

Questions on Notice 1

Ms CATE FAEHRMANN: You mentioned undertaking traffic modelling. How have you modelled the expected increase in containers? Has NSW Ports conducted any studies in relation to traffic and congestion impacts around the port, or is that all the work of the Government?

Ms CALFAS: We undertook some analysis of the actual truck and non-truck movements around Port Botany last year or the year before. We have done it in the last two years. That is why I can say to you that 14 per cent of the vehicles around Port Botany are port container trucks. The remainder on non-port commercial vehicles.

Ms CATE FAEHRMANN: Considering what the Committee is looking at, that analysis would be very useful. Is it a public document?

Ms CALFAS: It is not, but I am happy to provide it.

Ms CATE FAEHRMANN: Thank you very much.

NSW Ports Response

The NSW Ports *Port Botany Freight Study* dated 22 November 2017 is attached to this response at Attachment A.

Questions on Notice 2

Ms CATE FAEHRMANN: Just in reference to the Ports Assets (Authorised Transactions) Act 2012, as you are aware does it authorise the Government to make support payments to NSW Ports and, if so, what section of the Act?

Ms CALFAS: I am not familiar with whether the Act itself authorises the New South Wales Government to make payments.

Ms CATE FAEHRMANN: Would you be able to take that on notice?

Ms CALFAS: I can take that on notice, yes.

Ms CATE FAEHRMANN: And also whether there is any limit on the amount of support payments by the New South Wales Government within that?

Ms CALFAS: Within the Act?

Ms CATE FAEHRMANN: Yes.

Ms CALFAS: Yes.

NSW Ports Response

NSW Ports' understanding is that the Port Assets (Authorised Transactions) Act 2012 (NSW) (Act) confers on the Treasurer broad powers to effect an "authorised transaction" in any manner the Treasurer considers appropriate, without limitation, which includes leases of land at Port Botany, Port Kembla and Port of Newcastle. See sections 4, 6 and 7 of the Act.

The Act expressly allows compensation to be paid "under a transaction arrangement to a party to the transaction arrangement in connection with the performance of obligations under the transaction arrangement." See section 30(2) of the Act.

Accordingly, the Act does confer on the Treasurer the ability to enter into agreements in connection with the Port Botany and Port Kembla lease transactions which includes the ability to provide support payments.

Attachment A: Port Botany Freight Study (22 November 2017)



Port Botany Freight Study

FINAL REPORT

NSW Ports

22 November 2017

aurecon

*Bringing ideas
to life*

NSW Ports

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Contents

Executive Summary	5
1 Introduction	14
1.1 Background	14
1.2 Objectives of the Port Botany Freight Study	14
2 Study Methodology	16
2.1 Overview	16
2.2 Data Collection / Locations	16
2.3 Video Data Collection and Classification	19
2.4 ATC Collection and Classification	22
2.5 Data Validation	23
2.6 Data Analysis	24
3 Results	25
3.1 Port Precinct Traffic	25
3.2 Port Traffic	57
3.3 Port Terminals	71
3.4 Coal Pier Estate	80
4 Discussion	91

Figures

Figure 1 - Overview of count locations	5
Figure 2 - Average weekday total vehicles (with road labels)	6
Figure 3 - Daily vehicles entering the port	10
Figure 4 - Weekday heavy commercial vehicles entering the port (combined)	11
Figure 5 - Weekday time of day profile for vehicles entering and leaving the port (all locations)	11
Figure 6 - Weekday total vehicles exiting each terminal driveway	12
Figure 7 - Average weekday traffic (Coal Pier Estate)	13
Figure 8 - Port Botany and Study Area	15
Figure 9 - Overview of count locations	17
Figure 10 - Average weekday total vehicles (with road labels)	25
Figure 11 - Average weekday Cars and LCVs	26
Figure 12 - Average weekday Small HCVs and Large HCVs	26
Figure 13 - Foreshore Road survey locations (refer numbering in Table 17)	30
Figure 14 - General Holmes Drive / Foreshore Road Intersection (from General Holmes Drive)	32
Figure 15 - General Holmes Drive / Foreshore Road Time of Day (from General Holmes Drive)	33
Figure 16 - General Holmes Drive / Foreshore Road Intersection (from Foreshore Road)	34
Figure 17 - General Holmes Drive / Foreshore Road Time of Day (from Foreshore Road)	34
Figure 18 - Foreshore / Botany Intersection (from Foreshore Road eastbound)	36
Figure 19 - Foreshore / Botany Time of Day (from Foreshore Road eastbound)	36
Figure 20 - Foreshore / Botany Intersection (from Botany Road southbound)	37
Figure 21 - Foreshore / Botany Time of Day (from Botany Road southbound)	37
Figure 22 - Foreshore / Botany Intersection (from Botany Road westbound)	39
Figure 23 - Foreshore / Botany Time of Day (from Botany Road westbound)	39
Figure 24 - Foreshore / Botany Intersection (from Penrhyn Road northbound)	40
Figure 25 - Foreshore / Botany Time of Day (from Penrhyn Road northbound)	40
Figure 26 - Botany Road / Beauchamp Road Intersection (from Botany Road eastbound)	42
Figure 27 - Botany Road / Beauchamp Road Time of Day (from Botany Road eastbound)	42
Figure 28 - Botany Road / Beauchamp Road Intersection (from Beauchamp Road southbound)	43
Figure 29 - Botany Road / Beauchamp Road Time of Day (from Beauchamp Road southbound)	43
Figure 30 - Botany Road / Beauchamp Road Intersection (from Botany Road westbound)	44
Figure 31 - Botany Road / Beauchamp Road Time of Day (from Botany Road westbound)	44
Figure 32 - Botany / Bumborah Intersection (from Botany Road eastbound)	46
Figure 33 - Botany / Bumborah Time of Day (from Botany Road eastbound)	46
Figure 34 - Botany / Bumborah Intersection (from Orora)	47
Figure 35 - Botany / Bumborah Time of Day (from Orora)	47
Figure 36 - Botany / Bumborah Intersection (from Botany Road westbound)	48
Figure 37 - Botany / Bumborah Time of Day (from Botany Road westbound)	48
Figure 38 - Botany / Bumborah Intersection (from Bumborah Point Road northbound)	49
Figure 39 - Botany / Bumborah Time of Day (from Bumborah Point Road northbound)	49
Figure 40 - Military / Bumborah Intersection (from Military Road westbound)	51
Figure 41 - Military / Bumborah Time of Day (from Military Road westbound)	51
Figure 42 - Military / Bumborah Intersection (from Simblist Road eastbound)	52
Figure 43 - Military / Bumborah Time of Day (from Simblist Road eastbound)	52
Figure 44 - Military / Bumborah Intersection (from Bumborah Point Road southbound)	53
Figure 45 - Military / Bumborah Time of Day (from Bumborah Point Road southbound)	53
Figure 46 - Car traffic morning peak movements	56

Figure 47 - Car traffic afternoon peak movements	57
Figure 48 - Daily vehicles entering the port	58
Figure 49 - Daily vehicles entering the port via Sirius Road	59
Figure 50 - Daily vehicles entering the port via Penrhyn Road	60
Figure 51 - Daily vehicles entering the port via Bumborah Point Road	60
Figure 52 - Daily vehicles entering the port via Military Road	61
Figure 53 - Weekday heavy commercial vehicles entering the port using Penrhyn Road	62
Figure 54 - Weekday heavy commercial vehicles entering the port using Bumborah Point Road	63
Figure 55 - Weekday heavy commercial vehicles entering the port using Military Road	63
Figure 56 - Average weekday laden / unladen Container Trucks	64
Figure 57 - Weekday time of day profile for vehicles entering the port (all locations)	66
Figure 58 - Weekday time of day profile for vehicles exiting the port (all locations)	66
Figure 59 - Weekday time of day profile for vehicles entering the port via Sirius Road	67
Figure 60 - Weekday time of day profile for vehicles exiting the port via Sirius Road	67
Figure 61 - Weekday time of day profile for vehicles entering the port via Penrhyn Road	68
Figure 62 - Weekday time of day profile for vehicles exiting the port via Penrhyn Road	68
Figure 63 - Weekday time of day profile for vehicles entering the port via Bumborah Point Road	69
Figure 64 - Weekday time of day profile for vehicles exiting the port via Bumborah Point Road	69
Figure 65 - Weekday time of day profile for vehicles entering the port via Military Road	70
Figure 66 - Weekday time of day profile for vehicles exiting the port via Military Road	70
Figure 67 - Weekday total vehicles exiting each terminal driveway	72
Figure 68 - Daily vehicles exiting terminals on Bumborah Point Road	73
Figure 69 - Daily vehicles exiting terminals on Simblist Road	73
Figure 70 - Daily vehicles exiting terminals on Charlotte Road	74
Figure 71 - Daily vehicles exiting terminals on Friendship Road	74
Figure 72 - Daily vehicles exiting terminals on Botany Road	75
Figure 73 - Daily vehicles exiting terminals on Penrhyn Road	75
Figure 74 - Daily vehicles exiting terminals on Sirius Road	76
Figure 75 - Weekday time of day profile for vehicles exiting terminals on Bumborah Point Road	77
Figure 76 - Weekday time of day profile for vehicles exiting terminals on Simblist Road	77
Figure 77 - Weekday time of day profile for vehicles exiting terminals on Charlotte Road	78
Figure 78 - Weekday time of day profile for vehicles exiting terminals on Friendship Road	78
Figure 79 - Weekday time of day profile for vehicles exiting terminals on Friendship and Botany	79
Figure 80 - Weekday time of day profile for vehicles exiting terminals on Penrhyn and Sirius	79
Figure 81 - Coal Pier Estate (shown in green)	80
Figure 82 - Average weekday traffic (Coal Pier Estate*)	81
Figure 83 - Daily vehicles - Botany Road (south of Stephen Road)	83
Figure 84 - Daily vehicles - Botany Road (north of Penrhyn Road)	83
Figure 85 - Daily vehicles - Hill Street	84
Figure 86 - Daily vehicles - Exell Street	85
Figure 87 - Daily vehicles - Coal Pier Road	85
Figure 88 - Daily vehicles - McPherson Street (east of Coal Pier Road)	86
Figure 89 - Weekday time of day profile - Botany Road (south of Stephen Road)	87
Figure 90 - Weekday time of day profile - Botany Road (north of Penrhyn Road)	87
Figure 91 - Weekday time of day profile - Hill Street	88
Figure 92 - Weekday time of day profile - Exell Street	88
Figure 93 - Weekday time of day profile - Coal Pier Road	89
Figure 94 - Weekday time of day profile - McPherson Street (east of Coal Pier Road)	89

Tables

Table 1 - Average weekday traffic (key locations)	7
Table 2 - Average weekday traffic (Foreshore / General Holmes Drive Intersection)	7
Table 3 - Average weekday traffic (Foreshore Road / Botany Road Intersection)	8
Table 4 - Average weekday traffic (Botany Road / Beauchamp Road Intersection)	8
Table 5 - Average weekday traffic (Botany Road / Bumborah Point Road Intersection)	9
Table 6 - Average weekday traffic (Military Road / Bumborah Point Road Intersection)	10
Table 7 - Average weekday traffic (Coal Pier Estate)	13
Table 8 - Video count locations (collection for 2 x 24 hours)	17
Table 9 - ATC road counter locations (collection for two consecutive weeks)	18
Table 10 - ATC Terminal locations (collection for two consecutive weeks)	19
Table 11 - Example of vehicle classification from video	20
Table 12 - Valid entries for 'vehicle type'	20
Table 13 - Valid entries for 'commercial vehicle type' (LCVs and HCVs only)	20
Table 14 - Valid entries for 'vehicle configuration' (HCVs only)	22
Table 15 - Example of vehicle classification from ATC counter	22
Table 16 - Average weekday traffic	27
Table 17 - Foreshore Road historical average weekday traffic	29
Table 18 - Botany Road historical average weekday traffic (west of Beauchamp Road)	30
Table 19 - Botany Road historical average weekday traffic (east of Beauchamp Road)	30
Table 20 - Average weekday traffic (Foreshore / General Holmes Drive Intersection)	32
Table 21 - Average weekday traffic (Foreshore Road / Botany Road Intersection)	35
Table 22 - Average weekday traffic (Botany Road / Beauchamp Road Intersection)	41
Table 23 - Average weekday traffic (Botany Road / Bumborah Point Road Intersection)	45
Table 24 - Average weekday traffic (Military Road / Bumborah Point Road Intersection)	50
Table 25 - Changes in traffic between intersections	54
Table 26 - Daily vehicles entering the port	58
Table 27 - Vehicles entering the Port Precinct related to the Port	59
Table 28 - Weekday heavy commercial vehicles entering the Port Precinct	62
Table 29 - Average weekday laden / unladen Container Trucks	64
Table 30 - Average weekday vehicles exiting each terminal	71
Table 31 - Average weekday traffic (Coal Pier Estate)	81
Table 32 - Vehicles entering the Port Precinct related to the Coal Pier Estate	82

Executive Summary

Aims and Objectives

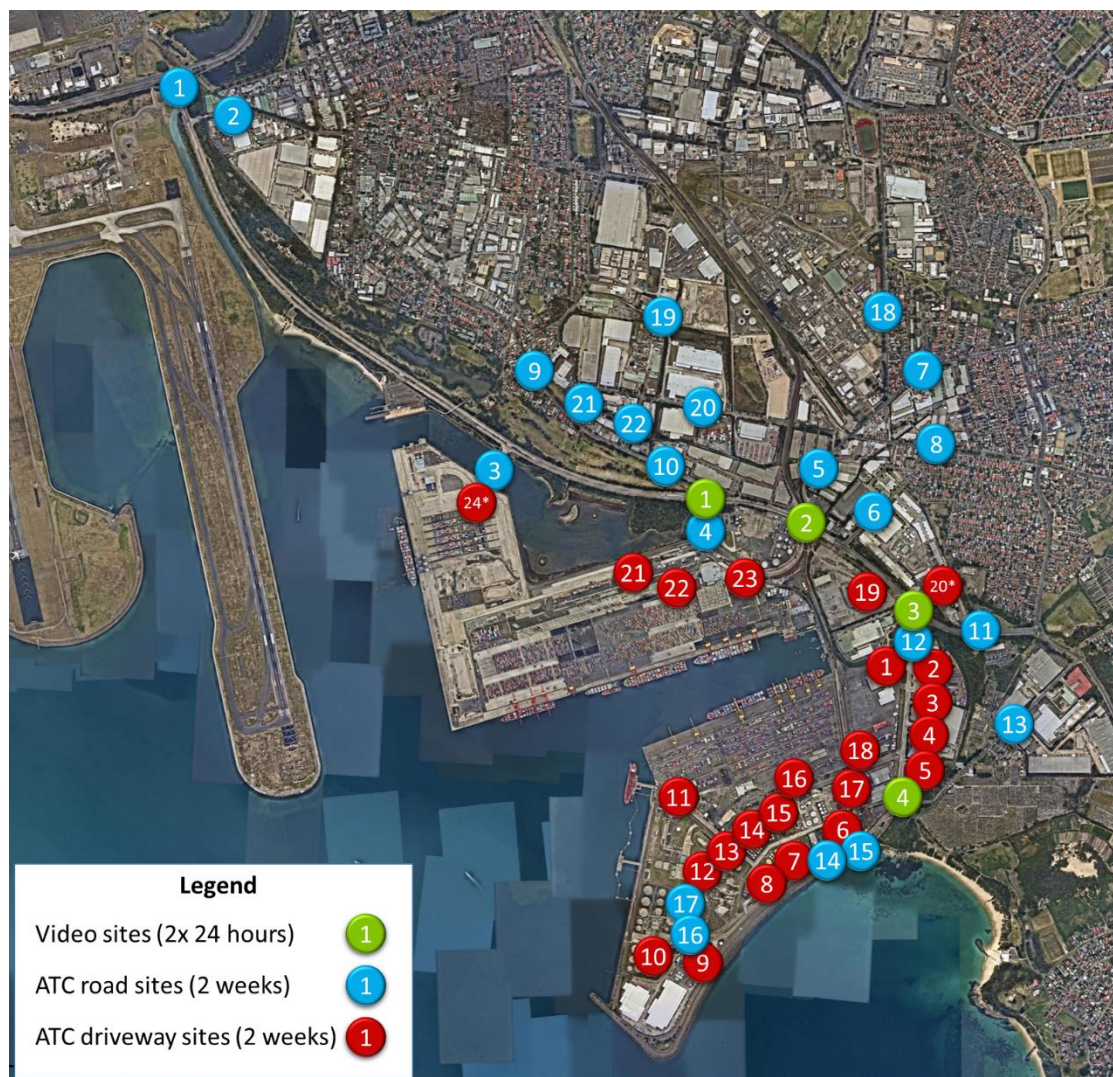
NSW Ports manages four major infrastructure assets in NSW: Port Botany, Port Kembla, the Enfield Intermodal Logistics Centre and the Cooks River Intermodal Terminal. It has a vested interest in the long-term sustainability of these assets. To achieve this sustainability for Port Botany, understanding the traffic that currently operates within the port and the wider precinct is extremely important. Knowing the number of vehicles that operate within the port, or on its boundary, at various times will provide the information needed to inform improvements within the precinct.

To achieve these objectives, NSW Ports has conducted a detailed and comprehensive data collection and analysis project, within Port Botany itself, along its boundary and in the mainly industrial area to the north of Port Botany (including Coal Pier Estate).

Methodology

This study has used a hybrid approach to collecting vehicle information in and around Port Botany. At four key locations video data was collected for two separate 24-hour periods, from which a detailed vehicle classification was undertaken. At 22 on-road locations, Automatic Tube Counters (ATC) were used for two continuous weeks to count and classify traffic. At 22 terminal locations (individual sites within Port Botany), ATC counters were used to classify traffic (also collected for two continuous weeks). These locations are shown in Figure 1.

Figure 1 - Overview of count locations



This approach was adopted to allow video identification of various types of trucks and light commercial vehicles and to allow traditional ATC counters to provide both a longer time period (two weeks) and a comprehensive spread of counters.

Results - Port Precinct

The Port Precinct covers the Port (immediately south of Foreshore Road and Botany Road) and the industrial area to the north (including Coal Pier Estate). Figure 2 shows a visual representation of traffic operating in the Precinct, with thicker lines representing more traffic.

Figure 2 - Average weekday total vehicles (with road labels)



Apart from the western end of Foreshore Road, Botany Road, between Foreshore Road and Beauchamp Road, carries the most traffic in the precinct on an average weekday, most of which comes from Foreshore Road. Key road volumes are shown in Table 1, with the main Foreshore Road-Botany Road corridor rows highlighted.

Table 1 - Average weekday traffic (key locations)

Location	Detail	Direction	Car	LCV	Small HCV	Large HCV	Total
Foreshore (ATC)	North of Hale	Two-way	27,309	5,734	5,849	7,196	46,088
Foreshore (Video)	West of Penrhyn	Two-way	22,073	4,635	3,074	7,381	37,164
Botany (ATC)	South of Stephen	Two-way	7,275	2,167	2,015	381	11,838
Botany (ATC)	North of Penrhyn	Two-way	6,986	2,080	2,388	2,765	14,220
Penrhyn (ATC)	South of Foreshore	Two-way	1,142	295	448	2,533	4,418
Botany (Video)	East of Penrhyn	Two-way	24,587	5,285	3,391	6,194	39,457
Botany (Video)	West of Beauchamp	Two-way	24,214	5,339	3,371	6,194	39,118
Beauchamp (ATC)	North of Botany	Two-way	12,967	3,109	2,631	1,704	20,411
Botany (Video)	East of Beauchamp	Two-way	11,827	2,545	2,373	6,052	22,796
Botany (Video)	West of Bumborah	Two-way	11,497	2,425	2,264	5,913	22,098
Botany (ATC)	East of Bumborah	Two-way	8,069	1,527	1,645	296	11,536
Bumborah (ATC)	South of Botany	Two-way	3,583	1,067	2,683	5,447	12,780
Military (Video)	East of Bumborah	Two-way	1,177	253	621	449	2,500
Simblist (ATC)	South of Prince of Wales	WB	1,267	223	464	3,107	5,061
Friendship (ATC)	North of Simblist	NB	1,245	220	505	3,117	5,088

As shown in the highlighted rows, traffic volumes decrease on the main Foreshore Road-Botany Road corridor as the road travels east, from 46,088 to 11,536 per average weekday. The key intersections within the precinct from west to east (along with observations) are described below.

General Holmes Drive / Foreshore Road

A total of 24,191 vehicles enter the precinct using Foreshore Road each weekday (of which 26% are trucks), with 87% of these turning right from General Holmes Drive (from the west). There is a large morning peak of 1,500 cars per hour between 6:00 AM and 8:00 AM.

Table 2 - Average weekday traffic (Foreshore / General Holmes Drive Intersection)

From	Direction	Car	LCV	Small HCV	Large HCV	Total
General Holmes	Left into Foreshore	1,193	250	687	927	3,057
	Right into Foreshore	13,530	2,841	2,054	2,710	21,135
	Total	14,723	3,092	2,741	3,636	24,191
Foreshore	Left into General Holmes	11,523	2,420	2,177	2,749	18,869
	Right into General Holmes	1,063	223	931	811	3,028
	Total	12,586	2,643	3,108	3,560	21,897

A total of 21,897 vehicles (30% trucks) use this intersection per weekday to exit the precinct, 87% of which turn left (to the west). Traffic peaks at 1,100 cars per hour between 2:00 PM and 5:00 PM.

Not unexpectedly, the percentage of trucks is higher in this area than other parts of Sydney. The analysis also shows that there is a large component of car (commuter) traffic that arrives in the morning and then leaves in the afternoon.

Foreshore Road / Botany Road / Penrhyn Road

By the next main intersection, traffic has dropped from 24,191 in the south/east direction to 18,802. This reduction is associated with opportunities for vehicles to turn left onto Hale Street at the northern section of Foreshore Road, or turn right into Sirius Road (into Hutchinson Ports).

Table 3 - Average weekday traffic (Foreshore Road / Botany Road Intersection)

From	Direction	Car	LCV	Small HCV	Large HCV	Total
Penrhyn	Left into Foreshore	349	79	52	824	1,304
	Straight into Botany	142	47	24	210	422
	Right into Botany	165	38	29	391	623
	Total	655	163	105	1,425	2,348
Botany	Left into Penrhyn	170	70	38	437	714
	Straight into Foreshore	9,420	1,844	1,094	2,178	14,536
	Right into Botany	2,311	606	494	454	3,864
	Total	11,901	2,519	1,625	3,068	19,113
Botany	Left into Botany	2,897	863	636	472	4,867
	Straight into Penrhyn	134	37	25	222	417
	Right into Foreshore	1,013	338	392	681	2,424
	Total	4,043	1,237	1,053	1,374	7,707
Foreshore	Left into Botany	1,351	448	403	702	2,903
	Straight into Botany	9,525	1,845	1,101	2,264	14,734
	Right into Penrhyn	335	66	33	733	1,166
	Total	11,211	2,358	1,536	3,698	18,802

In total, 87% of this eastbound traffic stream continues straight onto Botany Road, joined by 63% of the traffic that is coming south along Botany Road (near the Coal Pier Estate industrial area). Traffic from Foreshore Road peaks at 1,200 cars per hour between 8:00 AM and 9:00 AM.

From the east, 76% of the traffic travels from Botany Road onto Foreshore Road, peaking in the afternoon at 1,100 vehicles per hour between 5:00 PM and 6:00 PM.

A relatively small amount of traffic comes out of Penrhyn Road (2,348 vehicles per weekday), with most turning left into Foreshore Road. This has a much higher proportion of trucks, peaking in the afternoon at 115 per hour between 2:00 PM and 3:00 PM.

Botany Road / Beauchamp Road

Along the corridor, the next main intersection is between Botany Road and Beauchamp Road. Given the merging of traffic from Foreshore Road and Botany Road at the previous intersection, the number of vehicles entering this intersection is higher at 20,094 per weekday. To cope with this, the number of lanes increases from 2 to 3.

Table 4 - Average weekday traffic (Botany Road / Beauchamp Road Intersection)

From	Direction	Car	LCV	Small HCV	Large HCV	Total
Botany (EB)	Straight into Botany	5,269	1,132	929	2,761	10,091
	Left into Beauchamp	7,118	1,696	835	355	10,003
	Total	12,387	2,828	1,763	3,116	20,094
Botany (WB)	Straight into Botany	5,519	1,076	911	2,681	10,187
	Right into Beauchamp	497	159	271	290	1,217
	Total	6,016	1,235	1,182	2,971	11,404
Beauchamp	Left into Botany	542	178	262	320	1,302
	Right into Botany	6,308	1,435	697	398	8,837
	Total	6,850	1,613	959	718	10,138

From this data we observed a roughly 50:50 split in eastbound traffic turning left into Beauchamp Road and continuing straight ahead on Botany Road. For cars, there is both a morning peak of 1,150 cars between 8:00 AM and 9:00 AM, and an afternoon peak of 950 cars between 5:00 PM and 6:00 PM.

This afternoon peak is most likely associated with commuter vehicles leaving the port at Penrhyn Road and those using Botany Road (north of Foreshore Road) to get home. A similar morning and afternoon peak is observed for vehicles exiting Beauchamp Road.

Botany Road / Bumborah Point Road

Further east, the next main intersection with Botany Road is Bumborah Point Road. Bumborah Point Road is the main access to the Port Terminals along Bumborah Point Road, Simblist Road and Friendship Road. It is therefore an important access point to the port as a whole.

Table 5 - Average weekday traffic (Botany Road / Bumborah Point Road Intersection)

From	Direction	Car	LCV	Small HCV	Large HCV	Total
Botany (EB)	Left into Orora	153	39	78	94	363
	Straight into Botany	3,918	726	394	82	5,120
	Right into Bumborah	1,724	506	700	2,885	5,814
	Total	5,795	1,271	1,171	3,060	11,296
Bumborah	Left into Botany	1,999	461	758	2,807	6,024
	Straight into Orora	10	1	5	22	38
	Right into Botany	162	46	292	83	582
	Total	2,171	507	1,055	2,911	6,643
Botany (WB)	Left into Bumborah	198	41	439	32	709
	Straight into Botany	3,609	682	332	45	4,668
	Right into Orora	2	1	-	1	3
	Total	3,809	723	771	77	5,379
Orora	Left into Botany	42	6	3	1	51
	Straight into Bumborah	2	-	1	-	3
	Right into Botany	94	12	4	2	111
	Total	138	18	7	2	165

For vehicles travelling east, 68% of cars stay on Botany Road, while 85% of trucks turn right into Bumborah Point Road. Of the trucks that stay on Botany Road, the majority are Small HCVs. For these movements, there is a significant morning peak of 500 cars per hour between 5:00 AM and 8:00 AM, and smaller peaks at other times aligning with port shift start times.

Given that greater than 50% of vehicles turn right onto Bumborah Point Road at this intersection, there is an obvious imbalance in the number of lanes available. Botany Road continues with three lanes, while Bumborah Point Road has a single turn right lane and continues to maintain a single lane for its entire length.

For vehicles travelling westbound on Botany Road, 87% continue on Botany Road; the majority of these are cars. From this direction, there is a short morning peak of 280 cars per hour and a long afternoon peak of approximately 320 cars per hour between 2:00 PM and 6:00 PM.

From Bumborah Point Road, 91% of traffic turns left into Botany Road, most of the car traffic is in a long afternoon peak of 250 vehicles per hour between 2:00 PM and 6:00 PM.

Bumborah Point Road / Military Road / Simblist Road

The last main intersection is that between Bumborah Point Road (at its southern end), Military Road and Simblist Road.

Table 6 - Average weekday traffic (Military Road / Bumborah Point Road Intersection)

From	Direction	Car	LCV	Small HCV	Large HCV	Total
Military	Left into Simblast	347	64	33	18	461
	Right into Bumborah	362	83	253	209	906
	Total	709	146	286	227	1,367
Bumborah	Left into Military	404	98	330	223	1,054
	Right into Simblast	1,043	382	390	2,908	4,723
	Total	1,447	480	720	3,131	5,777
Simblast	Left into Bumborah	80	16	10	3	108
	Right into Military	65	9	6	-	79
	Total	144	25	16	3	187

The majority of traffic entering this intersection is from Bumborah Point Road, 82% of which turns right into Simblast Road for access to Port Terminals on Simblast and Friendship Roads.

For cars, we observed several peaks that coincide with Port Terminal shift start times (or lunch breaks) at 5:00 AM, 8:00 AM, 1:00 PM and 9:00 PM. Trucks, in particular Large HCVs, are low in numbers before 5:00 AM, but increase from then to a peak of 225 trucks per hour between 1:00 PM and 2:00 PM.

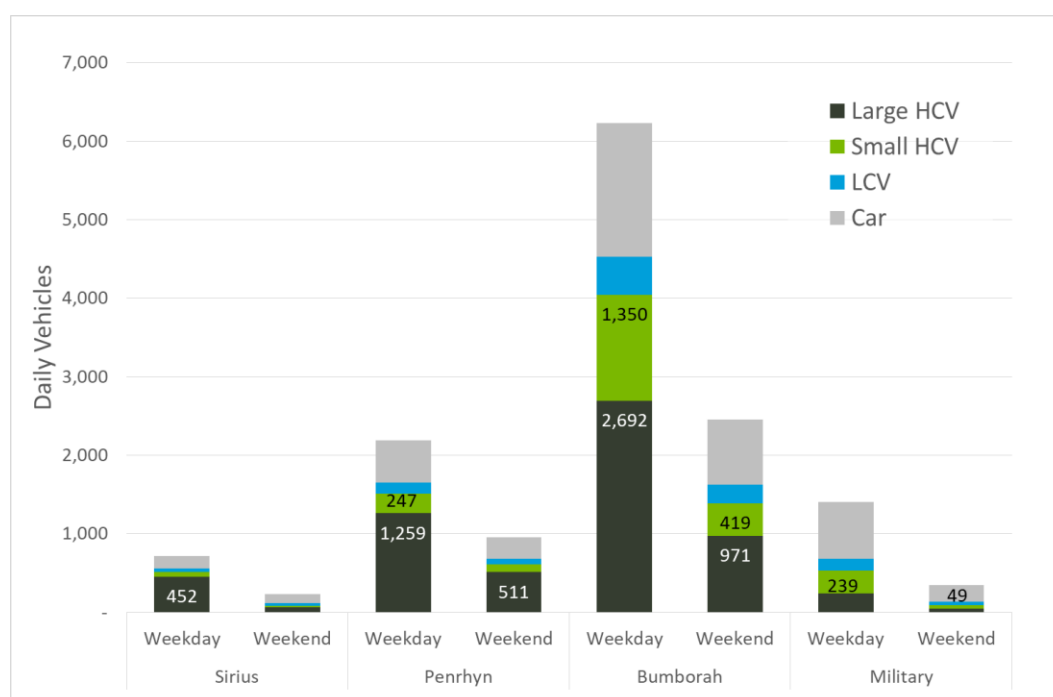
Results - Port

Daily Traffic

Vehicles can access the terminals at Port Botany via Sirius Road (Hutchinson Ports), Penrhyn Road (Patrick's), Bumborah Point Road (contains multiple terminals and provides access to Simblast and Friendship Roads) and Military Road (access to Simblast and Friendship Roads).

On an average weekday, 10,540 vehicles enter the port via these four roads: 59% via Bumborah Point Road, 21% via Penrhyn Road, 13% via Military Road and 7% via Sirius Road. This drops to 3,981 per day on the weekend.

Figure 3 - Daily vehicles entering the port

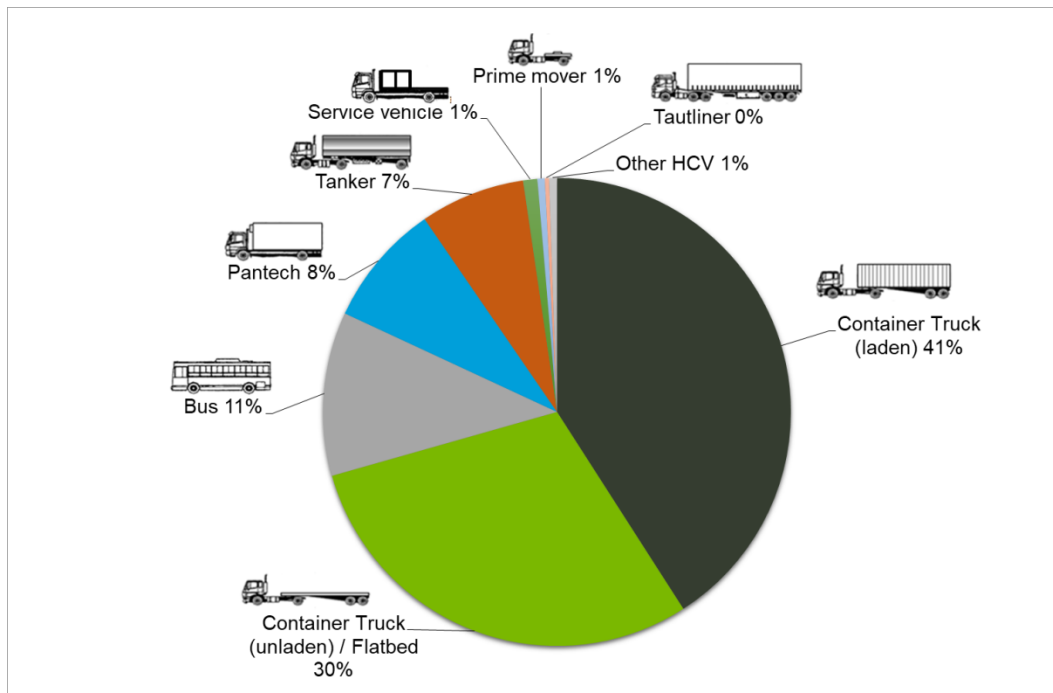


Sirius Road had the greatest day-to-day variability, with Monday and Tuesday being the busiest; however, for the other port access roads there is no consistency in the busiest day across the different locations.

Vehicle Types

From a detailed classification of the video data, we were able to undertake an analysis of the types of vehicles entering the port from Penrhyn Road, Bumborah Point Road and Military Road.

Figure 4 - Weekday heavy commercial vehicles entering the port (combined)

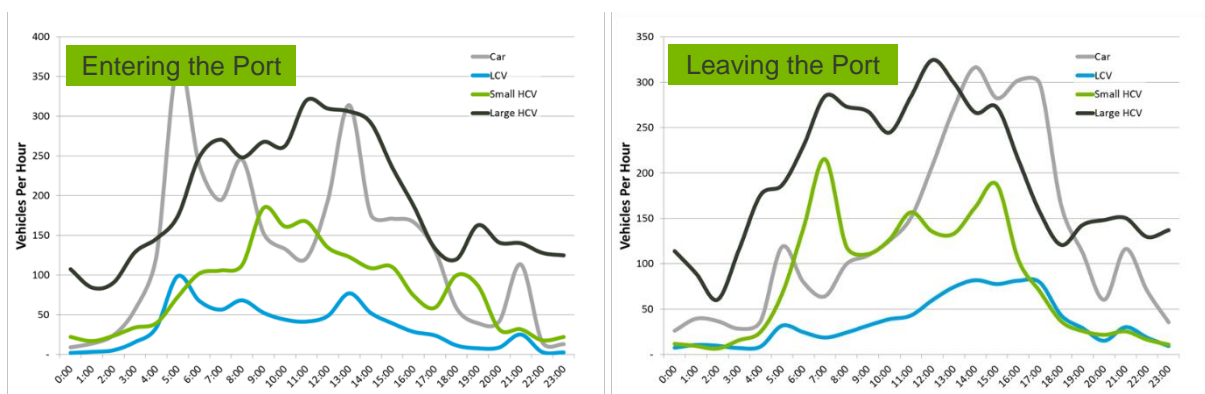


Over the three access roads with video capture, a total of 71% of trucks were container trucks (either laden or unladen). Penrhyn Road recorded the highest percentage (89%), followed by Bumborah Point Road (67%) and lastly Military Road (50%). We observed, however, that the types of vehicles did vary between different access roads, due to the different nature and operation of the terminals.

Times of Day

Within a Port Precinct we would expect to see a 'last kilometre' behaviour, as vehicles arrive and leave in coordination with shift starts, collections and deliveries.

Figure 5 - Weekday time of day profile for vehicles entering and leaving the port (all locations)



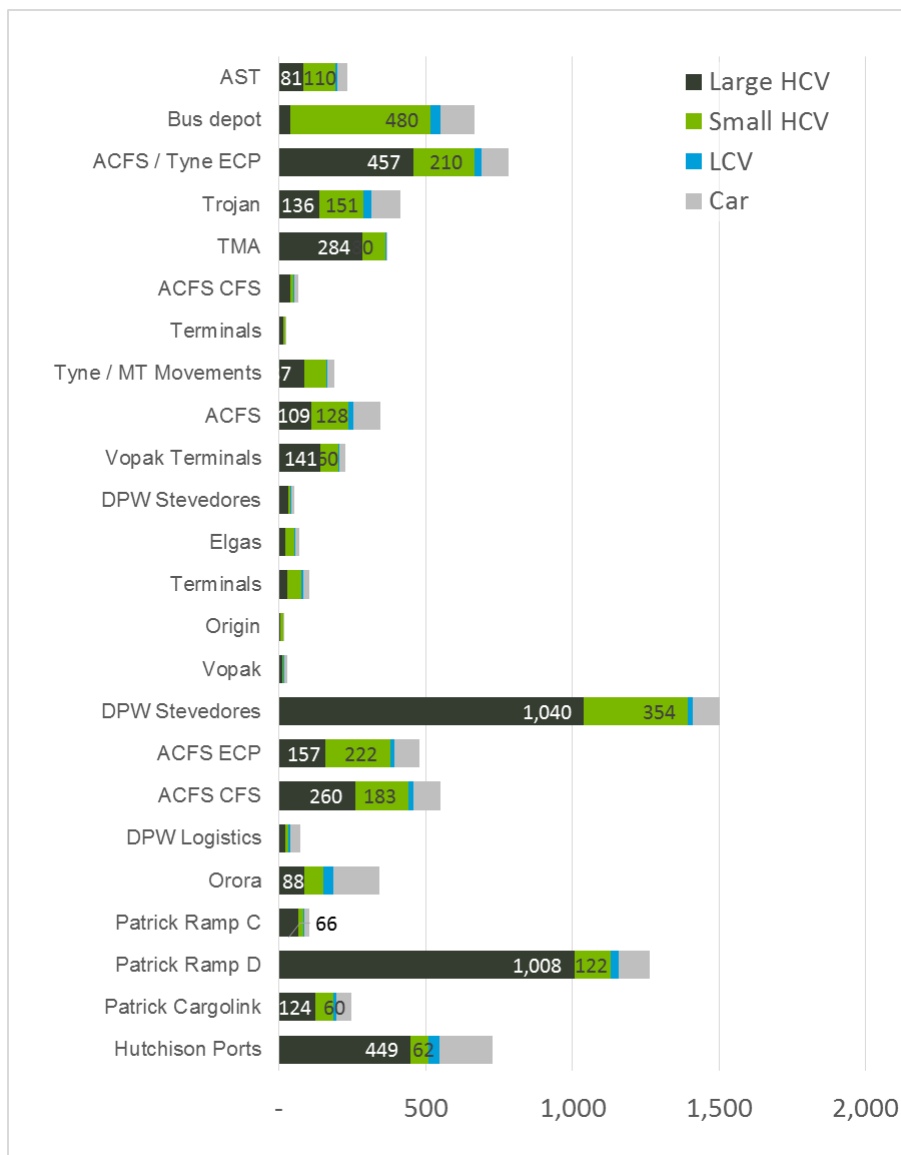
We observe that the numbers of cars arriving at the port are the highest at 5:00 AM, 8:00 AM and 9:00 PM, which are the shift start times, and at 1:00 PM with employees most likely returning from lunch. Most trucks entering the port do so between 6:00 AM and 6:00 PM, with Small HCVs peaking at 175 vehicles per hour between 9:00 AM and 12:00 PM and Large HCVs peaking at 310 vehicles per hour between 11:00 AM and 2:00 PM.

For cars that exit the port, the end of shifts at 5:00 AM, 5:00 PM and 9:00 PM are the peak times, with likely exits for lunch between 1:00 PM and 2:00 PM. As expected, the exit profile for trucks follows that for the entry profile; in that the majority of trucks are entering the port to collect freight and then exit.

Results - Terminals

A total of 22 ATC counters were deployed during the study, to capture vehicle movements from the majority of the terminals within the port. In each case, they were placed on the driveway exits.

Figure 6 - Weekday total vehicles exiting each terminal driveway



In total, 8,864 vehicles were captured during the study for an average weekday, with 28% of these being Small HCVs and 53% Large HCVs. The number of vehicles varies considerably from terminal to terminal, with DPW Stevedores on Friendship Road averaging 1,500 vehicles per day, of which over 1,000 were Large HCVs. Patrick (Ramp D) and Hutchison Ports were the next two largest with 1,266 and 721 vehicles per weekday respectively.

The time of day profiles also vary considerably from terminal to terminal, partially in relation to shift start times. With few exceptions, the busiest hours of the day were between 6:00 AM and 4:00 PM, with approximately two-thirds of terminals operating throughout the night. For each of the terminals in the port, weekday traffic is considerably higher than weekend traffic, and weekday traffic relatively constant from day-to-day.

Results - Coal Pier Estate

Coal Pier Estate is a large industrial area within the Port Precinct, bounded by Stephen Road to the west, the railway line to the north and east, and Botany Road to the south. Given its location, it has only two access points: Stephen Road and Botany Road.

