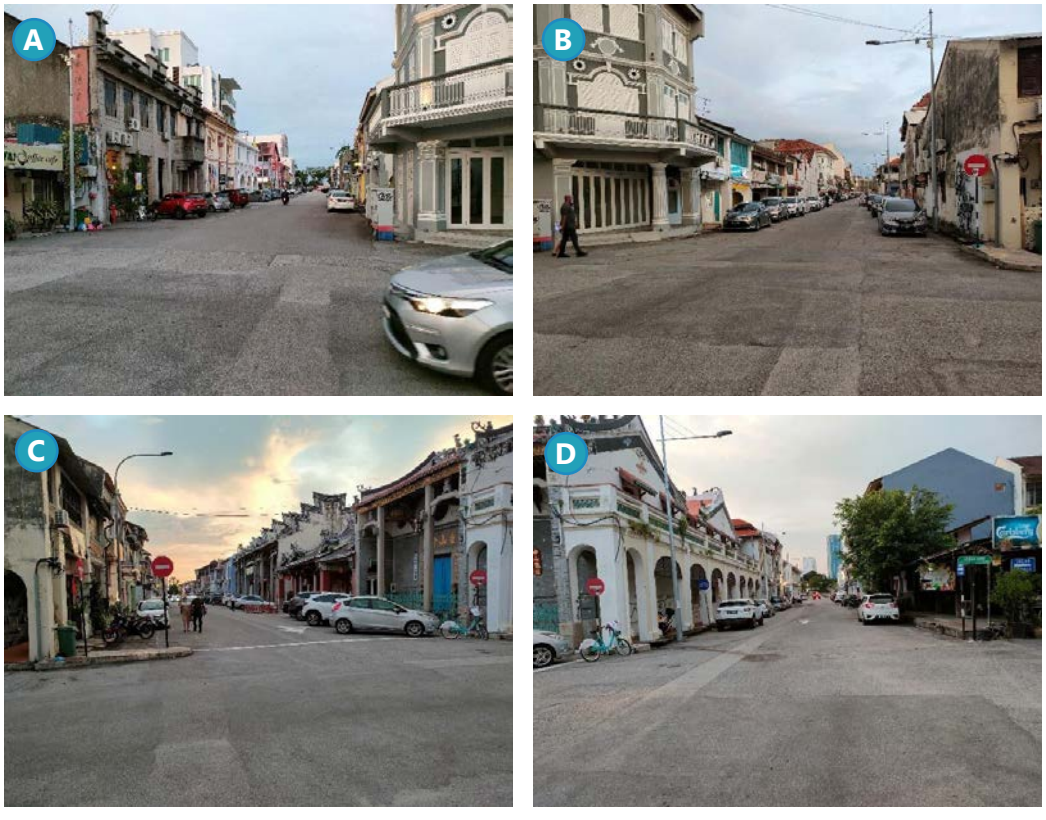

Figure 140: Junction 47 Traffic Condition

A.1.48 JUNCTION 48: CHURCH STREET / QUEEN STREET

Junction 48 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

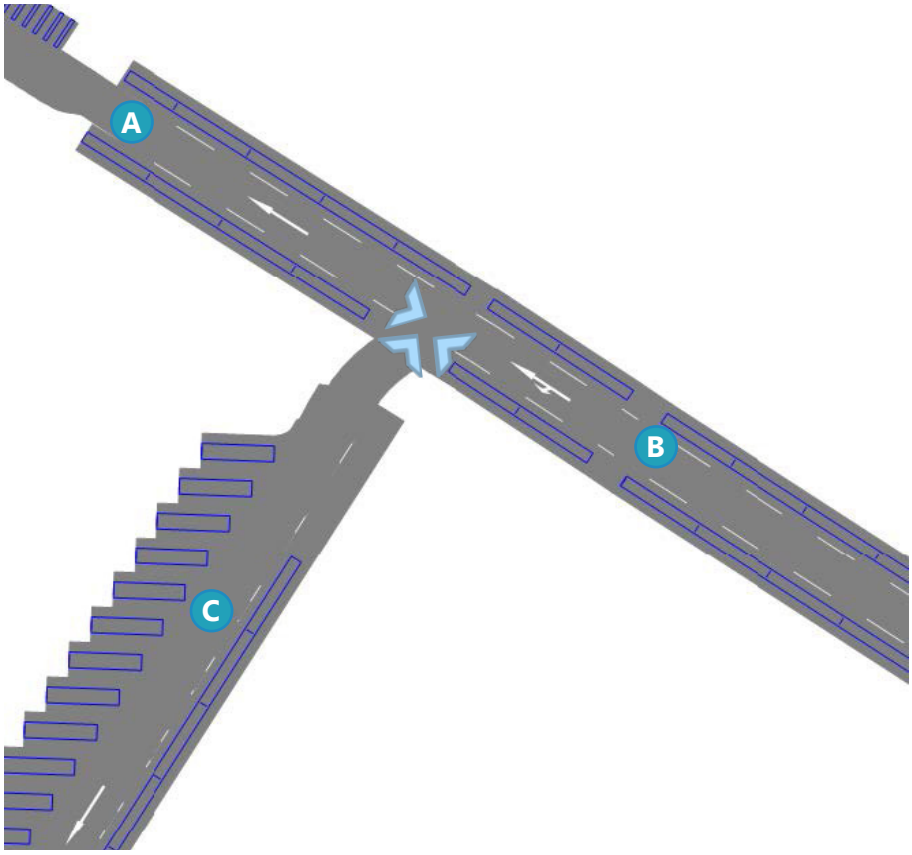

Figure 141: Junction 48 Layout

Figure 142: Junction 48 Traffic Condition

A.1.49 JUNCTION 49: CHURCH STREET / JALAN LEBUH KAPITAN KELING

Junction 49 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Medium-length queues were observed on approaches of the junction.

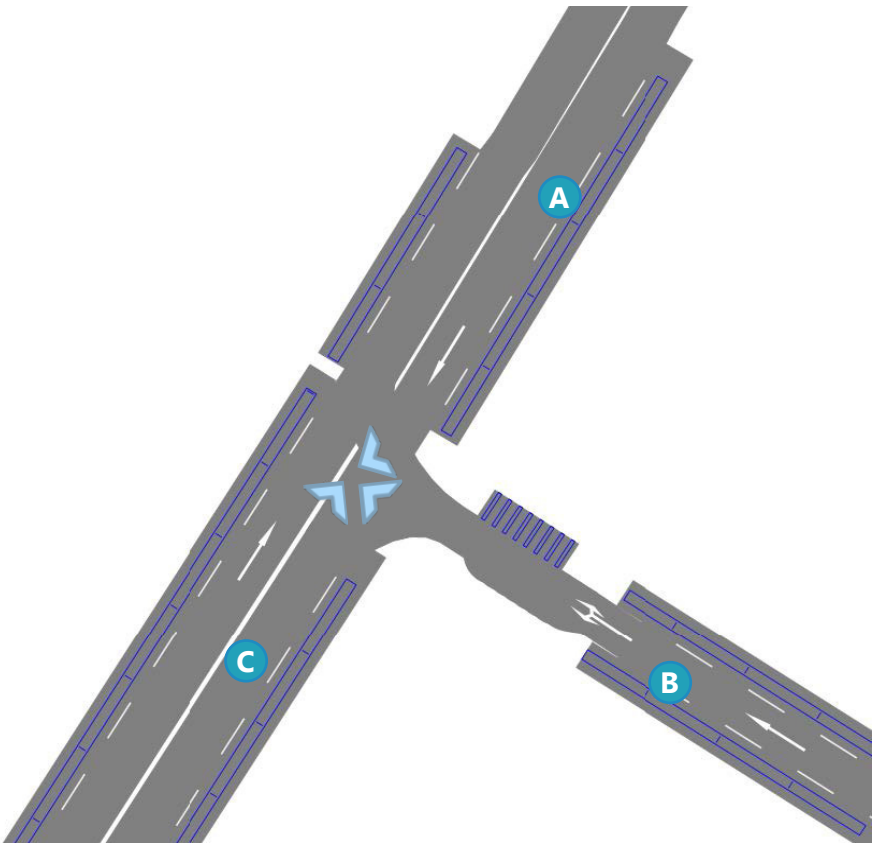

Figure 143: Junction 49 Layout

Figure 144: Junction 49 Traffic Condition

A.1.50 JUNCTION 50: LORONG ARGUS / JALAN LEBUH KAPITAN KELING

Junction 50 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction during the morning and evening