Figure 7 - Average weekday traffic (Coal Pier Estate)



Table 7 - Average weekday traffic (Coal Pier Estate)

Location	Detail	Direction	Car	LCV	Small HCV	Large HCV	Total
Botany (ATC)	South of Stephen	Two-way	7,275	2,167	2,015	381	11,838
Botany (ATC)	North of Penrhyn	Two-way	6,986	2,080	2,388	2,765	14,220
Hill (ATC)	North of Botany	NB	1,416	422	663	1,587	4,087
Exell (ATC)	North of Botany	SB	1,334	397	728	1,593	4,053
Coal Pier (ATC)	North of McPherson	Two-way	503	150	462	1,002	2,117
McPherson (ATC)	East of Coal Pier	Two-way	1,180	351	204	825	2,561

We estimate that 65% of vehicles using Hill Street access the estate from the south (i.e. the intersection of Foreshore-Botany-Penrhyn Roads) and 35% from the north. A similar ratio is found for vehicles exiting the site. Also, we estimate that 31% of the vehicles using Botany Road (between Stephen Road and Penrhyn Road) are associated with Coal Pier Estate.

For cars and LCVs associated with Coal Pier Estate, there is a morning peak of 240 vehicles entering per hour between 8:00 AM and 9:00 AM, with an afternoon peak of 230 vehicles exiting per hour. Approximately 42% of these cars and LCVs park on, or are associated with businesses on, the eastern end of McPherson Street. For Coal Pier Estate, weekday traffic is also considerably higher than weekend traffic, and weekday traffic is relatively constant from day-to-day.

1 Introduction

1.1 Background

NSW Ports is a consortium of IFM Investors, Australian Super, Tawreed Investments Limited and Q Super. It manages (via a 99-year lease from April 2013) four major infrastructure assets in NSW: Port Botany, Port Kembla, the Enfield Intermodal Logistics Centre and the Cooks River Intermodal Terminal. NSW Ports has a vested interest in the long-term sustainability of these assets, especially Port Botany and Port Kembla, which are both of national significance and critical to economic growth for NSW.

To achieve this sustainability, understanding the traffic that currently operates within Port Botany and the wider precinct is extremely important. Knowing the number of vehicles that operate within the port, or on its boundary, at various times will provide the information needed to inform improvements within the precinct; either through direct or targeted investment, improving policies and procedures, or working with NSW Roads and Maritime Services (RMS) to improve access to the port or within the Port Precinct for all users.

This study, the largest of its kind for Port Botany, aims to provide a detailed understanding of the traffic in the Port Precinct, the port itself and for terminals within the port, to help shape future planning.

1.2 Objectives of the Port Botany Freight Study

The main overarching objective of the Port Botany Freight Study, is to provide a detailed and thorough investigation of vehicles operating within the Port Precinct (which covers Port Botany and the industrial area immediately to the north). This investigation is to provide information and insight to:

- Enable NSW Ports to quantify current traffic volumes to be used for future traffic forecasts;
- Enable NSW Ports to conduct maintenance planning for its road assets; and
- Enable NSW Ports to predict when road upgrades/expansions will be required.

To achieve this, it will:

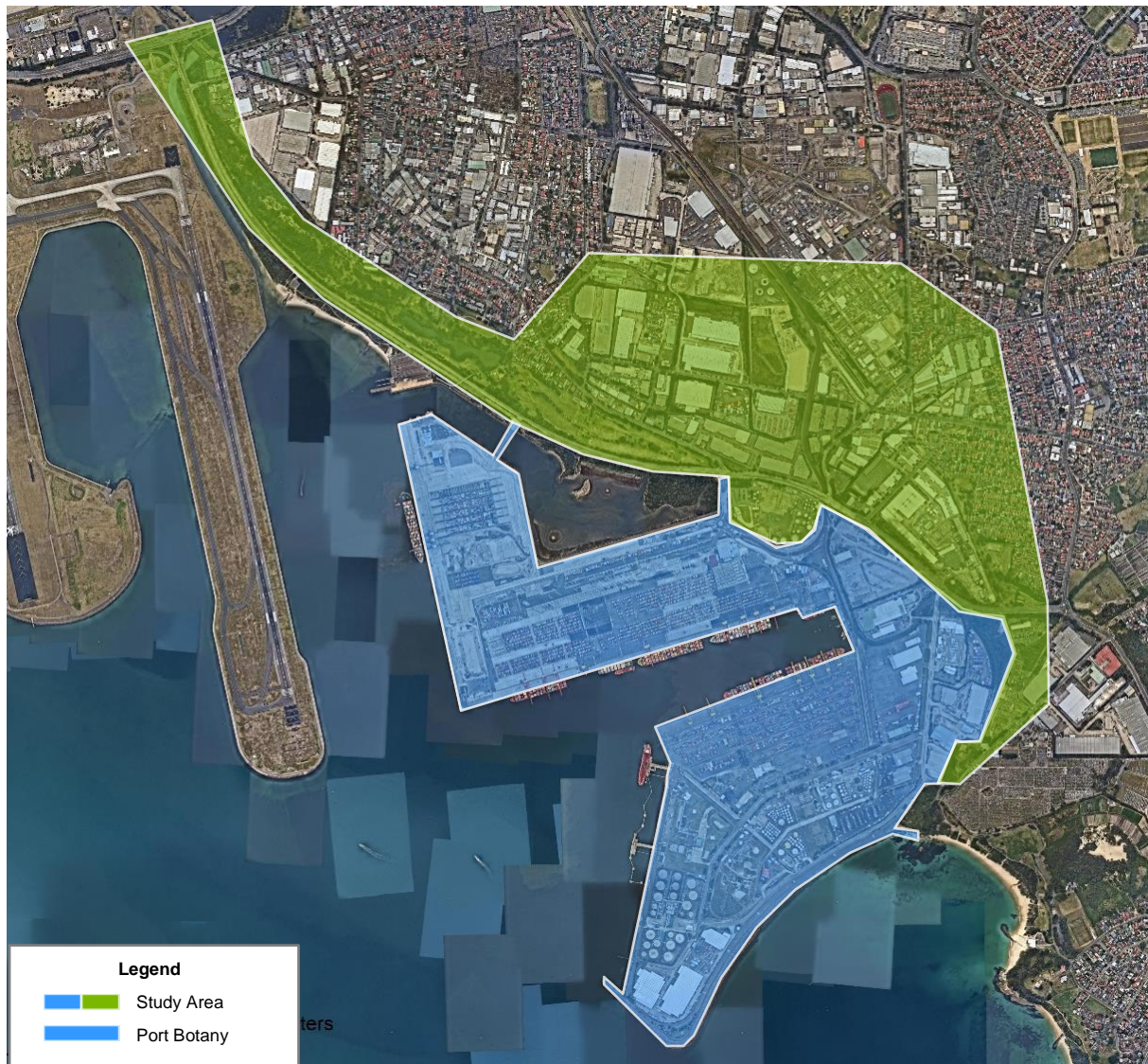
- Collect traffic volume information in the Port Precinct including:
 - Volume of light vehicles
 - Volume of bulk liquids trucks
 - Volume of non-container trucks
 - Volume of container trucks to container terminals
 - Volume of container trucks to other facilities (CFS, empty depots, etc.)
- Collect and compare port-related and non-port related traffic volumes on access roads;
- Collect traffic volume information for various bulk liquids, i.e. gas, fuels, bitumen, chemicals;
- Collect traffic volume information regarding sources of large non-cargo related traffic volumes;
- Collect directional split of traffic on key intersections, including, but not limited to:
 - Traffic volume information regarding traffic turning east onto General Holmes Drive from Foreshore Road;
 - Traffic volume information regarding traffic turning onto Foreshore Road coming from the east on General Holmes Drive;
 - Traffic volume information regarding traffic turning onto Beauchamp Road from Botany Road;
 - Traffic volume information regarding traffic turning onto Botany Road from Beauchamp Road; and

- Traffic volume information regarding traffic turning onto McCauley Street from Botany Road.

To achieve these objectives, NSW Ports, in partnership with Aurecon Australia Pty Ltd (Aurecon), has conducted a detailed and comprehensive data collection and analysis project, both within Port Botany itself, along its boundary and in the mainly industrial area to the north of Port Botany, including the Coal Pier Estate (Figure 8, the Study Area).

A combination of data collection technologies was used (refer Section 2) to get the best and longest coverage of vehicles in the Port Precinct and to achieve the above objectives.

Figure 8 - Port Botany and Study Area



2 Study Methodology

2.1 Overview

The Port Botany Freight Study has used a hybrid approach for collecting vehicle information in and around Port Botany. At four key locations, video data was collected for two separate 24-hour periods, from which a detailed vehicle classification was undertaken. At 22 on-road locations, Automatic Tube Counters (ATC) were used to count and classify traffic for two continuous weeks. At 22 terminal locations (individual sites within Port Botany), ATC counters were used to classify traffic (also collected for two continuous weeks).

This hybrid approach was adopted to allow video identification of various types of trucks and light commercial vehicles. It also allowed traditional ATC counters to provide both a longer time period (two weeks) and a comprehensive spread of counters. A video-only solution would have been prohibitively expensive and would not have been able to provide the comprehensiveness or duration achieved in this study.

The combination of counters allowed information to be gathered about the Port Precinct (covering the port as well as the industrial area immediately north of Port Botany), the port and the terminals within it. Valuable information was then extracted about the types of traffic the roads are carrying, as well as indications of which individual terminals are contributing the most to the traffic flow.

The data analysis (contained in Section 2.6) focuses on these four areas:

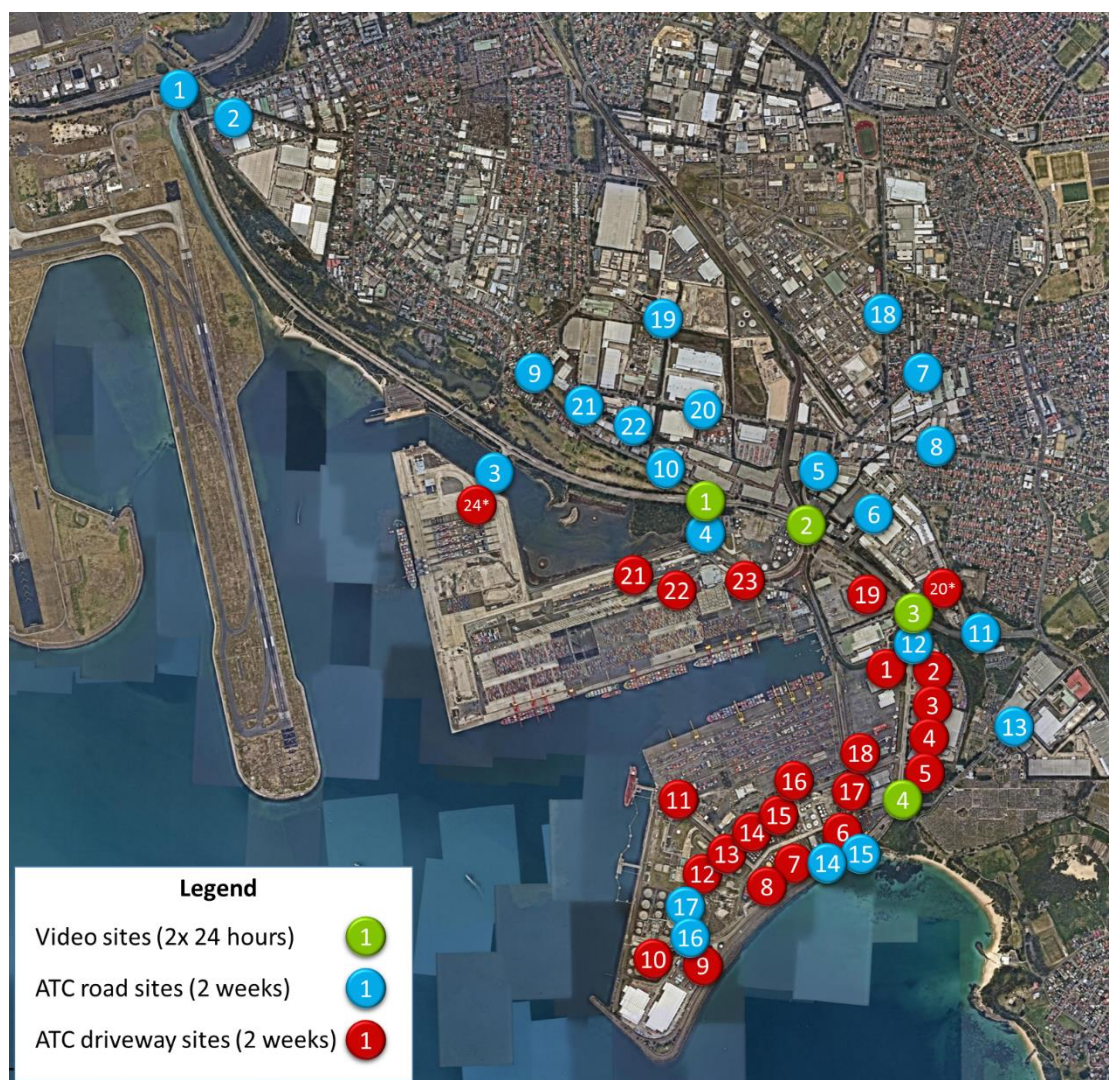
1. The Port Precinct (the whole Study Area);
2. The Port (in particular, vehicles entering or exiting the port at Sirius Road, Penrhyn Road, Bumborah Point Road and Military Road);
3. The terminals within the port; and
4. The Coal Pier Estate.

The analysis focuses on the volume of vehicles, the proportion of Heavy Commercial Vehicles (HCVs), the types of HCVs and the times of day when particular roads and terminals are the busiest.

2.2 Data Collection / Locations

As described previously, video data was collected from four main intersections bounding the port, ATC count data from 22 on-road sites and 22 terminals within the port. The locations are shown in Figure 9.

Figure 9 - Overview of count locations



The video data (green sites) was collected for two 24-hour periods (Tuesday 20 June 2017 and Thursday 29 June 2017). The technique of surveying separate days in separate weeks was undertaken to provide a more reliable count than would be given by a single day. The four sites were selected because they represent the main entry and exit points for the port, but would also be valuable in understanding the quantity and types of vehicles operating on the boundary of the port.

The four video sites are shown in Table 8, with numbering reflecting those shown in Figure 9. Information about the video capture and classification is described in Section 2.3.

Table 8 - Video count locations (collection for 2 x 24 hours)

ID	Location	Directions
1	Penrhyn Road / Foreshore Road / Botany Road intersection	8
2	Botany Road / Beauchamp Road intersection	6
3	Botany Road / Bumborah Point Road intersection	8
4	Simblist Road / Military Road / Bumborah Point Road intersection	6

The ATC road data (blue sites) was collected for two consecutive weeks (Monday 19 June 2017 through to Sunday 2 July 2017¹). A two-week data collection allows additional confidence in the data analysis compared to a single week.

The 22 ATC road locations and the number of directions are shown in Table 9, with numbering reflecting those shown in Figure 9. Information about the ATC road capture and classification scheme is described in Section 2.4.

Table 9 - ATC road counter locations (collection for two consecutive weeks)

ID	Road	Location	Directions
1	Foreshore Road	South of General Holmes Drive	4
2	Hale Street	East of Foreshore Road	2
3	Sirius Road	South of Foreshore Road	2
4	Penrhyn Road	South of Foreshore / Botany Road	2
5	Beauchamp Road	North of Botany Road	2
6	McCauley Street	North of Botany Road	1
7	Beauchamp Road	North of Denison Street	2
8	Perry Street	East of Beauchamp Road	2
9	Botany Road	South of Stephen Road	2
10	Botany Road	North of Foreshore Road	2
11	Botany Road	East of Bumborah Point Road	2
12	Bumborah Point Road	South of Botany Road	2
13	Military Road	West of Bunnerong Road	2
14	Simblist Road	South of Prince of Wales Drive	1
15	Prince of Wales Drive	East of Simblist Road	2
16	Simblist Road	South of Friendship Road	1
17	Friendship Road	North of Simblist Road	1
18	Denison Street	North of Beauchamp Road	2
19	Coal Pier Road	North of McPherson Street	2
20	McPherson Street	East of Coal Pier Road	2
21	Hill Street	North of Botany Road	1
22	Exell Street	North of Botany Road	1

In addition to ATC counters positioned on roads both within the port and in the wider precinct, individual terminals (sites within the port) were also captured. Different sites were captured on Bumborah Point Road, Simblist Road, Charlotte Road, Friendship Road, Botany Road, Penrhyn Road and Sirius Road, as shown in Table 10.

In each case, the counter was placed on the driveway capturing vehicles exiting each site. At the three sites marked with “*”, individual driveway ATCs were not installed; however, we were able to undertake analysis on each of them, based on the location of counters near the individual sites.

Information about the ATC driveway capture and classification process is described in Section 2.4.

¹ Some sites required counting beyond these dates, where the tubes were damaged during the survey period or otherwise and data was missing that would have affected the integrity of the analysis.

Table 10 - ATC Terminal locations (collection for two consecutive weeks)

ID	Terminal Description
Bumborah Point Road	
1	AST
2	Bus depot
3	ACFS / Tyne ECP
4	Trojan
5	Temporary Marshalling Area (TMA)
Simblist Road	
6	ACFS CFS
7	Terminals
8	Tyne / MT Movements
9	ACFS
10	Vopak Terminals
Charlotte Road	
11	DPW Stevedores
Friendship Road	
12	Elgas
13	Terminals
14	Origin
15	Vopak
16	DPW Stevedores
17	ACFS ECP
18	ACFS CFS
Botany Road	
19	DPW Logistics
20*	Orora
Penrhyn Road	
21	Patrick - Ramp C
22	Patrick - Ramp D
23	Patrick - CargoLink
Sirius Road	
24*	Hutchison Ports

* Sites where no physical counter was installed, but used video or ATC data to calculate.

2.3 Video Data Collection and Classification

Video classification has been a key component of the study. Understanding the make-up of vehicles operating within the port and the Port Precinct is not just about knowing the size of vehicles, but, where possible, the types of vehicles. It also gives some indication of the activity the vehicles are involved in.

The classification scheme for this project is designed around collecting detailed individual vehicle information from the video (not summarised into 15-minute slots), so that robust verification and detailed analysis can be undertaken.

The capture and classification process was undertaken by Matrix888 direct from the video. The results were then checked for completeness and accuracy by Aurecon. A single record was created for each vehicle, as defined (with examples) in Table 11. Pedestrians and vehicles that do not fit into the

general category of motor vehicles, e.g. bicycles and motorcycles, have been excluded from classification and analysis.

Table 11 - Example of vehicle classification from video







Timestamp	Vehicle Type	Austroads Class	Commercial Vehicle Type (LCV & HCV only)	Vehicle Configuration (HCV only)
20-Jun-2017 6:34	Private	1	-	-
20-Jun-2017 6:35	LCV	1	Ute	-
20-Jun-2017 6:36	HCV	10	Container Truck (laden)	B-Double

The following tables provide more information on what data produces a valid return value for each column of information. For 'vehicle type' the following definitions have been used:

Table 12 - Valid entries for 'vehicle type'

Vehicle Type	Description
Private	Any private vehicle that does not look like a commercial vehicle, e.g. sedans, hatches, wagons, SUVs, but <u>not</u> including those with business logos and/or markings, or coloured utes.
LCV	Any small vehicle that is most likely commercial in nature, i.e. sedans, hatches, wagons and SUVs with business markings; vans and utes, including coloured utes, with or without business markings. Mini-buses and taxis fit into this category.
HCV	A larger vehicle (Austroads 3-12) used to transport material, equipment, or to provide a service.

Table 13 - Valid entries for 'commercial vehicle type' (LCVs and HCVs only)

Commercial Vehicle Type	Example	Description
LCVs		
Sedan / Hatch / Wagon / SUV		A sedan, hatch, wagon or SUV with business markings.
Ute		A white or coloured ute.
Van		A white or coloured van.
Mini-bus		A small vehicle designed to carry multiple passengers, with or without business markings.
Other LCV		An LCV that does not fit into one of the categories above.
HCVs		
Container Truck (laden)		A heavy commercial vehicle, which carries one or more standardised shipping containers. This is different to a Pantech and a Tautliner.
Container Truck (unladen) / Flatbed		A heavy commercial vehicle pulling an empty trailer (often called a skel), designed to carry standardised shipping containers. Flatbed trucks are also included in this category as they are not reliably distinguishable from skel trailers.












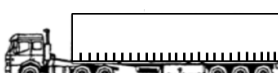


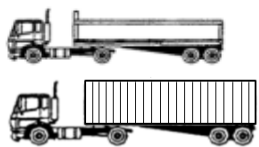


Commercial Vehicle Type	Example	Description
Pantech		A heavy commercial vehicle, usually with rear-facing doors and hard side walls. A large percentage of Pantechs are refrigerated. This is different to a Container Truck and Tautliner.
Bus		A large vehicle designed to carry multiple passengers, with or without business markings.
Cement Mixer		A heavy commercial vehicle used in the transport of cement, often to building sites.
Crane		A heavy commercial vehicle whose primary purpose is to lift equipment, such as building materials or similar heavy equipment.
Fire engine		A heavy commercial vehicle used in the transport of firefighting equipment.
Livestock		A heavy commercial vehicle used in the transport of livestock.
Prime mover		A heavy commercial vehicle, which serves as a method of moving various types of trailers.
Refuse truck		A heavy commercial vehicle used to collect and transport waste.
Service vehicle		A heavy commercial vehicle, often part Flatbed and part storage lockers.
Street sweeper		A heavy commercial vehicle designed to sweep roads.
Tanker		A heavy commercial vehicle, which carries a tank. It is designed to carry liquefied loads, dry bulk cargo or gases on roads.
Tautliner		A heavy commercial vehicle with movable side curtains made of reinforced fabric and coated with a waterproof coating.
Tow truck / Car carrier		A heavy commercial vehicle designed to carry one or more cars, including semi-trailers tasked with delivering cars to dealers.
Other HCV		An HCV that does not fit into one of the categories above.

Table 14 - Valid entries for 'vehicle configuration' (HCVs only)

Commercial Vehicle Type	Example	Description
HCVs		
Rigid		A rigid heavy commercial vehicle, determined by the size of the vehicle and the number of axles. Prime movers have been classified as rigid for the purposes of this study.
Articulated		A singly articulated heavy commercial vehicle, determined by the size of vehicle and the number of axles.
B-Double+		A doubly or triply articulated heavy commercial vehicle, determined by the size of vehicle and the number of axles.
Truck & Trailer		A rigid or articulated vehicle with a trailer. This includes road trains, A-Doubles, truck and dog, truck and pig, etc.

2.4 ATC Collection and Classification

The hardware technology used for both the road and driveway ATCs was provided by MetroCount ([link](#)). Two hollow rubber tubes are anchored across the road 1.0 metre apart and connected to a MetroCount counter. The counter receives a pulse of air from one tube and then the other, when a vehicle passes.

From the difference in time between the front axle crossing the first and then the second tube, an estimate of speed can be produced. From the number and spacing of axles (and axle groups), the vehicle can be reliably classified according to the Austroads vehicle classification scheme ([link](#)).

At the completion of the data collection period, Matrix888 uninstalled the MetroCount equipment and then downloaded the data. For each site, Aurecon has obtained vehicle-by-vehicle information (rather than summarised), a sample is shown in Table 15.

Table 15 - Example of vehicle classification from ATC counter

Timestamp	Direction	Axles	Groups	Austroads	Grouping
4-Jul-2017 13:58	NB	2	2	1	o o
4-Jul-2017 13:59	NB	2	2	3	o o
4-Jul-2017 13:59	NB	6	3	9	o oo ooo

Other information provided for each vehicle, but not used, showed speed, the wheelbase length and the headway between vehicles.

The 'grouping' column provides an illustration of the axles and groups as a visual representation of the individual vehicle. The first record above is defined as a car, the second a small truck (based on a longer wheelbase), the final record as a semi-trailer, with a prime-mover with dual rear axle and a trailer with a single group of three axles.

ATC counters provide a reliable and inexpensive method for collecting traffic related data; however, they do have their limitations. These are summarised below:

1. **Vehicles that slow or stop.** When a vehicle noticeably slows down as it crosses the tubes, or even stops while over the tubes, it means that the ATC algorithm will get confused about the type of vehicle.

Consider the third record in Table 15. If the semi-trailer stopped over the tube, then the counter will interpret the prime-mover as a small rigid truck (Austroads class 3) and the trailer as a separate vehicle that does not match any Austroads class.

2. **Vehicles approach the tube on an angle or turn on the tube.** If a vehicle approaches the tubes on an angle, or turns while over the tubes, then the ATC counter will get a pulse of air for the left front wheel, separately from the right front wheel, and so on for each axle pair. Some of this echoing can be detected by the ATC algorithm, but, nevertheless, this issue can reduce the reliability of the data.
3. **Multiple lanes.** Tubes can easily be anchored over multiple lanes, whether travelling in the same or opposite directions. However, if vehicles travelling in the same direction pass over the tubes at the same time, the pulses of air will be mixed together. This makes it difficult for the algorithm to split them reliably.

Therefore, where possible, separate ATC counters are usually installed for each lane, tethered to poles and trees at the roadside. Where this is not possible, expensive 'no count' tubes can be used. These provide a hard tube that does not record as a vehicle passes over it, so it does not count vehicles operating in a particular lane.

While 'no count' tubes would have been Aurecon's preference to use, advice from Matrix888 was that the high percentage of heavy vehicles would have meant a high chance of breakages, which would result in periods without data.

To establish the likely extent of data reliability issues for this study, Aurecon undertook a pilot study at one road site with multiple lanes and one driveway. Each pilot site was covered by a single ATC counter and a video camera. At the completion of the trial, a comparison was made between the video observations and the ATC individual vehicle results.

The pilot study showed a very reliable count of total vehicles, but some misclassification within Austroads classes, particularly at terminal exits. This outcome helped determine the best locations for the ATC counters and what validation should be undertaken in the complete study (as it would not be possible to install a single camera adjacent to each ATC counter).

2.5 Data Validation

The combined video-classified and ATC-classified data, produced a single record for each vehicle captured during the study. The data was supplied for individual vehicles to allow us to check and validate the data much more closely than would have been possible with aggregated data. The types of data validation undertaken for the project are described below:

1. **Mismatch in data fields.** Mismatches in data fields occur when an individual record contains a vehicle combination that is either not possible, or very unlikely. An example is a rigid truck showing an Austroads classification of 5-12. Here the classifier must have misinterpreted the Austroads classification, the truck type or the vehicle classification.

Having identified a mismatched record, Aurecon reviewed the video footage, identified the individual vehicle and updated the classification. The most common issues identified were: trucks and trailers classified as Austroads 3 and 4 that should have been Austroads 6 and 7; Austroads class 3 to 5 classified as articulated vehicles, but should have been rigid vehicles; and Austroads class 6 to 12 classified as rigid, but should have been articulated. Overall, the number of corrections undertaken was small (approximately 0.5%).

2. **Fire engines.** From the video data, the number of fire engines was a lot higher than expected by NSW Ports. A review of the video for each individual vehicle, showed that many of these

were incorrectly classified and these were corrected by Aurecon. In each case, the vehicle was indeed red, but usually another type of truck.

3. **Vehicle stops.** As described previously, vehicles slowing or stopping over the ATC tubes can result in misclassification. Matrix888 and MetroCount were able to update their algorithm to reduce the occurrence of this, but it was not possible to eliminate it. Aurecon post-processed all of the ATC data, checked for individual records that were most likely broken over two records, then re-joined them where it was appropriate to do so.
4. **Equipment failure / start and end times.** During the study, several of the ATC tubes were damaged and had to be re-installed. This resulted in some days with missing data. In addition, some counters collected data for part days only; either collecting before midnight on the first day, or after midnight on the last. To ensure the data is as reliable as possible, Aurecon checked every single dataset for days with incomplete information and removed data that would have biased the resulting analysis.

In all, 1,066,403 records of video data and 2,074,451 records of ATC data were collected for the study, representing a total of 3,140,854 vehicles observed and classified for the project. This is a significant dataset, which provides an incredible depth of results for NSW Ports.

2.6 Data Analysis

With such a large dataset, including records from different sources and formats, Aurecon developed custom verification and analysis software that would allow datasets to be filtered, counted and analysed in any number of ways.

The analysis package was written in Microsoft Excel using VBA. This would read in the verified, cleaned and corrected individual vehicle data for one or more sites and summarise it according to individual analysis requirements. Validation was undertaken for each analysis to ensure that all vehicles were appropriately accounted for.

Except as described below, each analysis undertaken was independently calculated, which allowed a further level of validation to ensure that the totals for individual sites were consistent. If there were inconsistencies, further checks were undertaken.

An exception to this separate calculation of results was caused by the need, in some cases, to combine the different technologies of data collection together. For the ATC data, for example, it is possible to distinguish cars (Austroads 1-2), Small HCVs (Austroads 3-5) and Large HCVs (Austroads 6-12); however, it is not possible to distinguish between private cars and light commercial vehicles (LCVs), because an ATC records them as the same type of vehicle. The video data, however, is able to distinguish between the two and, therefore, we were able to estimate the percentage of LCVs in different parts of the Port Precinct.

The main outputs produced by the analysis tool developed for this project were: tabulated vehicle counts, charts visually showing quantities or profiles, as well as intersection counts and maps. Intersection counts combine both tabulated and visual outputs to give the user a better understanding of the analysis (compared to a simple table by itself).

Maps have also been produced with drawn links, to show the whole Port Precinct (and Coal Pier Estate), which has been possible because of the extensive data collection undertaken for this project.

3 Results

This section contains the analysis results for the Port Botany Freight Study, based on the collection of individual vehicle data, using video from four sites and ATC data from 22 road and 22 terminal locations. The results are presented firstly at the highest level, the Port Precinct (Section 3.1); then drilling down further to lower levels: the Port (vehicles entering and exiting the port via Sirius Road, Penrhyn Road, Bumborah Point Road and Military Road, Section 3.2); at the individual terminal level (Section 3.3); and finally for Coal Pier Estate (Section 3.4).

3.1 Port Precinct Traffic

3.1.1 Overall Precinct

The Port Precinct covers the Port (immediately south of Foreshore and Botany Roads) and the industrial area to the north (including Coal Pier Estate). Figure 10 shows a visual representation of traffic operating in the precinct, with thicker lines representing more traffic.

Figure 10 - Average weekday total vehicles (with road labels)



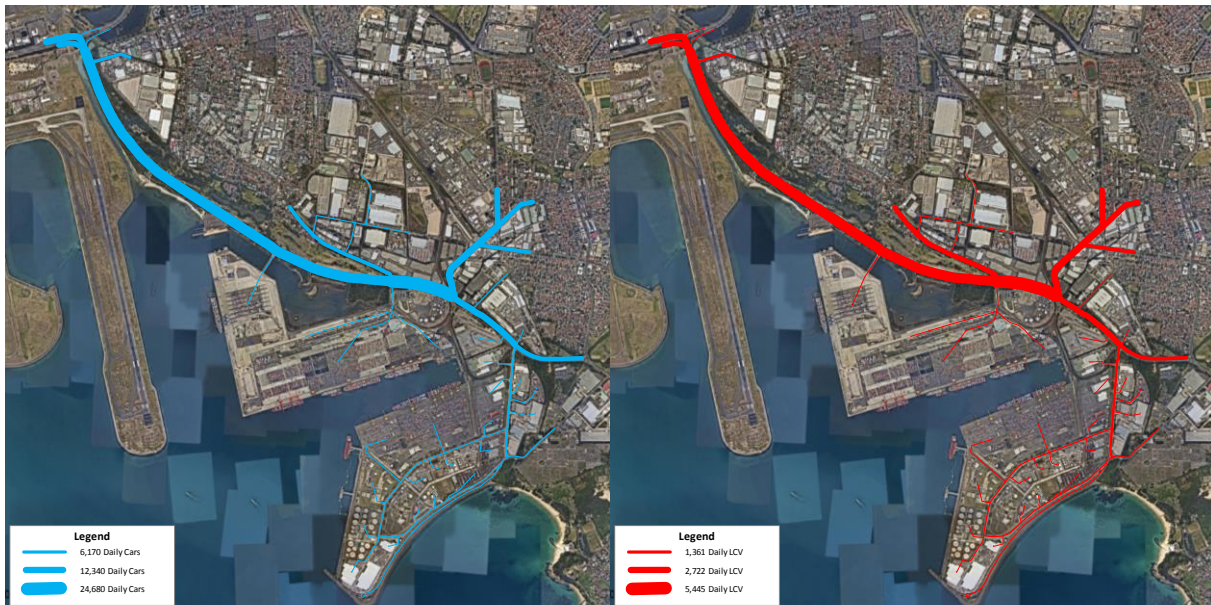
Other than at the western end of Foreshore Road, Botany Road (between Foreshore Road and Beauchamp Road) carries the most traffic in the Port Precinct on an average weekday, most of which comes from Foreshore Road itself. Traffic on Foreshore Road is predominantly to and from General Holmes Drive to the west.

Further east, Beauchamp and Bumborah Point Roads both take a considerable amount of traffic from Botany Road. In relative terms, Military Road, Simblist Road and Friendship Road carry much smaller overall volumes of traffic.

The circles show the relative traffic contribution of individual sites, with DPW (off Friendship Road), and Patrick Ramp D (off Penrhyn Road) the two largest contributors. More detail about individual terminals will be described in Section 3.3.

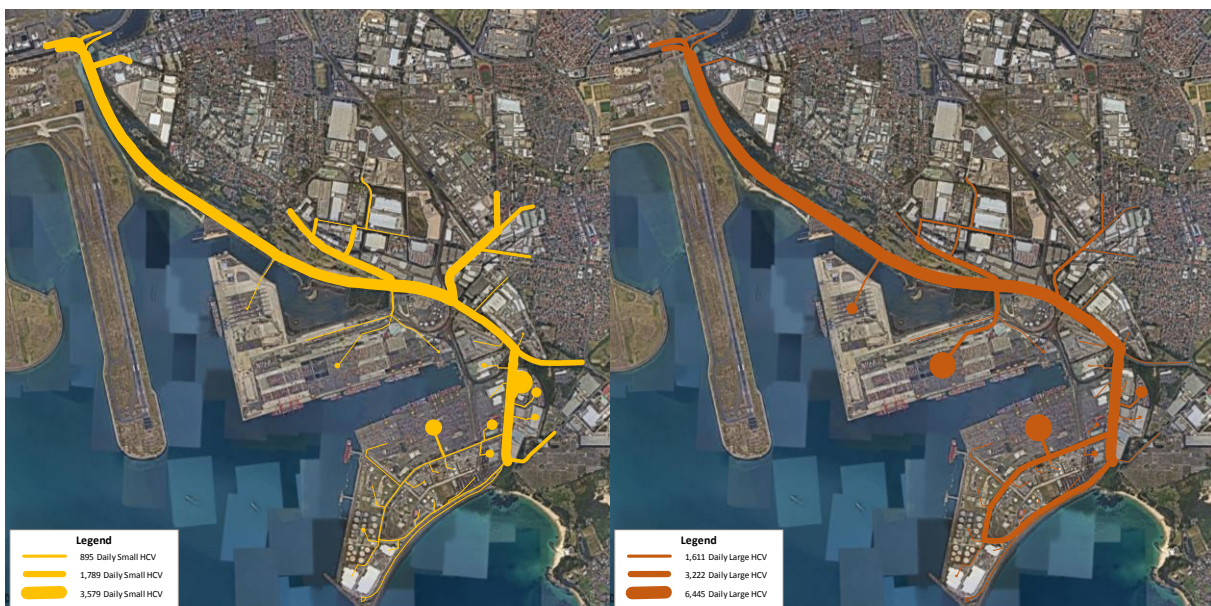
Figures 11 and 12 show a breakdown of the traffic in the precinct by vehicle class.

Figure 11 - Average weekday Cars and LCVs



For cars and LCVs, the traffic distribution closely follows that of 'all vehicles' as shown in Figure 10, with Foreshore and Botany Roads taking the majority of traffic through the precinct.

Figure 12 - Average weekday Small HCVs and Large HCVs



For Small HCVs, there is a very even use of Foreshore Road, Botany Road, Beauchamp Road and Bumborah Point Road. There are relatively lower traffic flows on Military Road, Simblist Road and Friendship Road.

For Large HCVs, the core corridor is from Foreshore, Botany, Bumborah Point, Simblist and then Friendship Road (with much higher use of the terminals). The most easterly section of Botany Road and Beauchamp Road carry very few vehicles of this class.

Table 16 shows the average weekday traffic by road and type of vehicle. The different technology of each count is also shown for comparison purposes.

Table 16 - Average weekday traffic

Location	Detail	Direction	Car	LCV	Small HCV	Large HCV	Total
Beauchamp (ATC)	North of Botany	NB	6,944	1,665	1,565	790	10,963
		SB	6,024	1,444	1,066	914	9,448
		Total	12,967	3,109	2,631	1,704	20,411
Beauchamp (Video)	North of Botany	NB	7,615	1,855	1,106	645	11,220
		SB	6,850	1,613	959	718	10,139
		Total	14,465	3,468	2,064	1,362	21,359
Beauchamp (ATC)	North of Denison	NB	5,207	1,248	615	36	7,106
		SB	5,060	1,213	683	87	7,043
		Total	10,267	2,461	1,298	123	14,149
Botany (ATC)	South of Stephen	NB	3,418	1,018	927	134	5,497
		SB	3,857	1,149	1,088	247	6,341
		Total	7,275	2,167	2,015	381	11,838
Botany (ATC)	North of Penrhyn	NB	3,378	1,006	1,131	1,368	6,883
		SB	3,608	1,074	1,257	1,397	7,337
		Total	6,986	2,080	2,388	2,765	14,220
Botany (Video)	North of Penrhyn	NB	3,822	1,105	920	1,365	7,212
		SB	4,066	1,244	1,053	1,374	7,737
		Total	7,888	2,349	1,973	2,739	14,949
Botany (Video)	East of Penrhyn	EB	12,640	2,757	1,766	3,126	20,288
		WB	11,947	2,529	1,625	3,068	19,169
		Total	24,587	5,285	3,391	6,194	39,457
Botany (Video)	West of Beauchamp	EB	12,387	2,828	1,763	3,116	20,094
		WB	11,827	2,511	1,608	3,079	19,024
		Total	24,214	5,339	3,371	6,194	39,118
Botany (Video)	East of Beauchamp	EB	5,811	1,310	1,191	3,081	11,392
		WB	6,016	1,235	1,182	2,971	11,404
		Total	11,827	2,545	2,373	6,052	22,796
Botany (Video)	West of Bumborah	EB	5,795	1,271	1,171	3,060	11,296
		WB	5,702	1,155	1,093	2,853	10,802
		Total	11,497	2,425	2,264	5,913	22,098
Botany (ATC)	East of Bumborah	EB	4,102	776	831	177	5,885
		WB	3,967	751	814	119	5,651
		Total	8,069	1,527	1,645	296	11,536
Botany (Video)	East of Bumborah	EB	4,122	778	689	165	5,753
		WB	3,809	723	771	77	5,379
		Total	7,931	1,501	1,459	241	11,131
Bumborah (ATC)	South of Botany	NB	1,894	564	1,333	2,756	6,547
		SB	1,689	503	1,350	2,692	6,233
		Total	3,583	1,067	2,683	5,447	12,780
Bumborah (Video)	South of Botany	NB	2,171	507	1,055	2,911	6,643
		SB	1,923	547	1,139	2,917	6,525
		Total	4,094	1,054	2,194	5,828	13,168
Charlotte (ATC)	West of Friendship	EB	12	2	8	31	53
		WB	14	2	33	20	69
		Total	26	4	41	51	122
Coal Pier (ATC)	North of McPherson	NB	274	82	219	511	1,085
		SB	229	68	243	491	1,032
		Total	503	150	462	1,002	2,117
Denison (ATC)	North of Beauchamp	NB	5,454	1,308	1,015	466	8,243
		SB	5,111	1,225	796	499	7,631
		Total	10,566	2,533	1,811	965	15,874

Location	Detail	Direction	Car	LCV	Small HCV	Large HCV	Total
Exell (ATC)	North of Botany	SB	1,334	397	728	1,593	4,053
		Total	1,334	397	728	1,593	4,053
Foreshore (ATC)	Left into GHD	EB	11,523	2,420	2,177	2,749	18,869
	Right into GHD	NB	1,063	223	931	811	3,028
		Total	12,586	2,643	3,108	3,560	21,897
Foreshore (ATC)	North of Hale	NB	12,586	2,643	3,108	3,560	21,897
		SB	14,723	3,092	2,741	3,636	24,191
		Total	27,309	5,734	5,849	7,196	46,088
Foreshore (Video)	West of Penrhyn	EB	11,253	2,367	1,536	3,698	18,854
		WB	10,820	2,269	1,538	3,683	18,310
		Total	22,073	4,635	3,074	7,381	37,164
Friendship (ATC)	North of Simblist	NB	1,245	220	505	3,117	5,088
		Total	1,245	220	505	3,117	5,088
General Holmes (ATC)	Left into Foreshore	SB	1,193	250	687	927	3,057
	Right into Foreshore	SB	13,530	2,841	2,054	2,710	21,135
		Total	14,723	3,092	2,741	3,636	24,191
Hale (ATC)	East of Foreshore	EB	3,486	732	904	474	5,596
		WB	2,172	456	855	637	4,120
		Total	5,658	1,188	1,759	1,111	9,716
Hill (ATC)	North of Botany	NB	1,416	422	663	1,587	4,087
		Total	1,416	422	663	1,587	4,087
McCauley (ATC)	North of Botany	NB	648	168	168	80	1,064
		Total	648	168	168	80	1,064
McPherson (ATC)	East of Coal Pier	EB	606	181	103	425	1,315
		WB	574	171	101	401	1,246
		Total	1,180	351	204	825	2,561
Military (ATC)	West of Bunnerong	NB	907	194	362	94	1,557
		SB	980	210	321	86	1,598
		Total	1,887	405	683	180	3,154
Military (Video)	East of Bumborah	NB	469	107	336	223	1,133
		SB	709	146	286	227	1,367
		Total	1,177	253	621	449	2,500
Penrhyn (ATC)	South of Foreshore	NB	601	155	201	1,274	2,231
		SB	541	140	247	1,259	2,188
		Total	1,142	295	448	2,533	4,418
Penrhyn (Video)	South of Foreshore	NB	658	164	105	1,425	2,351
		SB	642	173	96	1,391	2,301
		Total	1,300	336	201	2,815	4,652
Perry (ATC)	East of Beauchamp	EB	3,567	855	387	45	4,855
		WB	3,233	775	466	132	4,605
		Total	6,800	1,630	853	177	9,460
Prince of Wales (ATC)	South of Simblist	EB	202	-	23	2	227
		WB	189	-	24	2	215
		Total	391	-	48	3	442
Simblist (ATC)	South of Prince of Wales	WB	1,267	223	464	3,107	5,061
		Total	1,267	223	464	3,107	5,061
Sirius (ATC)	South of Foreshore	NB	182	38	62	439	721
		SB	171	36	60	452	719
		Total	354	74	122	891	1,441

Several sites were collected using both video and ATC, which allows a comparison of the different technologies (shaded rows in the above table). In each case, counts from the video were 3-5% higher than from ATC, with the exception of Botany Road east of Bumborah Point Road, which was 4% lower.

The consistency in results provides confidence that the data was reliably collected and is representative of traffic during the study period. The small difference in counts can be at least partially attributed to the fact that the video was collected for two single days (one Tuesday and one Thursday), while the ATC was collected for two full weeks.

3.1.2 Traffic Imbalances

As Table 16 contains traffic counts for each direction for all two-way sites, it is possible to determine the level of imbalance between the two directions and consequently infer whether drivers select one route for one direction of their trip and another for the return journey. The top five sites with significant differences are described below:

1. **Hale Street, east of Foreshore Road (ATC)** was used 36% more in the eastbound direction than in the westbound.
2. **Military Road, east of Bumborah (video) and west of Bunnerong (ATC)** was used 22% more in the southbound direction than in the northbound direction.
3. **Beauchamp Road, north of Botany Road (ATC)** was used 16% more in the northbound direction than in the southbound.
4. **Botany Road, south of Stephen Road (ATC)** was used 15% more in the southbound direction than in the northbound.
5. **Foreshore Road, north of Hale Street (ATC)** was used 10% more in the southbound direction than in the northbound.

With the exception of Military Road, the common theme suggests that a higher proportion of traffic enters the precinct using Foreshore and Botany Road from the west than in the opposing direction (a large proportion of that traffic then using Beauchamp Road).

Given the road layout within the area, this traffic is likely heading north (via Beauchamp Road, Bunnerong Road and possibly Anzac Parade) on the return journey. Anecdotally, heavy traffic and the associated congestion on Foreshore Road in the afternoon is the likely reason that vehicles avoid the corridor for the return journey.

3.1.3 Historical Traffic Counts

Aurecon has sourced historical data from RMS ([link](#)) in the precinct. Three counters were found:

1. Permanent counter: Foreshore Road, west of Sirius Road, year 2008 only (ID 16088);
2. Sample counter: Botany Road, west of Beauchamp Road, year 2009 only (ID 16013); and
3. Sample counter: Botany Road, east of Beauchamp Road, year 2009 only (ID 16012).

While the data is 8-9 years old, it may provide an illustration of growth or change in traffic over this period. Table 17 shows a comparison with the closest site(s) collected for this study for Foreshore Road.

Table 17 - Foreshore Road historical average weekday traffic

Location	Technology	Year	Direction	Cars	LCV	Small HCV	Large HCV	Total
1. South of Hale	Permanent counter	2008	NB	n/a	n/a	n/a	n/a	11,793
			SB	n/a	n/a	n/a	n/a	14,033
			Total	n/a	n/a	n/a	n/a	25,826
2. North of Hale	ATC	2017	NB	12,586	2,643	3,108	3,560	21,897
			SB	14,723	3,092	2,741	3,636	24,191
			Total	27,309	5,734	5,849	7,196	46,088
3. West of Penrhyn	Video	2017	WB	10,820	2,269	1,538	3,683	18,310
			EB	11,253	2,367	1,536	3,698	18,854
			Total	22,073	4,635	3,074	7,381	37,164

Foreshore Road is a difficult site to compare as the historical counter's location is different to this study. Vehicles have the opportunity to get off Foreshore Road at Hale Street if coming from, or going to, General Holmes Drive, or to get off Foreshore Road at Sirius Road if coming from, or going to, the intersection of Foreshore, Botany and Penrhyn Roads (Figure 13).

From the 2017 data, we observe that the two-way traffic has an average weekday traffic of 46,088 at the northern end and 37,164 at the southern end (near Penrhyn Road). On the mid-section, where a permanent counter used to be located, traffic has grown from 25,826 to at least 37,164 vehicles per day (a 44% increase in traffic).

Figure 13 - Foreshore Road survey locations (refer numbering in Table 17)

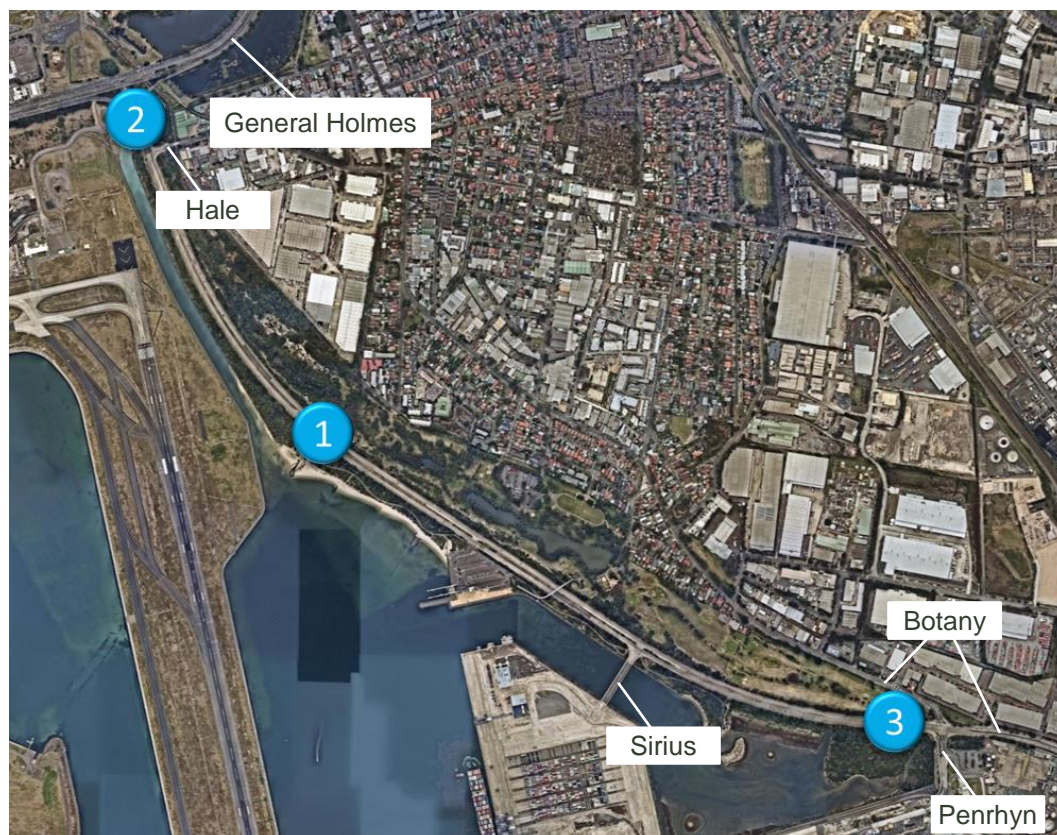


Table 18 and Table 19 compare sections of Botany Road immediately west and east of Beauchamp Road.

Table 18 - Botany Road historical average weekday traffic (west of Beauchamp Road)

Technology	Year	Direction	Cars	LCV	Small HCV	Large HCV	Total
Sample counter	2009	EB	n/a	n/a	n/a	n/a	22,023
		WB	n/a	n/a	n/a	n/a	25,577
		Total	n/a	n/a	n/a	n/a	47,600
Video	2017	EB	12,387	2,828	1,763	3,116	20,094
		WB	11,827	2,511	1,608	3,079	19,024
		Total	24,214	5,339	3,371	6,194	39,118

Table 19 - Botany Road historical average weekday traffic (east of Beauchamp Road)

Technology	Year	Direction	Cars	LCV	Small HCV	Large HCV	Total
Sample counter	2009	EB	n/a	n/a	n/a	n/a	16,099
		WB	n/a	n/a	n/a	n/a	15,764
		Total	n/a	n/a	n/a	n/a	31,863
Video	2017	EB	5,811	1,310	1,191	3,081	11,392
		WB	6,016	1,235	1,182	2,971	11,404
		Total	11,827	2,545	2,373	6,052	22,796

From the available data, traffic on Botany Road (west of Beauchamp Road) has decreased by 18% from 2009 to 2017, the majority of this in the westbound direction. For the section of Botany Road east of Beauchamp, traffic has decreased by 28% over the same period.

In conclusion, from the available data and assuming the reliability and representativeness of the data is fit for comparison, Foreshore Road has increased significantly in terms of total traffic from 2008 to 2017, while Botany Road near Beauchamp has significantly decreased in traffic over effectively the same period.

The scarcity of historical data underlines the importance of this study in providing both a snapshot of existing traffic through the precinct, but equally as important is its role in establishing a benchmark to allow future studies to understand how this traffic is changing over time.

3.1.4 Traffic Comparison

Foreshore Road (north of Hale Street) and Botany Road (between Penrhyn and Beauchamp Roads) are the busiest sections of road within the precinct, with 46,088 vehicles (2 lanes each direction) and 39,118 vehicles (3 lanes each direction) per weekday respectively.

At the total vehicle level, this is not high, as other counters in the southeast of Sydney have higher volumes, i.e. Wentworth Avenue (ID 16129) 49,670 vehicles per weekday and Marsh Street (ID 23067) 57,089 vehicles per weekday, both sites with two lanes in each direction.

However, the Port Precinct cannot be directly compared to other sites as there is a much higher proportion of trucks in the area. Considering the high proportion of trucks, Foreshore Road and Botany Road carry 73,526 PCU² (2 lanes each direction) and 61,430 PCU (3 lanes each direction).

At the busiest times of day, this equates to 1,491 PCU per lane, per hour, from 7:00 AM to 9:00 AM southbound on Foreshore and 1,213 PCU per lane, per hour, from 2:00 PM to 3:00 PM northbound on Foreshore. Given the additional lane on Botany Road, traffic never exceeds 800 PCU per lane, per hour.

According to Austroads Guide to Traffic Management (Volume 3, Table 4.4, page 41), the level of service of a multilane arterial will start to breakdown at 1,120 PCU per lane, per hour. Therefore the high volume of traffic at the northern end of Foreshore Road is likely to produce this issue at certain times of day (even though it is only a short section of road).

Breakdown of traffic flows and congestion can also occur at intersections within the precinct. This is most likely the cause of lower northbound volumes on Foreshore Road where it joins General Holmes Drive. It could also be an issue with certain turning movements along Botany Road, given the high proportion of trucks entering the port. We recommend that further modelling and analysis be undertaken along the Foreshore / Botany Road corridor, to ensure that sustainable growth in port activity can be met by the road network in the precinct.

3.1.5 Intersections

Along the main Foreshore-Botany corridor in the precinct, there are a number of main intersections that either lead into the port, or into the industrial area immediately to the north. This section contains a more detailed view along this main corridor, as well as to the east where Military Road enters the port.

Foreshore Road / General Holmes Drive Intersection

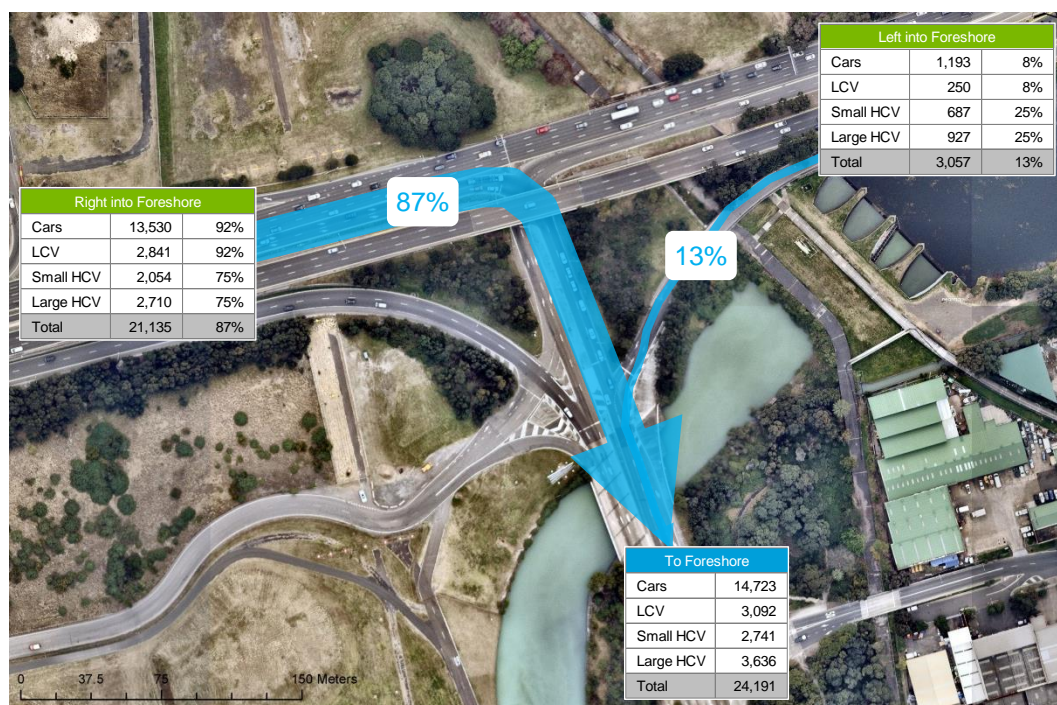
To the west of the study area, we have the grade-separated intersection of Foreshore Road and General Holmes Drive, which, as shown previously, is the intersection that carries most of the traffic to and from the precinct. Average weekday traffic for this intersection is shown in Table 20, and Figures 14 and 16.

² PCU = passenger car units, assuming Small HCV = 2.0 PCU and Large HCV = 4.0 PCU (RMS).

Table 20 - Average weekday traffic (Foreshore / General Holmes Drive Intersection)

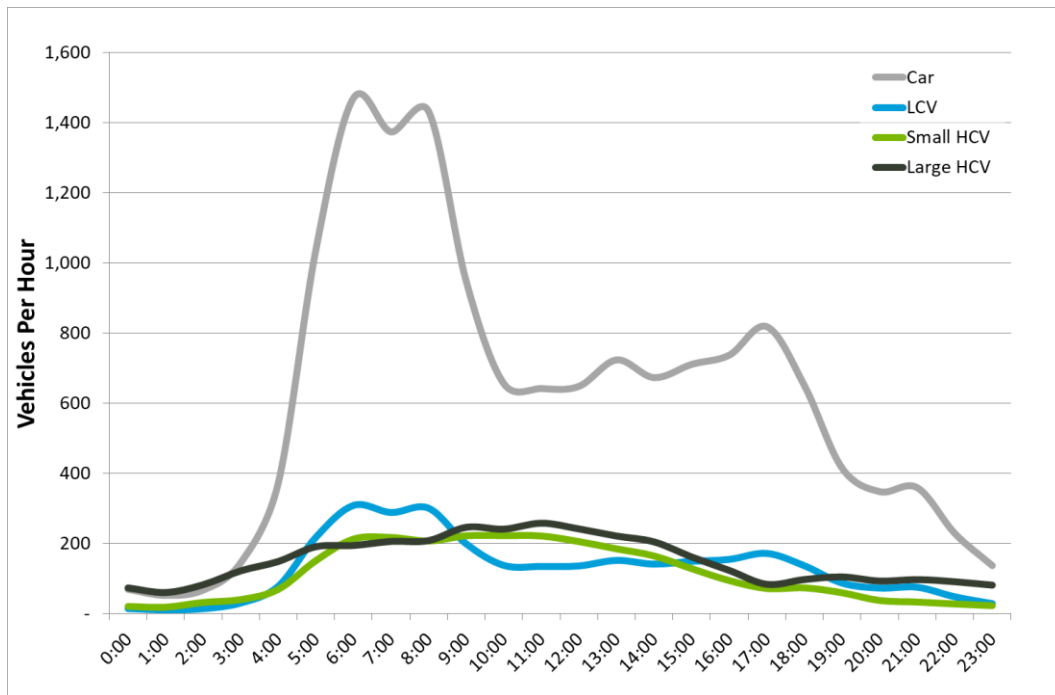
From	Direction	Car	LCV	Small HCV	Large HCV	Total
General Holmes	Left into Foreshore	1,193	250	687	927	3,057
	Right into Foreshore	13,530	2,841	2,054	2,710	21,135
	Total	14,723	3,092	2,741	3,636	24,191
Foreshore	Left into General Holmes	11,523	2,420	2,177	2,749	18,869
	Right into General Holmes	1,063	223	931	811	3,028
	Total	12,586	2,643	3,108	3,560	21,897

Figure 14 - General Holmes Drive / Foreshore Road Intersection (from General Holmes Drive)



For vehicles entering the precinct via General Holmes Drive, the majority come from the west (87%), with a much greater proportion of trucks coming from the east (25%).

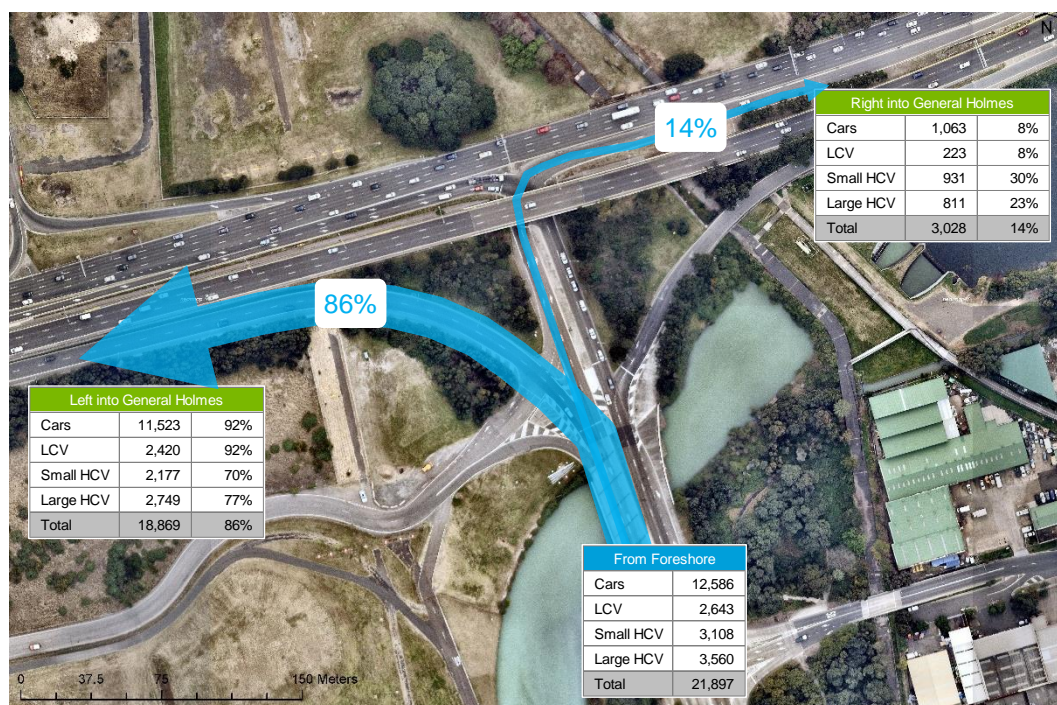
Figure 15 - General Holmes Drive / Foreshore Road Time of Day (from General Holmes Drive)



As shown, for car and LCV traffic entering the Port Precinct via Foreshore Road, there is a peak of 1,400 vehicles per hour between 5:00 AM and 9:00 AM, and a much smaller peak of 800 vehicles per hour between 5:00 PM and 6:00 PM. Both Small and Large HCV volumes are much more even through the day, with numbers peaking between 10:00 AM and 12:00 PM.

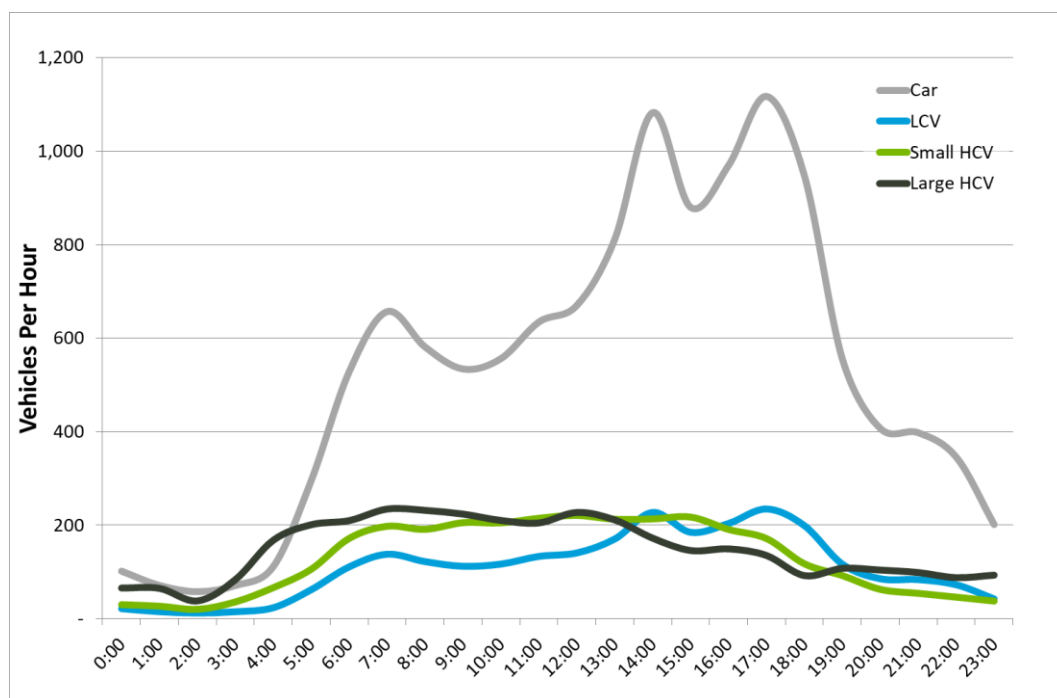
Small HCVs decrease to minimal numbers overnight and early morning; however, Large HCVs maintain approximately 100 vehicles per hour after 5:00 PM.

Figure 16 - General Holmes Drive / Foreshore Road Intersection (from Foreshore Road)



As shown, approximately 86% of traffic leaving the precinct goes west; however, the percentage of trucks travelling east is much higher (23-30%).

Figure 17 - General Holmes Drive / Foreshore Road Time of Day (from Foreshore Road)



For vehicles exiting the Port Precinct via Foreshore Road, cars and LCVs show a large peak of 1,000+ vehicles per hour in the mid to late afternoon between 2:00 PM and 6:00 PM, and a small peak in the morning between 7:00 AM and 8:00 AM. For both Small and Large HCVs, traffic volumes are steady from 4:00 AM through to 4:00 PM, before decreasing overnight.

In conclusion, most traffic entering and leaving Foreshore Road is either coming from or heading west; however, a greater proportion of trucks, compared to cars, either come from or head east. The time of

day profiles demonstrate the 24-hour operation of the trucks, with a long peak from 4:00 AM through to 4:00 PM on weekdays.

Car and LCV traffic mostly enters the precinct in the morning between 5:00 AM and 9:00 AM and exits between 2:00 PM and 6:00 PM. By comparing afternoon peaks in the time of day profiles from the intersection of Botany Road and Bumborah Point Road (refer page 31), we estimate that up to 30% of car traffic goes through the precinct without stopping.

Foreshore Road / Botany Road Intersection

The next main intersection along Foreshore Road is at the junction between Foreshore Road, Botany Road and Penrhyn Road. Table 21 and Figures 18 to 22 show the average weekday traffic captured during the study.

Table 21 - Average weekday traffic (Foreshore Road / Botany Road Intersection)

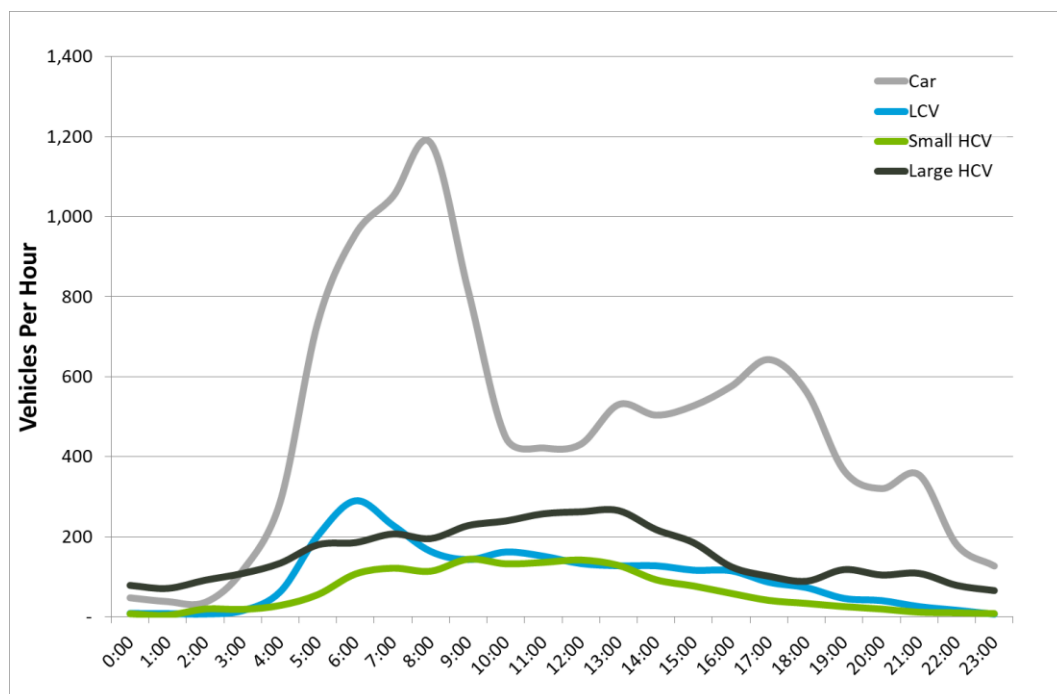
From	Direction	Car	LCV	Small HCV	Large HCV	Total
Penrhyn	Left into Foreshore	349	79	52	824	1,304
	Straight into Botany	142	47	24	210	422
	Right into Botany	165	38	29	391	623
	Total	655	163	105	1,425	2,348
Botany	Left into Penrhyn	170	70	38	437	714
	Straight into Foreshore	9,420	1,844	1,094	2,178	14,536
	Right into Botany	2,311	606	494	454	3,864
	Total	11,901	2,519	1,625	3,068	19,113
Botany	Left into Botany	2,897	863	636	472	4,867
	Straight into Penrhyn	134	37	25	222	417
	Right into Foreshore	1,013	338	392	681	2,424
	Total	4,043	1,237	1,053	1,374	7,707
Foreshore	Left into Botany	1,351	448	403	702	2,903
	Straight into Botany	9,525	1,845	1,101	2,264	14,734
	Right into Penrhyn	335	66	33	733	1,166
	Total	11,211	2,358	1,536	3,698	18,802

Figure 18 - Foreshore / Botany Intersection (from Foreshore Road eastbound)



From Foreshore Road, the majority of traffic goes straight ahead onto Botany Road (78%), with only a small number of vehicles turning right into the port at Penrhyn Road. For small HCVs, 26% turn left into Botany Road and for Large HCVs, 20% turn right into Penrhyn Road.

Figure 19 - Foreshore / Botany Time of Day (from Foreshore Road eastbound)

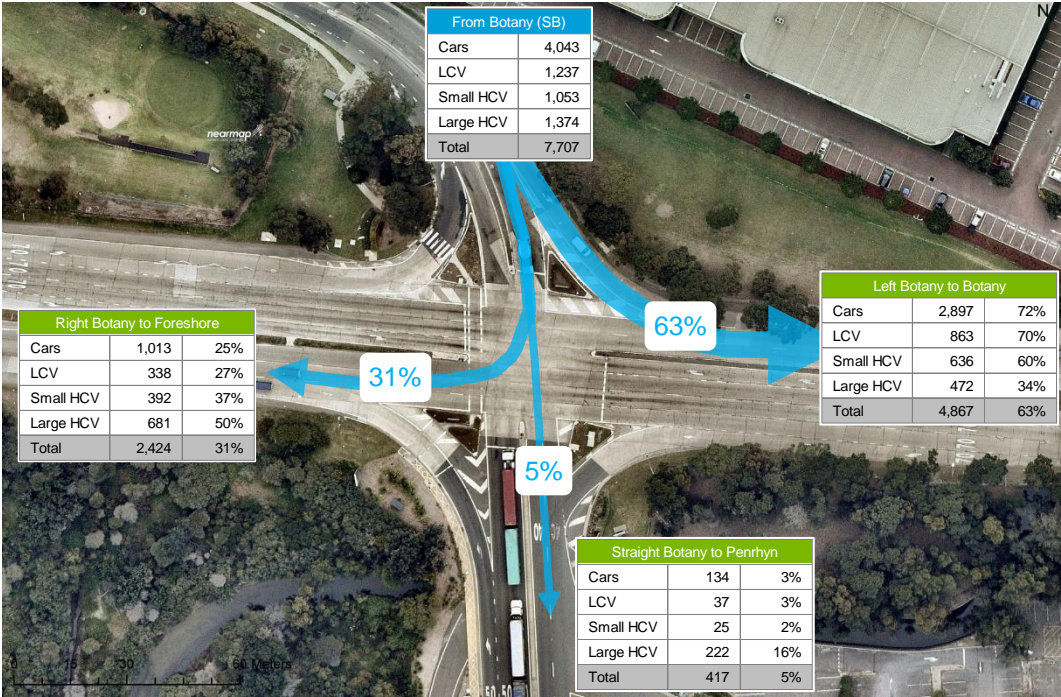


For cars, the eastbound direction peaks at approximately 1,200 vehicles per hour between 8:00 AM and 9:00 AM; lower than the 1,400 vehicles per hour entering the western end of Foreshore Road in the peak. This reduction, along with the reduction in the 5:00 AM peak, implies significant car traffic getting off Foreshore Road between these two intersections.

Across the whole day, an estimated 5,400 vehicles exit Foreshore Road either at Hale Street (at the western end of Foreshore Road) or at Sirius Road (Hutchinson Ports). From traffic counts undertaken

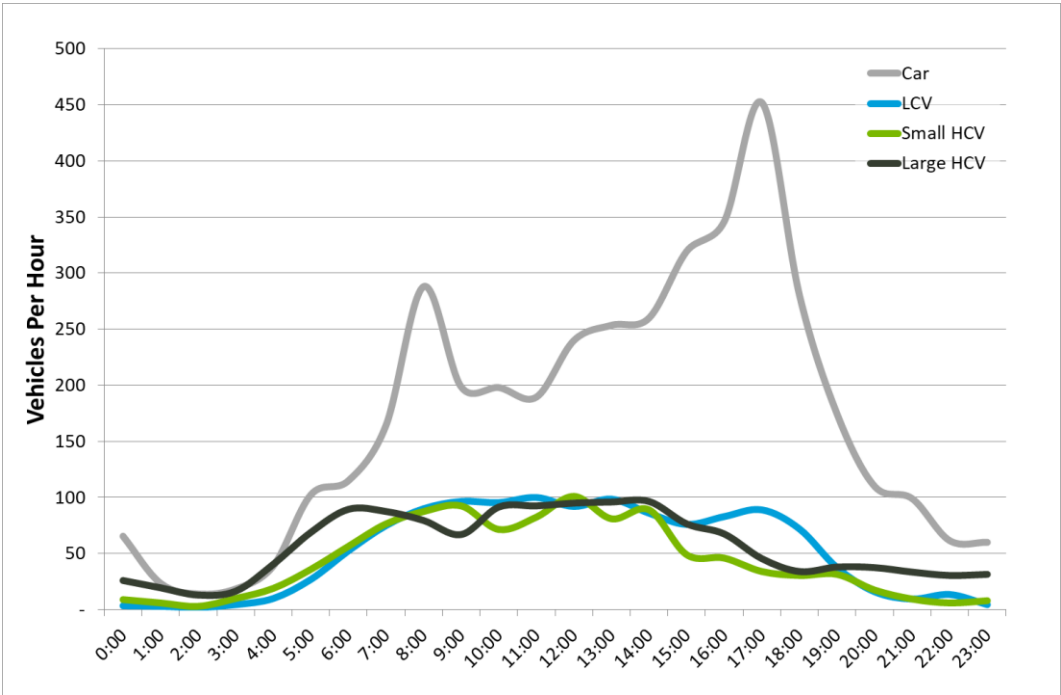
for the study at these two locations, Hale Street would be used mostly by cars, while Sirius Road would have a much higher proportion of trucks.

Figure 20 - Foreshore / Botany Intersection (from Botany Road southbound)



From Botany Road travelling south, 5% of vehicles go straight ahead into Penrhyn Road (most of these are Large HCVs). Of the remainder, approximately two-thirds turn left onto Botany Road and one-third turn right onto Foreshore Road. For Large HCVs, 50% turn right onto Foreshore Road, with a smaller percentage staying on Botany Road.

Figure 21 - Foreshore / Botany Time of Day (from Botany Road southbound)



For southbound car traffic on Botany Road, there is a peak in the afternoon between 5:00 PM and 6:00 PM and a smaller peak in the morning between 8:00 AM and 9:00 AM. The majority of the cars in

the PM-peak are turning left onto Botany Road, implying that those working in the industrial precinct north of Botany Road use Botany Road (eastbound) to travel home to the east. They are less likely to use Foreshore Road to head home in the west, preferring Hale Street or continuing up Botany Road to Southern Cross Drive, to exit the precinct.

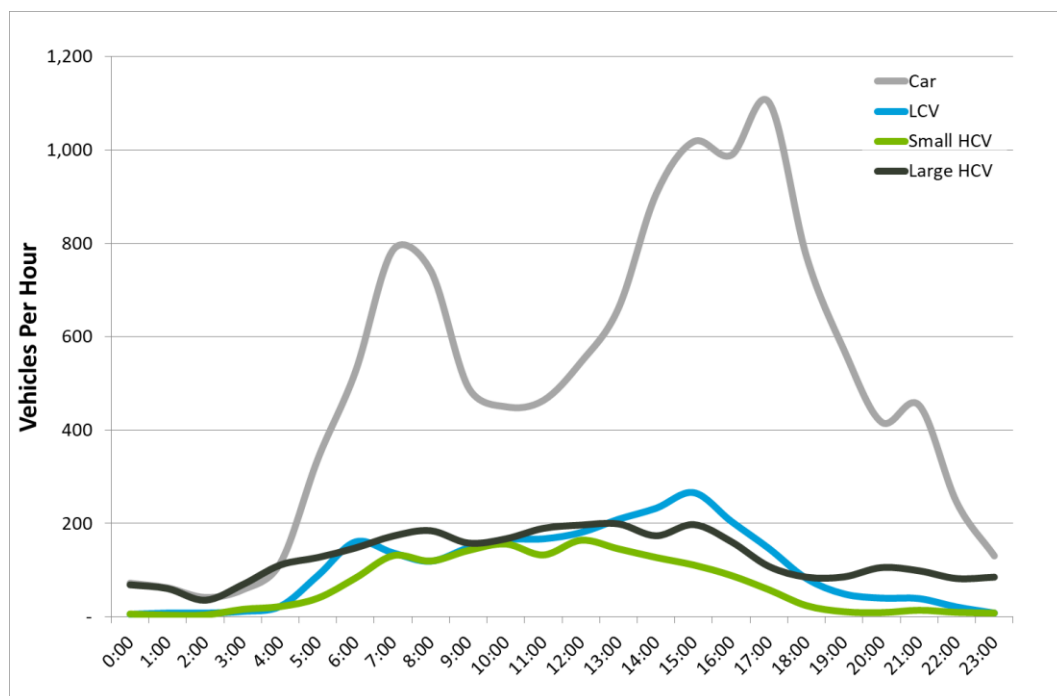
Given the balanced numbers of vehicles entering and leaving the precinct using Foreshore Road, car traffic to and from the industrial area to the north of Port Botany is more likely to be using Hale Street, rather than entering the precinct using Foreshore Road and then exiting via another route.

Figure 22 - Foreshore / Botany Intersection (from Botany Road westbound)



For vehicles travelling west on Botany Road, 76% go straight ahead onto Foreshore Road, 20% turn right into Botany Road and the remaining 4% turn left into Penrhyn Road. Again, Penrhyn Road has a higher proportion of Large HCVs, but relatively low numbers overall.

Figure 23 - Foreshore / Botany Time of Day (from Botany Road westbound)



For westbound traffic, there is both an AM-peak and a PM-peak. Higher volumes were observed in the PM-peak, complementary with higher AM-peak traffic in the eastbound direction (i.e. private vehicles commuting to and from work). A similar observation can be made for LCVs.

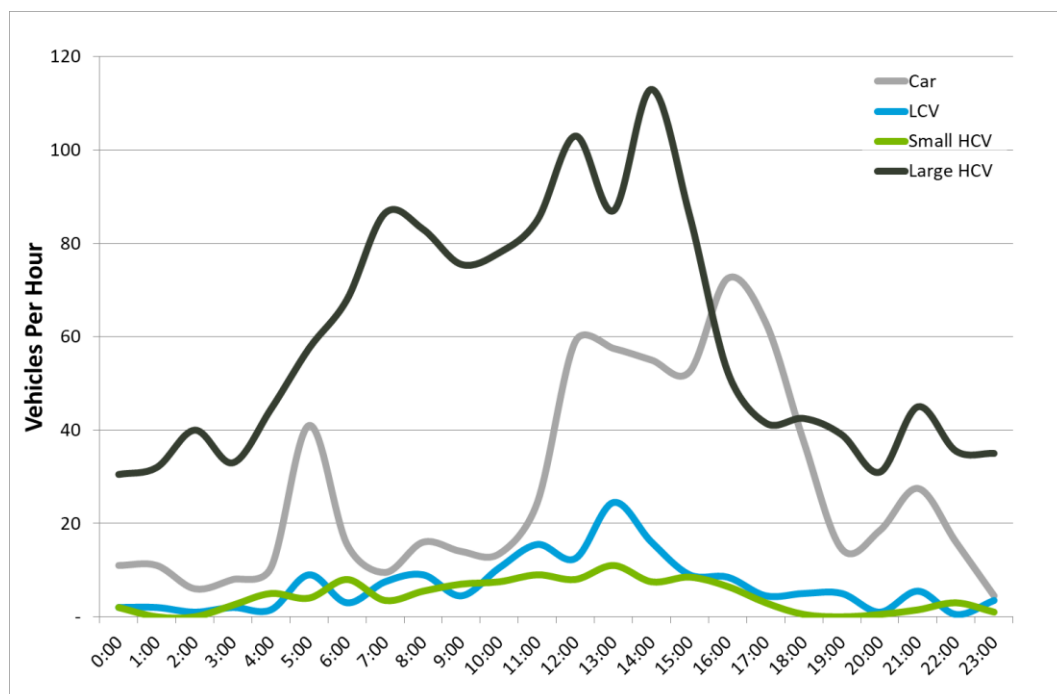
Unlike cars and LCVs, Small and Large HCVs do not show increased numbers of vehicles in the AM- or PM-peak periods, with relatively consistent traffic across the day, but smaller numbers of vehicles overnight (particularly for Small HCVs).

Figure 24 - Foreshore / Botany Intersection (from Penrhyn Road northbound)



From Penrhyn Road, the majority of the traffic (56%) turns left into Foreshore Road, 27% turn right into Botany Road and the remaining 18% travels straight ahead. Unlike Foreshore Road and General Holmes Drive, the percentage is relatively consistent between the different vehicle types.

Figure 25 - Foreshore / Botany Time of Day (from Penrhyn Road northbound)



For vehicles exiting the port via Penrhyn Road, we observed a much smaller proportion of cars and a much higher proportion of Large HCVs. For the cars, there is a small peak of traffic between 5:00 AM and 6:00 AM, coinciding with the end of shift for workers at the Patrick terminals, then a much larger exit in the afternoon from 12:00 PM through to 6:00 PM.