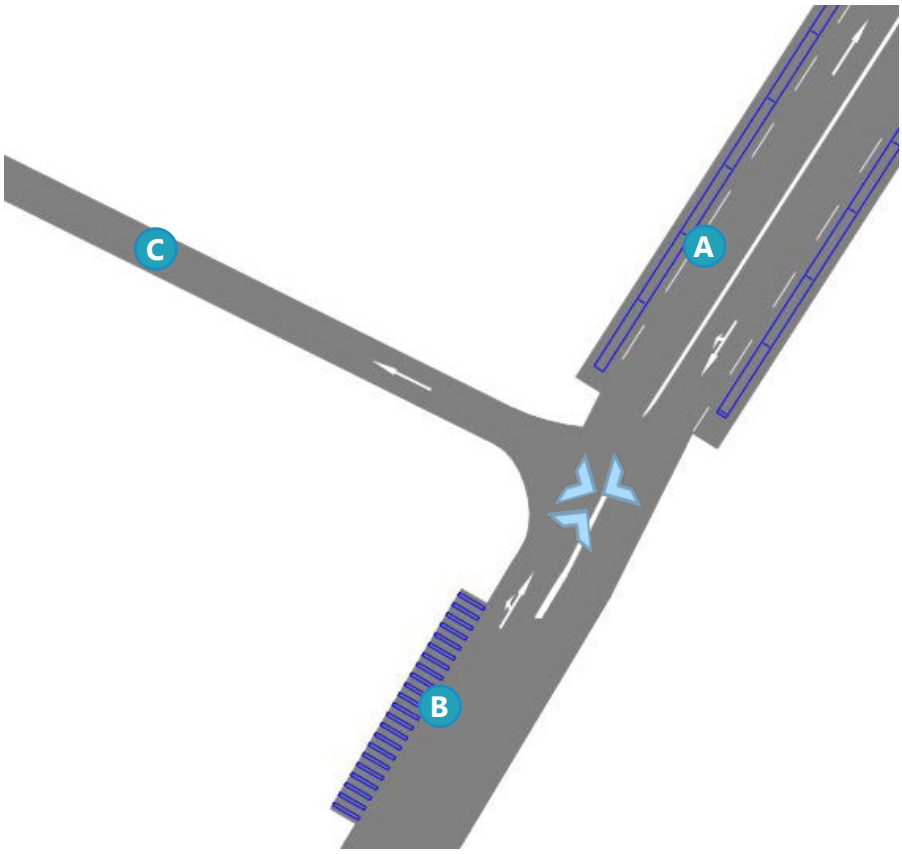

Figure 145: Junction 50 Layout

Figure 146: Junction 50 Traffic Condition

A.1.51 JUNCTION 51: LEBUH BISHOP / JALAN LEBUH KAPITAN KELING

Junction 51 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

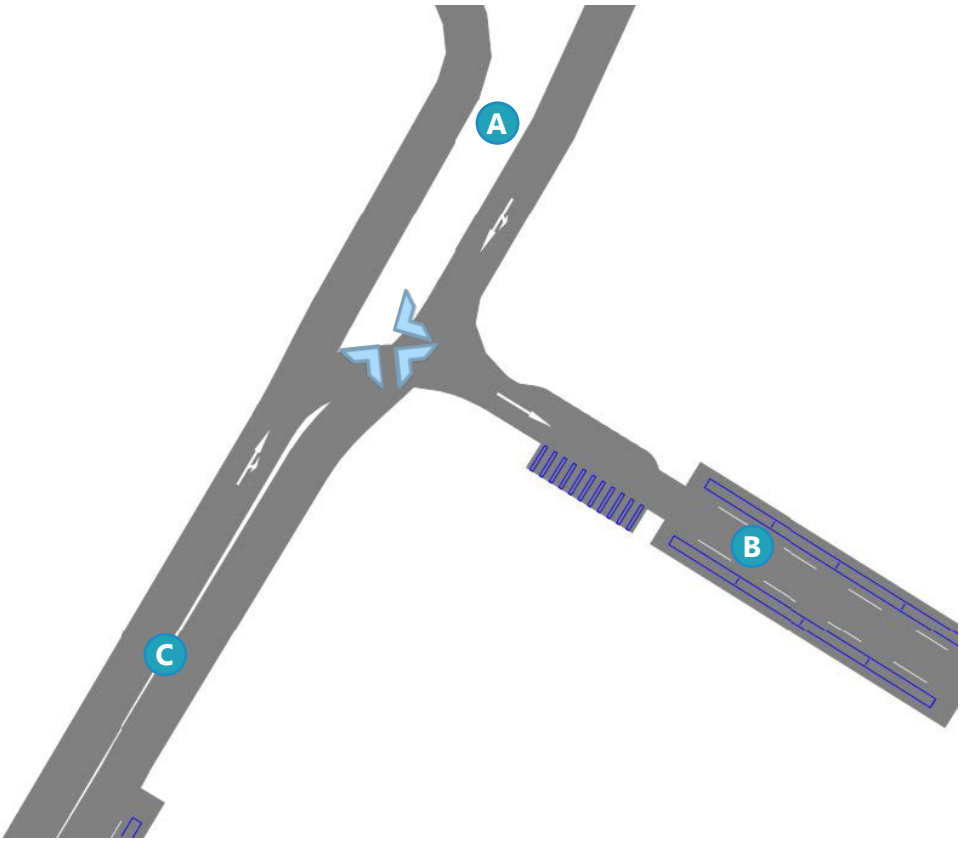

Figure 147: Junction 51 Layout

Figure 148: Junction 51 Traffic Condition

A.1.52 JUNCTION 52: LEBUH BISHOP / LEBUH KING

Junction 52 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

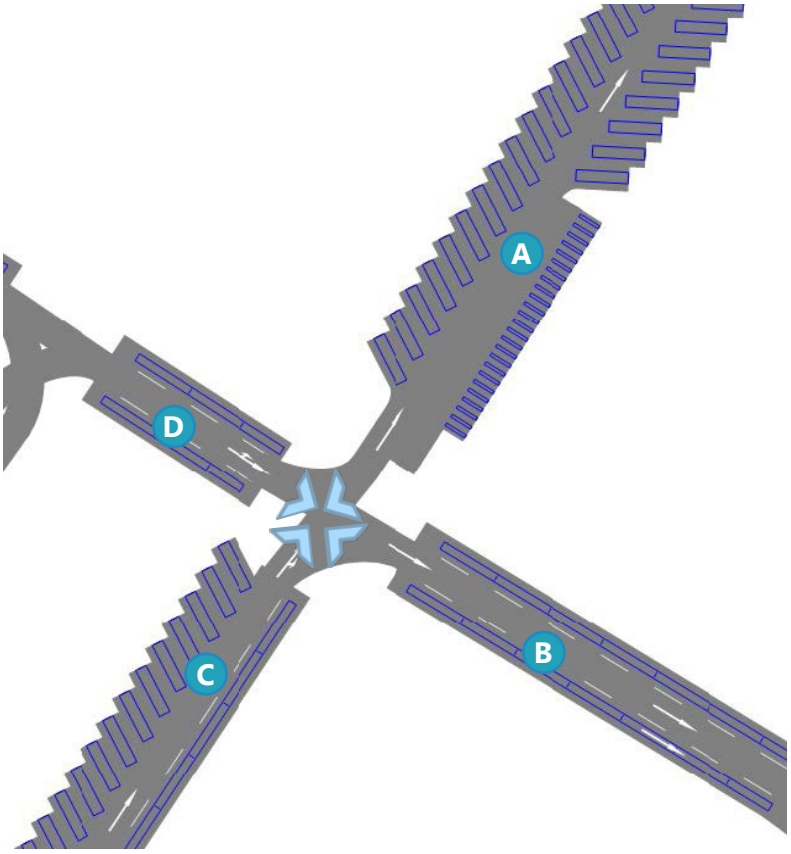

Figure 149: Junction 52 Layout

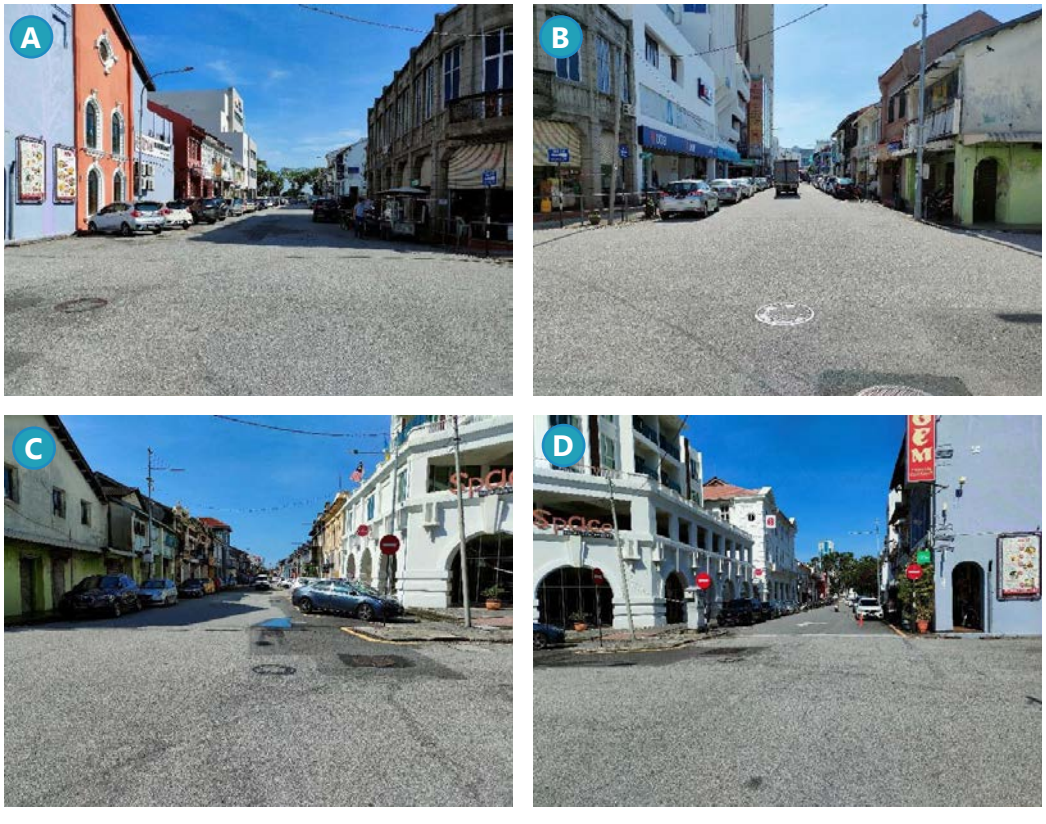

Figure 150: Junction 52 Traffic Condition

A.1.53 JUNCTION 53: LEBUH BISHOP / PENANG STREET

Junction 53 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

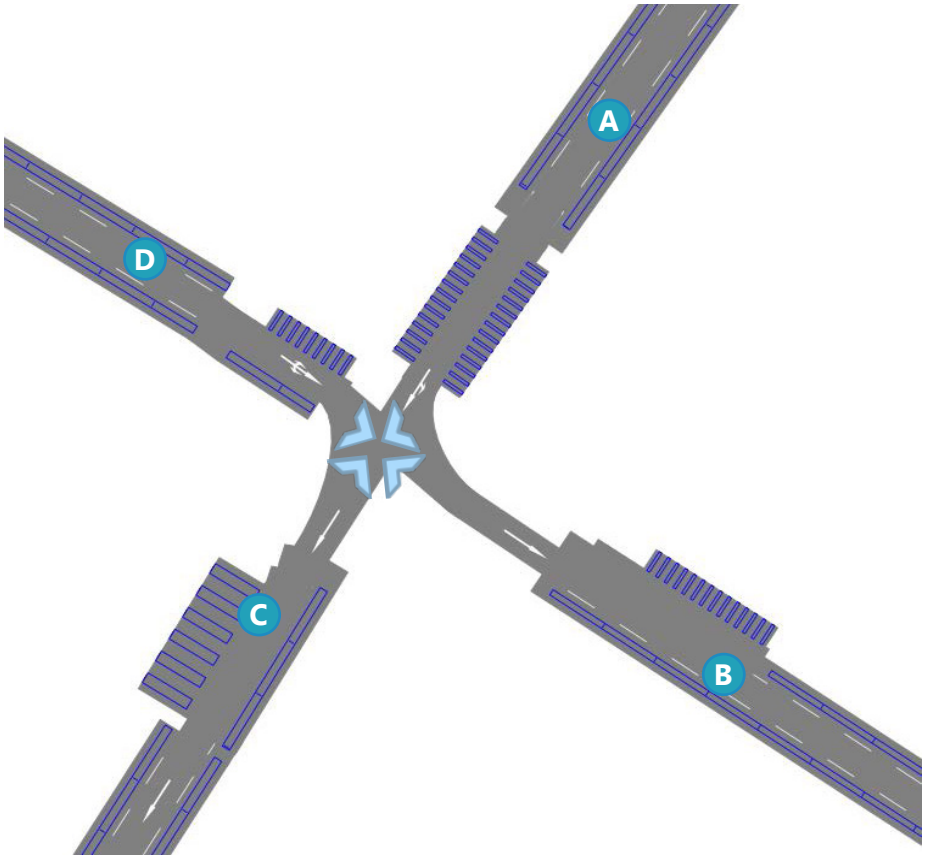

Figure 151: Junction 53 Layout

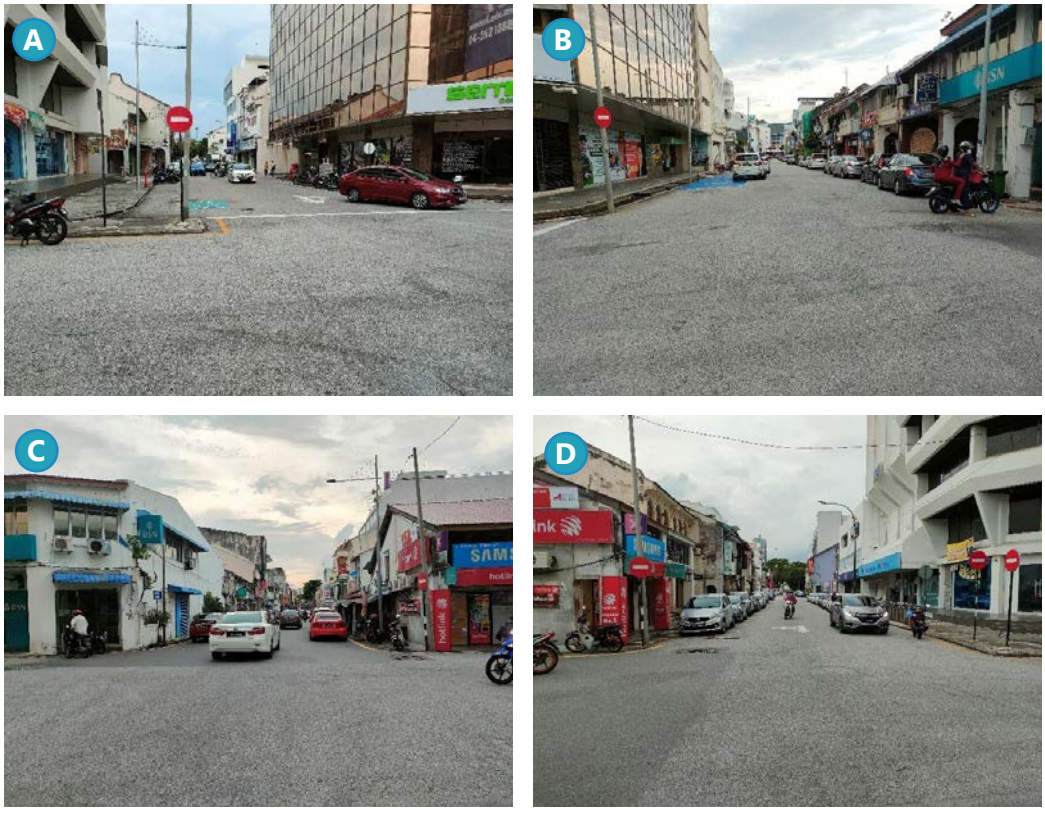

Figure 152: Junction 53 Traffic Condition