For Large HCVs, there is a consistent level of 30-40 vehicles exiting per hour from 4:00 PM to 4:00 AM, then a steady increase over the next few hours, with the bulk of the movements occurring

between 7:00 AM and 3:00 PM, peaking at 100 to 115 vehicles per hour between 12:00 PM and 2:00 PM.

In conclusion, this intersection is dominated (60-70%) by east-west traffic travelling from Foreshore Road to Botany Road and vice-versa, with 20-25% accessing the industrial area (and residential section) to the north; only about 5% of vehicles use Penrhyn Road. Not unexpectedly, the latter includes a high proportion of Large HCVs.

The time of day profiles show a high proportion of the eastbound private vehicle traffic occurring in the AM-peak and westbound in the PM-peak, indicating that a high proportion of commuter traffic uses the Foreshore Road to enter and leave the area.

Botany Road / Beauchamp Road Intersection

Travelling further east, Botany Road enters the next main intersection with Beauchamp Road, which is initially relatively industrial. It then travels to the residential areas of Matraville and Hillsdale. Table 22 and Figures 26 to 28 show the traffic for this 3-way intersection.

Table 22 - Average weekday traffic (Botany Road / Beauchamp Road Intersection)

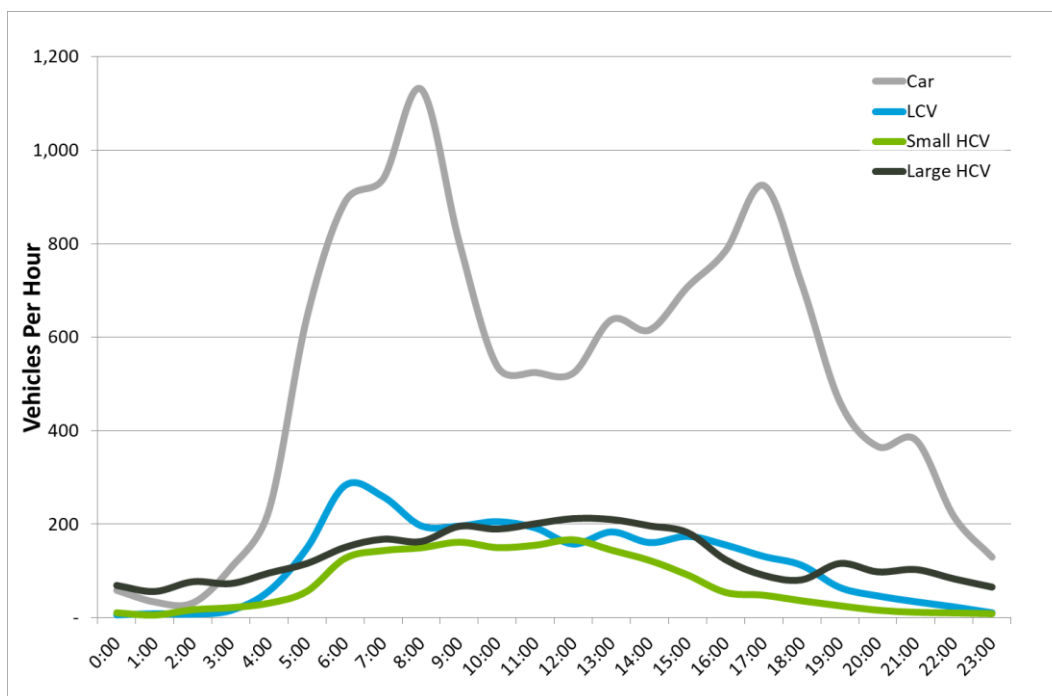
From	Direction	Car	LCV	Small HCV	Large HCV	Total
Botany (EB)	Straight into Botany	5,269	1,132	929	2,761	10,091
	Left into Beauchamp	7,118	1,696	835	355	10,003
	Total	12,387	2,828	1,763	3,116	20,094
Botany (WB)	Straight into Botany	5,519	1,076	911	2,681	10,187
	Right into Beauchamp	497	159	271	290	1,217
	Total	6,016	1,235	1,182	2,971	11,404
Beauchamp	Left into Botany	542	178	262	320	1,302
	Right into Botany	6,308	1,435	697	398	8,837
	Total	6,850	1,613	959	718	10,138

Figure 26 - Botany Road / Beauchamp Road Intersection (from Botany Road eastbound)



From the west, there is an even 50:50 split between the number of vehicles turning left into Beauchamp Road and those continuing straight on Botany Road. But for Large HCVs, nearly 90% continue straight on.

Figure 27 - Botany Road / Beauchamp Road Time of Day (from Botany Road eastbound)



For car traffic entering this intersection from the west, there is a peak in the morning between 8:00 AM and 9:00 AM, and a smaller peak in the afternoon between 5:00 PM and 6:00 PM. The smaller afternoon peak is a combination of vehicles travelling from Foreshore Road and those using Botany Road (from the industrial estate).

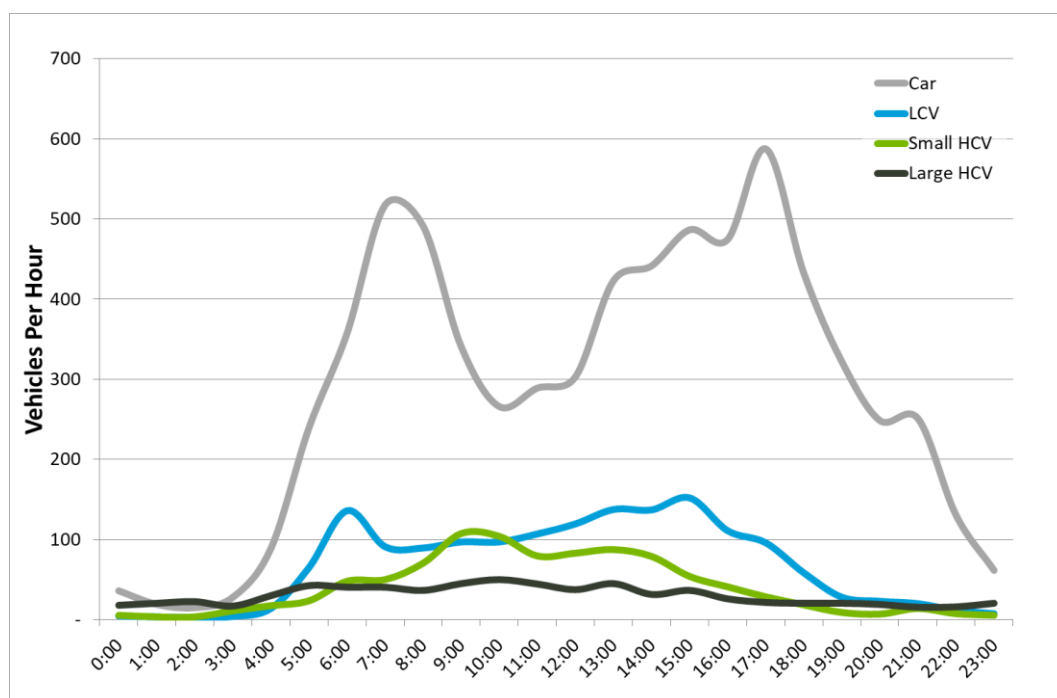
As expected, Small and Large HCVs follow similar profiles to those for the previous intersection (Foreshore / Botany / Penrhyn Roads).

Figure 28 - Botany Road / Beauchamp Road Intersection (from Beauchamp Road southbound)



From Beauchamp Road, 87% of the vehicles turn right into Botany Road; however, a high proportion of Small HCVs and, particularly, Large HCVs turn left, most likely to enter the port via Bumborah Point Road.

Figure 29 - Botany Road / Beauchamp Road Time of Day (from Beauchamp Road southbound)



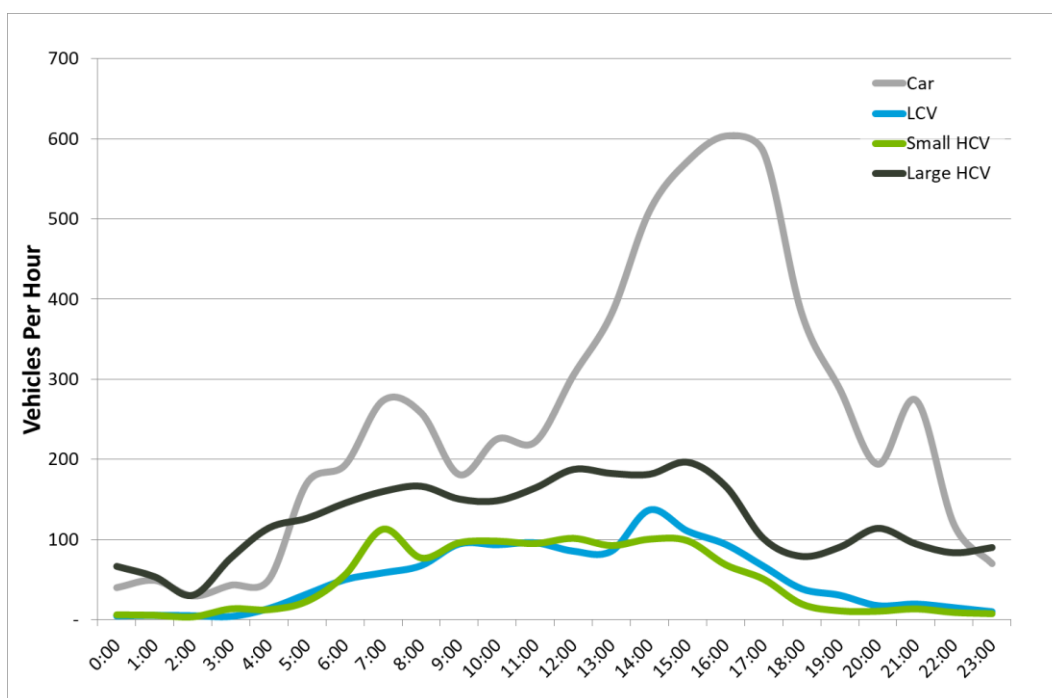
For vehicles entering Botany Road from Beauchamp Road, we observe for cars and LCVs a morning peak at 7:00 AM and an afternoon peak at 5:00 PM. From Beauchamp Road, there are relatively small numbers of Small and Large HCVs, with a Small HCV peak from 9:00 AM to 11:00 AM, with very little overnight traffic. This road is not heavily used by Large HCVs; however, the profile is fairly even across the day and night.

Figure 30 - Botany Road / Beauchamp Road Intersection (from Botany Road westbound)



From the east, the majority of vehicles continue straight along Botany Road; however, it is noticeable that a higher proportion of Small HCVs turn right onto Beauchamp Road, compared to the other vehicle types.

Figure 31 - Botany Road / Beauchamp Road Time of Day (from Botany Road westbound)



For traffic travelling westbound through this intersection, there is a fairly broad afternoon peak for cars (commuters) between 3:00 PM and 6:00 PM, and smaller peaks in the morning from 7:00 AM to 9:00 AM and the evening from 9:00 PM to 10:00 PM.

In conclusion, traffic to the east of this intersection is approximately half that to the west, so Beauchamp Road is a major contributor to traffic in the precinct; and this traffic is dominated by cars. There are, however, large numbers of both Small and Large HCVs remaining on Botany Road to the east of this intersection.

Analysis of the time of day profiles has shown that for Botany Road (eastbound) and Beauchamp Road, both have high peaks in the morning and afternoon, but Botany Road (westbound) only has an afternoon peak.

Truck profiles along the corridor exhibit very little in the way of peaks. Small HCVs make up relatively small numbers of vehicles and mainly operate from 6:00 AM to 6:00 PM. Large HCVs traffic is busiest between 6:00 AM and 6:00 PM, but with consistent numbers operating through the night (more than cars in most cases).

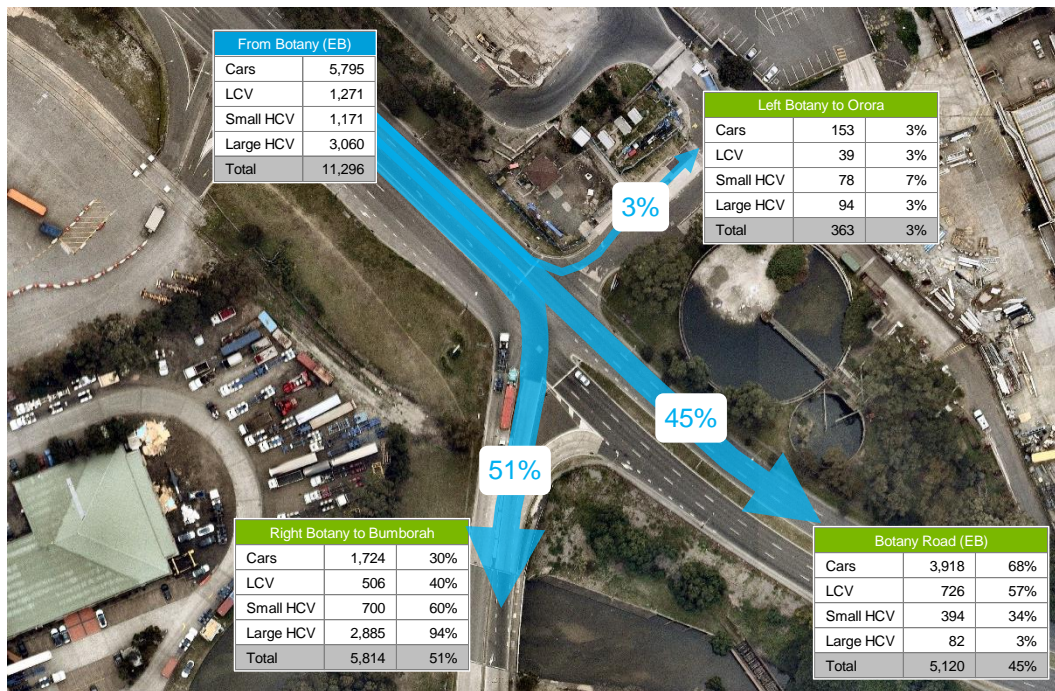
Botany Road / Bumborah Point Road Intersection

The next main intersection on Botany Road is with Bumborah Point Road. Bumborah Point Road has multiple terminals itself, but is also the gateway to the other port terminals on Simblist and Friendship Roads. Table 23 and Figures 32 to 38 show the observed weekday traffic entering this intersection.

Table 23 - Average weekday traffic (Botany Road / Bumborah Point Road Intersection)

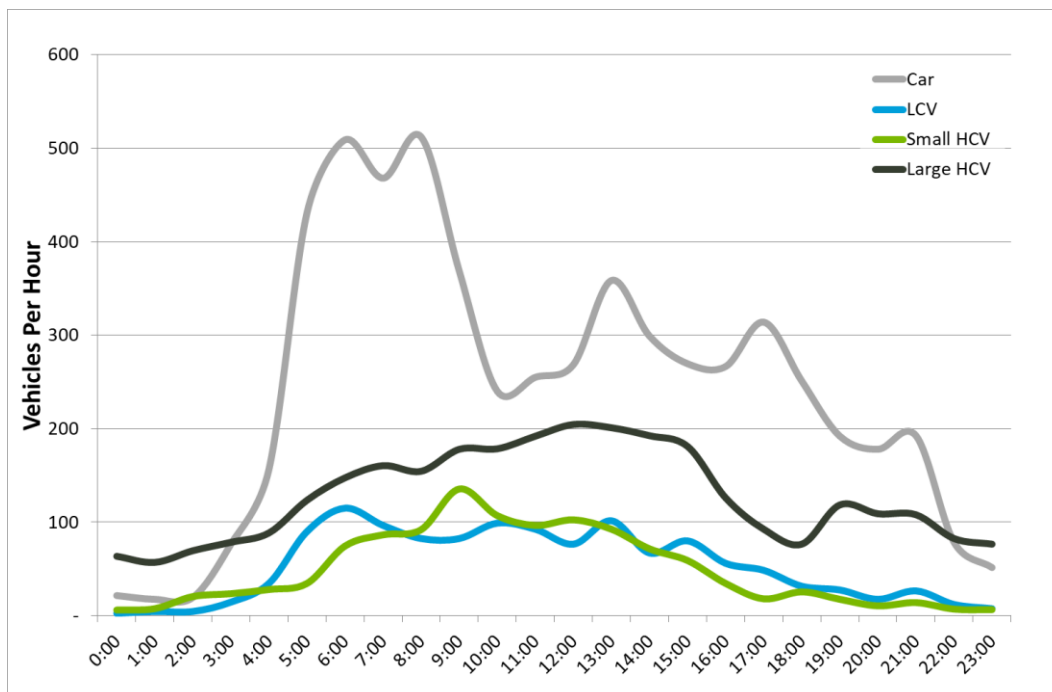
From	Direction	Car	LCV	Small HCV	Large HCV	Total
Botany (EB)	Left into Orora	153	39	78	94	363
	Straight into Botany	3,918	726	394	82	5,120
	Right into Bumborah	1,724	506	700	2,885	5,814
	Total	5,795	1,271	1,171	3,060	11,296
Bumborah	Left into Botany	1,999	461	758	2,807	6,024
	Straight into Orora	10	1	5	22	38
	Right into Botany	162	46	292	83	582
	Total	2,171	507	1,055	2,911	6,643
Botany (WB)	Left into Bumborah	198	41	439	32	709
	Straight into Botany	3,609	682	332	45	4,668
	Right into Orora	2	1	-	1	3
	Total	3,809	723	771	77	5,379
Orora	Left into Botany	42	6	3	1	51
	Straight into Bumborah	2	-	1	-	3
	Right into Botany	94	12	4	2	111
	Total	138	18	7	2	165

Figure 32 - Botany / Bumborah Intersection (from Botany Road eastbound)



Of the traffic travelling east through this intersection, 51% turns right into the port at Bumborah Point Road, 45% continues on Botany Road and the remaining 3% turns left into the Orora site. The right turning traffic is dominated by 3,500 HCVs, most of which are Large HCVs, while the traffic that continues on Botany Road is predominantly cars.

Figure 33 - Botany / Bumborah Time of Day (from Botany Road eastbound)



For cars and LCVs travelling east on Botany Road, there is an obvious morning peak between 6:00 AM and 8:00 AM, and noticeable mini-peaks at 1:00 PM, 5:00 PM and 9:00 PM. Unlike the Botany Road / Beauchamp Road intersection, there is not a major afternoon peak for the eastbound direction, suggesting most commuters have left Botany Road by the time they get to the Bumborah Point Road intersection.

As per other intersections on Botany Road, there is no obvious morning or afternoon peak for Small or Large HCVs. For Small HCVs there is a steady increase in volumes between midnight and 10:00 AM, and a decrease in volumes after 10:00 AM, while for Large HCVs, there is a steady increase in volumes between midnight and midday, and a decrease in volumes thereafter.

Figure 34 - Botany / Bumborah Intersection (from Orora)

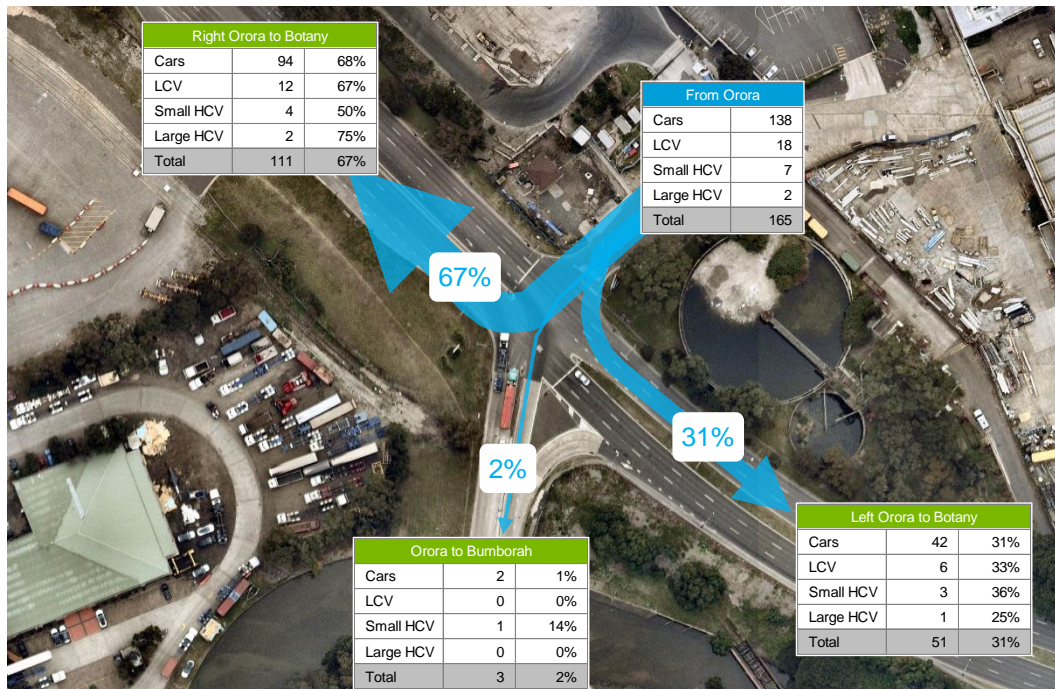
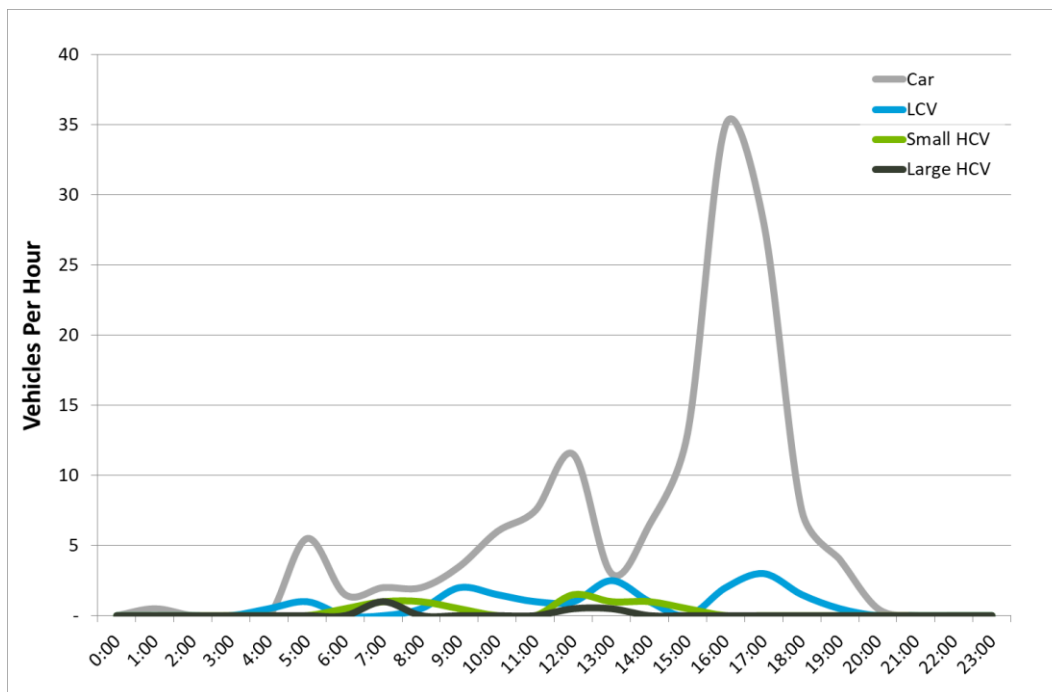


Figure 35 - Botany / Bumborah Time of Day (from Orora)

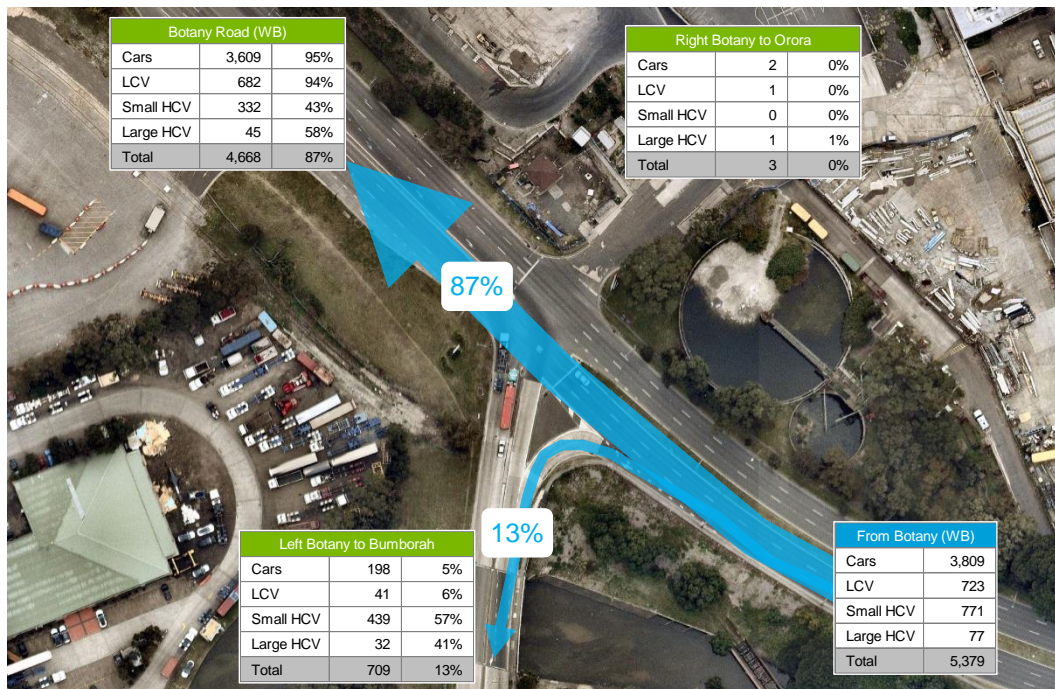


From the Orora site, approximately two-thirds of vehicles turn right onto Botany Road, while the remaining one-third turn left.

For cars leaving the Orora site, there is small morning peak, a small lunch peak and a large but short afternoon peak between 4:00 PM and 6:00 PM, consistent with a commuter type workforce. Numbers,

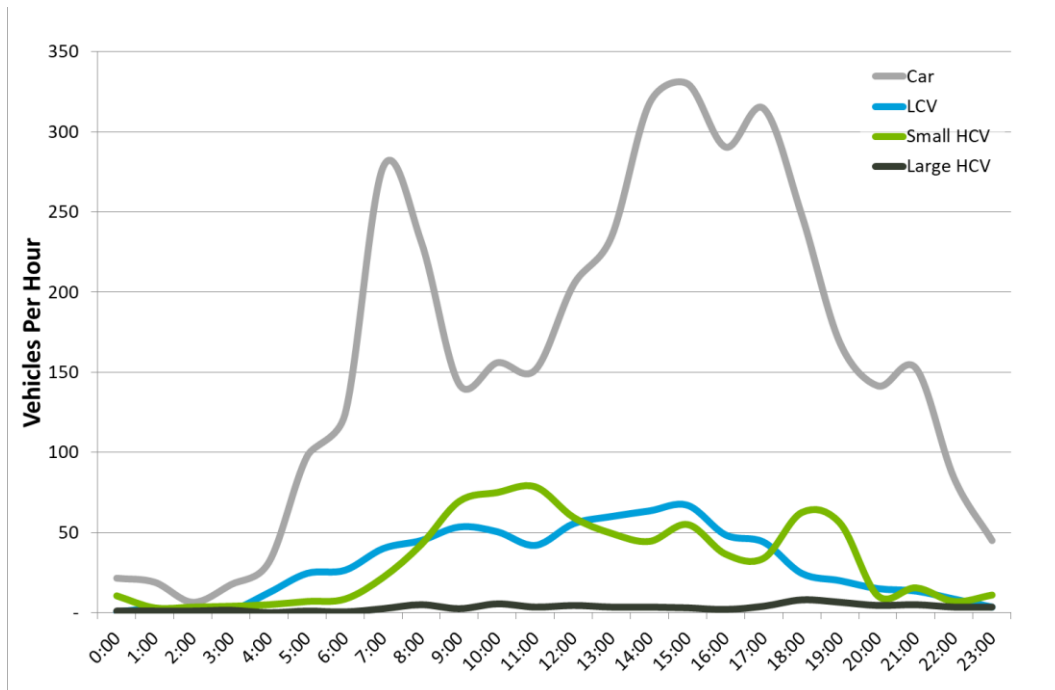
however, are very small compared to the other directions at this intersection. Truck numbers are very small also, with most trucks observed between 7:00 AM and 4:00 PM.

Figure 36 - Botany / Bumborah Intersection (from Botany Road westbound)



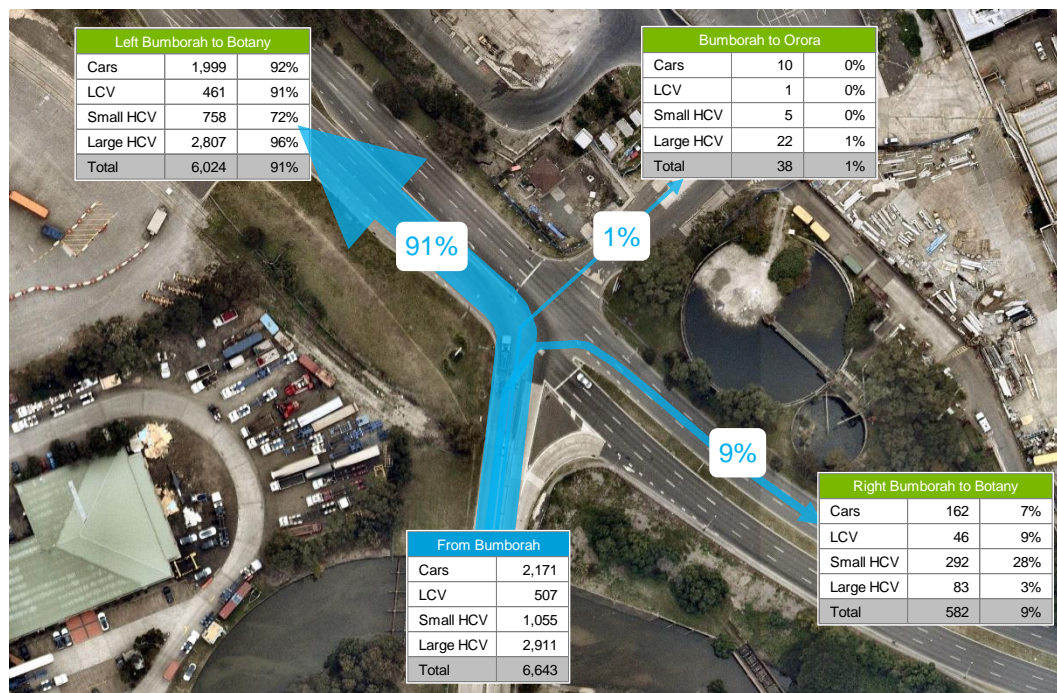
From Botany Road travelling west, the majority of cars and LCVs (95%) continue straight on, with about half the trucks continuing straight on and the remaining half turning left into the port at Bumborah Point Road.

Figure 37 - Botany / Bumborah Time of Day (from Botany Road westbound)



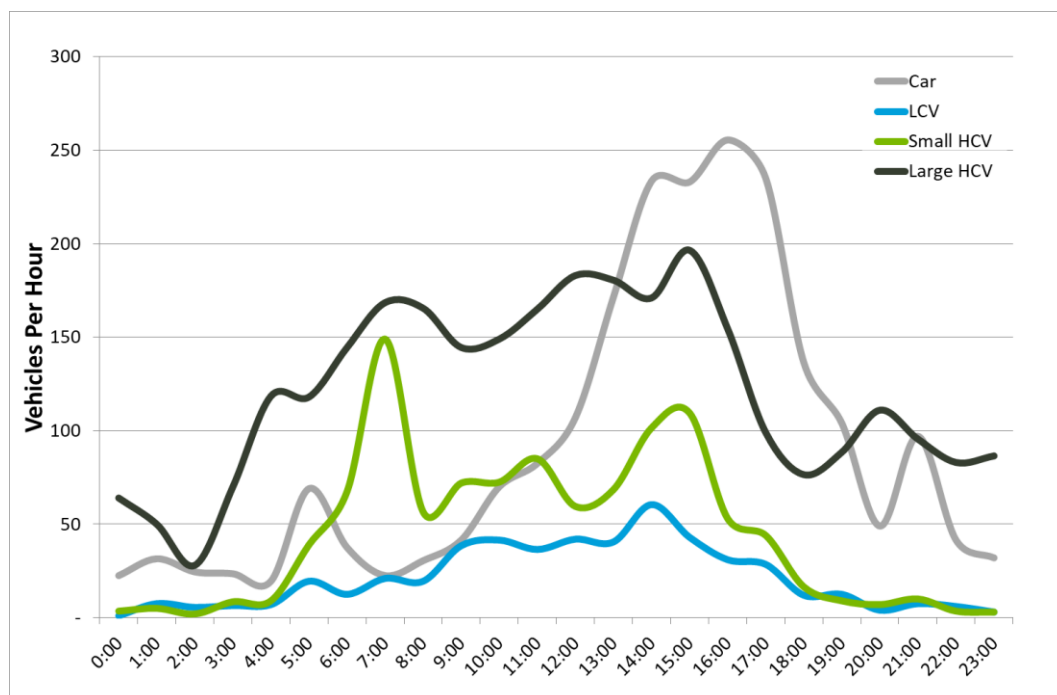
For cars travelling westbound on Botany Road, there is a short peak in the morning between 7:00 AM and 9:00 AM, a large and long afternoon peak between 2:00 PM and 6:00 PM. From this direction, trucks are generally Small HCVs rather than Large.

Figure 38 - Botany / Bumborah Intersection (from Bumborah Point Road northbound)



From Bumborah Point Road, 91% of the vehicles (which are mostly trucks) turn left onto Botany Road, 9% turn right and the remaining 1% go straight ahead into Orora. For Small HCVs, a much higher proportion (28%) turns right at this intersection.

Figure 39 - Botany / Bumborah Time of Day (from Bumborah Point Road northbound)



From Bumborah Point Road, there is a significant afternoon peak for cars between 2:00 PM and 6:00 PM, and significant numbers of trucks (the majority Large HCVs). The Small HCVs exhibit a small morning peak from 7:00 AM until 8:00 AM and an afternoon peak from 2:00 PM to 4:00 PM.

In conclusion, the majority of traffic entering this intersection is made up of right turn movements from Botany Road into Bumborah Point Road, or vice-versa. The traffic is dominated by 3,500 trucks each

day, each way. Car traffic, however, is much more likely to stay on Botany Road through this intersection.

Analysis of the time of day profiles has shown that most cars travel from west to east in the morning, and then east to west in the afternoon, with the exception of Bumborah Point Road itself, which has both a morning and an afternoon peak.

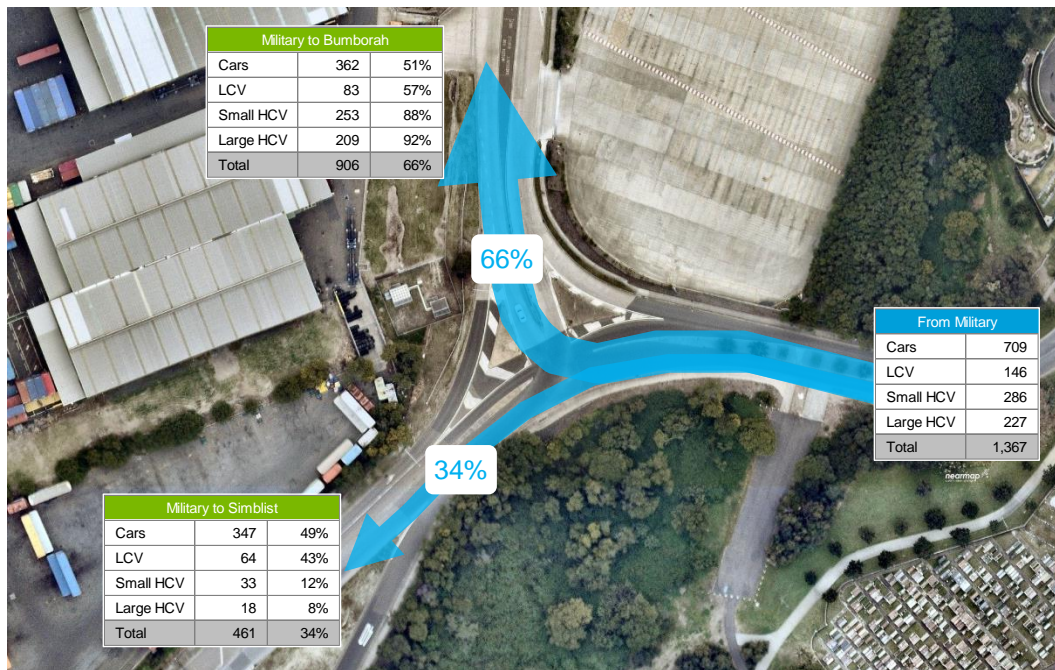
Military Road / Bumborah Point Road Intersection

The other main entrance to the port is along Military Road, where vehicles get more direct access to Simblist and Friendship Roads. The data collected for this study, however, shows significantly fewer vehicles entering the port or the precinct using this road. Table 24 and Figures 40 to 44 show the average daily traffic for this intersection.

Table 24 - Average weekday traffic (Military Road / Bumborah Point Road Intersection)

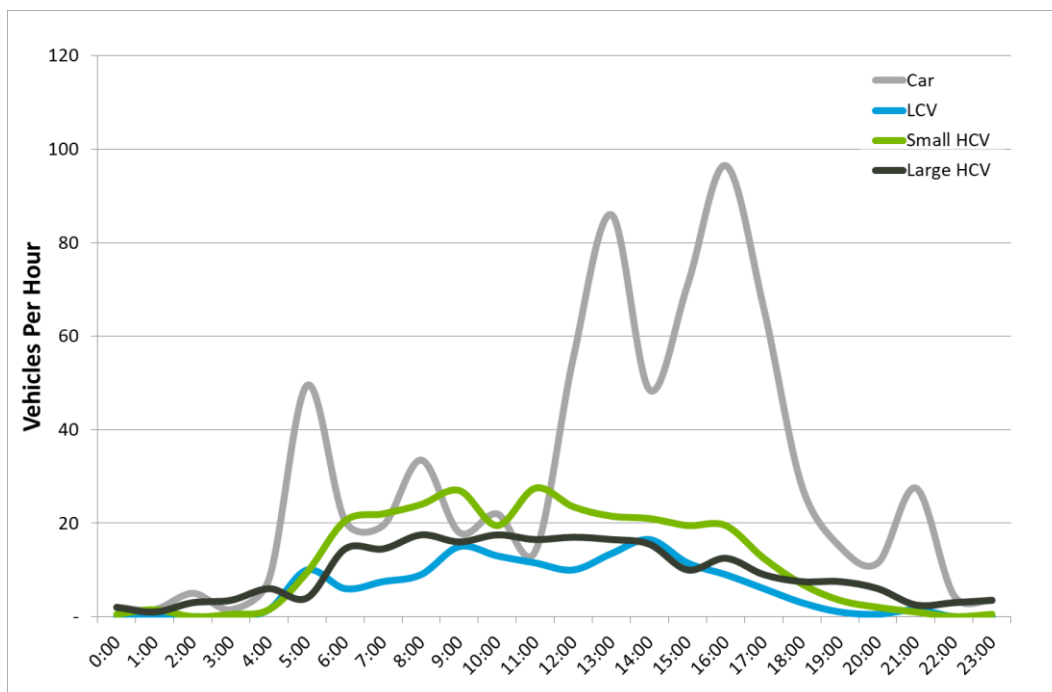
From	Direction	Car	LCV	Small HCV	Large HCV	Total
Military	Left into Simblist	347	64	33	18	461
	Right into Bumborah	362	83	253	209	906
	Total	709	146	286	227	1,367
Bumborah	Left into Military	404	98	330	223	1,054
	Right into Simblist	1,043	382	390	2,908	4,723
	Total	1,447	480	720	3,131	5,777
Simblist	Left into Bumborah	80	16	10	3	108
	Right into Military	65	9	6	-	79
	Total	144	25	16	3	187

Figure 40 - Military / Bumborah Intersection (from Military Road westbound)



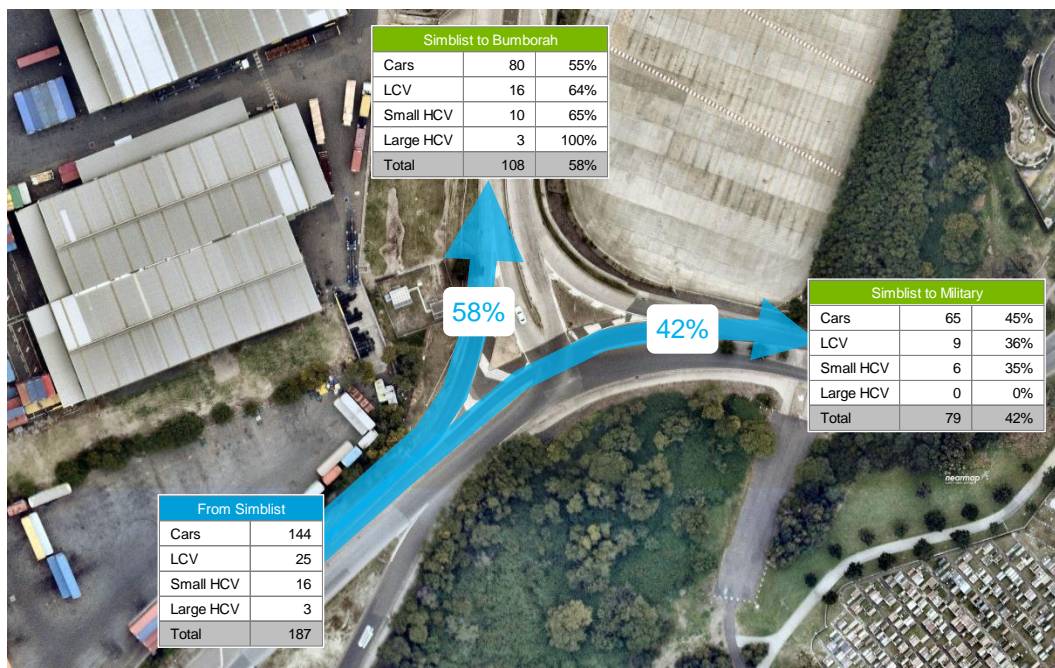
Relatively small numbers of vehicles use Military Road to enter the area, with only 1,367 vehicles captured for an average weekday. Of these, approximately two-thirds turn right into Bumborah Point Road, and the remaining one-third turn left onto Simblist Road. In this case, Simblist has a greater proportion of cars than trucks.

Figure 41 - Military / Bumborah Time of Day (from Military Road westbound)



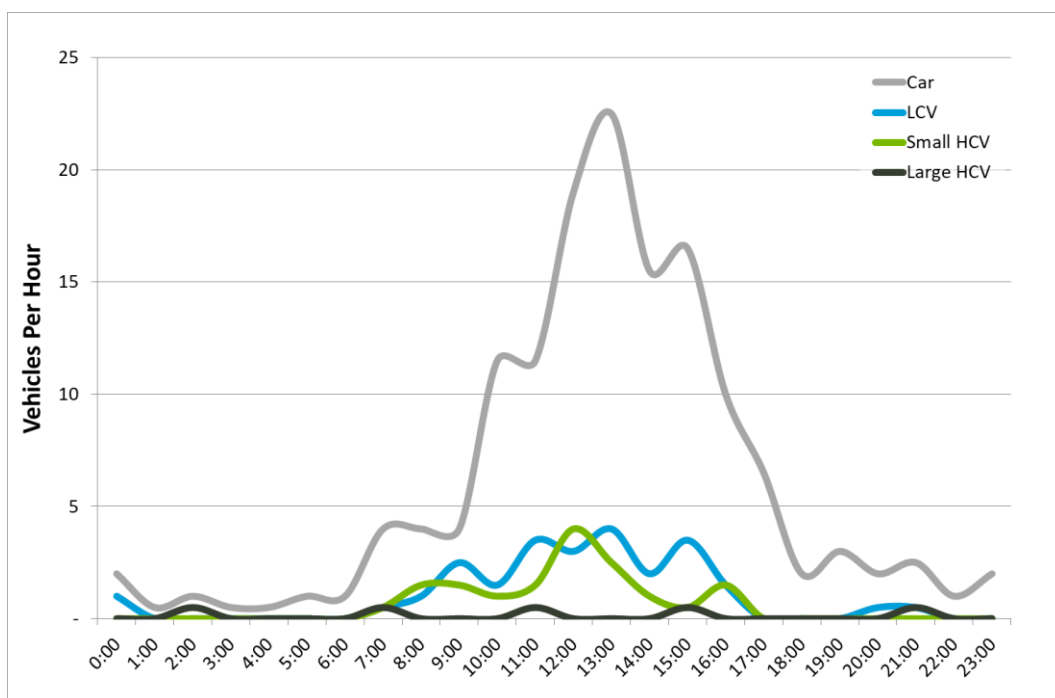
From the time of day profile, we observe the majority of the car traffic enters the intersection in the afternoon between 12:00 PM and 5:00 PM, with small peaks at 5:00 AM, 8:00 AM and 9:00 PM, aligned with shift start times. Like many intersections along Botany Road, truck movements do not have peaks, but rather core working hours between 6:00 AM and 4:00 PM.

Figure 42 - Military / Bumborah Intersection (from Simblist Road eastbound)



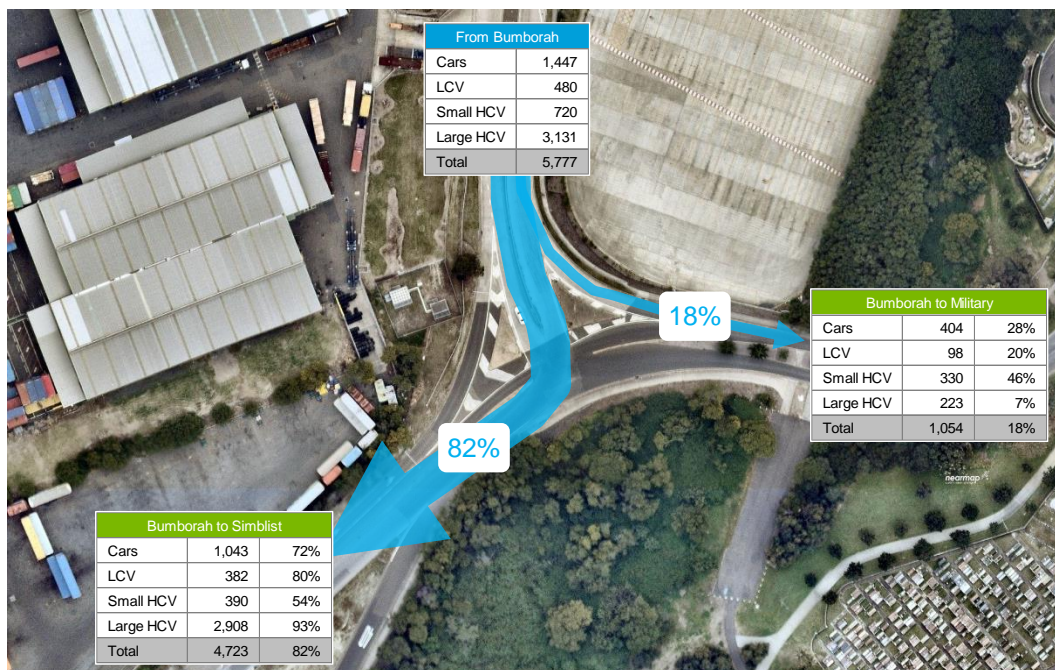
From Simblist travelling east, there are very few vehicles. This is because Simblist Road becomes a one-way road shortly after Prince of Wales Drive. Of those vehicles (mostly cars), 58% turn left up Bumborah Point Road and the remaining 42% turn right onto Military Road.

Figure 43 - Military / Bumborah Time of Day (from Simblist Road eastbound)



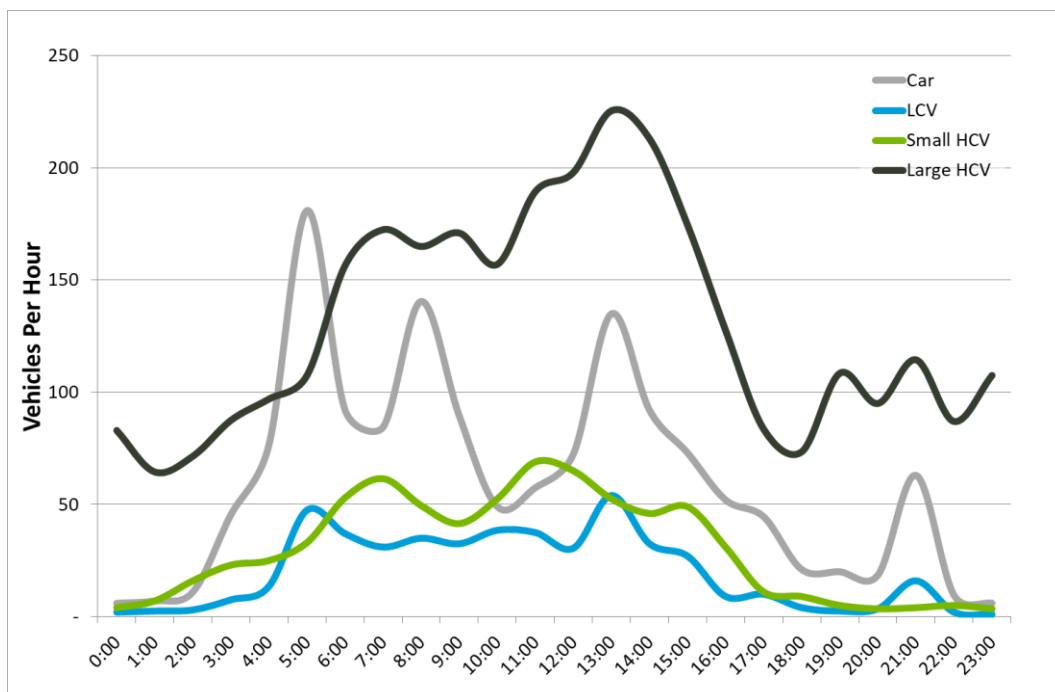
As expected, vehicles entering this intersection from Simblist are few, mainly cars, peaking at lunchtime and most likely vehicles leaving Prince of Wales Drive.

Figure 44 - Military / Bumborah Intersection (from Bumborah Point Road southbound)



The use, or lack of use, of Military Road for access to the port and the precinct, is highlighted by the fact that 82% of the vehicles coming down Bumborah Point Road turn right into Simblist Road, for access to the terminals on Simblist and Friendship Roads. The exception is Small HCVs, approximately 50% of these turn each way.

Figure 45 - Military / Bumborah Time of Day (from Bumborah Point Road southbound)



For those vehicles travelling south on Bumborah Point Road, the time of day profile shows peaks for cars associated with shift start times at terminals on Simblist and Friendship Roads. These are at 5:00 AM, 8:00 AM and 9:00 PM, and most likely workers returning from lunch at 1:00 PM (there is a similar profile for LCVs).

For Small HCVs, core operating hours are from 6:00 AM through to 4:00 PM, with small peaks at 7:00 AM and 11:00 AM. For Large HCVs, there is steady overnight traffic at approximately 100 vehicles per hour, increasing to 175 in the morning between 6:00 AM and 10:00 AM, peaking at 225 at 2:00 PM. The traffic returns to steady overnight volumes by 5:00 PM.

In conclusion, the data suggests that Military Road is not a primary access to the port or the precinct, with low volumes to and from this direction. The majority of vehicles travelling down Bumborah Point Road use it for access to Simblist and Friendship Roads.

The time of day profiles demonstrate the shift start times for cars, mostly via Bumborah Point Road, but a large afternoon peak of cars entering the intersection via Military Road.

3.1.6 Between Intersection Traffic Changes

The previous section contained detailed information collected during the study about the movement of vehicles through each of the key intersections that surround Port Botany. By comparing the total traffic exiting one intersection with that entering the next intersection, we can draw some conclusions about changes between intersections. Table 25 contains a summary of these changes.

Table 25 - Changes in traffic between intersections

Location	Detail	Direction	Car	LCV	Small HCV	Large HCV	Total
Foreshore (ATC)	North of Hale	NB	12,586	2,643	3,108	3,560	21,897
		SB	14,723	3,092	2,741	3,636	24,191
		Total	27,309	5,734	5,849	7,196	46,088
Foreshore (Video)	West of Penrhyn	WB	10,820	2,269	1,538	3,683	18,310
		EB	11,253	2,367	1,536	3,698	18,854
		Total	22,073	4,635	3,074	7,381	37,164
Change		NB/WB	-1,766	-374	-1,570	123	-3,587
		SB/EB	-3,470	-725	-1,205	62	-5,338
		Total	-5,235	-1,099	-2,775	185	-8,925
Botany (Video)	East of Penrhyn	EB	12,640	2,757	1,766	3,126	20,288
		WB	11,947	2,529	1,625	3,068	19,169
		Total	24,587	5,285	3,391	6,194	39,457
Botany (Video)	West of Beauchamp	EB	12,387	2,828	1,763	3,116	20,094
		WB	11,827	2,511	1,608	3,079	19,024
		Total	24,214	5,339	3,371	6,194	39,118
Change		EB	-253	71	-3	-11	-195
		WB	-120	-18	-18	11	-145
		Total	-373	53	-20	-	-340
Botany (Video)	East of Beauchamp	EB	5,811	1,310	1,191	3,081	11,392
		WB	6,016	1,235	1,182	2,971	11,404
		Total	11,827	2,545	2,373	6,052	22,796
Botany (Video)	West of Bumborah	EB	5,795	1,271	1,171	3,060	11,296
		WB	5,702	1,155	1,093	2,853	10,802
		Total	11,497	2,425	2,264	5,913	22,098
Change		EB	-16	-40	-20	-21	-96
		WB	-314	-81	-89	-119	-602
		Total	-330	-120	-109	-140	-698

We can draw the following conclusions along the Foreshore Road-Botany Road corridor:

1. **General Holmes Drive and Penrhyn Road.** Between these two intersections, there is a reduction of 8,925 vehicles, mostly cars and LCVs, and a small increase in Large HCVs. These vehicles are getting off (or getting on) at Hale Street, Sirius Road, or at the public facility boat ramp.
2. **Penrhyn Road and Beauchamp Road.** Between these two intersections, there is a small decrease in traffic, mostly cars. There is a single opportunity in each direction to get off

between these two intersections: Goodman (eastbound) and Gate B100 (westbound, which is no longer in use).

3. **Beauchamp Road and Bumborah Point Road.** Between these two intersections, there is an overall change in traffic, mostly in the westbound direction. Traffic is getting off (eastbound) and on (westbound) at McCauley Street (north side of Botany Road) and DPW Logistics (south side of Botany Road).

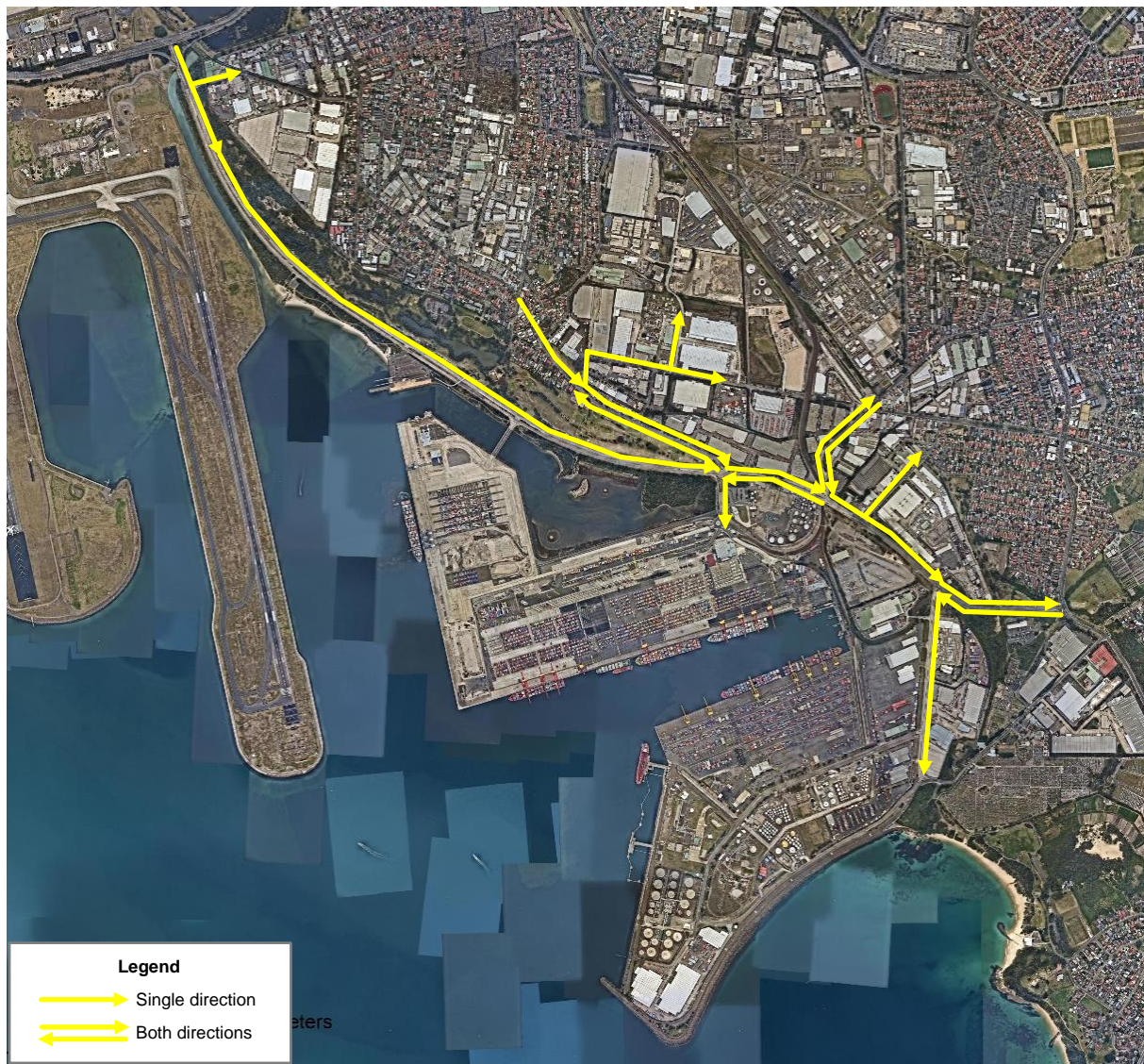
In conclusion, with one exception, where Foreshore and Botany Roads merge together, traffic decreases in the Foreshore Road / Botany Road corridor, mostly at the major intersections with Beauchamp Road and Bumborah Point Road (refer Section 3.1.4). There is also a net decrease in traffic as the corridor travels further east, most of which comes on the link between General Holmes Drive and Penrhyn Road, where vehicles exit or enter the corridor using Hale Street and Sirius Road (Hutchinson Ports).

3.1.7 Peak Movements

As described in Section 3.1.4, car traffic has peaks at certain times of day for some roads and in particular directions. For trucks, the same peak behaviour is not observed, but rather truck traffic is consistently high during core hours from 6:00 AM to 5:00 PM and lower overnight.

This section aims to understand how the peak movements link together for cars, to get a better appreciation of traffic movements into and within the precinct. Figures 46 and 47 contain a graphical illustration of the car peak movements, derived from the time of day profiles shown in Section 3.1.4, along with others within the precinct.

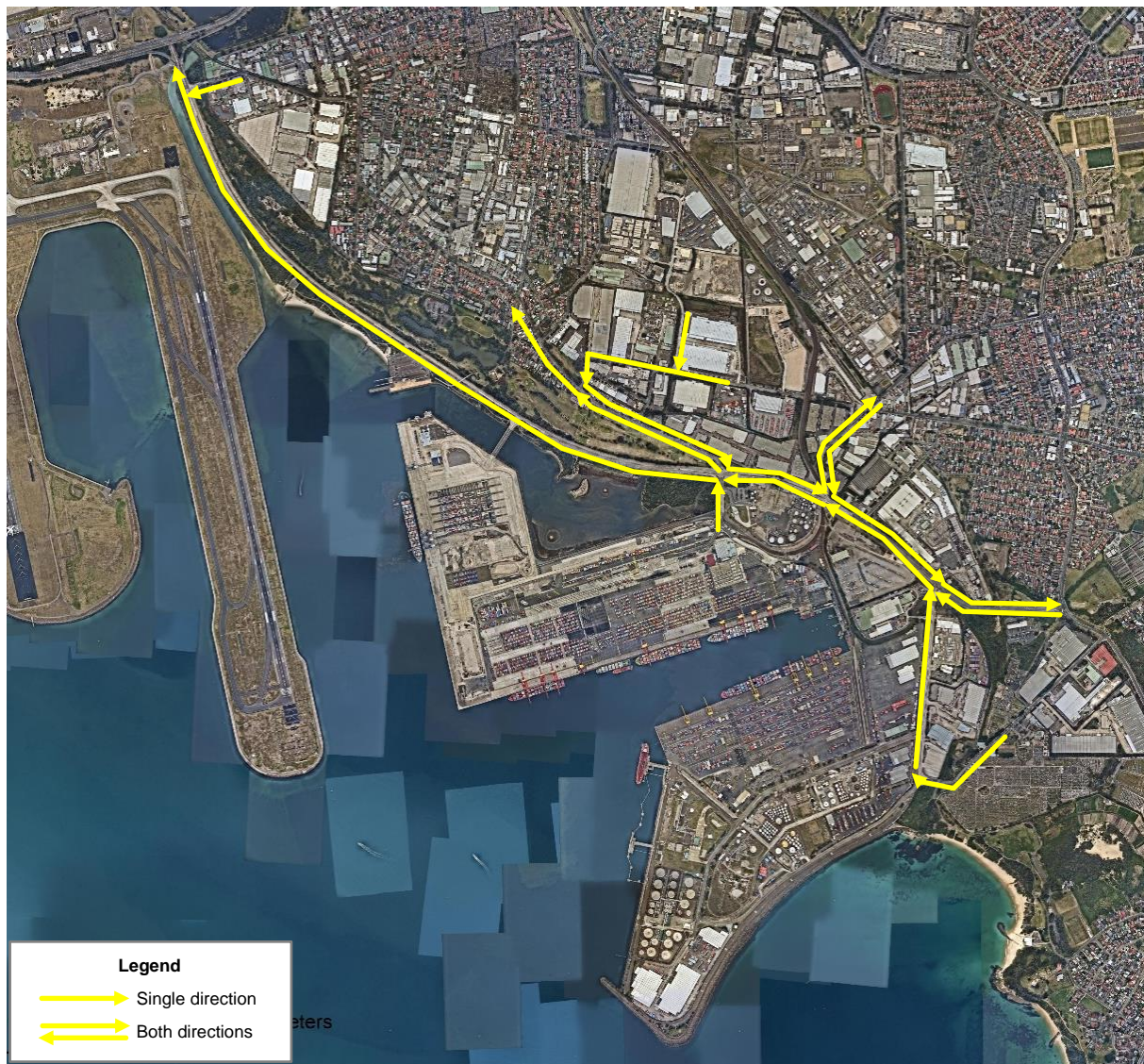
Figure 46 - Car traffic morning peak movements



From the time of day profiles, in the AM-peak car traffic enters the precinct from all directions, with the exception of Military Road. The majority of traffic entering the precinct using Beauchamp Road and Botany Road (from the east) is likely to be staying within the precinct.

Any through traffic is eastbound, either from Foreshore Road or Botany Road and exiting at Botany Road.

Figure 47 - Car traffic afternoon peak movements



With the exception that cars also enter the precinct using Military Road, the afternoon peak for cars mirrors the morning peak. Predominantly flows are westbound, with the exception of Coal Pier Estate to Beauchamp or Botany Road eastbound.

In conclusion, the majority of the car traffic enters the precinct from the west in the morning and then leaves the precinct to the west along Foreshore or Botany Roads, with both roads relatively tidal (busy in one direction, but quiet in the other).

Flows along Beauchamp Road have significant peaks in car traffic in both the morning and afternoon. The most likely route for through traffic is Foreshore Road or Botany Road in the west, through to Botany Road in the east in the morning and the opposite direction in the afternoon.

3.2 Port Traffic

Section 3.1 has given an overview of traffic within the Port Precinct, with emphasis on intersections on the boundary of the precinct, in particular Foreshore, Botany and Military Roads. This section delves into the port itself, focusing on vehicles entering and leaving the port at Sirius Road, Penrhyn Road, Bumborah Point Road and Military Road.

Based primarily on the data captured and classified from video, we are able to drill down for more detail on the volumes and types of trucks and even on the time of day that the movements are occurring.

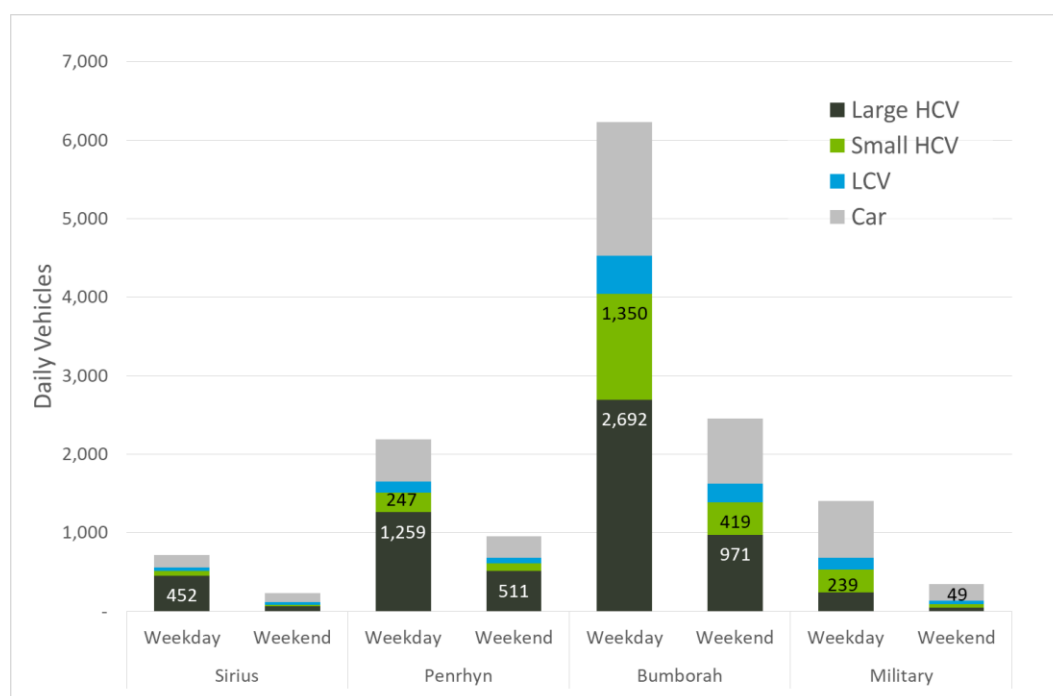
3.2.1 Average Weekday and Weekend Traffic

Table 26 and Figure 48 show the numbers of vehicles entering the port on an average weekday and weekend day.

Table 26 - Daily vehicles entering the port

Vehicle Type	Sirius	Penrhyn	Bumborah	Military	Total
Weekday					
Car	164	537	1,707	723	3,131
LCV	43	144	485	149	822
Small HCV	60	247	1,350	289	1,946
Large HCV	452	1,259	2,692	239	4,642
Total	719	2,188	6,233	1,400	10,540
Weekend					
Car	119	267	830	216	1,431
LCV	31	72	236	44	383
Small HCV	20	101	419	38	578
Large HCV	59	511	971	49	1,589
Total	230	950	2,455	347	3,981

Figure 48 - Daily vehicles entering the port



As shown, an average of 10,540 vehicles enter the port on an average weekday (during the study) and an average of 3,981 per day on the weekend. The majority of these enter the port using Bumborah Point Road, followed by Penrhyn Road and then Military Road. With the exception of Military Road, all port entrances have a very high percentage of trucks, particularly Large HCVs.

3.2.2 Proportion of port-related vehicles in Port Precinct

It is possible to estimate the proportion of port-related vehicles entering the precinct by comparing the number of vehicles entering the precinct, to the number of vehicles entering the port.

Access to Port Botany is via four road intersections within the precinct: Sirius Road (Hutchinson Ports), Penrhyn Road (Patricks), Bumborah Point Road (various terminals and access to Simblast and Friendship Roads) and Military Road. It is possible that some vehicles could enter Bumborah Point

Road and exit using Military Road (or vice-versa) without entering a terminal, but, from our analysis, we believe that this is a small number.

Table 27 shows a comparison of vehicles entering the precinct versus the number of vehicles entering the port.

Table 27 - Vehicles entering the Port Precinct related to the Port

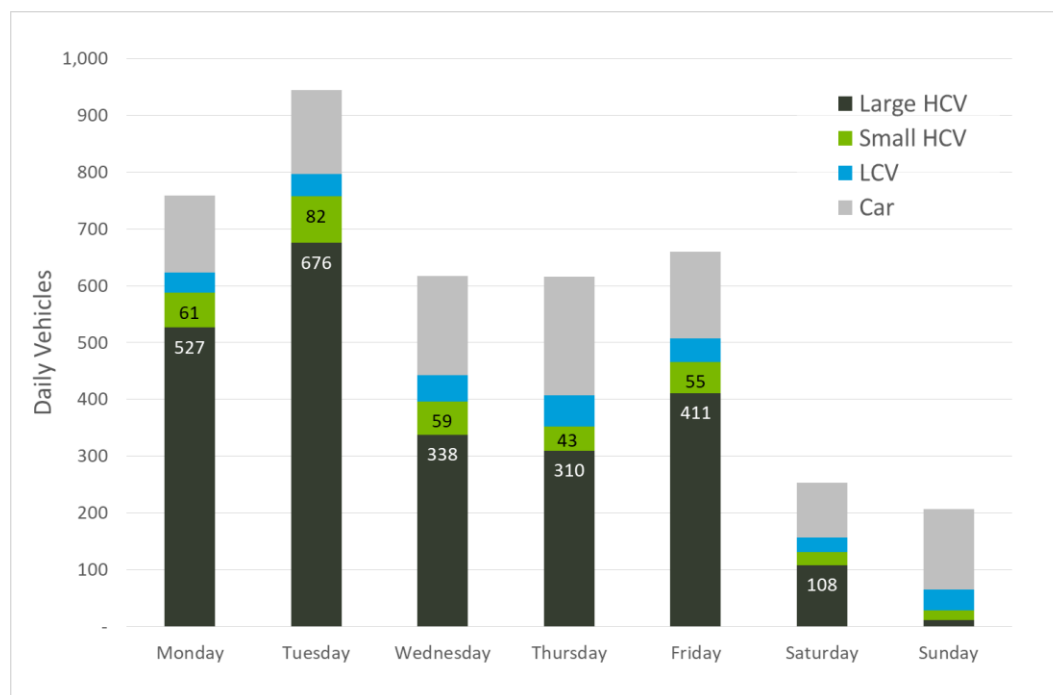
Location	Detail	Direction	Car	LCV	Small HCV	Large HCV	Total
Foreshore (ATC)	North of Hale	SB	14,723	3,092	2,741	3,636	24,191
Botany (ATC)	South of Stephen	SB	3,857	1,149	1,088	247	6,341
Beauchamp (ATC)	North of Botany	SB	6,024	1,444	1,066	914	9,448
Botany (ATC)	East of Bumborah	WB	3,967	751	814	119	5,651
Military (Video)	East of Bumborah	SB	709	146	286	227	1,367
Total entering Port Precinct			29,279	6,581	5,995	5,143	46,997
Total entering Port Botany			3,131	822	1,946	4,642	10,540
Percentage of precinct traffic that is port-related			11%	12%	32%	90%	22%

As shown, nearly one quarter of all traffic within the precinct is port-related, with the highest percentage relating to Large HCVs. Car and LCV traffic is the smallest at 11% and 12% respectively.

3.2.3 Days of the Week

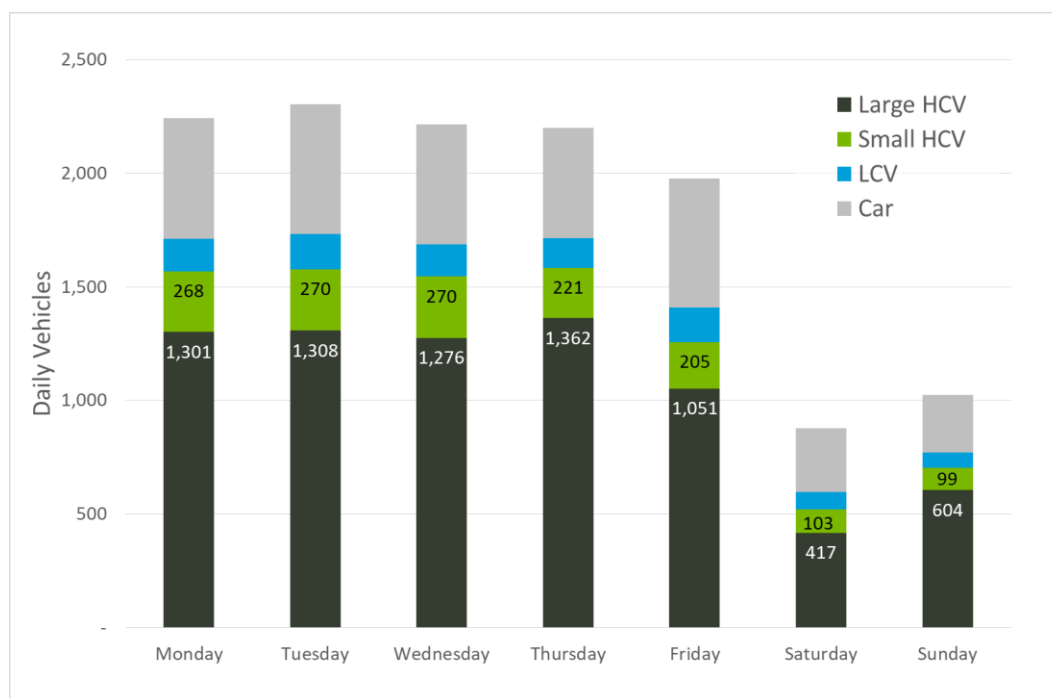
Figures 49 to 52 show how the volumes change for each port entrance, so we can understand the variability from day-to-day.

Figure 49 - Daily vehicles entering the port via Sirius Road



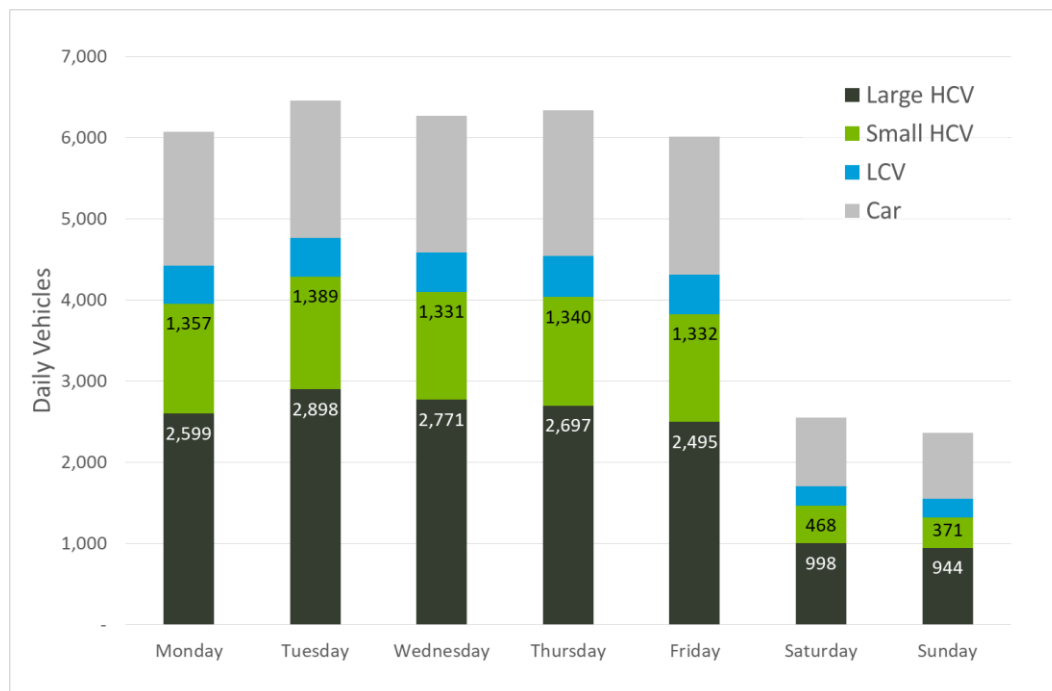
In the data collected during the study, Sirius Road (Hutchinson Ports) varies between 600 vehicles per weekday to 950, the most noticeable variation is for the Large HCVs, with the busiest days early in the week. There is a significant decrease in vehicles on the weekend, particular for Large HCVs.

Figure 50 - Daily vehicles entering the port via Penrhyn Road



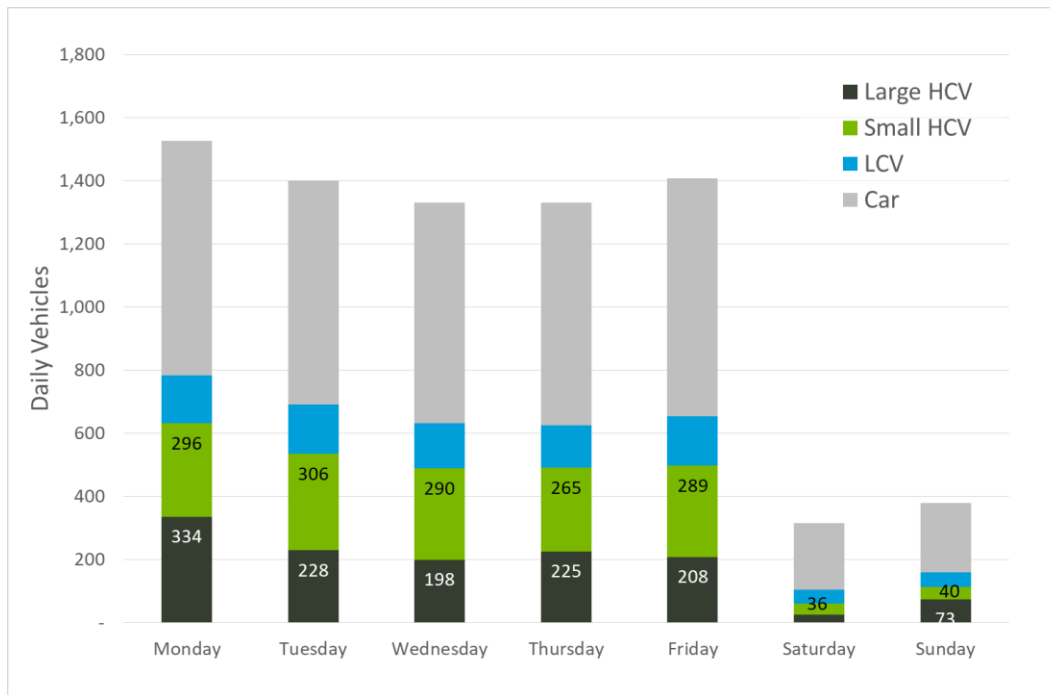
For vehicles entering the port using Penrhyn Road, there is much less variability day-to-day, with approximately 2,200 total vehicles, including 1,300 Large HCVs, Monday to Thursday. Friday is the quietest weekday, before traffic halves for the days on the weekend.

Figure 51 - Daily vehicles entering the port via Bumborah Point Road



Like Penrhyn Road, Bumborah Point Road has consistency in both total vehicles and Large HCV volumes, even on Friday across the normal workweek. Saturday and Sunday are consistent with each other, but considerably lower than during the week.

Figure 52 - Daily vehicles entering the port via Military Road



While Military Road has consistent volumes across the working week, the chart demonstrates an increase in cars and only moderate numbers of LCVs and Small HCVs.

In conclusion, there is some day-to-day variability for vehicles entering the port, most noticeably at Sirius Road. Overall, however, there is no consistency in the busiest day across the different locations.

3.2.4 Vehicle Types

One of the benefits of using video to capture the data is the ability to observe and classify the types of vehicles operating in the precinct, and, importantly, those entering or leaving the port itself. We would expect a high proportion of container-related vehicles, particularly in relation to Hutchison Ports, Patrick and DPW operations; but understanding the movement patterns for other types of trucks will help to understand the other activities being undertaken in the port.

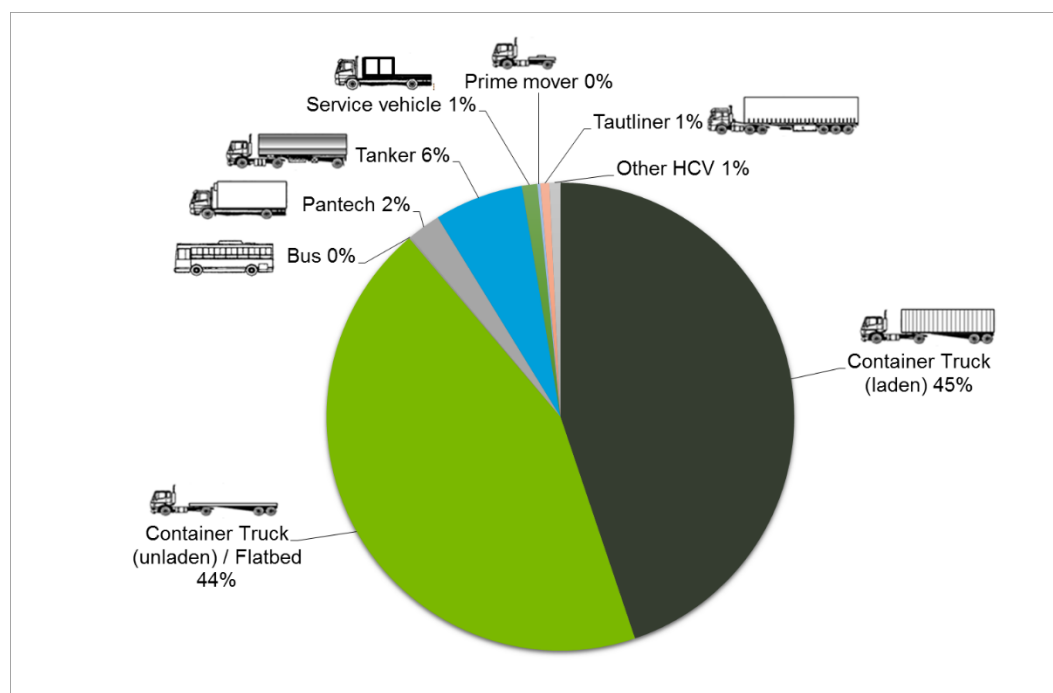
Table 28, and Figures 53 to 55 show a breakdown of the types of vehicles entering the port at Penrhyn Road, Bumborah Point Road and Military Road. No video was captured at Sirius Road, but given that the only terminal Sirius Road connects to is Hutchinson Ports, it is likely to carry predominantly container trucks (both laden and unladen).