A.1.54 JUNCTION 54: LEBUH UNION / PENANG STREET

Junction 54 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

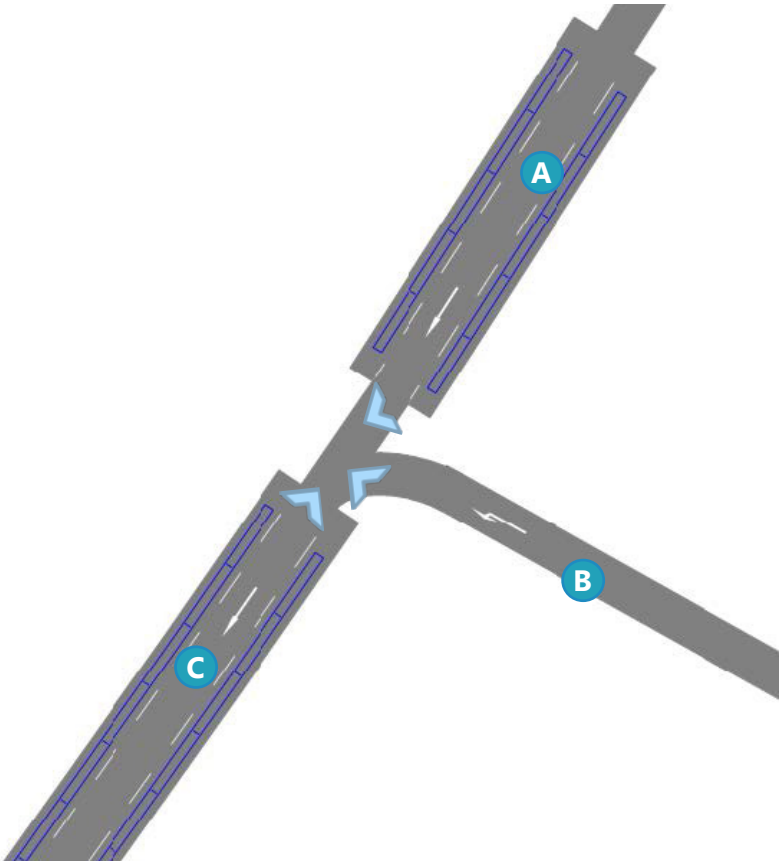

Figure 153: Junction 54 Layout

Figure 154: Junction 54 Traffic Condition

A.1.55 JUNCTION 55 LEBUH LIGHT / PENANG STREET

Junction 55 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

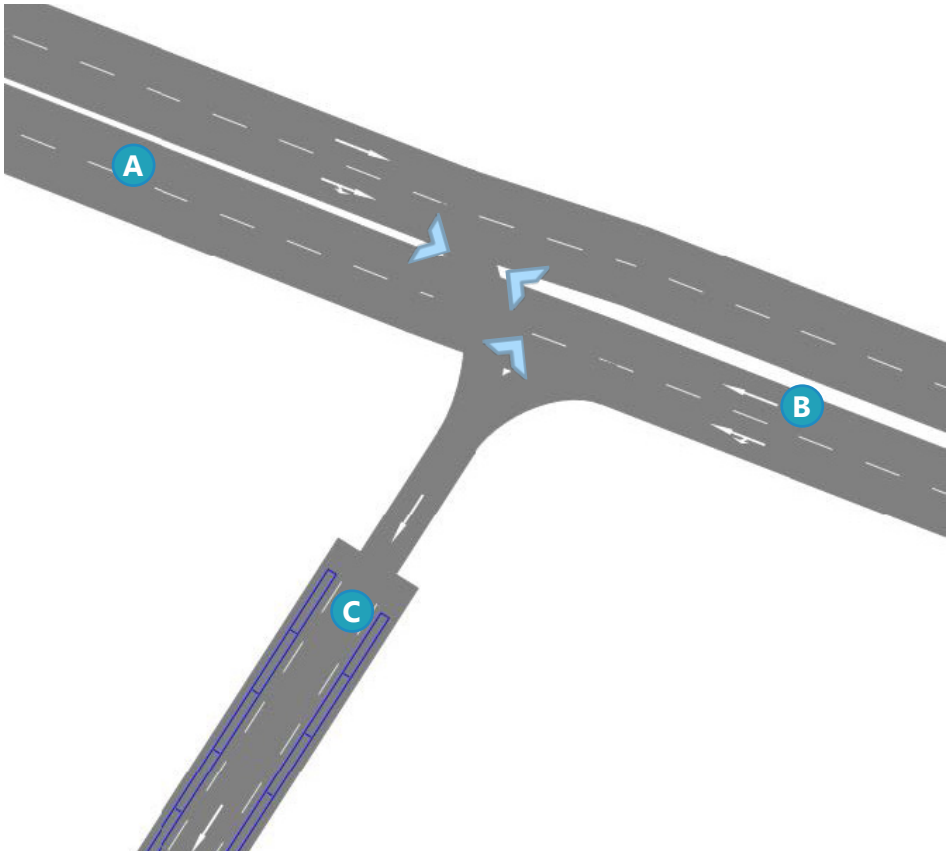

Figure 155: Junction 55 Layout

Figure 156: Junction 55 Traffic Condition

A.1.56 JUNCTION 56 LEBUH LIGHT / LEBUH KING

Junction 56 is a signalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

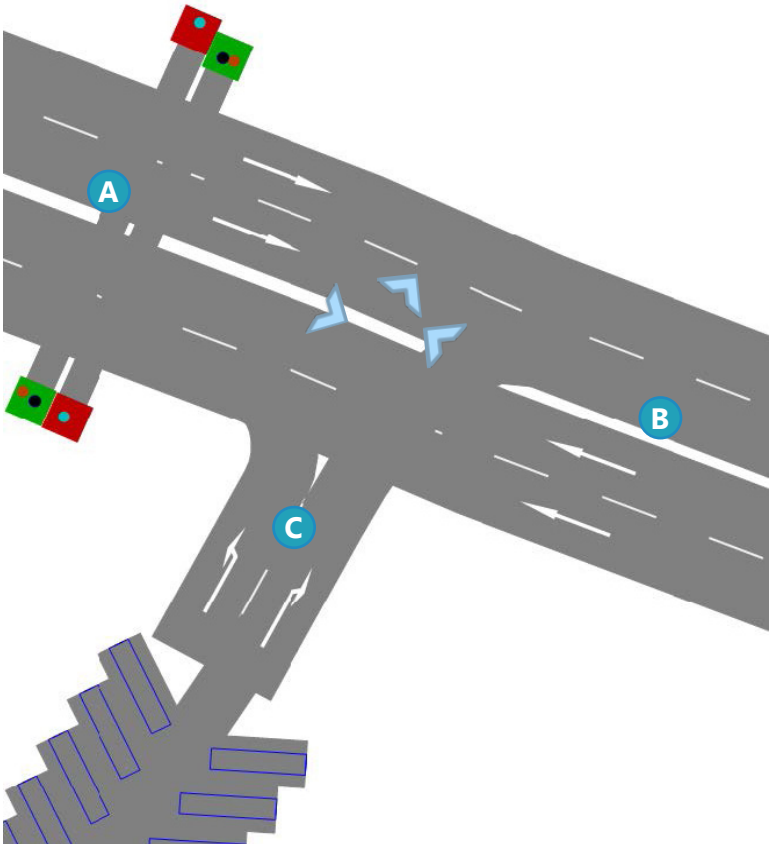

Figure 157: Junction 56 Layout

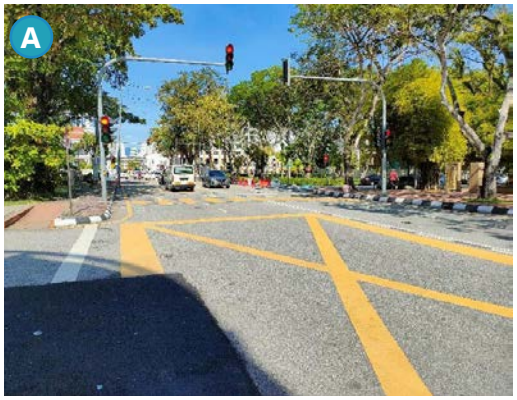

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Figure 158: Junction 56 Traffic Condition

A.1.57 JUNCTION 57 LEBUH LIGHT / JALAN PADANG KOTA LAMA

Junction 57 is a signalized T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

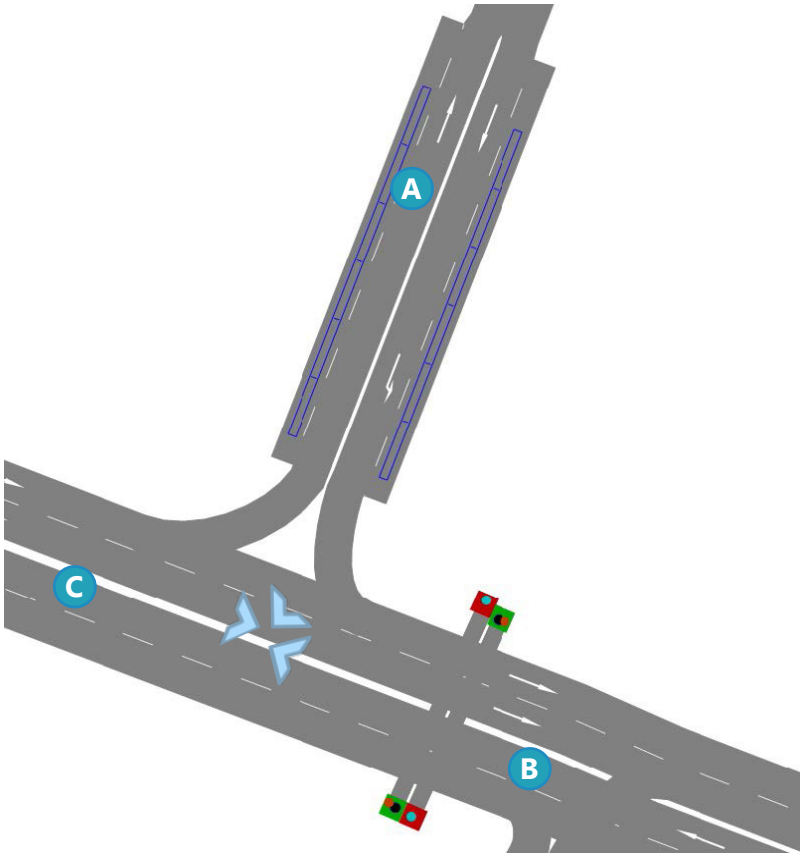

Figure 159: Junction 57 Layout

Figure 160: Junction 57 Traffic Condition

A.1.58 JUNCTION 58 LEBUH LIGHT / JALAN MASJID KAPITAN KELING

Junction 58 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

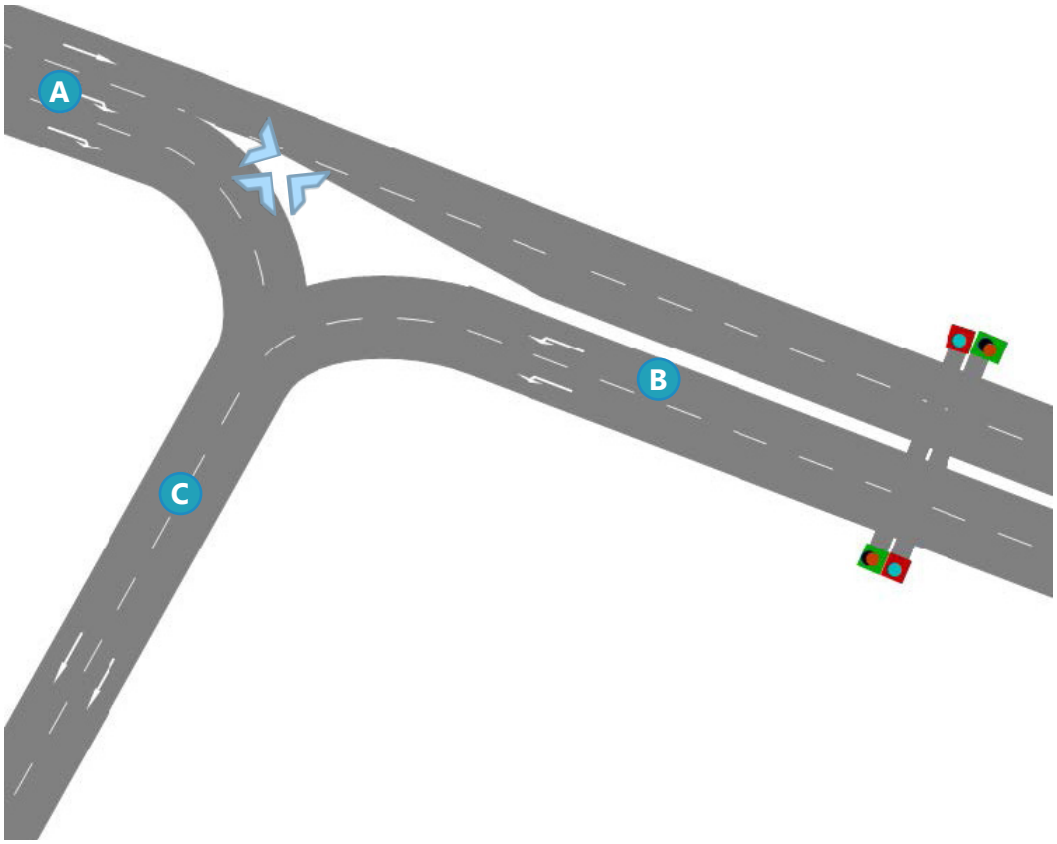

Figure 161: Junction 58 layout

Figure 162: Junction 58 Traffic Condition

A.1.59 JUNCTION 59 LEBUH FARQUHAR / JALAN MASJID KAPITAN KELING

Junction 59 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

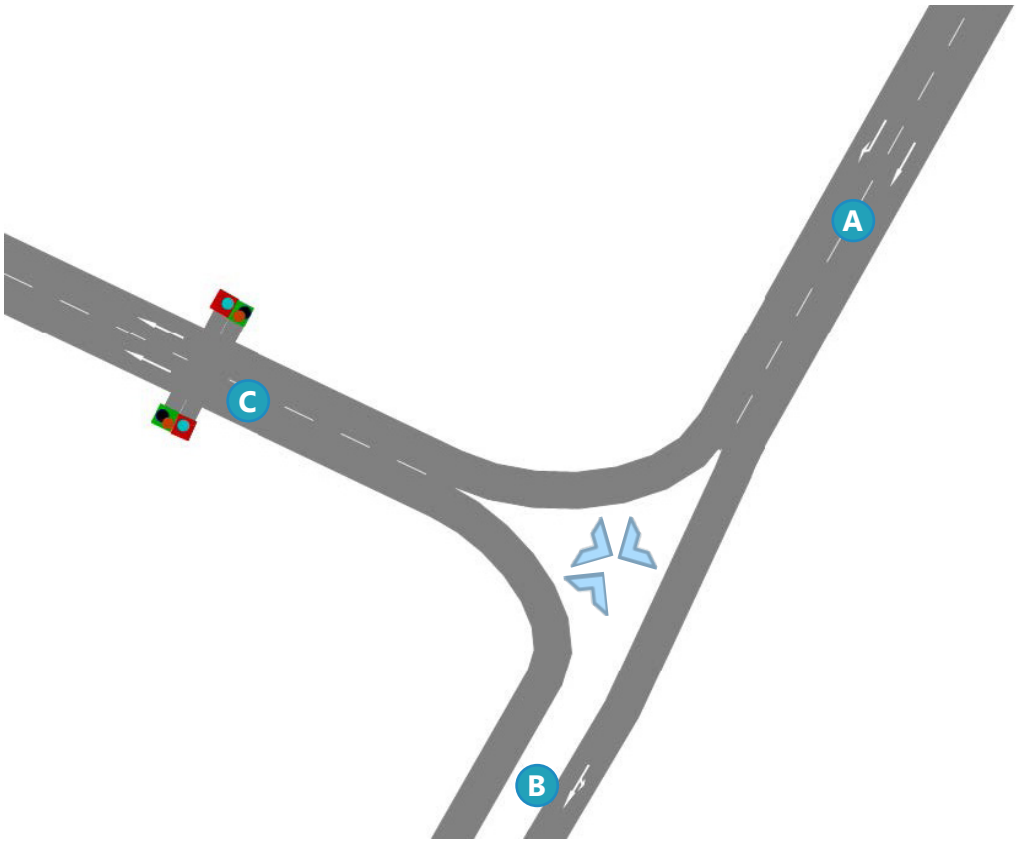

Figure 163: Junction 59 Layout

Figure 164: Junction 59 Traffic Condition

A.1.60 JUNCTION 60 LEBUH LIGHT / JALAN TUN SYED SHEH BARAKBAH

Junction 60 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

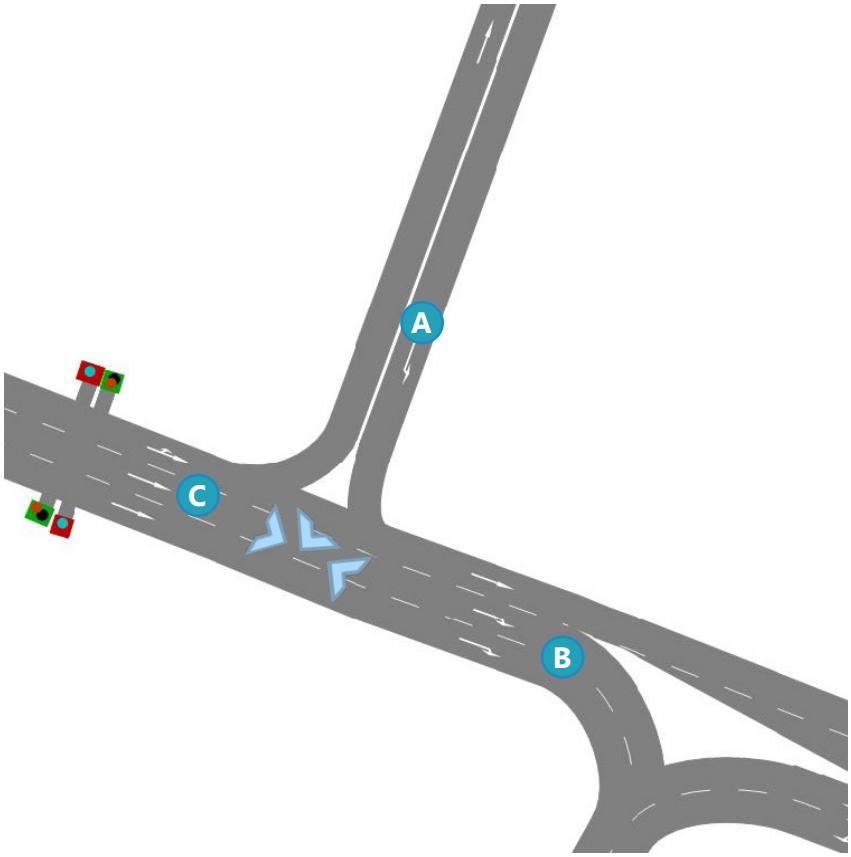

Figure 165: Junction 60 Layout

Figure 166: Junction 60 Traffic Condition

A.1.61 JUNCTION 61 LEBUH FARQUHAR / ACCESS

Junction 61 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

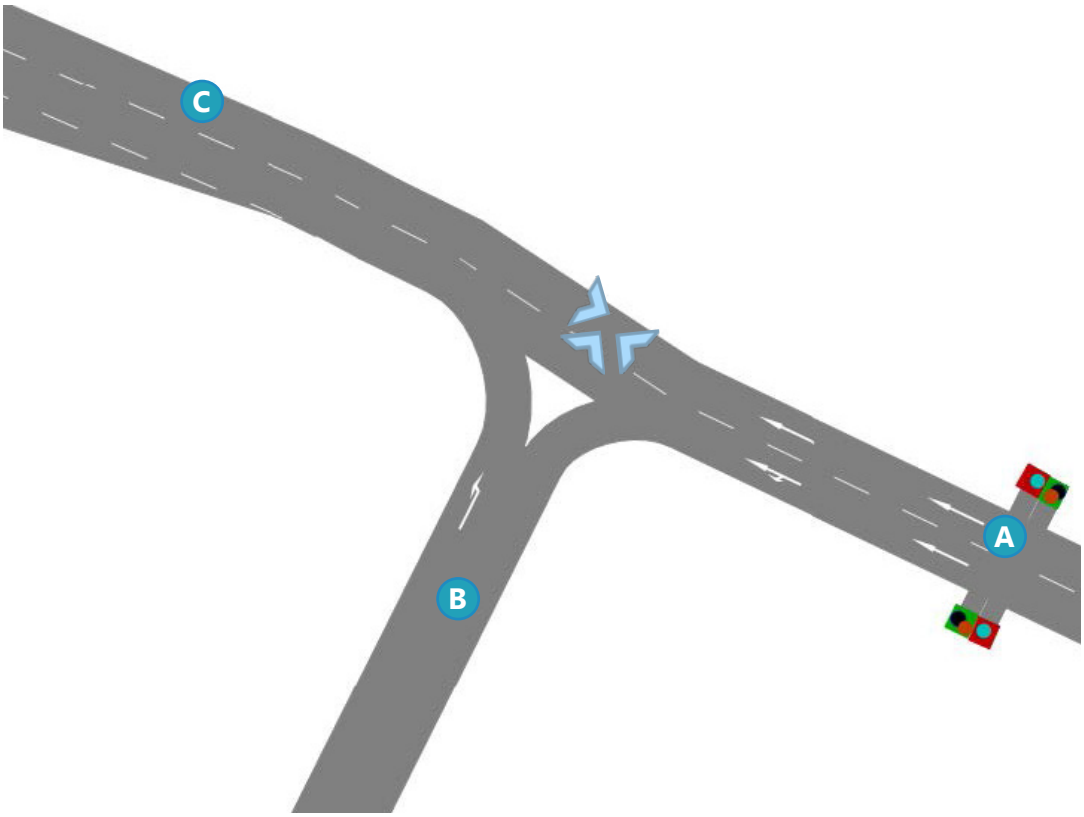

Figure 167: Junction 61 Layout

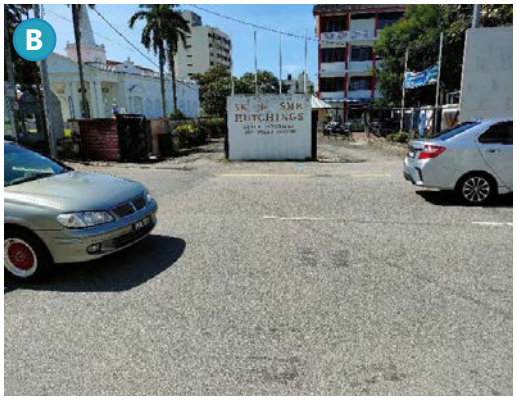

Figure 168: Junction 61 Traffic Condition

A.1.62 JUNCTION 62 LEBUH LIGHT / JALAN GREEN HALL

Junction 62 is a unsignalised T junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