Table 28 - Weekday heavy commercial vehicles entering the Port Precinct

Truck Type	Penrhyn	Bumborah	Military	Total
Container Truck (laden)	675	1,653	118	2,446
Container Truck (unladen) / Flatbed	662	1,038	77	1,778
Bus	2	619	49	670
Pantech	35	330	113	478
Tanker	93	345	3	440
Service vehicle	16	14	22	52
Prime mover	3	20	6	29
Tautliner	9	9	-	18
Refuse truck	5	4	4	12
Cement truck / crane	4	1	0	5
Street sweeper	1	3	1	4
Livestock truck	2	3	-	4
Fire engine	1	1	1	2
Crane	-	3	-	3
Tow truck / Car carrier	1	-	-	1
Total	1,506	4,042	394	5,942

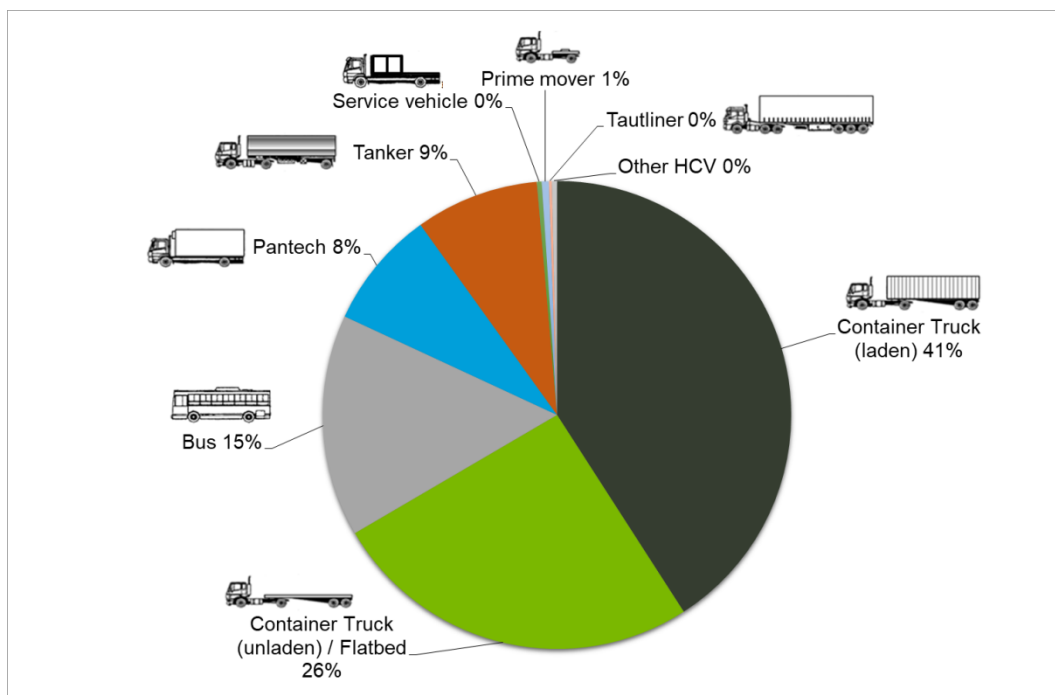
As discussed in Section 2.3, unladen Container Trucks and Flatbeds have been grouped together, as it is not possible to reliably determine the difference (and, in fact, some trucks are both). From the data, a total of 4,224 (71%) trucks entering the port were either laden or unladen Container Trucks. The other major truck types are Buses (particularly for Bumborah Point Road, where there is a bus depot), Pantech and Tankers, again mostly for Bumborah Point Road, which has more varied terminal uses.

Figure 53 - Weekday heavy commercial vehicles entering the port using Penrhyn Road



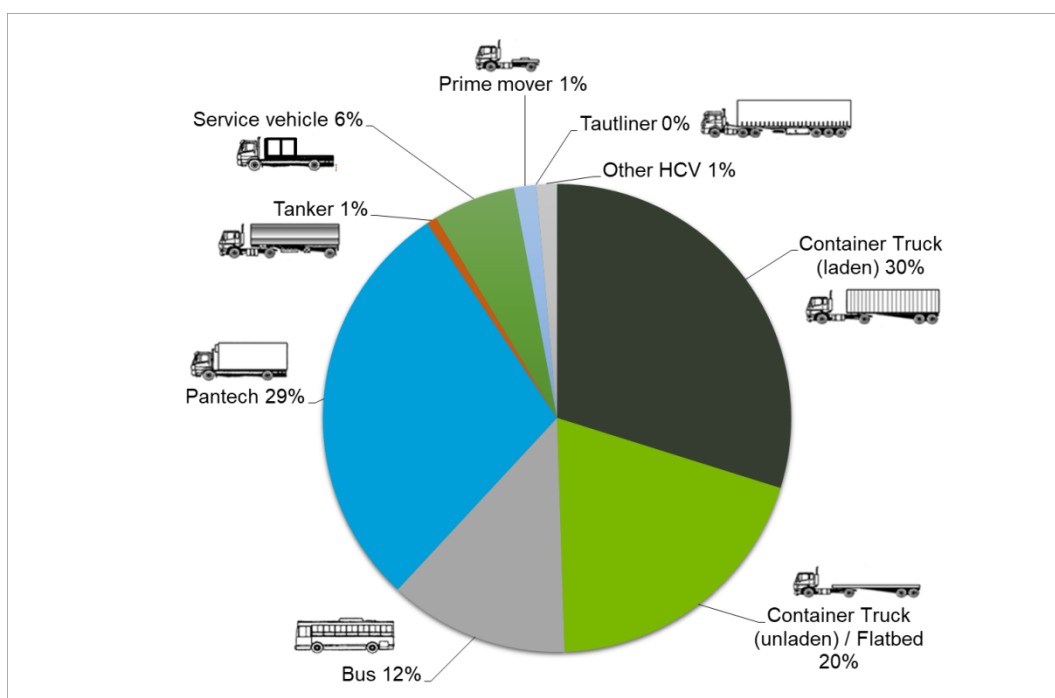
Laden and unladen Container Trucks were the most frequently observed trucks entering the port at Penrhyn Road, making up nearly 90% of the total. Approximately 6% were tankers, the majority of which were most likely bound for the Caltex Oil terminal, located east of Penrhyn Road.

Figure 54 - Weekday heavy commercial vehicles entering the port using Bumborah Point Road



Bumborah Point Road has a different mix of vehicles to Penrhyn Road. While Container Trucks still make up 67% of all trucks, Bumborah Point Road has a significant number of Buses, but also considerable numbers of Tankers and Pantechs.

Figure 55 - Weekday heavy commercial vehicles entering the port using Military Road



Finally, for the small number of trucks entering the port via Military Road, only 50% were Container Trucks, with a large number of Pantech Trucks and Buses.

In conclusion, we observe that Container Trucks make up the bulk of trucks entering the port (approximately 71%), but the proportions range from 50% at Military Road to 89% at Penrhyn Road. The greater diversity of businesses operating out of Bumborah Point Road in particular, is demonstrated by the greater diversity of vehicles. The number of Tautliners was very small at all three sites.

3.2.5 Container Truck Efficiency

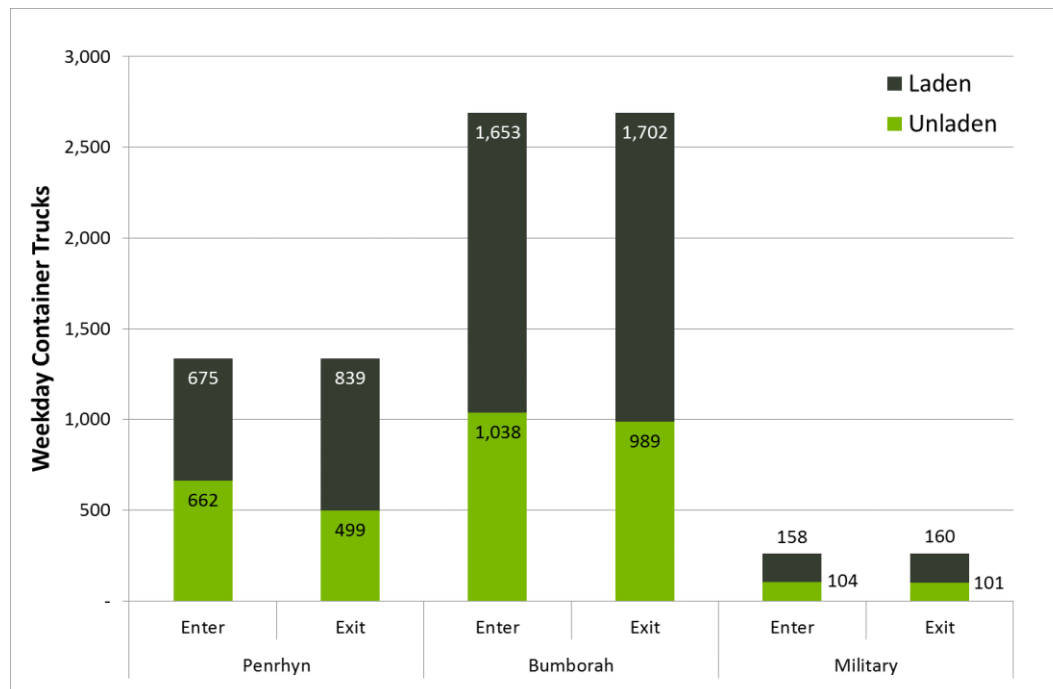
As described in the previous section, the port truck traffic is approximately 71% Container Trucks, either laden (with container) or unladen (without container). This section estimates the efficiency of these Container Truck movements into and out of the port.

Table 29 and Figure 56 show a summary of Container Truck movements into and out of the port on each access road. Again, this analysis excludes Sirius Road as no video was captured there.

Table 29 - Average weekday laden / unladen Container Trucks

Truck Type	Penrhyn	Bumborah	Military	Total
Enter Port				
Laden	675 (50%)	1,653 (61%)	158 (60%)	2,485 (58%)
Unladen	662 (50%)	1,038 (39%)	104 (40%)	1,804 (42%)
Total	1,338 (100%)	2,691 (100%)	261 (100%)	4,290 (100%)
Exit Port				
Laden	839 (63%)	1,702 (63%)	160 (61%)	2,700 (63%)
Unladen	499 (37%)	989 (37%)	101 (39%)	1,589 (37%)
Total	1,338 (100%)	2,691 (100%)	261 (100%)	4,290 (100%)

Figure 56 - Average weekday laden / unladen Container Trucks



A measure of efficiency is the minimisation of unladen trips; if trucks can be loaded in both directions wherever possible, this minimises the number of trucks entering and leaving the port. This cannot always be achieved due to container size differences, booking slots and transport operators.

This snapshot does not reveal the total extent of the efficiency of Container Truck movements, because it cannot account for trucks delivering a full container to the Patrick terminal (off Penrhyn

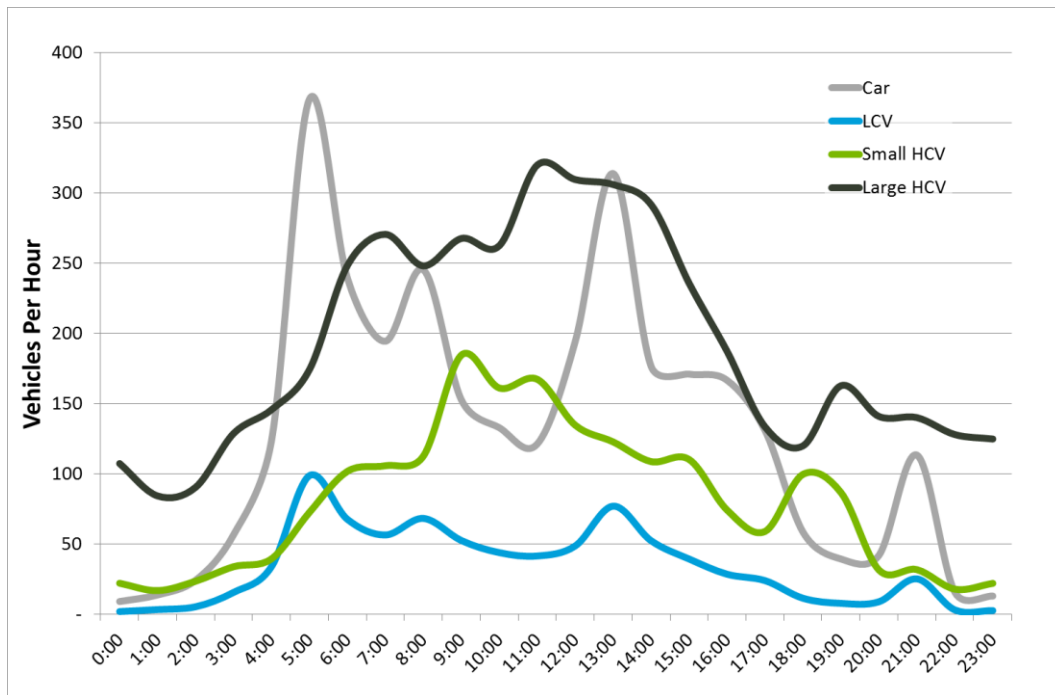
Road) and then collecting an empty container from an empty container park on Bumborah Point, Simblist or Friendship Roads.

3.2.6 Times of Day

The analysis conducted thus far has looked at the average weekday or weekend traffic, the variation between different days of the week and the types of vehicles operating. NSW Ports, however, also needs to understand the main times of day that vehicles are accessing the port. A typical freeway or arterial road will have a morning and an afternoon peak, moderate traffic in the inter-peak and low traffic at night.

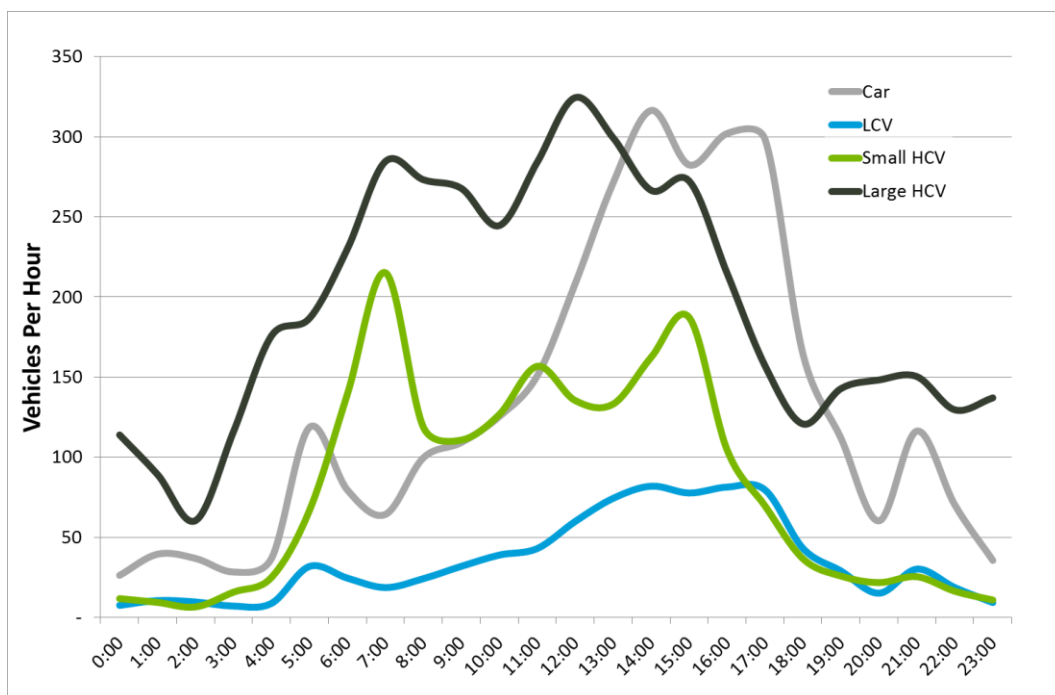
Within a Port Precinct, we would expect to see more 'last kilometre' behaviour, as vehicles arrive and leave in coordination with shift starts, collections and deliveries. Figures 57 to 66 show the time of day profiles for the port as a whole and for each port entry road separately.

Figure 57 - Weekday time of day profile for vehicles entering the port (all locations)



It is clear in this figure that the numbers of cars arriving at the port are the highest at 5:00 AM, 8:00 AM and 9:00 PM, which are the shift start times, also at 1:00 PM with employees most likely returning from lunch. For trucks entering the port, it is evident that most trucks entering the port do so between 6:00 AM and 6:00 PM, with Small HCVs peaking at 190 vehicles per hour between 9:00 AM and 10:00 AM and Large HCVs peaking at 325 vehicles per hour between 11:00 AM and 12:00 PM.

Figure 58 - Weekday time of day profile for vehicles exiting the port (all locations)



For cars that exit the port, the end of shifts at 5:00 AM, 5:00 PM and 9:00 PM are the peak times, with likely exits for lunch around 1:00 PM. As expected, the exit profile for trucks follows that for the entry profile; in that the majority of trucks are entering the port to collect freight and then exit.

Figure 59 - Weekday time of day profile for vehicles entering the port via Sirius Road

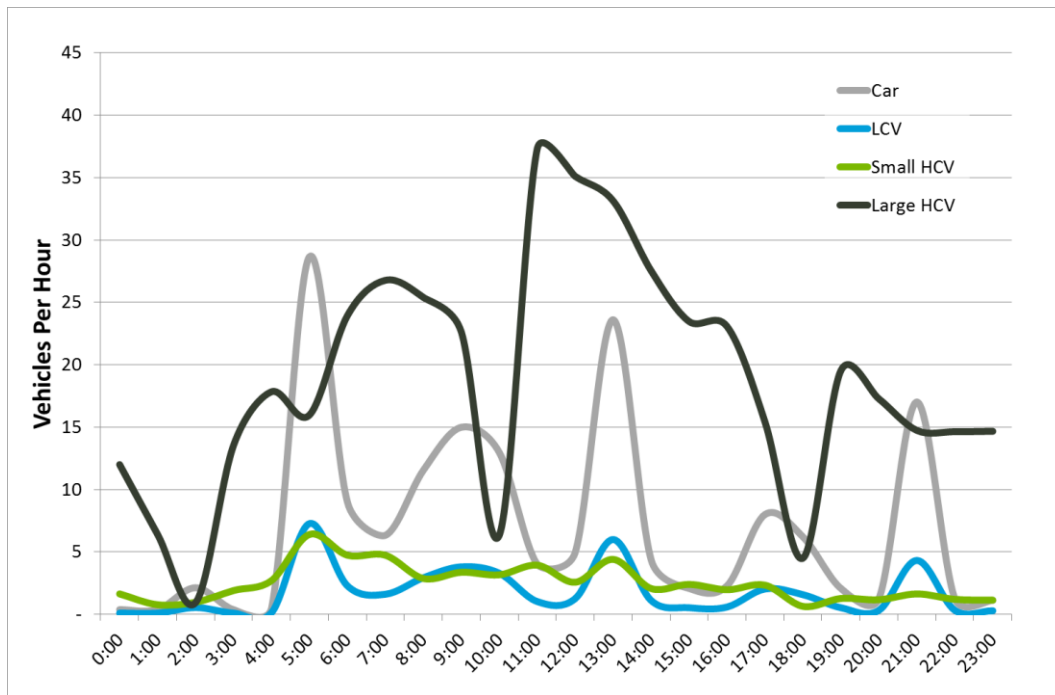
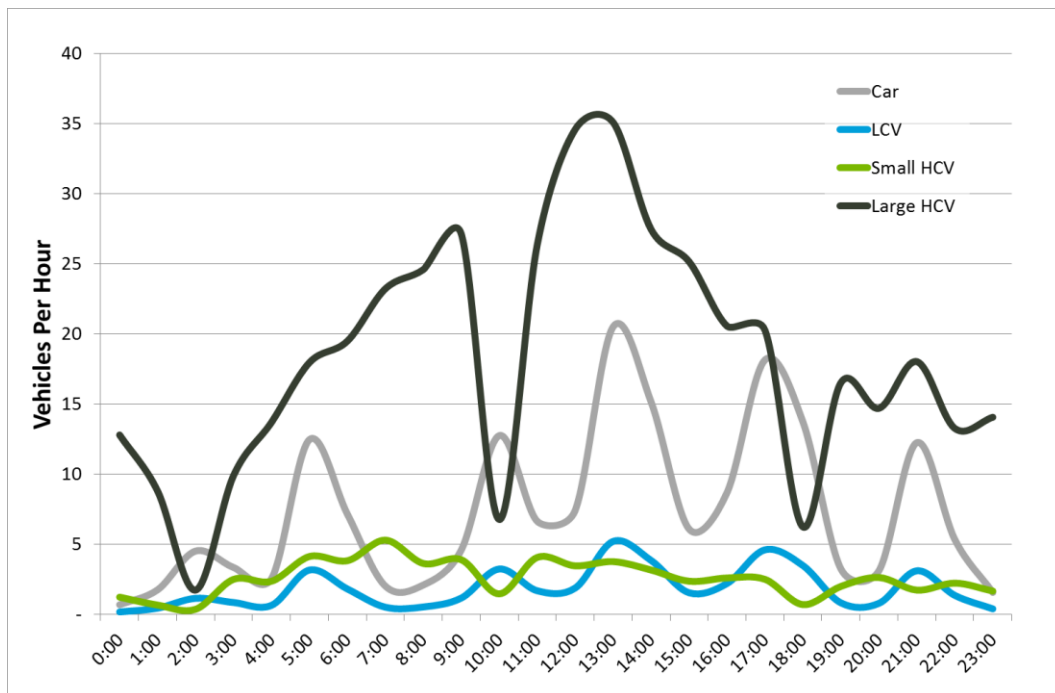


Figure 60 - Weekday time of day profile for vehicles exiting the port via Sirius Road



The entry and exit time of day profile for Sirius Road (Hutchison Ports) shows the starts of shifts at 5:00 AM, 1:00 PM and 9:00 PM and probably an office workforce at 8:00 AM. To a high degree, the troughs for the trucks align with these changeovers and other mandated breaks.

Figure 61 - Weekday time of day profile for vehicles entering the port via Penrhyn Road

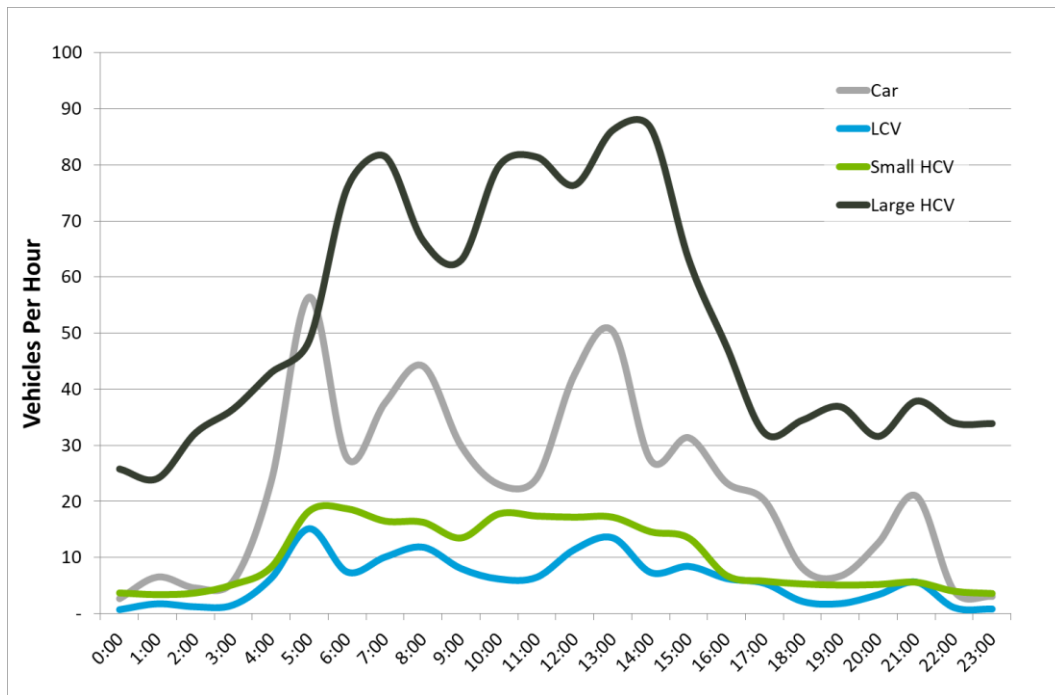
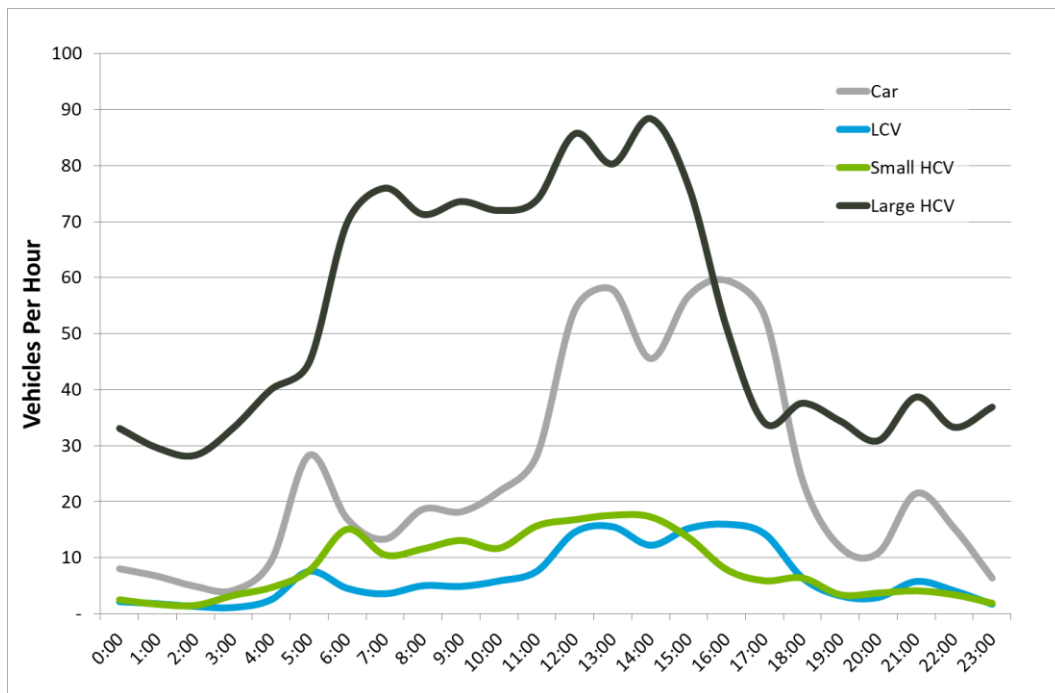


Figure 62 - Weekday time of day profile for vehicles exiting the port via Penrhyn Road



For Penrhyn Road traffic, shift start times are evident, particularly for cars, with a large and long afternoon peak from 3:00 PM until 6:00 PM. Truck traffic is much more constant across the core period of the day from 6:00 AM to 5:00 PM and then also relatively constant across the night hours.

Figure 63 - Weekday time of day profile for vehicles entering the port via Bumborah Point Road

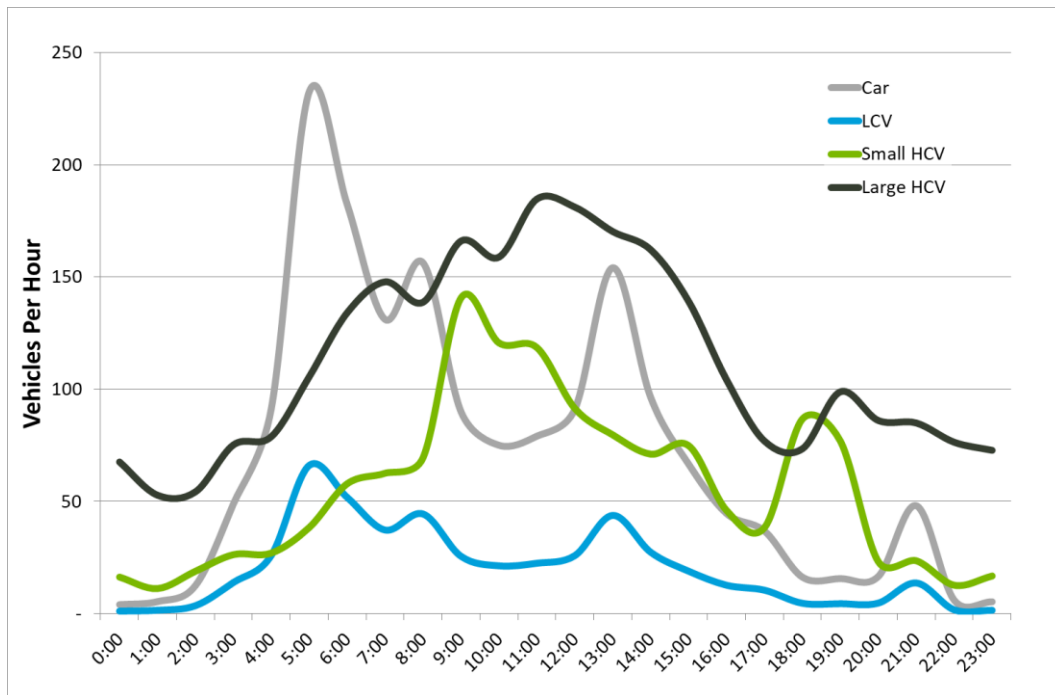
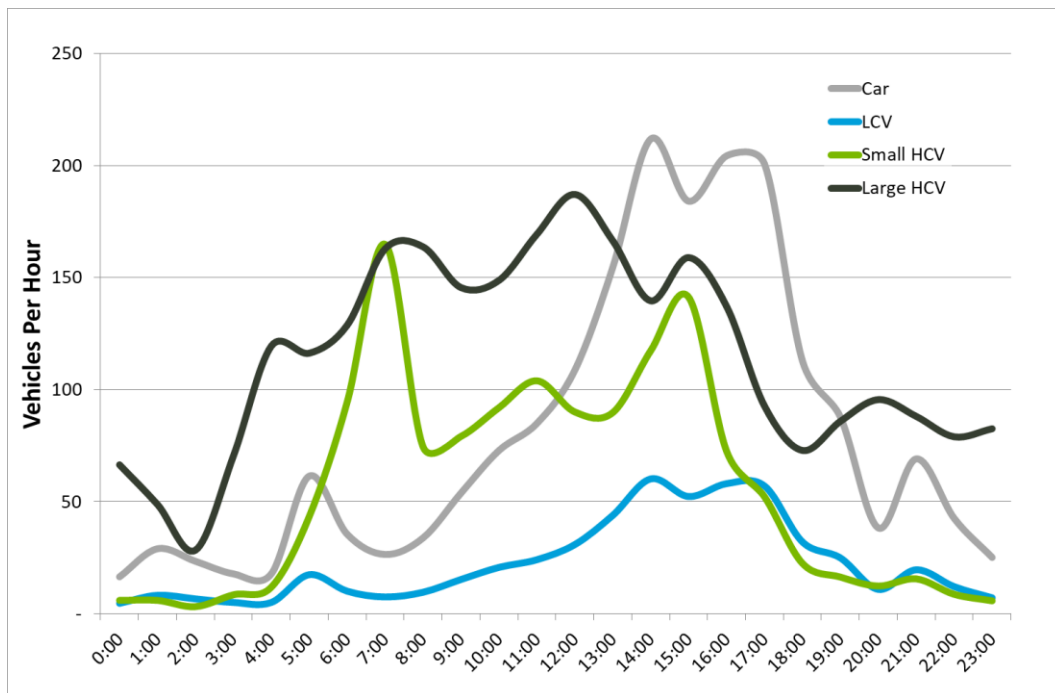


Figure 64 - Weekday time of day profile for vehicles exiting the port via Bumborah Point Road



For vehicles entering the port via Bumborah Point Road, there is much greater variation compared to Penrhyn Road. This is most likely because of the multiple terminals on Bumborah Point Road and also the access to the terminals on Simblist and Friendship Roads.

There are four distinct shift start times evident in the profile (which line up with the cars entering the port), with most of the car traffic leaving Bumborah Point Road between 1:00 PM and 6:00 PM.

Figure 65 - Weekday time of day profile for vehicles entering the port via Military Road

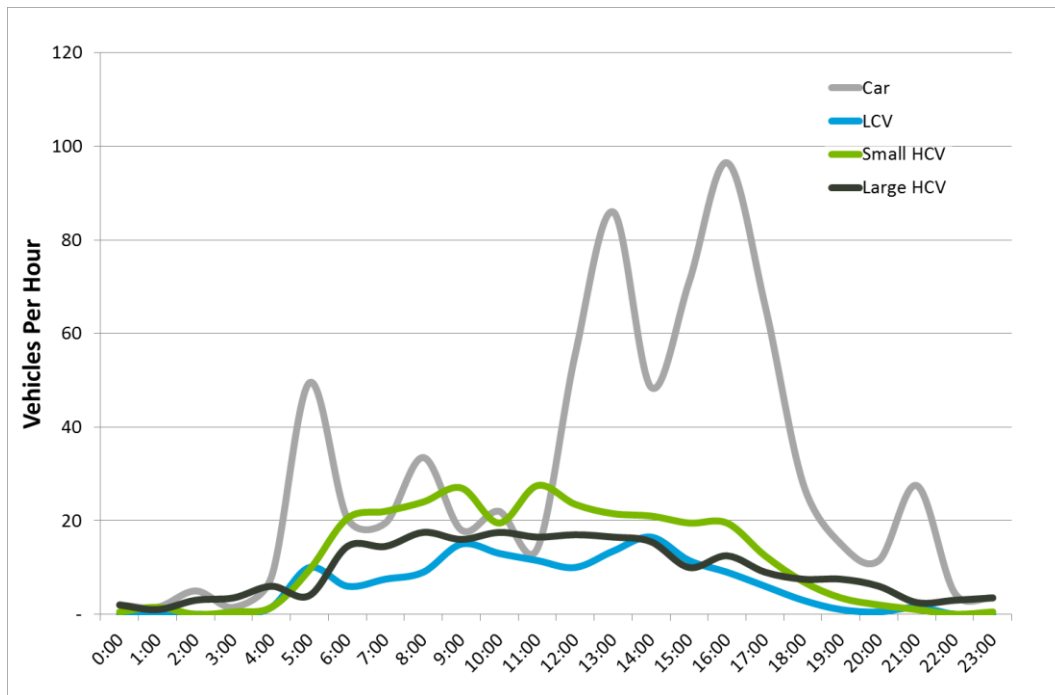
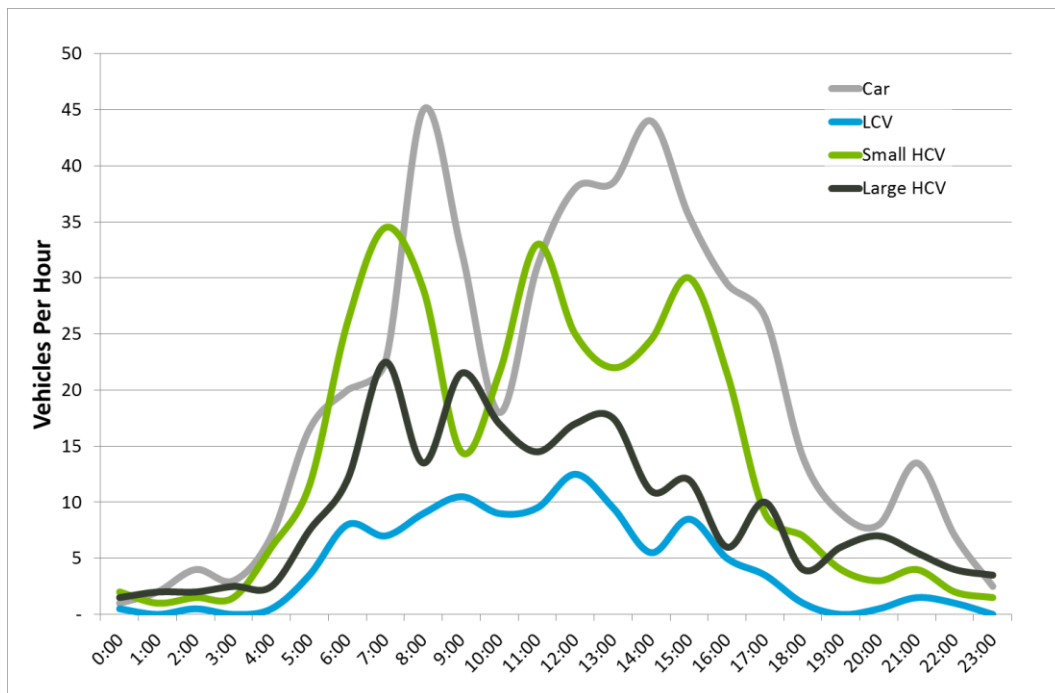


Figure 66 - Weekday time of day profile for vehicles exiting the port via Military Road



For Military Road, we observe a small number of cars entering aligned with the shift start times of 5:00 AM, 8:00 AM and 9:00 PM, but many vehicles entering in the afternoon, peaking at 95 vehicles per hour between 5:00 PM and 6:00 PM. This is likely to be commuter traffic that uses Bumborah Point Road-Military Road to get to work in the morning (supported by a large peak in the morning entering Bumborah Point Road and exiting Military Road at 8:00 AM, and a similar result for the opposite direction in the afternoon).

Truck numbers are generally much smaller, particularly for Large HCVs, with smooth arrivals of trucks, but a higher degree of oscillation for the exit journey.

3.3 Port Terminals

The final level of analysis is at the Port Terminal level. A total of 22 ATC counters were deployed during the study to capture vehicle movements from the majority of the terminals within the port. In each case, these were placed on the driveway exits.

3.3.1 Average Weekday Vehicles

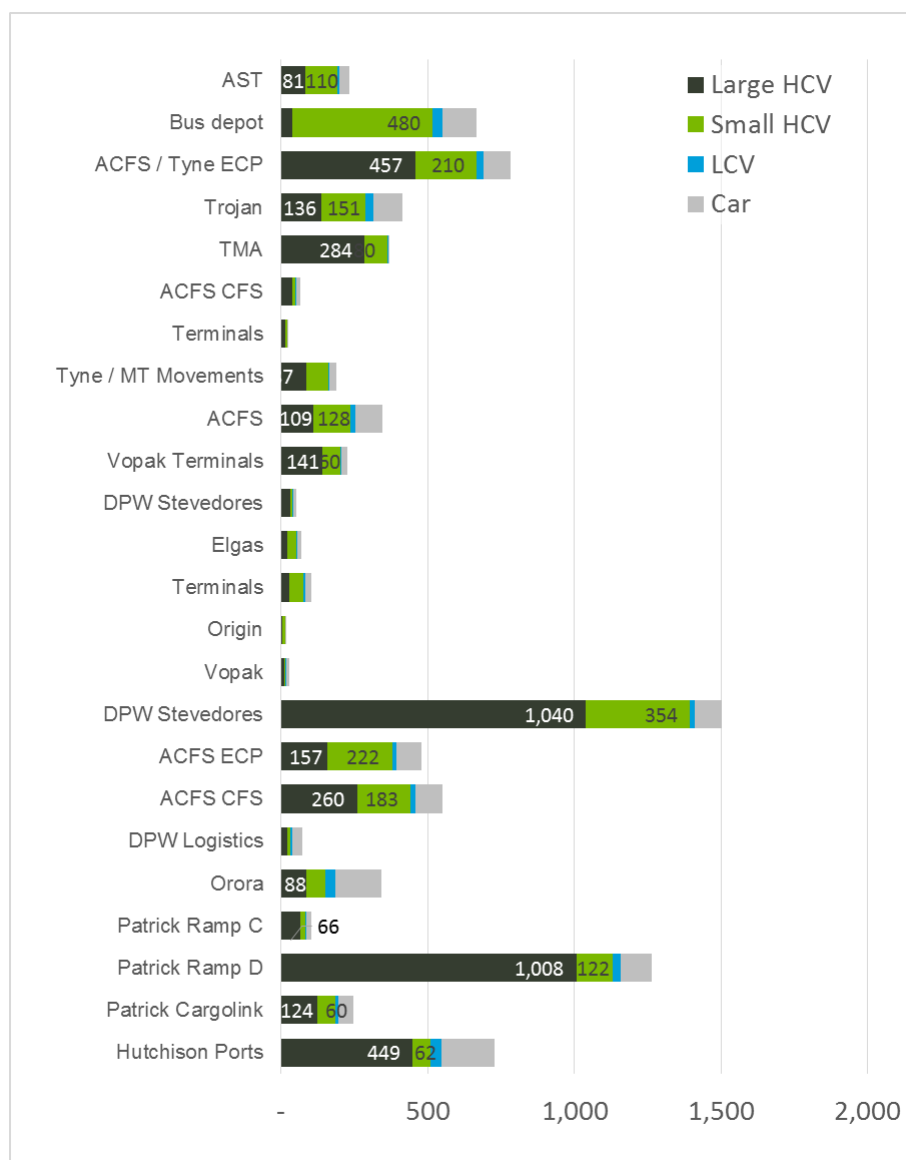
Table 30 and Figure 67 show the number of vehicles exiting each terminal on an average weekday.