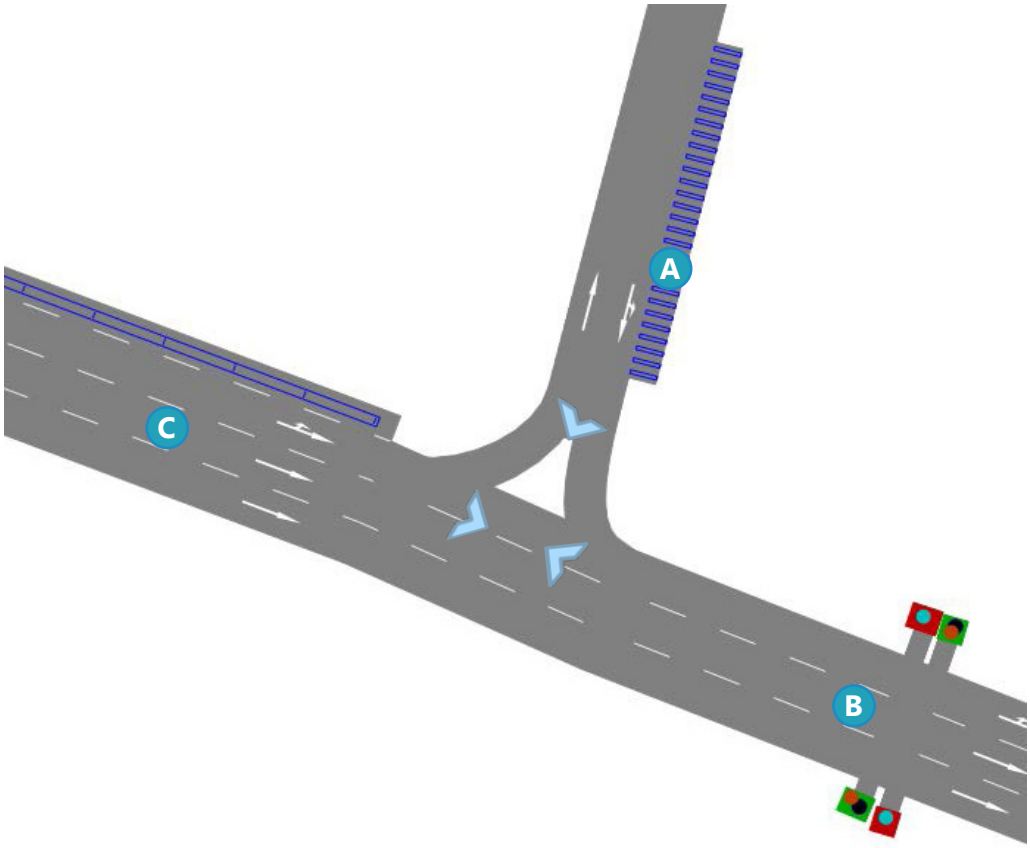

Figure 169: Junction 62 Layout

Figure 170: Junction 62 Traffic Condition

A.1.63 JUNCTION 63 LEBUH FARQUHAR / LEBUH LIGHT

Junction 63 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

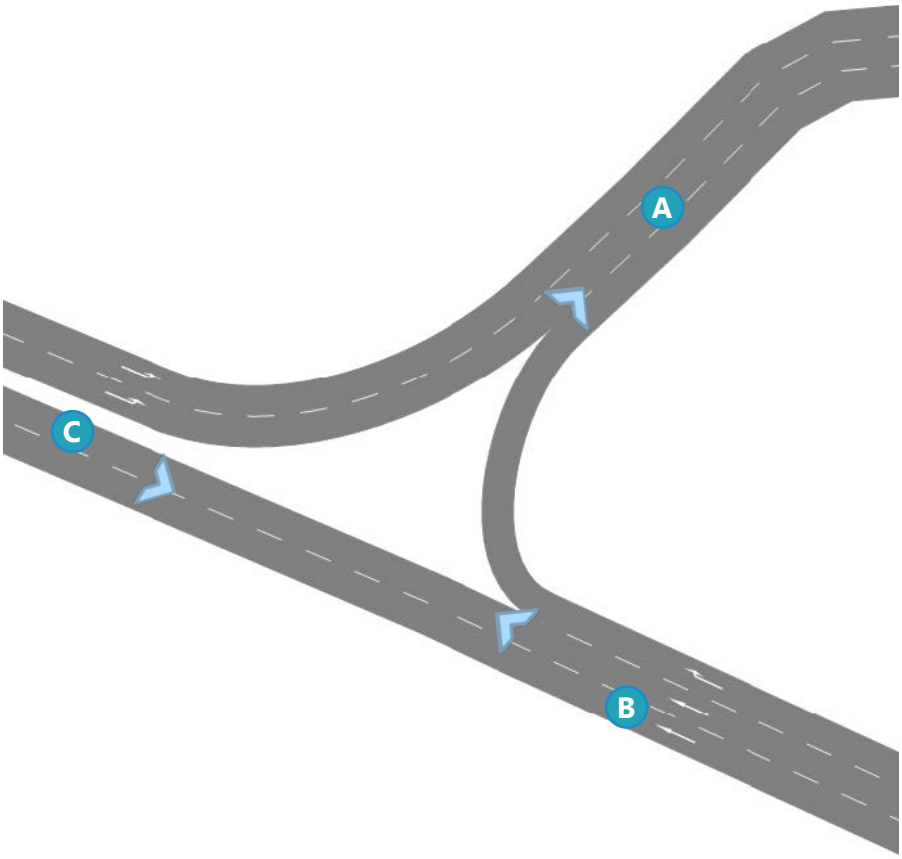

Figure 171: Junction 63 Layout

Figure 172: Junction 63 Traffic Condition

A.1.64 JUNCTION 64 JLN SULTAN AHMAD SHAH / LORONG LOVE

Junction 64 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

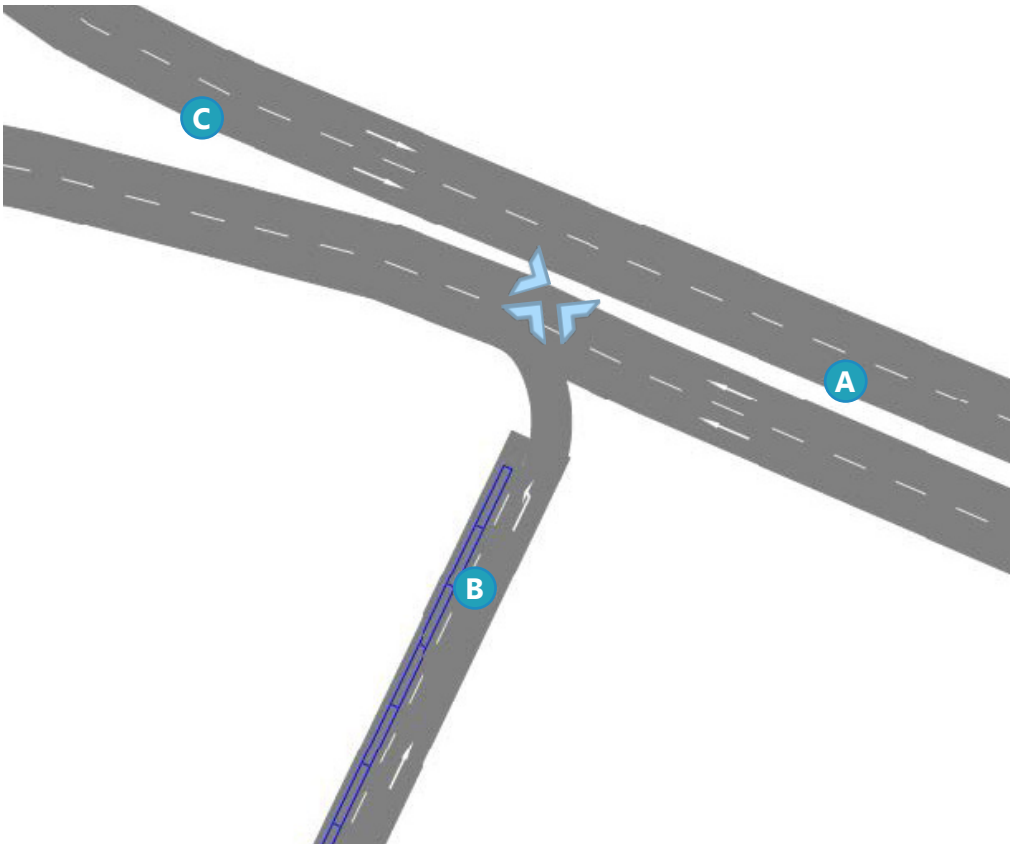

Figure 173: Junction 64 Layout

Figure 174: Junction 64 Traffic Condition

A.1.65 JUNCTION 65 LORONG ARGUS / LORONG LOVE

Junction 65 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction

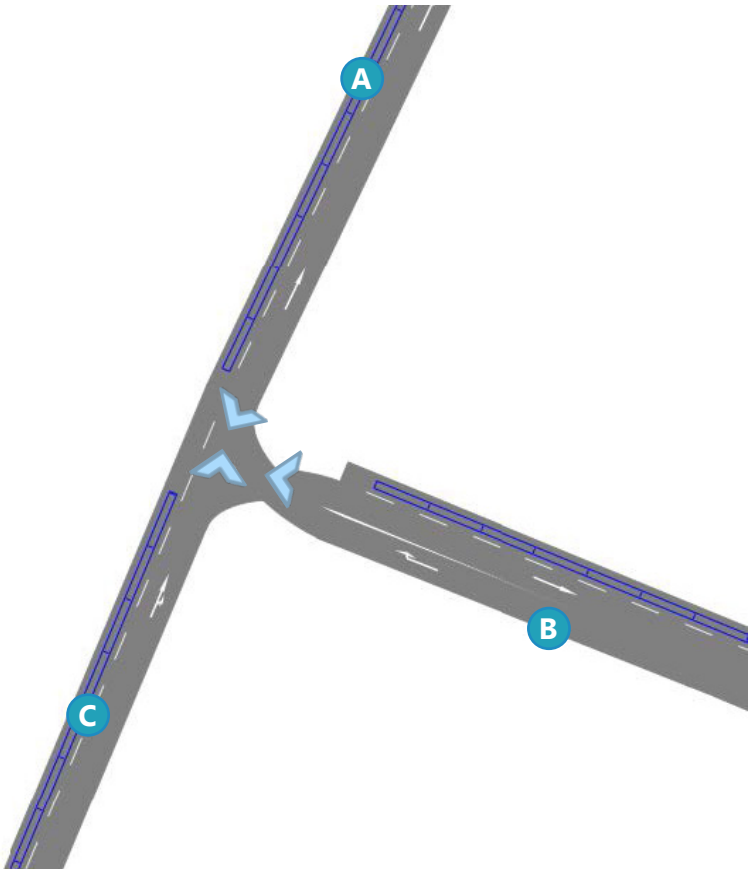

Figure 175: Junction 65 Layout

Figure 176: Junction 65 Traffic Condition

A.1.66 JUNCTION 66 LORONG STEWART / LORONG LOVE

Junction 66 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

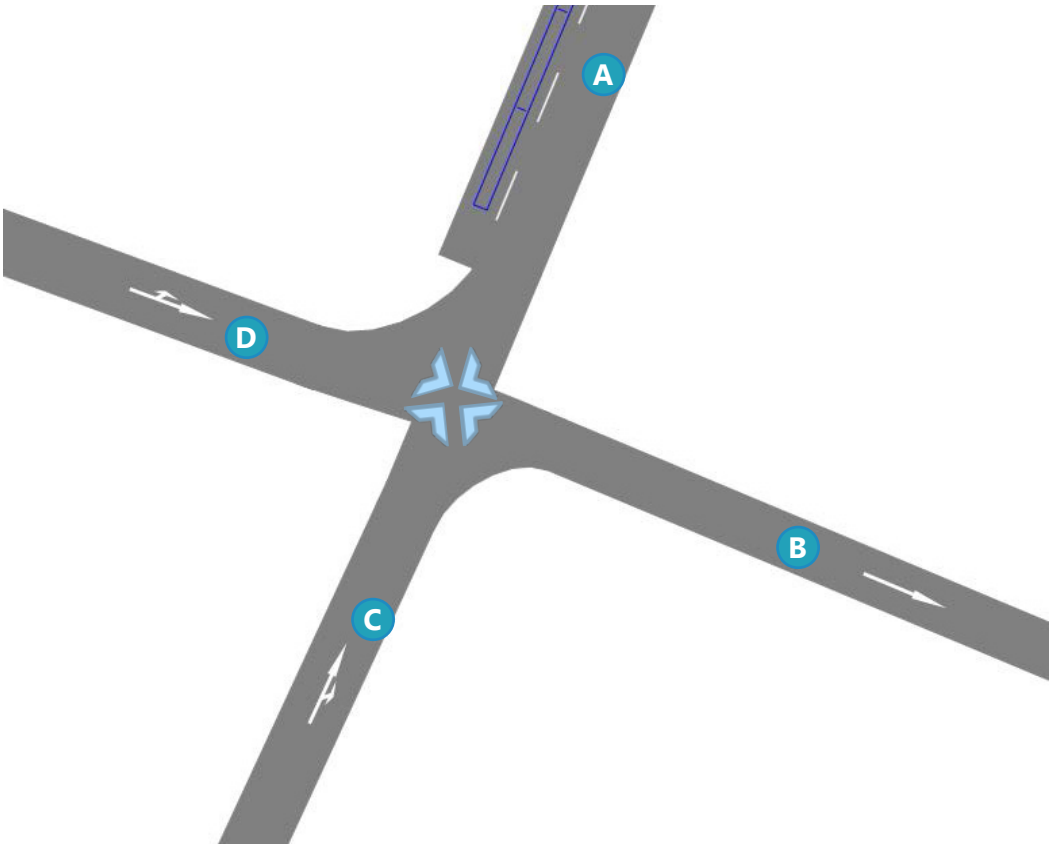

Figure 177: Junction 66 Layout

Figure 178: Junction 66 Traffic Condition

A.1.67 JUNCTION 67 LORONG STEWART / LORONG CHULIA

Junction 67 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

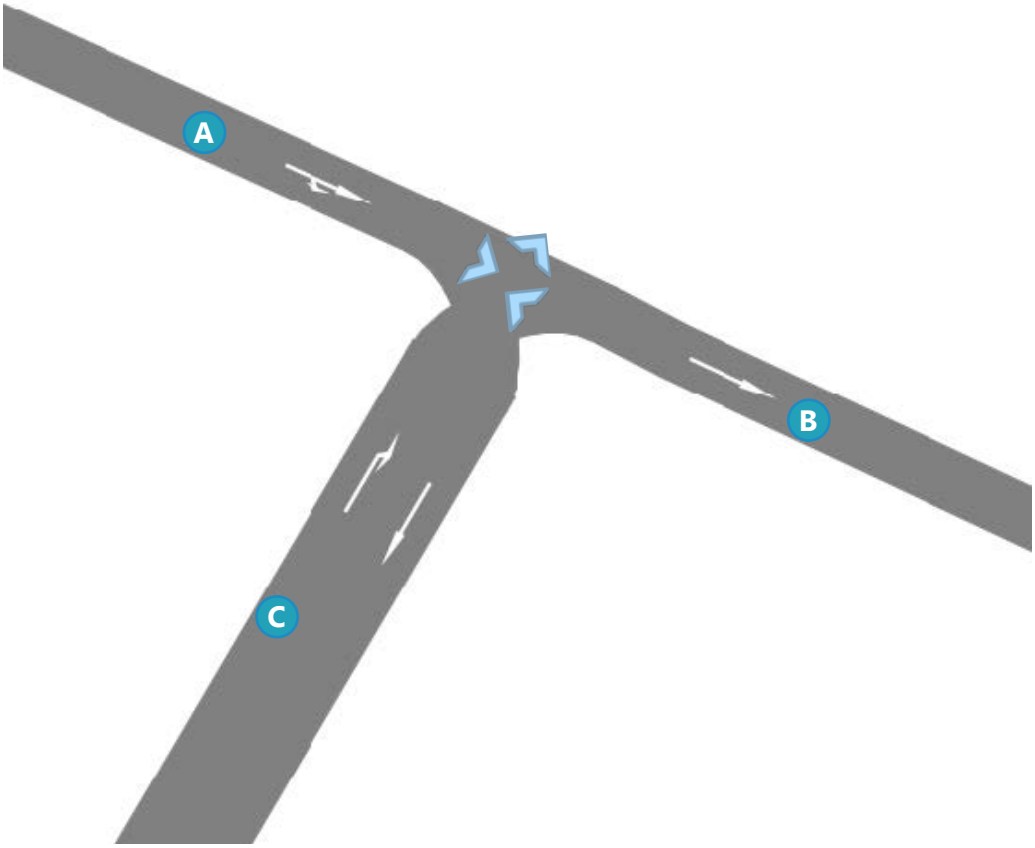

Figure 179: Junction 67 Layout

Figure 180: Junction 67 Traffic Condition

A.1.68 JUNCTION 68 LEBUH CARNAVON / CHULIA STREET

Junction 68 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

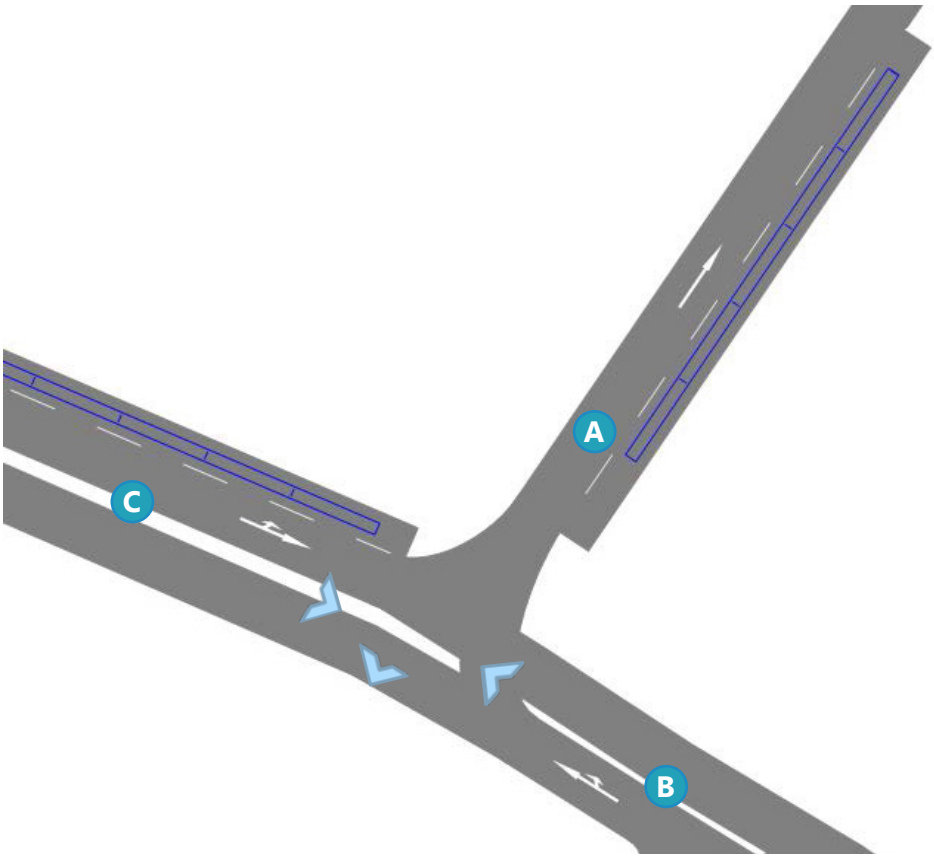

Figure 181: Junction 68 Layout

Figure 182: Junction 68 Traffic Condition

A.1.69 JUNCTION 69 LEBUH CARNAVON / CHULIA STREET