Table 30 - Average weekday vehicles exiting each terminal

Terminal	Car	LCV	Small HCV	Large HCV	Total
Bumborah Point Road					
AST	32	9	110	81	232
Bus depot	117	32	480	38	667
ACFS / Tyne ECP	90	25	210	457	782
Trojan	99	27	151	136	413
TMA	5	1	80	284	371
Simblist Road					
ACFS CFS	15	3	11	38	67
Terminals	4	1	7	13	25
Tyne / MT Movements	22	4	74	87	187
ACFS	91	16	128	109	344
Vopak Terminals	19	3	60	141	224
Charlotte Road					
DPW Stevedores	12	2	8	31	53
Friendship Road					
Elgas	14	2	33	20	69
Terminals	22	4	51	27	103
Origin	5	1	11	2	19
Vopak	13	2	5	9	29
DPW Stevedores	94	17	354	1,040	1,504
ACFS ECP	83	15	222	157	477
ACFS CFS	91	16	183	260	549
Botany Road					
DPW Logistics	34	7	9	22	72
Orora	157	35	64	88	343
Penrhyn Road					
Patrick Ramp C	16	4	17	66	103
Patrick Ramp D	108	28	122	1,008	1,266
Patrick Cargolink	48	12	60	124	245
Sirius Road					
Hutchison Ports	180	38	62	449	721
Total	1,371	303	2,511	4,686	8,864

In total, an average of 8,864 vehicles were captured during the study for an average weekday, with 28% of these being Small HCVs and 53% being Large HCVs. Note that not all cars may be captured if terminals have separate driveways for cars and trucks.

Figure 67 - Weekday total vehicles exiting each terminal driveway

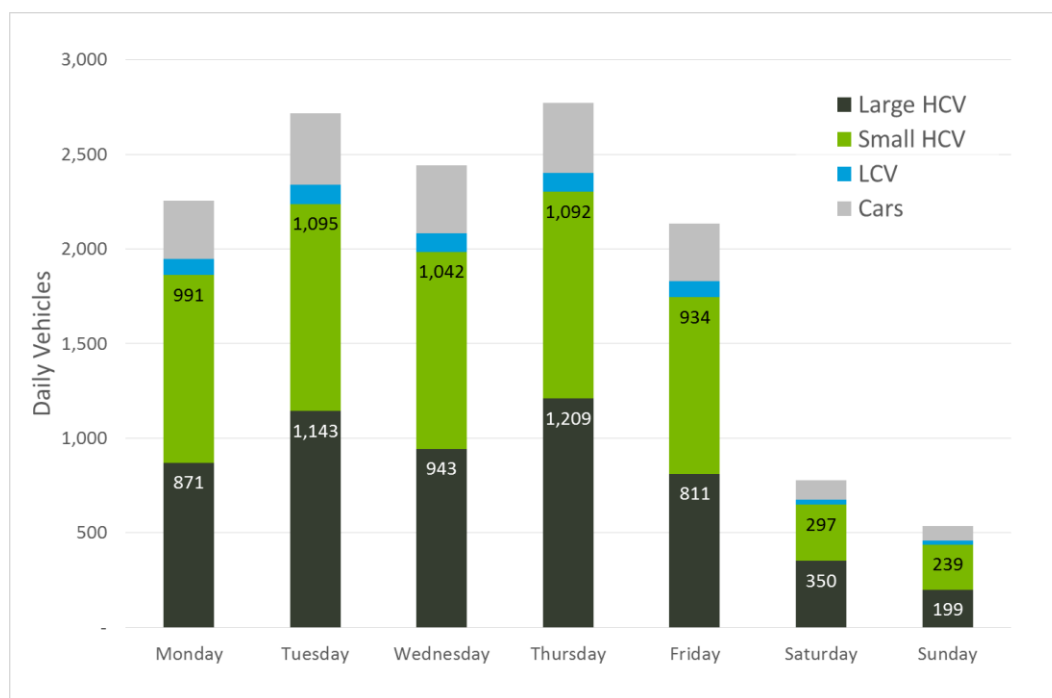


As shown, the average weekday number of vehicles varies considerably from terminal to terminal, with DPW Stevedores on Friendship Road averaging 1,500 vehicles per day, of which over 1,000 were Large HCVs. Patrick (Ramp D) and Hutchison Ports were the next two largest with 1,266 and 721 vehicles per weekday respectively.

3.3.2 Days of Week

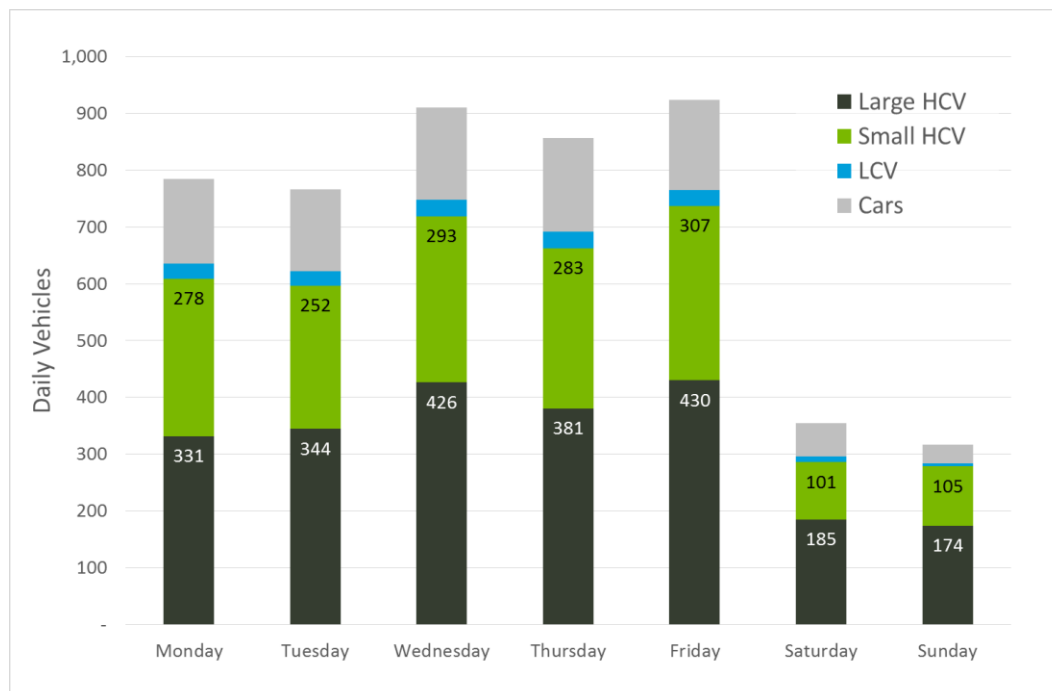
The remainder of the analysis for the terminals groups them according to the road on which each terminal is located. These are shown in Figures 68 to 74.

Figure 68 - Daily vehicles exiting terminals on Bumborah Point Road



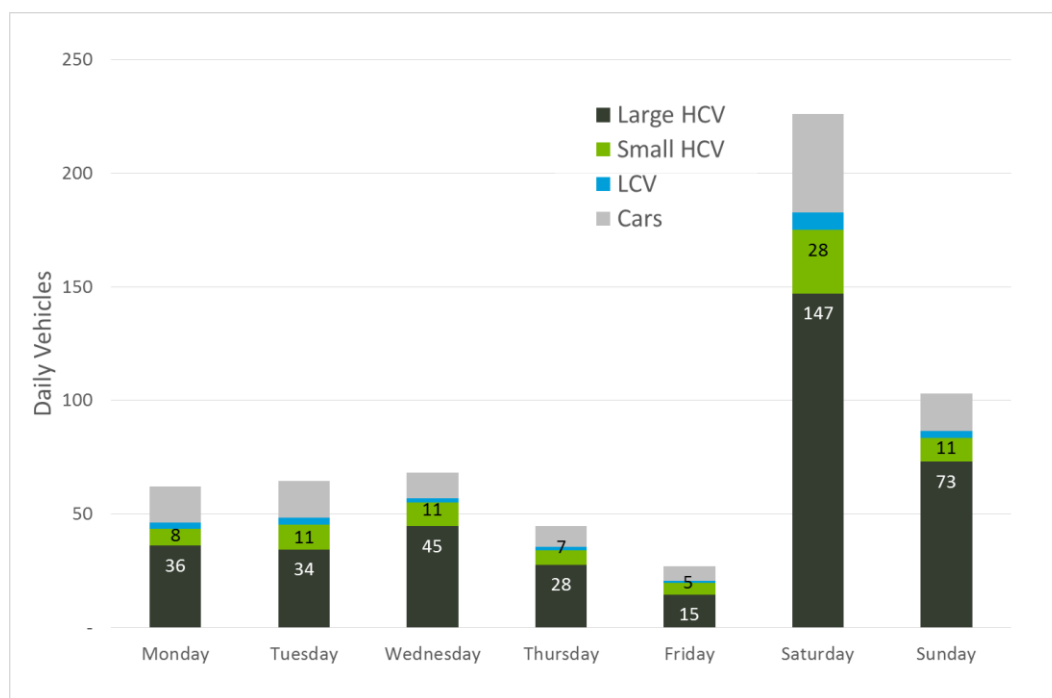
Terminals on Bumborah Point Road contribute approximately 2,500 trips to the port per weekday and 600 per day on the weekend. During the week, there is a high degree of variability, with the busiest days being Tuesday and Thursday, and the quietest weekdays are Monday and Friday.

Figure 69 - Daily vehicles exiting terminals on Simblist Road



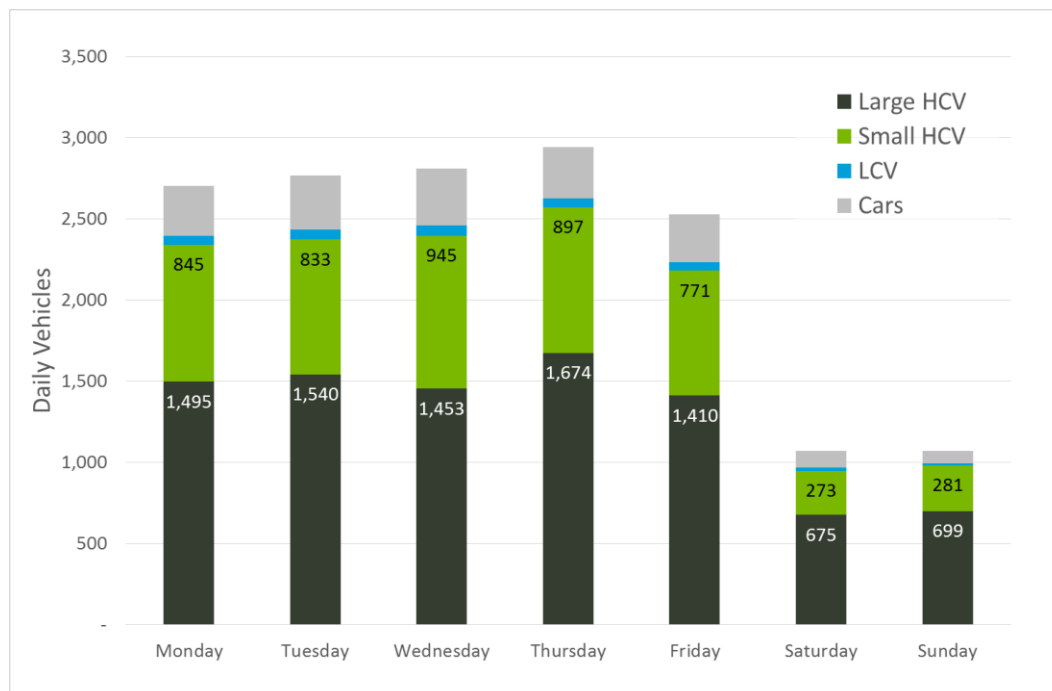
On Simblist Road, the number of vehicles averages 850 per weekday and nearly 350 on weekends. During the traditional workweek, Wednesdays and Fridays are the busiest days; Mondays and Tuesdays the quietest.

Figure 70 - Daily vehicles exiting terminals on Charlotte Road



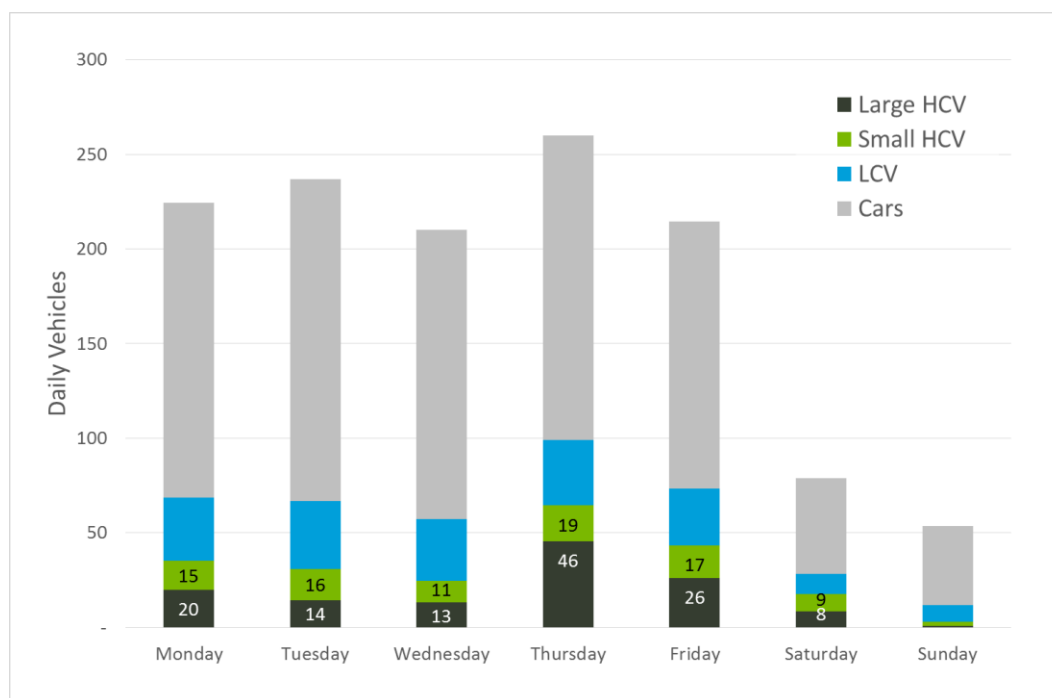
For Charlotte Road (the only terminal exit being DPW), the survey captured small numbers of vehicles during the week (only 50 per day), with considerably more vehicles on weekends (225 and 100), most likely representing bulk runs.

Figure 71 - Daily vehicles exiting terminals on Friendship Road



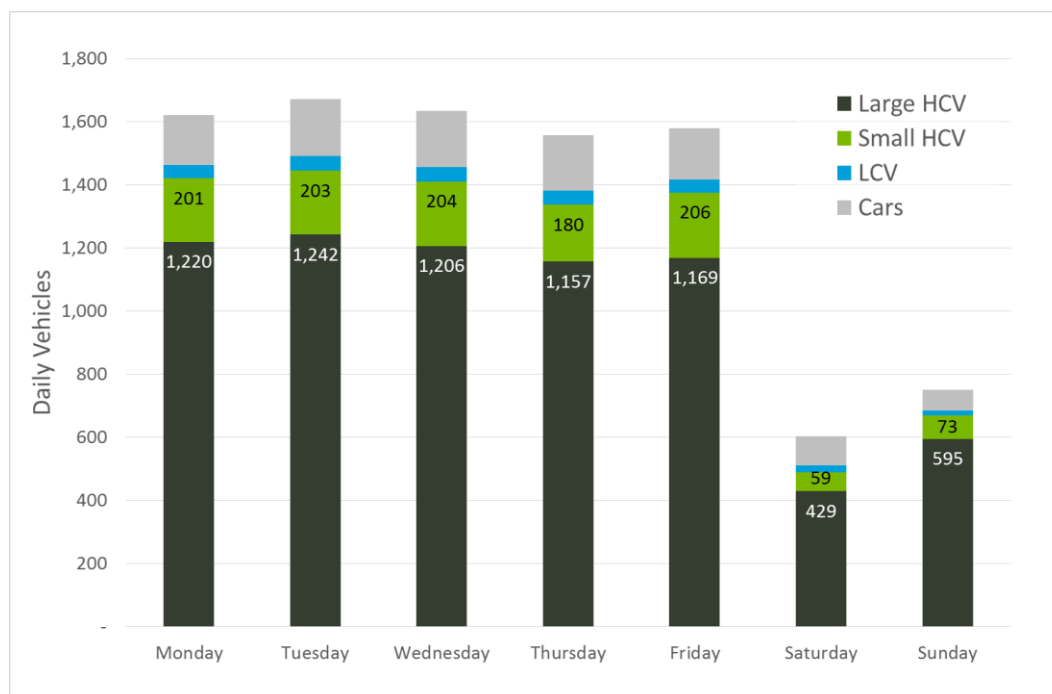
Terminals on Friendship Road contribute an average of 2,750 vehicles per weekday and 1,070 vehicles per day on the weekend. The variability is relatively low (volumes are consistent) during the traditional workweek, with Friday being the quietest day.

Figure 72 - Daily vehicles exiting terminals on Botany Road



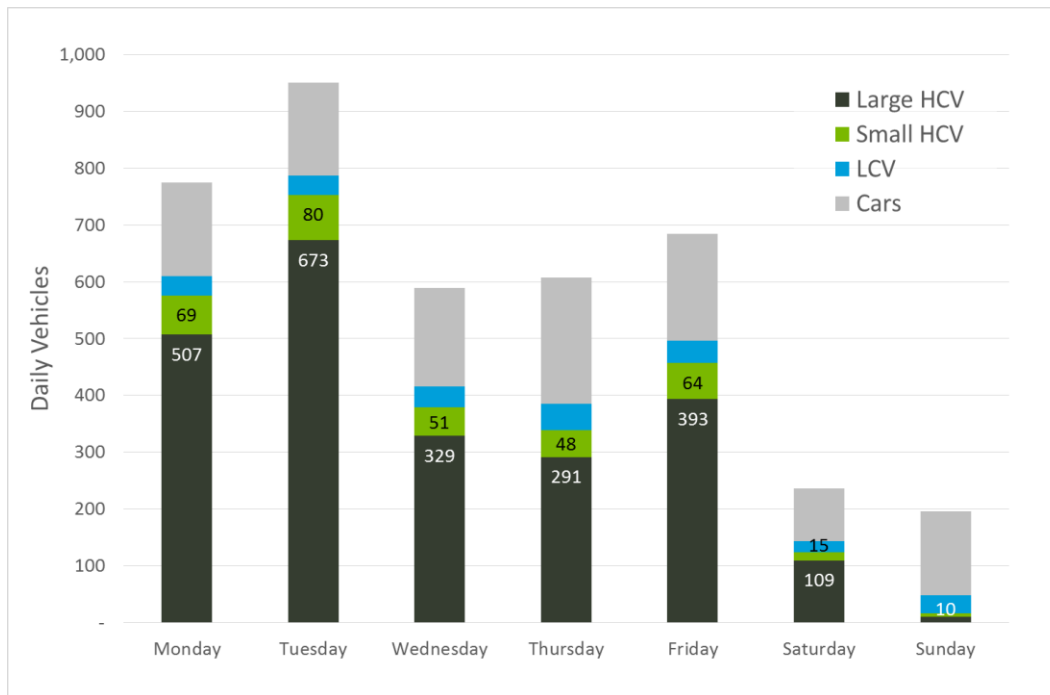
For the DPW Logistics terminal and Orora site located on Botany Road, the total number of vehicle movements (200-250) is significantly lower than the other roads and there is also a high degree of variability from day-to-day. As observed, Wednesdays are the quietest weekday and Thursdays are the busiest, with a high proportion of car traffic (relating mainly to Orora).

Figure 73 - Daily vehicles exiting terminals on Penrhyn Road



Unlike Botany Road, the Patrick terminals off Penrhyn Road have considerable weekday and weekend traffic, which is very consistent across the weekdays at around 1,600 vehicles. There is also considerable traffic on the weekend, with Sunday (750 vehicles per day) being slightly busier than Saturday (600 vehicles per day).

Figure 74 - Daily vehicles exiting terminals on Sirius Road



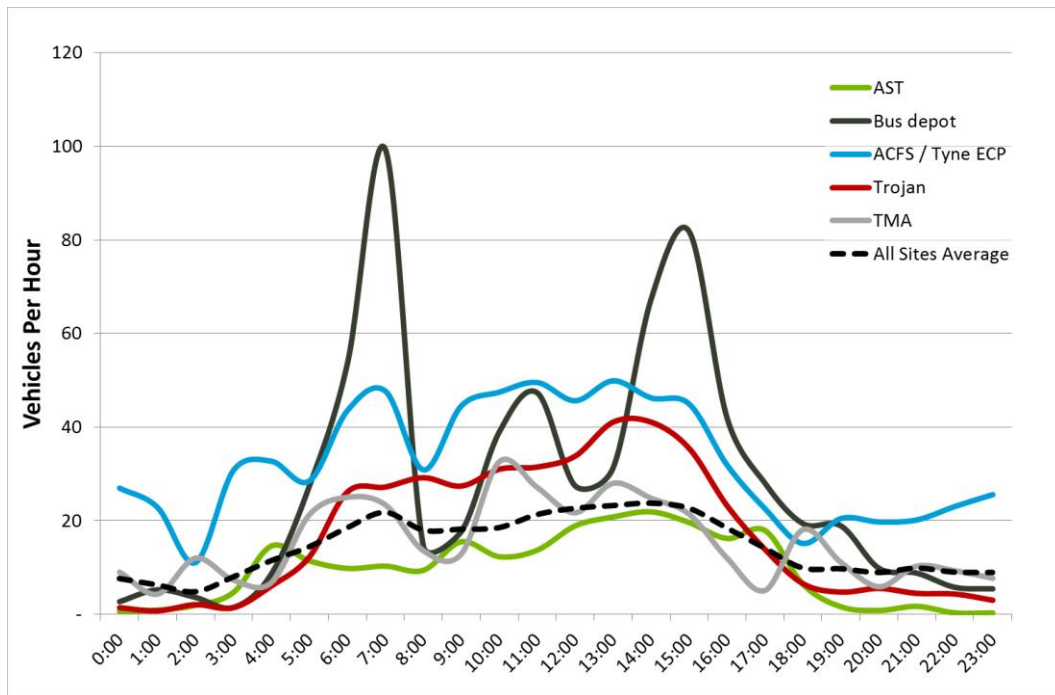
For Sirius Road (Hutchinson Ports), weekday traffic varies considerably, from a high of 950 for Tuesday down to fewer than 600 on Wednesday. Saturdays and Sundays are much quieter at approximately 200 vehicles per day, with virtually no trucks at all on Sundays.

In conclusion, for each of the roads in the port, weekday traffic is considerably higher than weekend traffic, with Friendship Road contributing the most vehicles (2,700 per weekday), then Bumborah Point Road (2,500 per weekday) and then Penrhyn Road (1,600 per weekday).

3.3.3 Times of Day

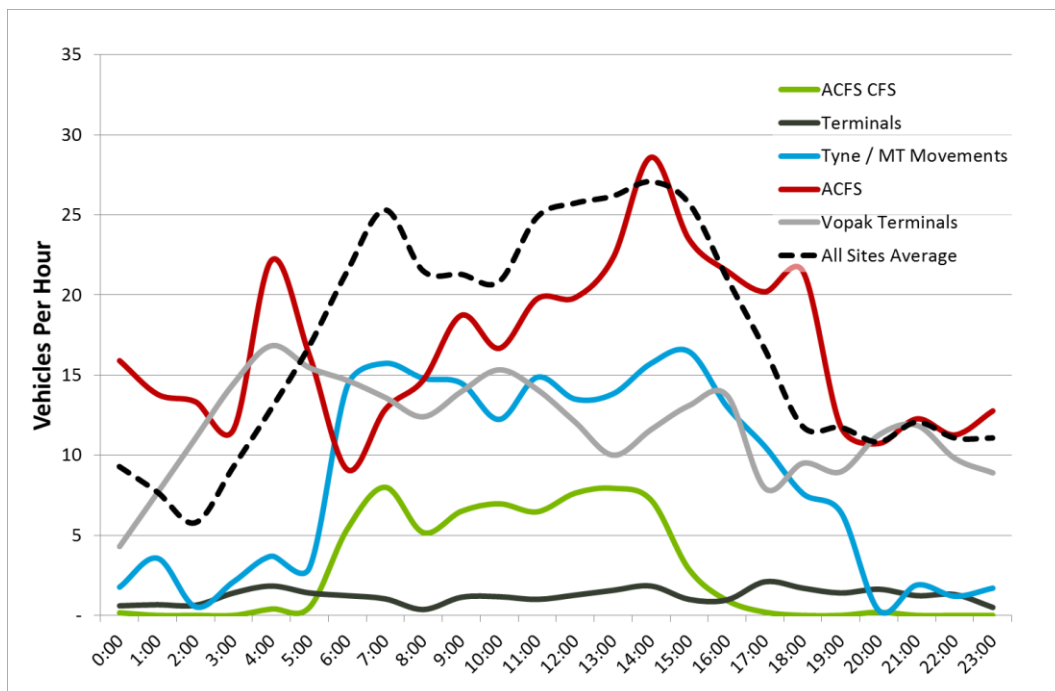
In Section 3.2.6 we provided times of day for each of the entry and exit roads for the port; this section contains times of day profiles for individual terminals for each road. Figures 75 to 80 show these time of day profiles.

Figure 75 - Weekday time of day profile for vehicles exiting terminals on Bumborah Point Road



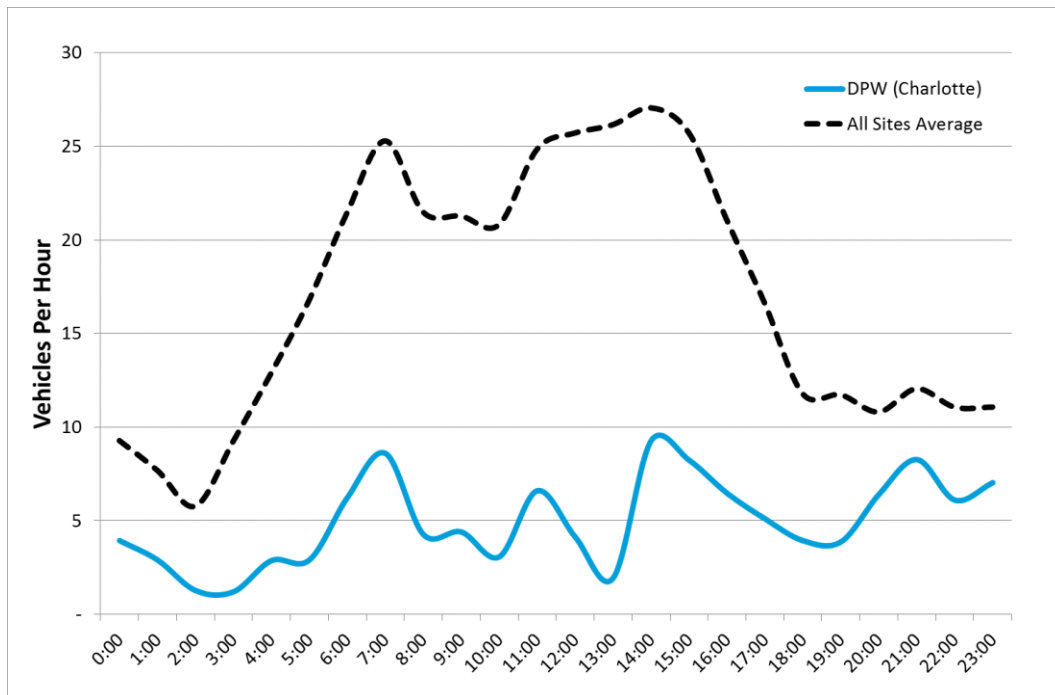
For each of the sites on Bumborah Point Road, there is a core period between 5:00 AM and 5:00 PM when traffic movements are highest. The bus depot, however, shows the highest level of departures before the AM and PM commuter peak periods.

Figure 76 - Weekday time of day profile for vehicles exiting terminals on Simblist Road



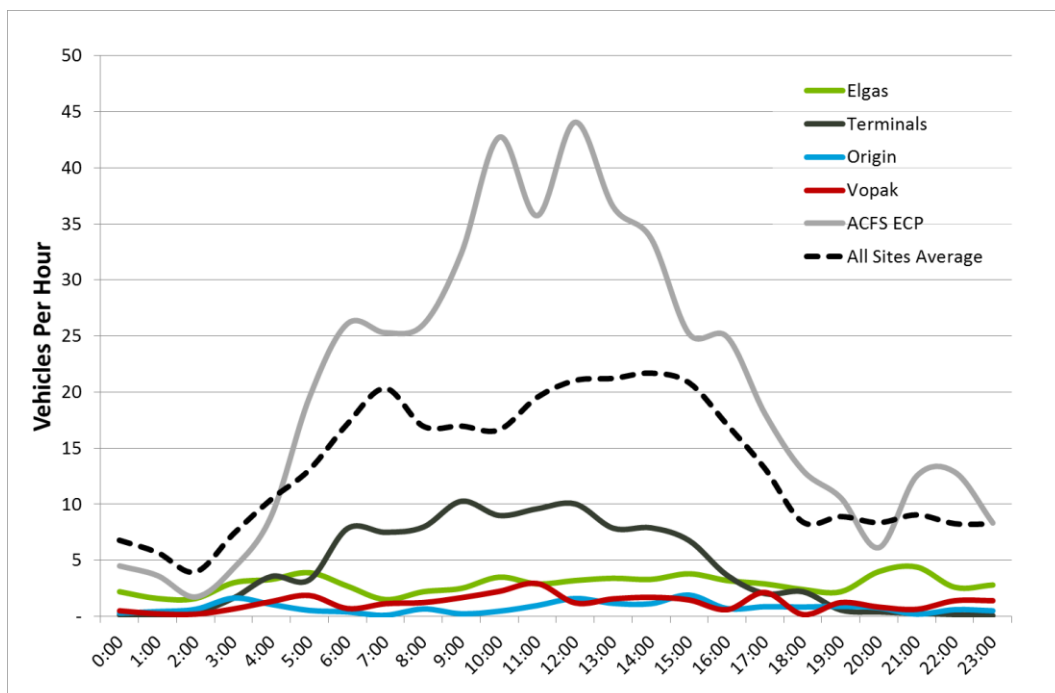
On Simblist Road, Terminals contributes very few movements overall, but they are spread very evenly across the full 24-hours, Tyne / MT Movements operates chiefly between 6:00 AM and 6:00 PM, and Vopak Terminals has several peaks, each 5 hours apart, likely to be associated with a 5-hour turnaround for a lot of the longer truck trips. ACFS has the greatest number of vehicle movements, with several peaks across the day.

Figure 77 - Weekday time of day profile for vehicles exiting terminals on Charlotte Road



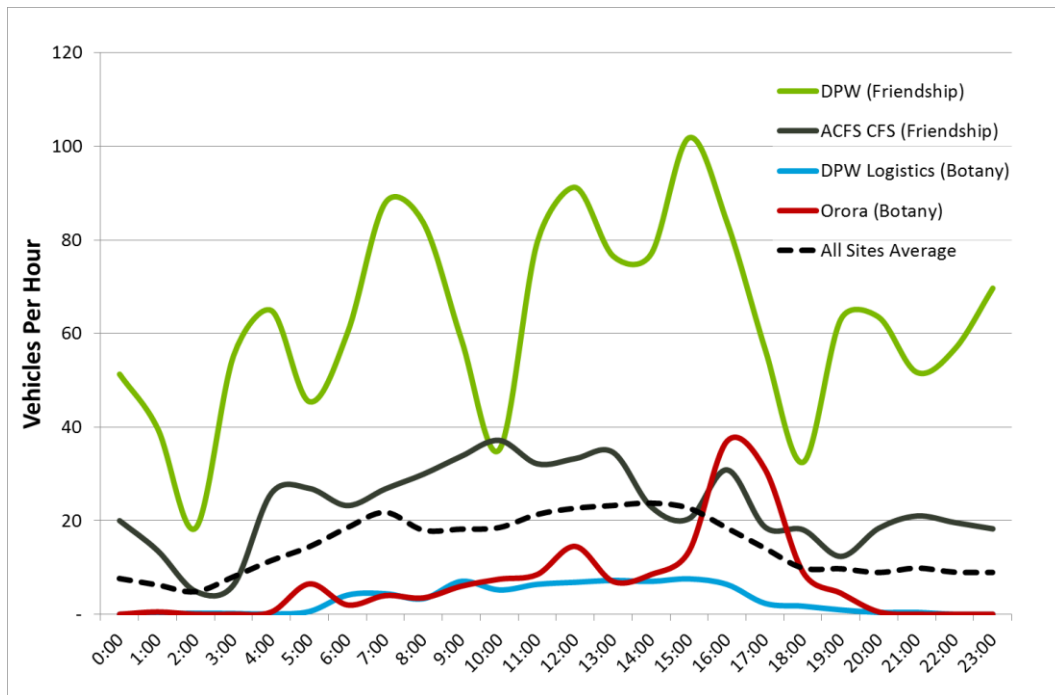
For DPW on Charlotte Road, the traffic movements are few and are relatively irregular across the day.

Figure 78 - Weekday time of day profile for vehicles exiting terminals on Friendship Road



For the terminals on Friendship Road, Elgas, Origin and Vopak all operate relatively evenly across the 24-hour period, while Terminals is busiest from 6:00 AM to 4:00 PM. The ACFS ECP terminal is the busiest of the terminals, with high demand starting at 6:00 AM and peaking in the middle of the day 10:00 AM to 2:00 PM.

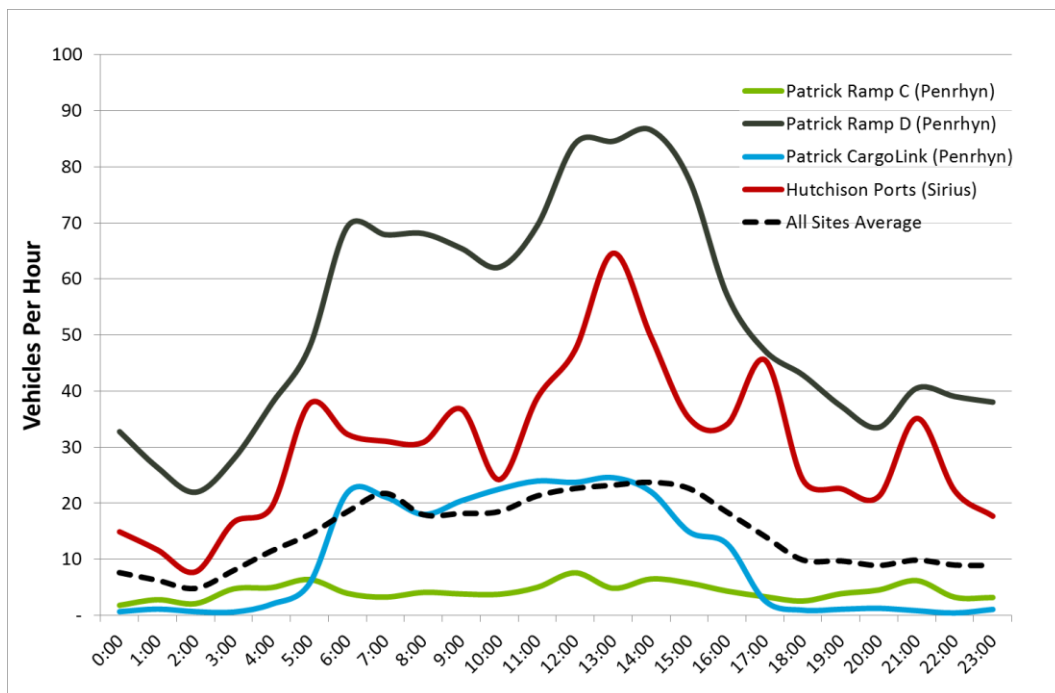
Figure 79 - Weekday time of day profile for vehicles exiting terminals on Friendship and Botany



For DPW on Friendship Road, we see higher traffic volumes and a high degree of variability from hour-to-hour, with the bulk of exits coming between 4:00 AM and 4:00 PM. For DPW Logistics on Botany Road, we observe core operating hours between 6:00 AM and 4:00 PM and consistent movements across the day.

For the Orora site, we observe similar core hours of 5:00 AM to 6:00 PM; however, the large peak from 4:00 PM to 6:00 PM implies an end-of-shift for an on-site type workforce, compared to the other terminals, which have vehicles entering and exiting throughout the day. This observation is consistent with the much higher number of cars (compared to trucks) that enter and exit this site.

Figure 80 - Weekday time of day profile for vehicles exiting terminals on Penrhyn and Sirius



For the Patrick terminals operating out of Penrhyn Road, we observe the busiest hours between 5:00 AM and 5:00 PM, with an afternoon peak for Ramp D between 12:00 PM and 4:00 PM. Ramp C has the lowest vehicle numbers and operates relatively evenly across the day.

For Hutchison Ports on Sirius Road, there is a high degree of variability from hour-to-hour, with some of the peaks caused by the end of shifts.

In conclusion, the time of day profiles vary considerably from terminal to terminal. However, most of the terminals have their busiest or core hours from 5:00 AM to 5:00 PM, with peaks and troughs either at shift-end times or preferred collection times (to get freight to customers at their preferred time).

3.4 Coal Pier Estate

Coal Pier Estate is a large industrial area within the Port Precinct, bounded by Stephen Road to the west, the railway line to the north and east, and Botany Road to the south (Figure 81). It has two main access points: Stephen Road and Botany Road.

Vehicles from the west must either use Botany Road from Southern Cross Drive or Foreshore Road and turn left into Botany Road. From the north, the most direct route is via Stephen Road. From the east, vehicles would use Botany Road, turning right at the Foreshore-Botany-Penrhyn intersection.

Figure 81 - Coal Pier Estate (shown in green)



Given the limited access routes, most vehicles travelling to and from the estate must interface and interact with other vehicles in the precinct. This includes vehicles using the Port Botany terminals and smaller industrial areas to the immediate east of the estate. It also includes through traffic (including commuter traffic). This section contains analysis related to this estate, with emphasis on the interface with the Foreshore-Botany Road main thoroughfare.

3.4.1 Overall Traffic

As part of the project, ATC data was collected within the Coal Pier Estate at key locations. Average weekday traffic numbers for these locations are shown in Table 31 and Figure 82.

Table 31 - Average weekday traffic (Coal Pier Estate)

Location	Detail	Direction	Car	LCV	Small HCV	Large HCV	Total
Botany (ATC)	South of Stephen	NB	3,418	1,018	927	134	5,497
		SB	3,857	1,149	1,088	247	6,341
		Total	7,275	2,167	2,015	381	11,838
Botany (ATC)	North of Penrhyn	NB	3,378	1,006	1,131	1,368	6,883
		SB	3,608	1,074	1,257	1,397	7,337
		Total	6,986	2,080	2,388	2,765	14,220
Botany (Video)	North of Penrhyn	NB	3,822	1,105	920	1,365	7,212
		SB	4,066	1,244	1,053	1,374	7,737
		Total	7,888	2,349	1,973	2,739	14,949
Botany (Video)	East of Penrhyn	EB	12,640	2,757	1,766	3,126	20,288
		WB	11,947	2,529	1,625	3,068	19,169
		Total	24,587	5,285	3,391	6,194	39,457
Coal Pier (ATC)	North of McPherson	NB	274	82	219	511	1,085
		SB	229	68	243	491	1,032
		Total	503	150	462	1,002	2,117
Exell (ATC)	North of Botany	SB	1,334	397	728	1,593	4,053
		Total	1,334	397	728	1,593	4,053
Foreshore (Video)	West of Penrhyn	EB	11,253	2,367	1,536	3,698	18,854
		WB	10,820	2,269	1,538	3,683	18,310
		Total	22,073	4,635	3,074	7,381	37,164
Hill (ATC)	North of Botany	NB	1,416	422	663	1,587	4,087
		Total	1,416	422	663	1,587	4,087
McPherson (ATC)	East of Coal Pier	EB	606	181	103	425	1,315
		WB	574	171	101	401	1,246
		Total	1,180	351	204	825	2,561
Penrhyn (ATC)	South of Foreshore	NB	601	155	201	1,274	2,231
		SB	541	140	247	1,259	2,188
		Total	1,142	295	448	2,533	4,418
Penrhyn (Video)	South of Foreshore	NB	658	164	105	1,425	2,351
		SB	642	173	96	1,391	2,301
		Total	1,300	336	201	2,815	4,652

Figure 82 - Average weekday traffic (Coal Pier Estate*)



*Other sites adjacent to Coal Pier Estate are shown for comparative purposes

As shown, Botany Road, south of Stephen Road carries 11,838 vehicles, while south of Exell Street it carries 14,220 per weekday. This implies that approximately 65% of vehicles using Hill Street access it from the south (the intersection of Foreshore-Botany-Penrhyn) and 35% from the north. A similar ratio is found for vehicles exiting the site. Therefore, an estimated 31% of the vehicles using Botany Road (between Stephen Road and Penrhyn Road) are associated with Coal Pier Estate.

Given the road network in the estate, of the 4,087 vehicles entering on an average weekday, approximately 27% are headed for the northern end of Coal Pier Road, 32% to the eastern end of McPherson Street and the remaining 40% of vehicles travel to other parts of the estate.