Junction 69 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

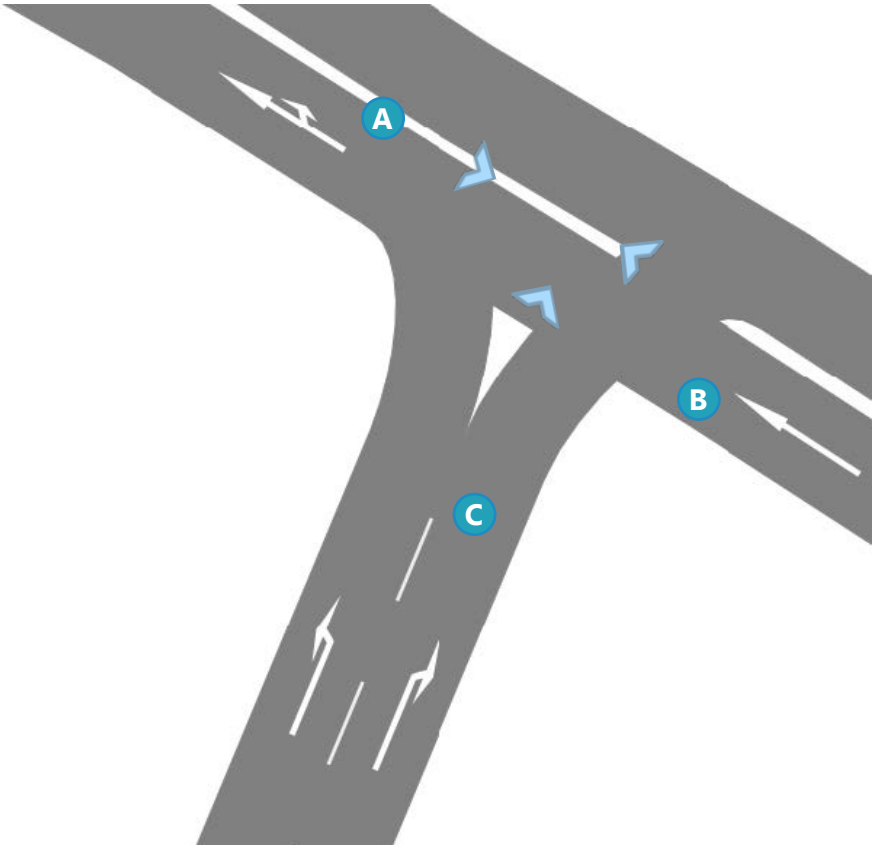

Figure 183: Junction 69 Layout

Figure 184: Junction 69 Traffic Condition

A.1.70 JUNCTION 70 LORONG CHULIA / CHULIA STREET

Junction 70 is a unsignalised T junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

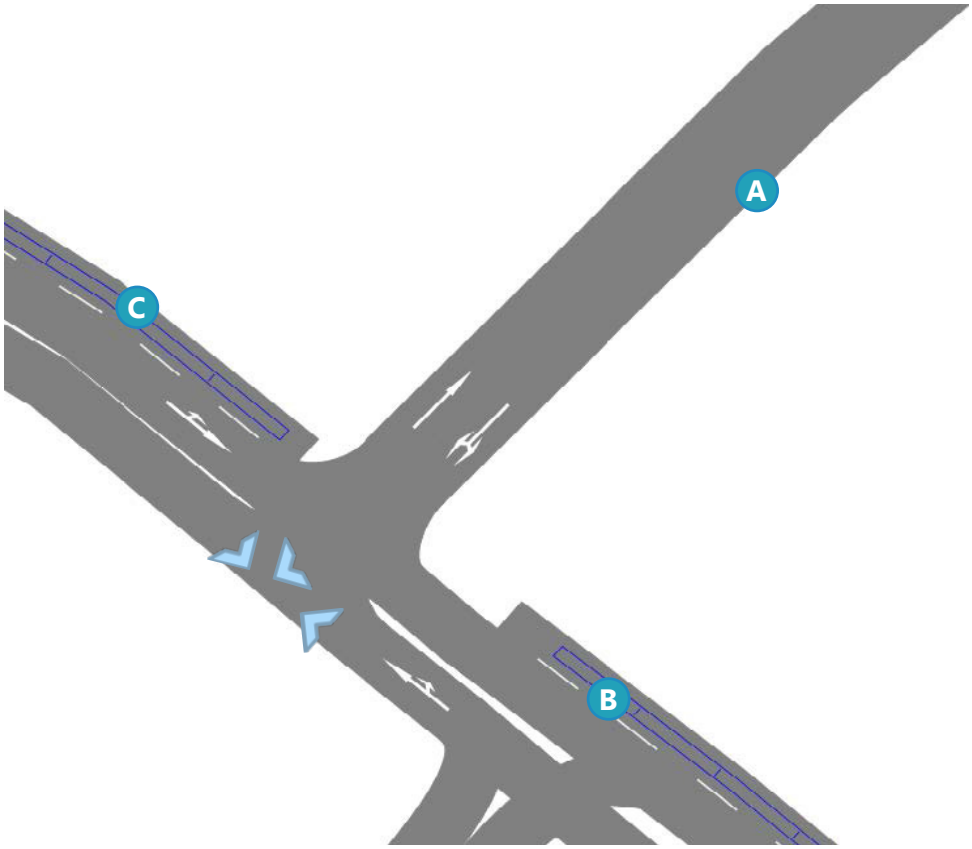

Figure 185: Junction 70 Layout

Figure 186: Junction 70 Traffic Condition

A.1.71 JUNCTION 71 JALAN CAMPBELL / LEBUH CARNAVON

Junction 71 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

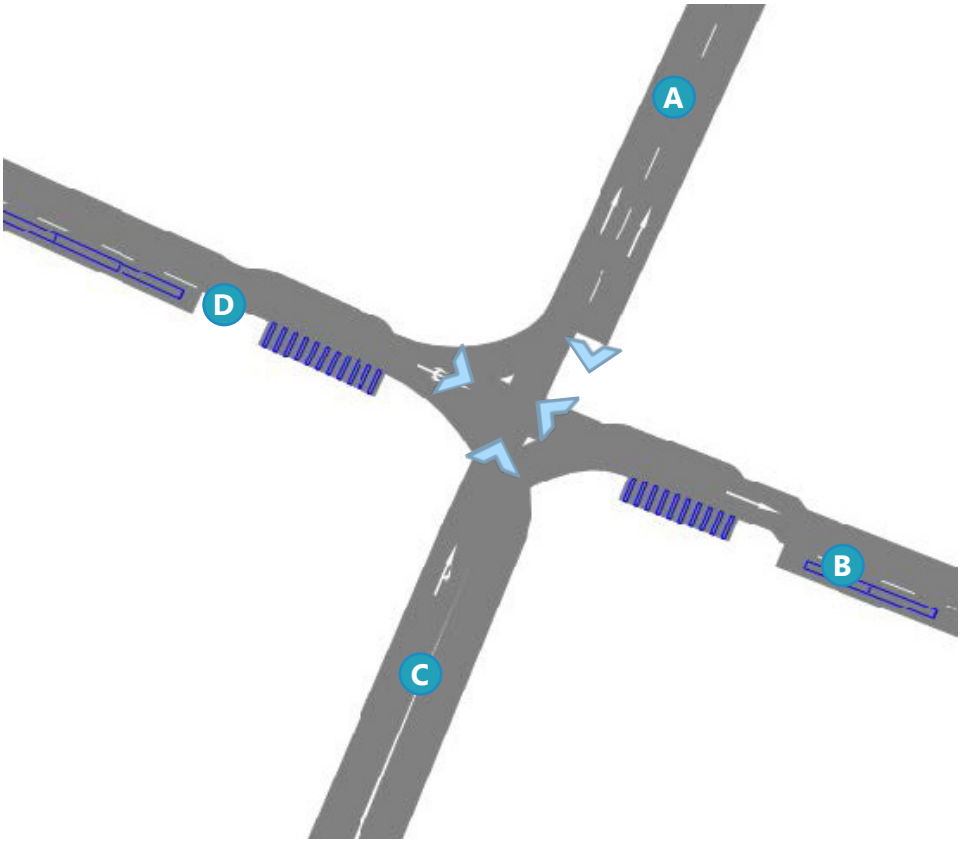

Figure 187: Junction 71 Layout

Figure 188: Junction 71 Traffic Condition

A.1.72 JUNCTION 72 LEBUH CARNAVON / JALAN KAMPUNG KOLAM

Junction 72 is a unsignalised cross junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

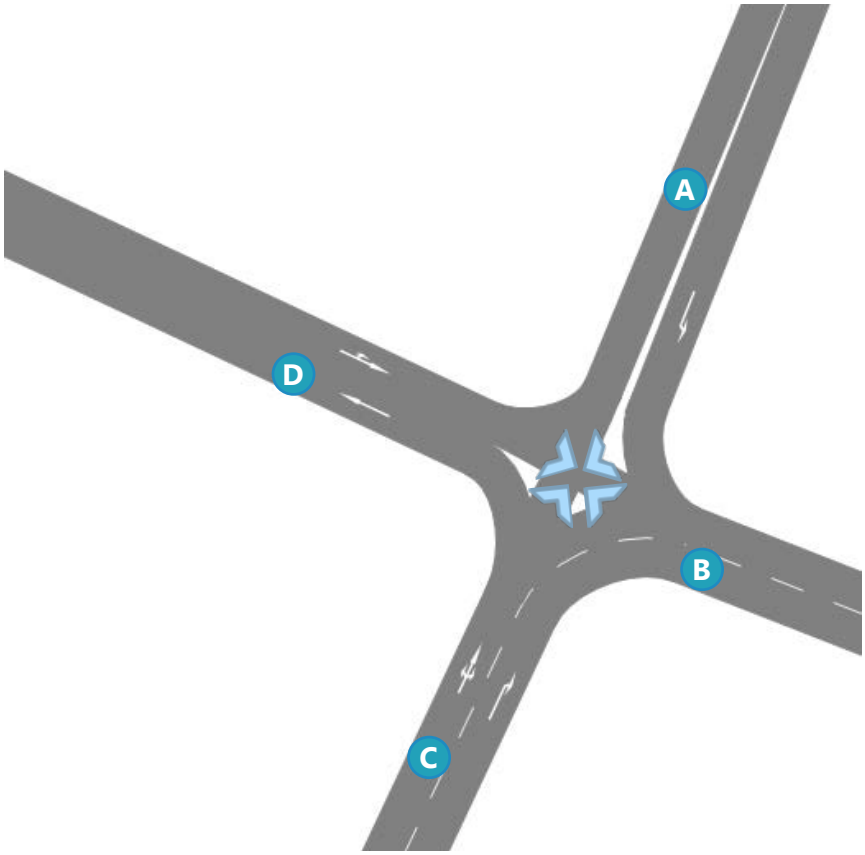

Figure 189: Junction 72 Layout

Figure 190: Junction 72 Traffic Condition

A.1.73 JUNCTION 73 LEBUH CARNAVON / JALAN KAMPUNG KOLAM

Junction 73 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

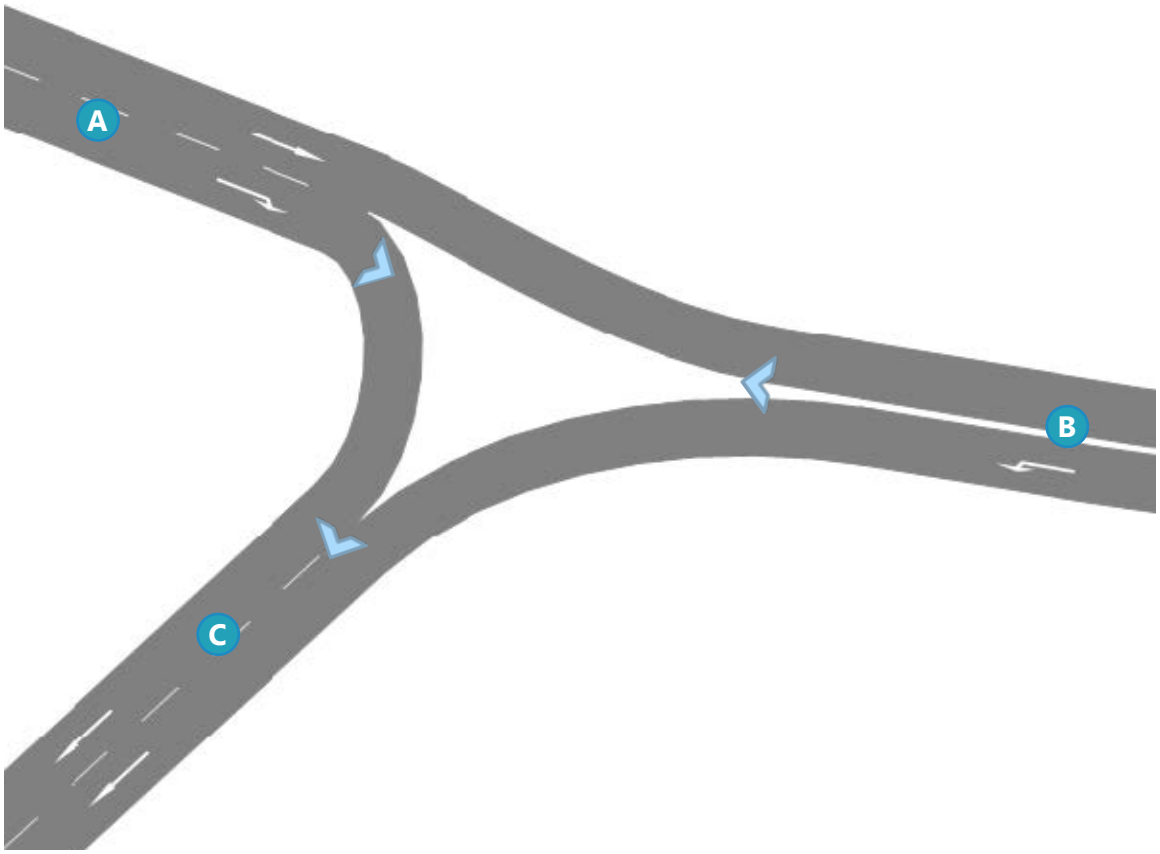

Figure 191: Junction 73 Layout

Figure 192: Junction 73 Traffic Condition

A.1.74 JUNCTION 74 LEBUH CARNAVON / LEBUH ACHEH

Junction 74 is a unsignalised T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

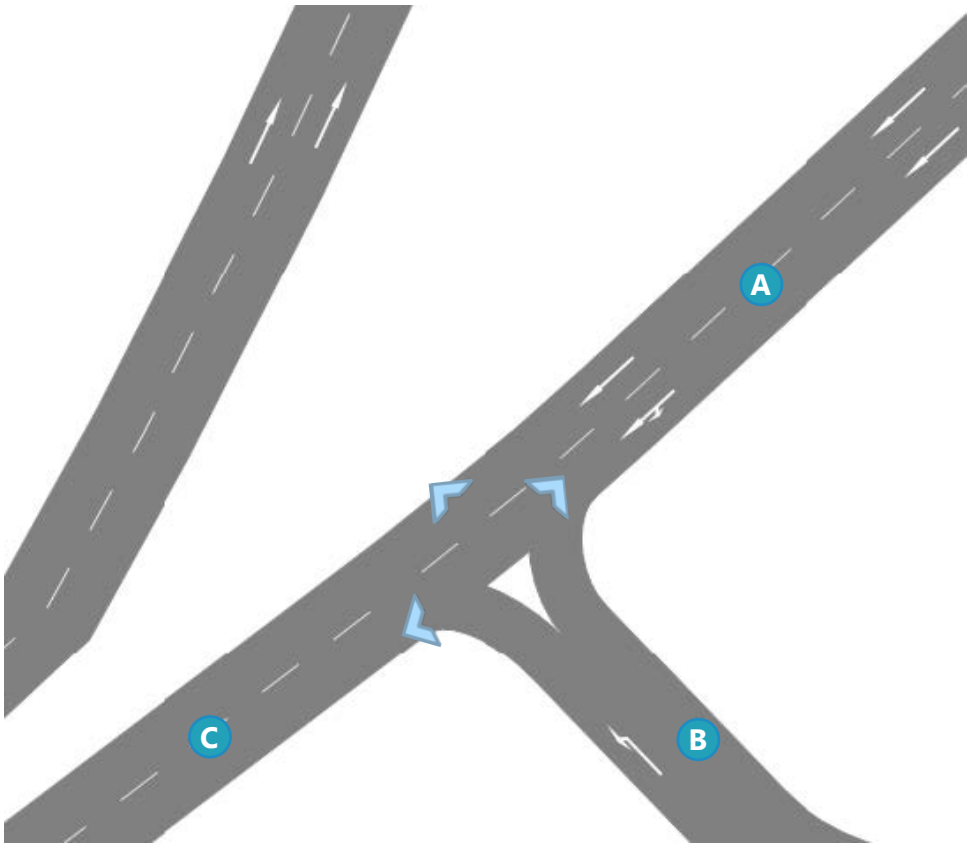

Figure 193: Junction 74 Layout

Figure 194: Junction 74 Traffic Condition

A.1.75 JUNCTION 75 LEBUH CARNAVON / LORONG CARNAVON

Junction 75 is a unsignalized double T-junction and the layout is shown in the figure below, followed by the site photos. Short queues were observed on approaches of the junction.

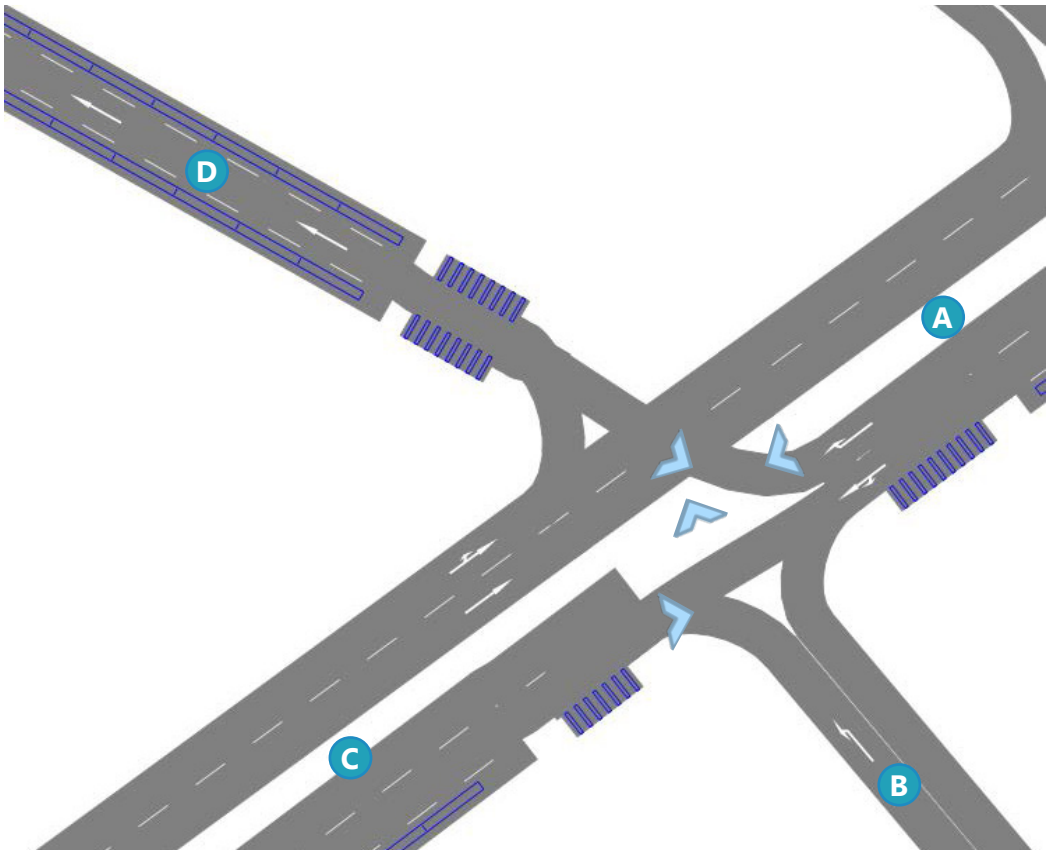

Figure 195: Junction 75 Layout

Figure 196: Junction 75 Traffic Condition

APPENDIX 2: SURVEY HEALTH & SAFETY

Traffic surveys have been conducted by our appointed Traffic Survey subconsultant in Malaysia, Fox Traffic Sdn Bhd. Fox Traffic conducted a health and safety briefing for all survey staff and manage health and safety requirements in accordance with local practices and requirements. The Fox Traffic Health and Safety briefing includes:

- Taking appropriate steps to protect survey staff from the dangers of traffic and/or transport systems and have regard for the rules and regulations that govern the conduct of passengers in the interests of safety.
- Requiring staff to wear the high visibility clothing given to survey staff and make full use of any other equipment designed to improve safety.
- Briefing survey staff to take no action that can, as a consequence, result in others suffering any danger or potential danger. Survey staff should also have regard to safety of others and warn them if survey staff foresee any dangerous consequences of their actions.
- Requiring that survey staff's actions cause no unnecessary obstruction of nuisance.
- Whilst every care is taken in organizing and scheduling survey work to avoid potentially dangerous situations, survey staff should not persevere with any survey assignment if survey staff feel that personal safety is unreasonably at risk.
- Staff involved in manual traffic surveys must obey all instructions given to them by their Manager/ Supervisor. Remembering that politeness and courtesy are essential when dealing with the public, and in that way conflict situation can be avoided.
- Employees experiencing incidents of physical or verbal violence must report this immediately to their Manager/Supervisor, who will in turn report the incident to the appropriate local authority. Any incident of this nature must also be passed on to the Health and Safety manager at the earliest opportunity.

Photo: ADB

ABOUT THE ASEAN AUSTRALIA SMART CITIES TRUST FUND

The ASEAN Australia Smart Cities Trust Fund (AASCTF) assists ASEAN cities in enhancing their planning systems, service delivery, and financial management by developing and testing appropriate digital urban solutions and systems. By working with cities, AASCTF facilitates their transformation to become more livable, resilient, and inclusive, while in the process identifying scalable best and next practices to be replicated across cities in Asia and the Pacific.

ASEAN AUSTRALIA SMART CITIES TRUST FUND
Asian Development Bank

Australian Government
Department of Foreign Affairs and Trade

ADB