3.4.2 Proportion of Coal Pier Estate-related vehicles in Port Precinct

In a similar way to understanding the number of port-related vehicles in the precinct, it is possible to estimate the proportion of Coal Pier Estate-related vehicles entering the precinct.

Table 27 shows a comparison of vehicles entering the precinct versus the number of vehicles entering Coal Pier Estate using Hill Street (off Botany Road).

Table 32 - Vehicles entering the Port Precinct related to the Coal Pier Estate

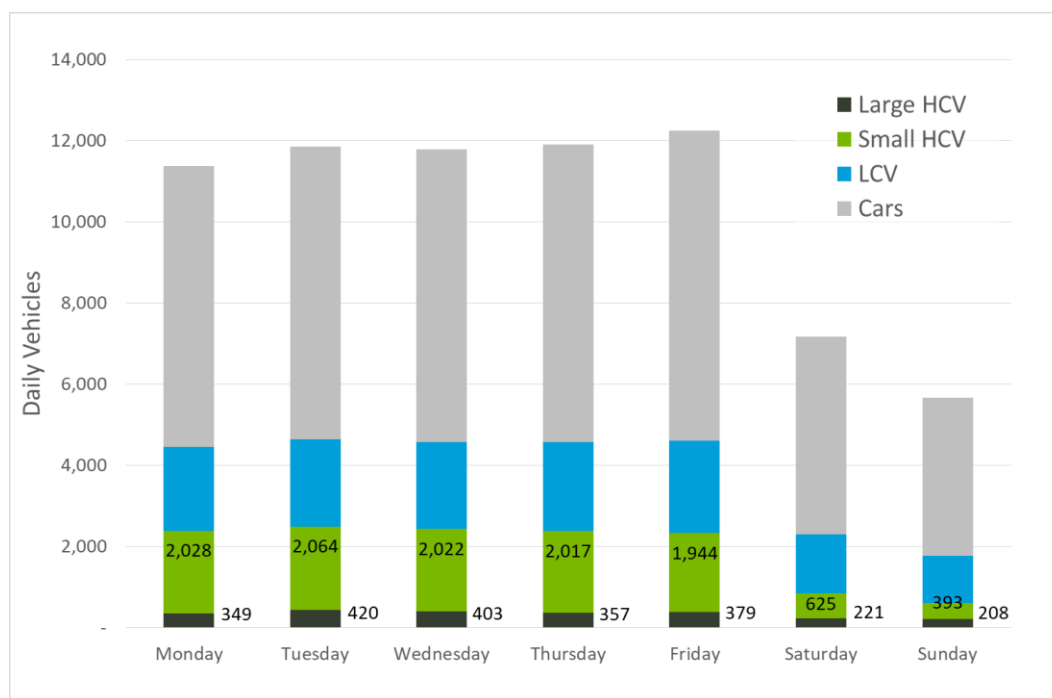
Location	Detail	Direction	Car	LCV	Small HCV	Large HCV	Total
Foreshore (ATC)	North of Hale	SB	14,723	3,092	2,741	3,636	24,191
Botany (ATC)	South of Stephen	SB	3,857	1,149	1,088	247	6,341
Beauchamp (ATC)	North of Botany	SB	6,024	1,444	1,066	914	9,448
Botany (ATC)	East of Bumborah	WB	3,967	751	814	119	5,651
Military (Video)	East of Bumborah	SB	709	146	286	227	1,367
Total entering Port Precinct			29,279	6,581	5,995	5,143	46,997
Total entering Coal Pier Estate			1,416	422	663	1,587	4,087
Percentage of traffic that is Coal Pier Estate-related			5%	6%	11%	31%	9%

As shown, 9% of all traffic within the precinct is related to Coal Pier Estate, with the highest percentage (31%) relating to Large HCVs. Car and LCV traffic is the smallest at 5% and 6% respectively.

3.4.3 Days of the Week

Like the remainder of the precinct, the Coal Pier Estate changes according to the day of the week. Figures 83 to 88 show the average number of vehicles by type for each day of the week.

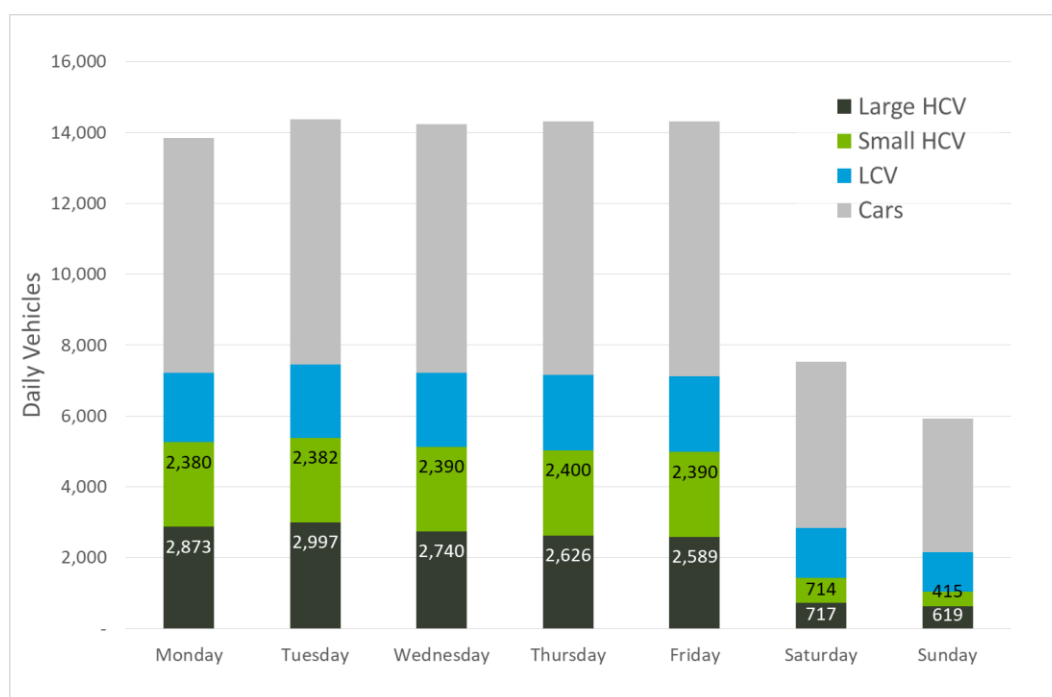
Figure 83 - Daily vehicles - Botany Road (south of Stephen Road)



Botany Road, immediately south of Stephen Road, borders the Coal Pier Estate at its southern edge. Consequently, it contains a variety of different traffic streams, including traffic not related to Coal Pier Estate. This is shown in the figure above by the high proportion of car traffic and relatively small proportion of Large HCVs.

Across the traditional workweek, Monday is the quietest day and Friday is the busiest, but with very consistent volumes of around 12,000 vehicles per day. Weekends are significantly lower, with Sunday being the quietest day of the week with fewer than 6,000 vehicles.

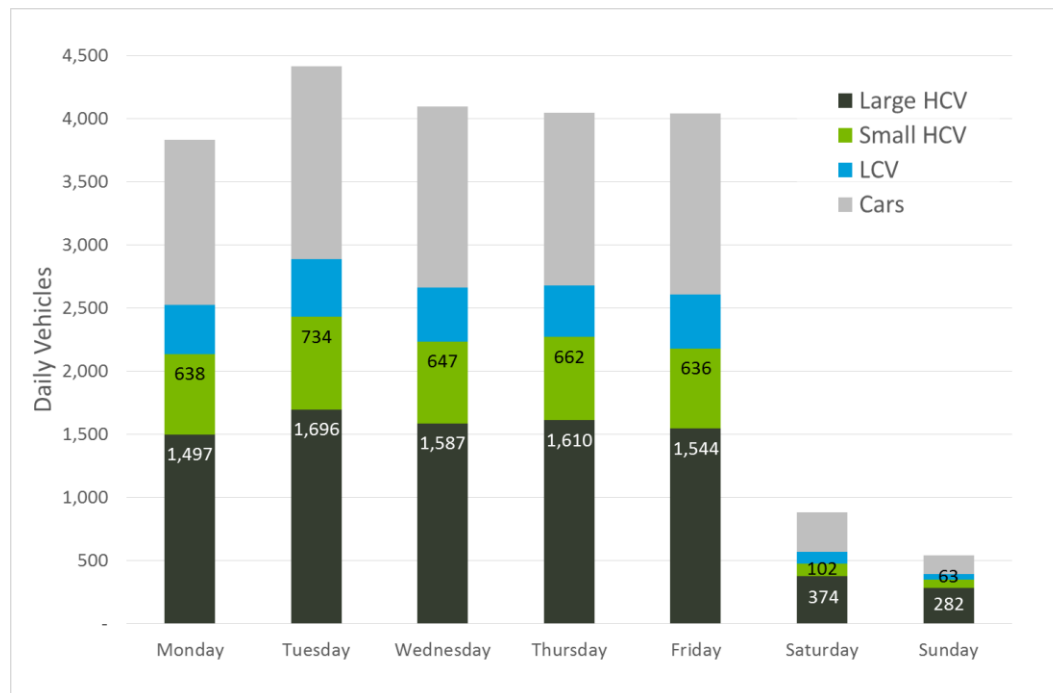
Figure 84 - Daily vehicles - Botany Road (north of Penrhyn Road)



Further down Botany Road, after the main Coal Pier Estate entrance and exit points (Hill Street and Exell Street respectively), we observe the same overall weekly pattern of consistent traffic volumes Monday to Friday, with less traffic on Saturday and Sunday.

Overall, the volumes on this section of road number approximately 2,000 vehicles per day higher than the road section just south of Stephen Road. Within this the most significant increase is in Large HCVs, while there is a small reduction in cars. This implies that most of the Large HCVs destined for the Coal Pier Estate come from the south, along the Foreshore-Botany Road corridor. A proportion of cars destined for the estate, however, come from the northwest, evidenced by the lower level of car traffic on this section of Botany Road.

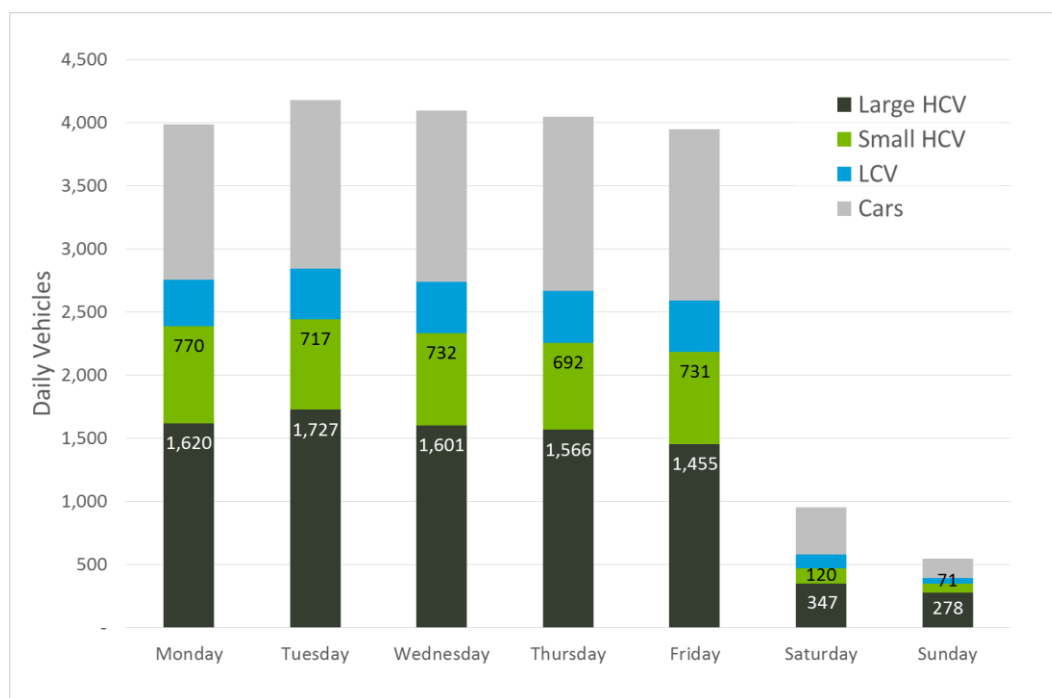
Figure 85 - Daily vehicles - Hill Street



The main entrance into Coal Pier Estate is the one-way road Hill Street, which runs off of Botany Road. This road averages approximately 4,000 vehicles per average weekday and approximately 700 on weekends. From the above chart we observe that the traffic is relatively consistent Monday to Friday and that Monday is the quietest day of the workweek, with Tuesday the busiest.

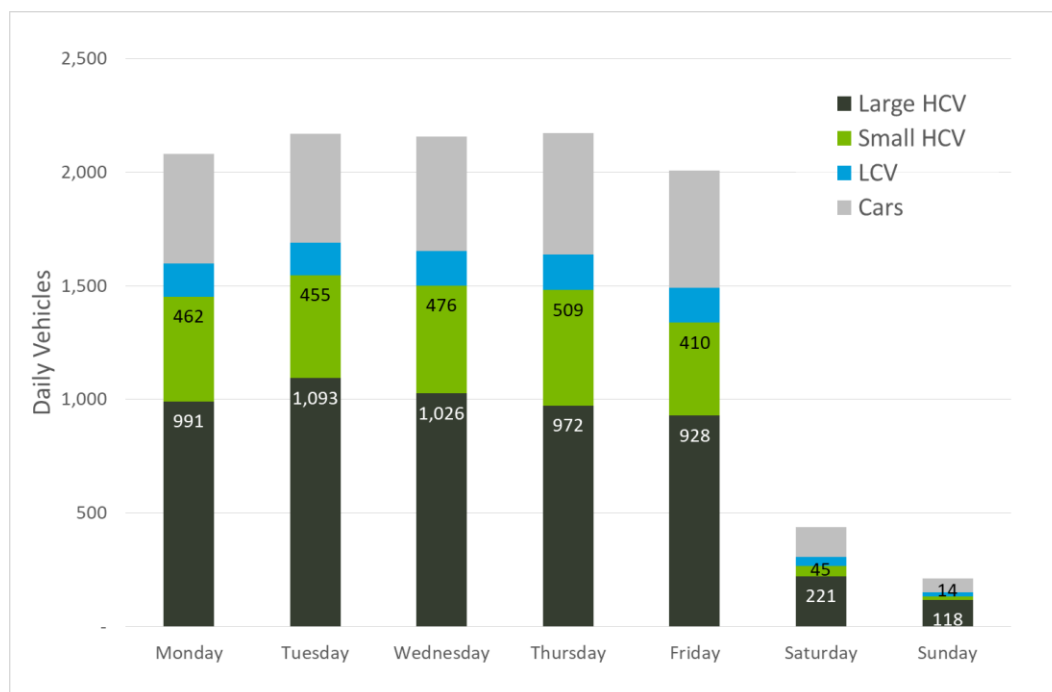
Notably, traffic on this road includes over 2,000 trucks per day (representing over 50% of all traffic), which compares to 20% and 36% on Botany Road (south of Stephen Road and north of Penrhyn Road respectively).

Figure 86 - Daily vehicles - Exell Street



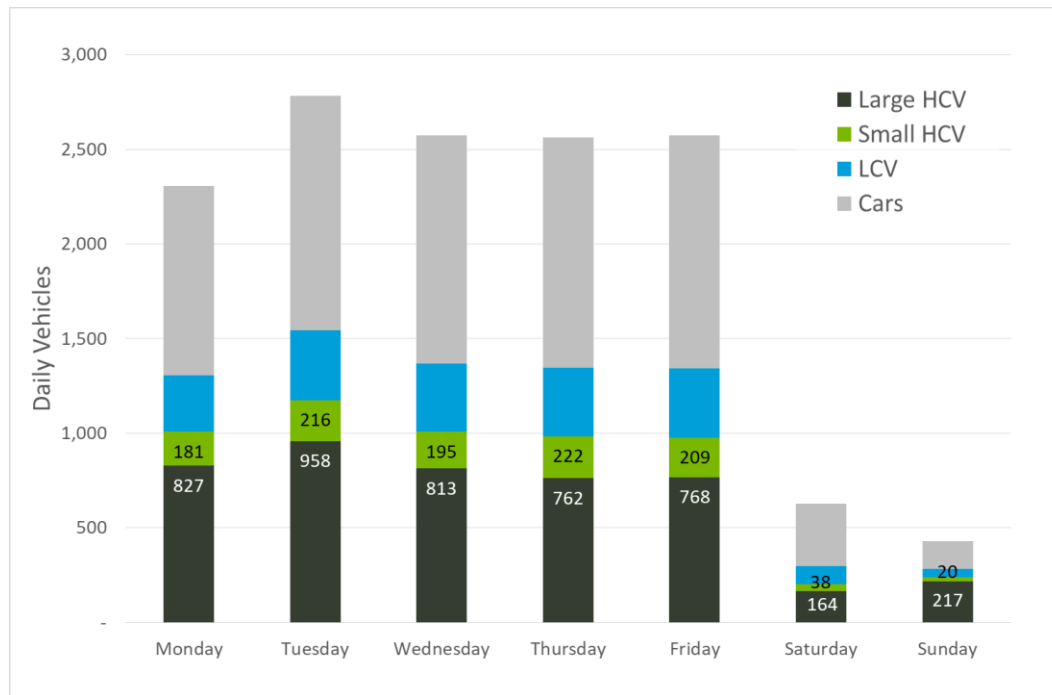
Exell Street is the main exit to Coal Pier Estate, complementing Hill Street as the entrance. We would therefore expect traffic volumes to be fairly balanced between the two, unless vehicles were entering via Hill Street and exiting using a different route. We observe a very similar profile and proportion of trucks across the two sites.

Figure 87 - Daily vehicles - Coal Pier Road



On Coal Pier Road, we observe consistent volumes of traffic each day during the traditional workweek, with Monday and Friday being the quietest days. We observe an even higher proportion of trucks on this section of road, with an average of 69%.

Figure 88 - Daily vehicles - McPherson Street (east of Coal Pier Road)



Traffic on McPherson Street is quietest on Monday and busiest on Tuesday, but has relatively fewer trucks (40%) compared to other sites within the estate.

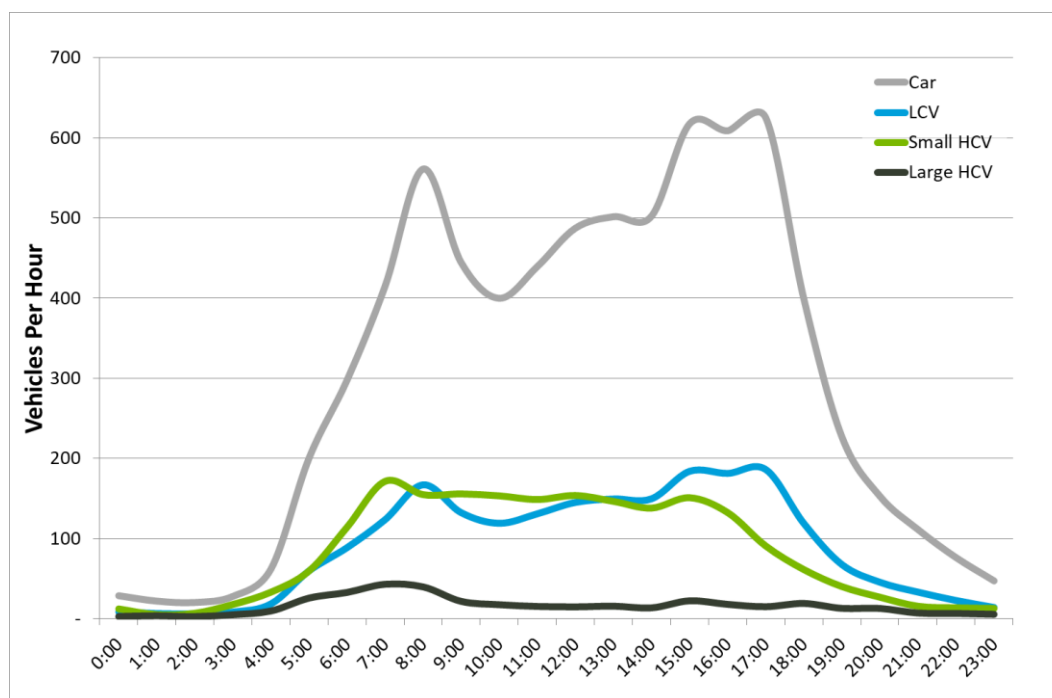
In conclusion, from the traffic data it is evident that Coal Pier Estate is predominantly a Monday to Friday operation, with approximately 4,000 vehicles per day entering via Hill Street and exiting via Exell Street each weekday. The volume of traffic is very consistent from day-to-day, with Monday generally being the quietest weekday.

As expected, the proportion of trucks is high, and it is relatively balanced between Small and Large HCVs; the latter mostly coming up from the Foreshore-Botany Road route, rather than down Botany Road. The proportion of trucks does vary throughout the estate, with approximately 55% entering via Hill Street, increasing to 69% on Coal Pier Road, but down to 40% on the eastern section of McPherson Street.

3.4.4 Times of Day

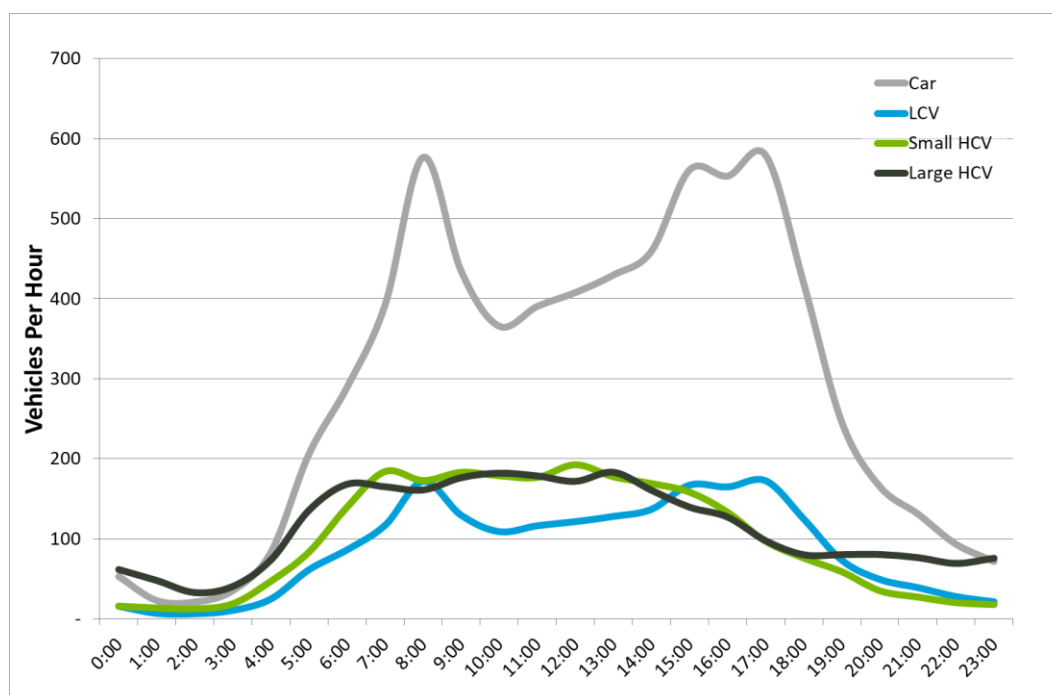
The analysis of vehicles operating in Coal Pier Estate has focused on the total volumes of traffic, how this changes across the week and the proportion of cars to trucks. This section drills down further into the times of day the vehicles are operating, to reveal shift patterns and general vehicle movements. Figures 89 to 94 show the time of day profiles for roads bordering, or within, the Coal Pier Estate.

Figure 89 - Weekday time of day profile - Botany Road (south of Stephen Road)



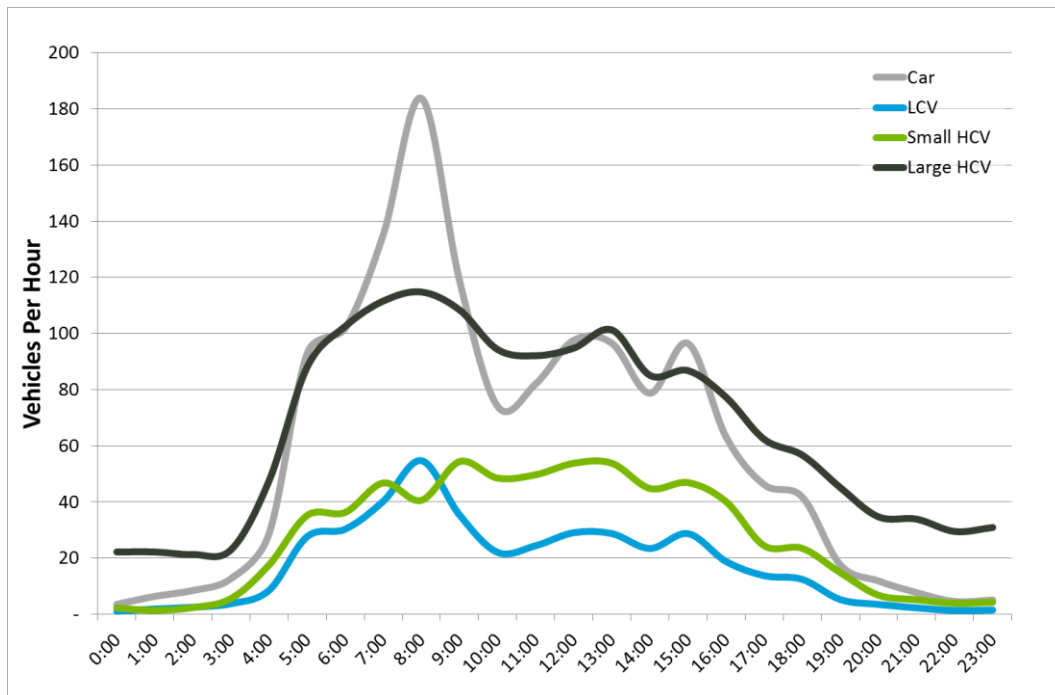
For the section of Botany Road immediately west of Coal Pier Estate (which carries a significant proportion of other streams of traffic), we observe for cars a short morning peak at 8:00 AM and a long afternoon peak from 3:00 PM to 6:00 PM. For both Small HCVs and Large HCVs, traffic volumes are very consistent across the day from 7:00 AM to 4:00 PM, before decreasing to very small overnight volumes.

Figure 90 - Weekday time of day profile - Botany Road (north of Penrhyn Road)



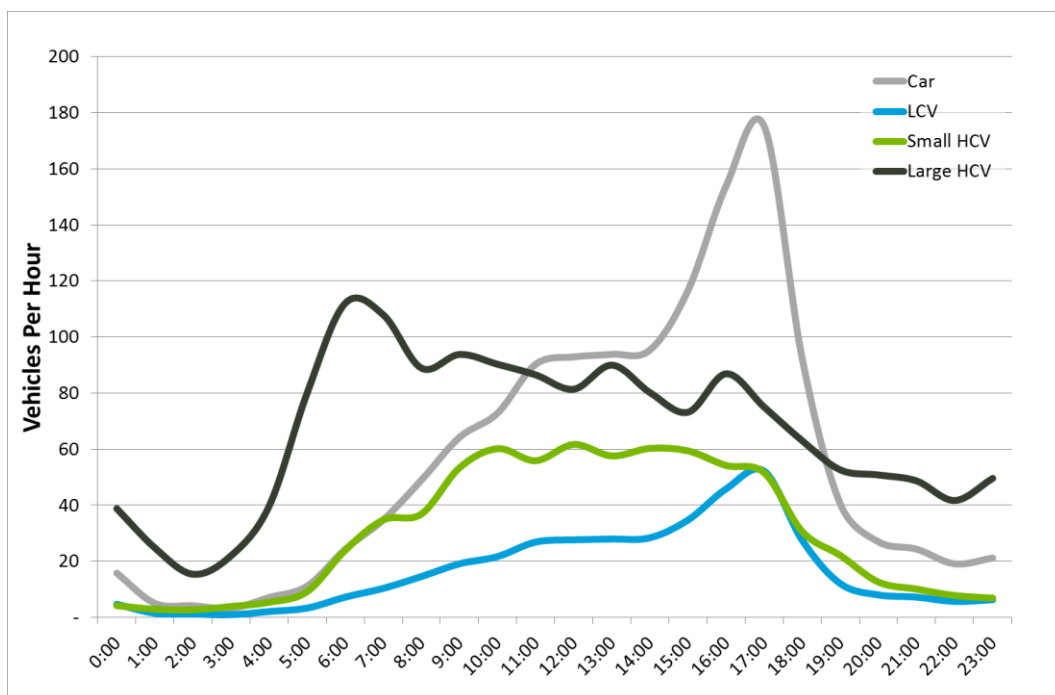
Further down Botany Road closer to the Foreshore-Botany Road corridor, we observe a very similar overall pattern, with a significant increase in the number of Large HCVs. There is an increase in overnight traffic for Small HCVs and a considerable overnight traffic for Large HCVs.

Figure 91 - Weekday time of day profile - Hill Street



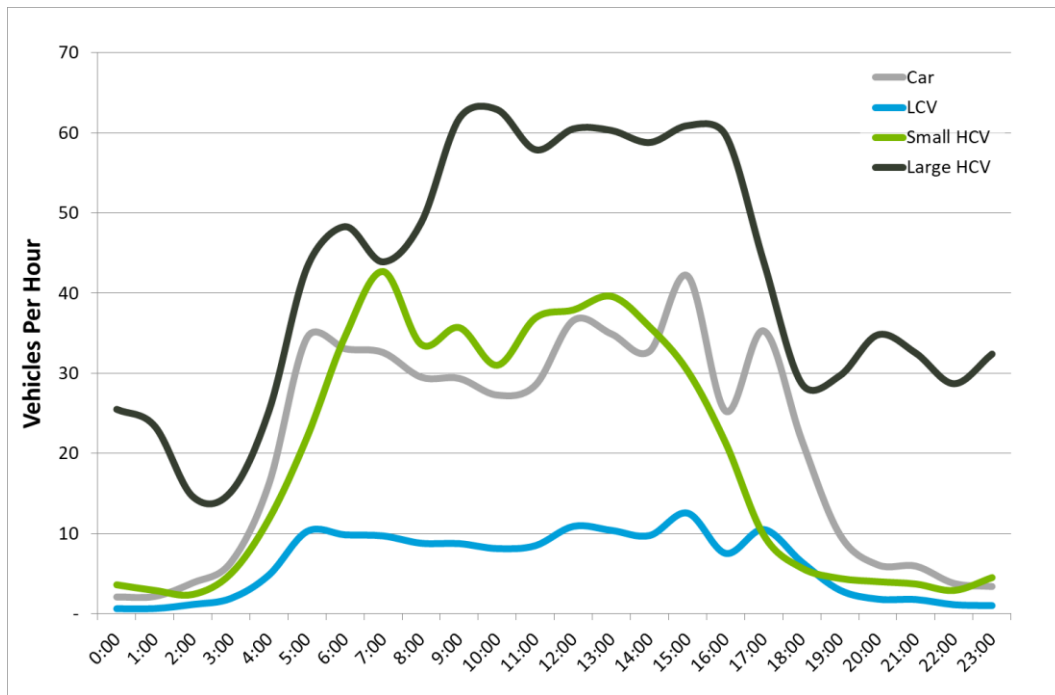
For Hill Street, the main entry point into Coal Pier Estate, we observe a large morning peak between 8:00 AM and 9:00 AM, with two smaller afternoon peaks at 12:00 PM and 3:00 PM. For Large HCVs, we observe that the morning from 5:00 AM until 10:00 AM is the busiest, with a sharp decline after 4:00 PM. For Small HCVs, the peak is in the middle of the day, but fairly even vehicle numbers from 5:00 AM through to 5:00 PM.

Figure 92 - Weekday time of day profile - Exell Street



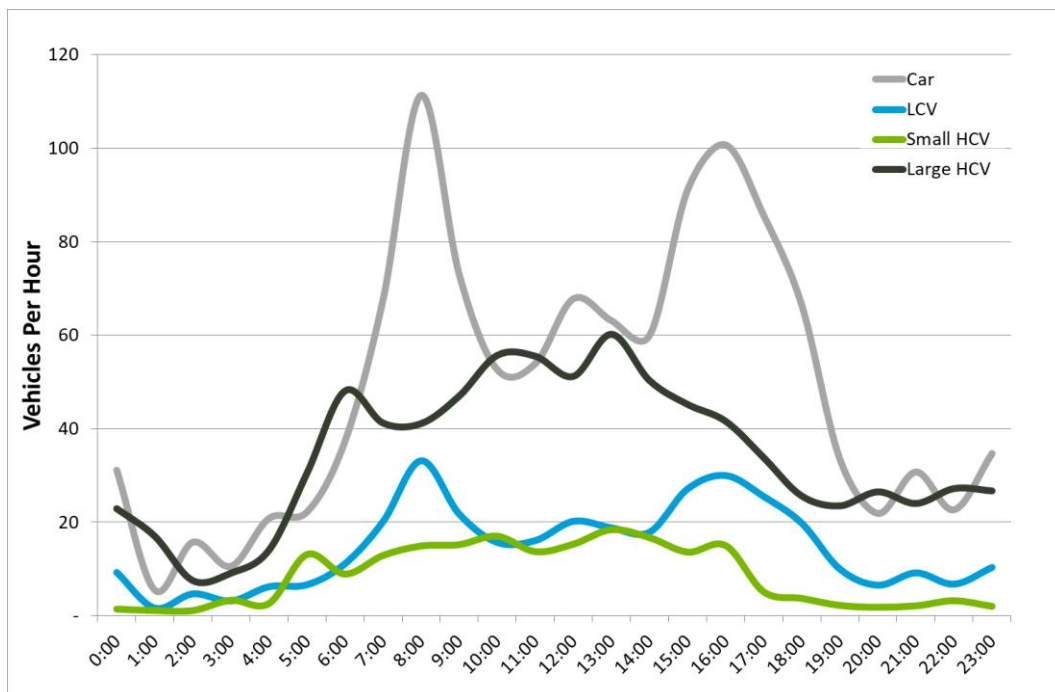
As expected, Exell Street, to some extent, mirrors Hill Street, with a large afternoon peak for cars at 5:00 PM. It carries relatively even numbers of Small and Large HCVs through the day, but slightly more Large HCVs in the morning and slightly more Small HCVs in the afternoon.

Figure 93 - Weekday time of day profile - Coal Pier Road



For Coal Pier Road, we observe fewer cars, with relatively steady traffic (not much in the way of peaks) between 5:00 AM and 6:00 PM. For Small HCVs, there is a small morning peak between 7:00 AM and 8:00 AM, with a small afternoon peak at 1:00 PM. For Large HCVs the highest volumes are between 9:00 AM and 6:00 PM.

Figure 94 - Weekday time of day profile - McPherson Street (east of Coal Pier Road)



For cars travelling on McPherson Street, there are large morning and afternoon peaks, with a small lunch peak at 12:00 PM. Most of the truck traffic is Large HCVs, with variable demands starting at 6:00 AM, peaking at 1:00 PM, before decreasing to steady night volumes of 25 trucks per hour.

In conclusion, the time of day profiles for the Coal Pier Estate show behaviour consistent with a traditional workforce, with a majority of cars arriving by 8:00 AM and leaving by 6:00 PM. A large percentage of these cars (42%) park in or drive along, McPherson Street.

Overall, trucks do not exhibit morning and afternoon peaks similar to those for cars. Instead, truck traffic increases in the early morning, remains relatively even throughout the day between 5:00 AM and 6:00 PM, before decreasing overnight. This picture is consistent with truck profiles on Botany Road and through the entire precinct.

4 Discussion

The overall aim of the Port Botany Freight Study is to provide information about traffic operating within the port and the Port Precinct to allow NSW Ports to understand:

1. The number of vehicles operating on different roads within the precinct;
2. The types of vehicles using the roads, both within the port and on its boundary;
3. The terminals and locations within the port that are contributing the most to vehicle movements within the port;
4. The days of the week that are the busiest; and
5. The times of day that are the busiest or the quietest (and how this contributes to understanding the operations of different terminals).

Through a comprehensive data collection and analysis across 4 intersections, 22 on-road ATC sites and 22 ATC terminal sites in the precinct, NSW Ports now has a much better understanding of this traffic. The core findings from this study are described below.

Wider Port Precinct

1. Foreshore Road carries approximately 46,100 vehicles into the Port Precinct per average weekday, of which approximately 86% are from the west and 14% from the east on General Holmes Drive. By the intersection of Foreshore Road, Botany Road and Penrhyn Road, traffic has dropped to 37,200 (as some traffic leaves Foreshore Road at Hale Street or Sirius Road).
2. The busiest section along the corridor is on Botany Road, between Foreshore Road and Beauchamp Road, with approximately 39,500 vehicles per day.
3. As Botany Road heads further east, the number of vehicles keeps decreasing and east of Bumborah Point Road, Botany Road is only carrying 11,200 vehicles per average weekday (mostly cars).
4. Along this corridor, approximately 25% of vehicles are either Small HCVs or Large HCVs, emphasising the importance of the corridor for access to the port and the industrial area (including Coal Pier Estate) immediately north of Botany Road.
5. To the north and east of Botany Road, there is more Small HCV traffic and, for the port itself, there is more Large HCV traffic. The percentage of trucks varies throughout the precinct, from 11% on Perry Road up to 71% on Friendship Road, with an average of 30%. This compares to an average of approximately 10%³ across Sydney.
6. On multilane highways, speed starts to decrease as congestion builds to 1,120 PCUs per lane per hour. Based on the available data, this rate is only exceeded at the northern end of Foreshore Road in the AM-peak.
7. Congestion in the precinct is therefore likely to be caused by queuing at intersections because of non-optimised signal timings, inefficient or inappropriate intersection design (not enough turn lanes), or insufficient available timing (too many vehicles from multiple directions at the same time).

Port Botany (the Port)

1. Access to Port Botany is through Sirius Road, Penrhyn Road, Bumborah Point Road and Military Road. On an average weekday, there are approximately 10,500 vehicles entering the port, of which 6,500 are trucks. On weekends, traffic volumes drop to an average of 4,700 vehicles per day, of which 2,200 are trucks.
2. The majority of vehicles enter the port using Bumborah Point Road, both on weekdays and weekends. This is because Bumborah Point Road is the main access to Simblast and Friendship Roads, as well as containing many terminals itself.

³ 10% is based on Aurecon's experience with data collection for other studies conducted in Sydney.

3. Across the week, there is some variability in which days are the busiest, but these are different for each entry road.
4. Container Trucks (laden or unladen) make up the bulk of truck movements in the port, with 89% Container Trucks on Penrhyn Road, 67% Container Trucks on Bumborah Point Road, and 50% Container Trucks on Military Road. Of the Container Trucks entering the port, 58% were classified as laden and 42% as unladen. For those exiting the port, there were 63% laden and 37% unladen.
5. Other prevalent heavy commercial vehicle types observed were: Buses (11%, particularly on Bumborah Point Road), Pantechs (8%) and Tankers (7%).
6. Across the day, cars and trucks have markedly different time of day profiles, which are also different on different access roads. Cars have noticeable peaks at times for the start and end of shifts, whereas most trucks tend to have the greatest activity and therefore highest volumes towards the middle of the day.
7. For vehicles entering the whole precinct, nearly one quarter are associated with the Port, overall only a small percentage of light vehicles (11-12%) and a large proportion of Large HCVs (90%).

Port Terminals

1. Of the 24 terminals for which data was collected and analysed, the three busiest were: DPW Stevedores (Friendship Road), with 1,500 vehicles per day; Patricks Ramp D (Penrhyn Road), with 1,250 vehicles per day; and Hutchison Ports (Sirius Road), with 750 vehicles per day.
2. Traffic volumes from Monday to Friday were relatively consistent, but with no distinct pattern for which weekday is generally the busiest.
3. Time of day profiles showed individual traffic characteristics, with the core period of activity between 5:00 AM and 5:00 PM for most terminals.

Coal Pier Estate

1. The Coal Pier Estate generates approximately 4,000 inbound and 4,000 outbound trips from Botany Road on an average weekday. This represents approximately 30% of all traffic on that section of Botany Road. We estimate that 65% of this traffic comes from the Foreshore Road-Botany Road corridor and 35% comes from the north.
2. Of this traffic, 45% of the vehicles are cars and LCVs, with a morning arrival peak of 240 vehicles per hour at 8:00 AM and an afternoon departure peak of 230 vehicles per hour at 5:00 PM. Of the cars and LCVs that enter, 42% of them park at the eastern end of McPherson Street. There is very little in the way of day-to-day changes during the traditional workweek.
3. Of the vehicles that enter Coal Pier Estate, 55% are trucks, roughly one-third Small and two-thirds Large HCVs. Trucks maintain a relatively even profile across the day, with slightly more Large HCVs in the morning and slightly more Small HCVs in the afternoon.
4. Nearly 10% of the vehicles in the whole precinct are associated with Coal Pier Estate.

In conclusion, the Port Botany Freight Study has undertaken detailed and rigorous data collection and analysis to quantify the number of vehicles within Port Botany and the Port Precinct, as well as to understand the types of vehicles, the days of week and the times of day they are operating.

This should provide an evidence-base for improvements and investments to ensure efficient operation of the port and movement of vehicles into, out of, and through the precinct. This will ensure that NSW Ports is able to maintain the long-term sustainability of Port Botany and support the economic growth for NSW that it brings.



*Bringing ideas
to life*

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