Technical Note

Title	**Rail Level Crossing Modelling Traffic Management Plan West Dapto Road – Kembla Grange**		
Client	Wollongong Recycling & Building Supplies Pty Ltd	**Project No**	82015053
Date	17 December 2014	**Status**	Version B
Author	David Yu	**Discipline**	Traffic and Transport
		Office	Sydney

1 Introduction

Cardno has been engaged by Wollongong Recycling and Building Supplies Pty Ltd to prepare a Modelling Traffic Management Plan in relation to traffic impact on the railway level crossing located on West Dapto Road, Kembla Grange NSW. This technical note is in response to Sydney Trains comments regarding the proposed expansion of the Re-cycling Facility located at 50 Wylie Road, Kembla Grange.

The railway level crossing is located at West Dapto Road on the northern side of Princes Highway, between Wylie Road and Princes Highway. This railway level crossing is located to the west of the Kembla Grange train station.

Figure 1 shows the location of the railway level crossing.

Figure 1: Site Location

2 Scope of Work

The following works have been undertaken as part of this study:

> Collate data and review background documents for the study site (railway level crossing and signalised intersection of West Dapto Road/Princes Highway);

> Assess traffic volumes based on existing (including committed developments which includes: Prixcar site, PAC Stage 2, and PAC Stage 3) plus proposed development flows (Wollongong Recycling and Building Supplies). The scenarios to be tested are 'Existing conditions,' and 'Future Baseline with Developments.'

> Undertake assessment of railway level crossing and the West Dapto Road / Princes Highway intersection using SIDRA modelling software;

> Extract anticipated performance indicators from the model such as queue lengths at the boom gate approach when it is closed; and

> To check if the proposed development with the baseline flows (including committed developments) is within the ALCAM rating of the rail crossing for the forecast design year.

Assumptions

> Traffic survey data and forecasted traffic from the Rail Level Modelling Traffic Management Plan report (for the Prixcar site, PAC Stage 2, and PAC Stage 3 developments) undertaken by Cardno (November 2014) used as a basis for baseline and committed development traffic generation.

> The weekday AM and PM peak hour periods shall be the focus of the assessment.

> We shall assume an annualised growth rate based on previous studies data.

> A freight train service assumed to operate during the peak periods.

3 Existing Conditions

ALCAM Rating

On the 13 October 2014 a traffic tube count (**Appendix A**) was undertaken for a seven day period (24 hours per day) adjacent to the railway level crossing on West Dapto Road. The survey results showed the total volume of traffic along West Dapto Road that would travel along the rail level crossing. The peak hour traffic volumes were also obtained for the AM and PM peak periods. The total daily volumes for the 7 days extracted from the traffic tube count survey data are shown below in **Table 1**.

Table 1: Total Daily Traffic Volumes (vehicles per day)

Daily Total Traffic Volume	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Eastbound	1660	1661	1734	1654	1748	1382	955
Westbound	1640	1688	1742	1702	1752	1403	989
Combined	**3300**	**3349**	**3476**	**3356**	**3500**	**2785**	**1944**

Based on discussions with Railcorp, the ALCAM rating was obtained for this rail level crossing adjacent to Kembla Grange train station, which is 3700 vehicle movements per day. As shown above the survey data reveals that the existing daily traffic volume is close to the ALCAM rating capacity of the rail level crossing.

Peak Hour Traffic Flows

Results from the traffic tube count undertaken from 13 October 2014 showed that the maximum peak hour combined traffic volume for AM was 391 vehicles per hour (Saturday) and 338 vehicles per hour for PM peak hour (Friday). These peak hour volumes are summarised in **Table 2** and **Table 3**.

Table 2: AM Peak Hour Traffic Volumes (vehicles per day)

AM Peak Hour	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Eastbound	154	156	173	149	168	191	121
Westbound	160	156	161	163	161	200	116
Combined	**314**	**312**	**334**	**312**	**329**	**391**	**237**

Table 3: PM Peak Hour Traffic Volumes (vehicles per day)

PM Peak Hour	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Eastbound	160	173	160	154	177	161	112
Westbound	137	148	147	146	161	128	107
Combined	**297**	**321**	**307**	**300**	**338**	**289**	**219**

The baseline traffic flows for the years 2015 and 2025 have been calculated with a 2.5% annual growth factor applied to the traffic volumes obtained for the year 2012 (consistent with other proposed developments traffic reports in the vicinity of the Wollongong Recycling and Building Supplies). These traffic volumes were larger than the volumes obtained from the traffic tube count undertaken in year 2014. Therefore, as a conservative approach was retained for this assessment.

Queue Lengths

The West Dapto Road / Rail level crossing intersection was analysed using SIDRA 6.0 intersection software. The SIDRA results are attached in **Appendix B**. This analysis was based on existing AM and PM peak hour road network volumes. **Figure 2** shows the layout of the intersection. This model was analysed based on the following assumptions

> The railway crossing level boom gate closure duration is 55 seconds for all trains (based on freight train information from Railcorp). This is a conservative approach as the freight trains have longer closure periods when compared to regular train services.

> The South Coast train line operates through Kembla Grange station with four train services operating during the AM and PM peak hour periods (based on Transport Sydney Trains timetable). For a conservative approach, one extra service will be added as part of the assessment, which will be for a freight train during these peak periods.

Figure 2: West Dapto Road / Rail Level Crossing Intersection Layout

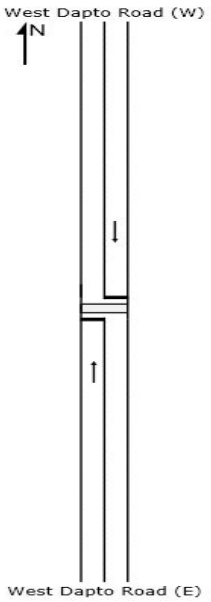

Table 4 shows the modelling queue lengths for the eastern and western approaches to the rail level crossing for the existing scenarios.

Table 4: West Dapto Road / Rail Level Crossing Intersection - Queue Lengths (Existing)

	AM Peak Hour 95th%ile Queue (m)	PM Peak Hour 95th%ile Queue (m)
West Dapto Road (East)	48.0m	37.7m
West Dapto Road (West)	45.6m	41.9m

The Wylie Road / West Dapto Road intersection is located 370m to the west of the West Dapto Road / Rail Level Crossing intersection. The western leg of the West Dapto Road / Rail Level Crossing intersection has a maximum queue length of 45.6m, which is well below the distance to the Wylie Road intersection. The West Dapto Road / Princes Highway intersection is located 130m to the east of the West Dapto Road / Rail Level Crossing intersection. The eastern leg of the West Dapto Road / Rail Level Crossing intersection has a maximum queue length of 48.0m, which is below the distance to the Princes Highway intersection.

The West Dapto Road / Princes Highway intersection was analysed using SIDRA 6.0 intersection software. This analysis was based on AM and PM existing peak road network volumes. **Figure 3** shows the layout of the intersection.

Figure 3: West Dapto Road / Princes Highway Intersection Layout

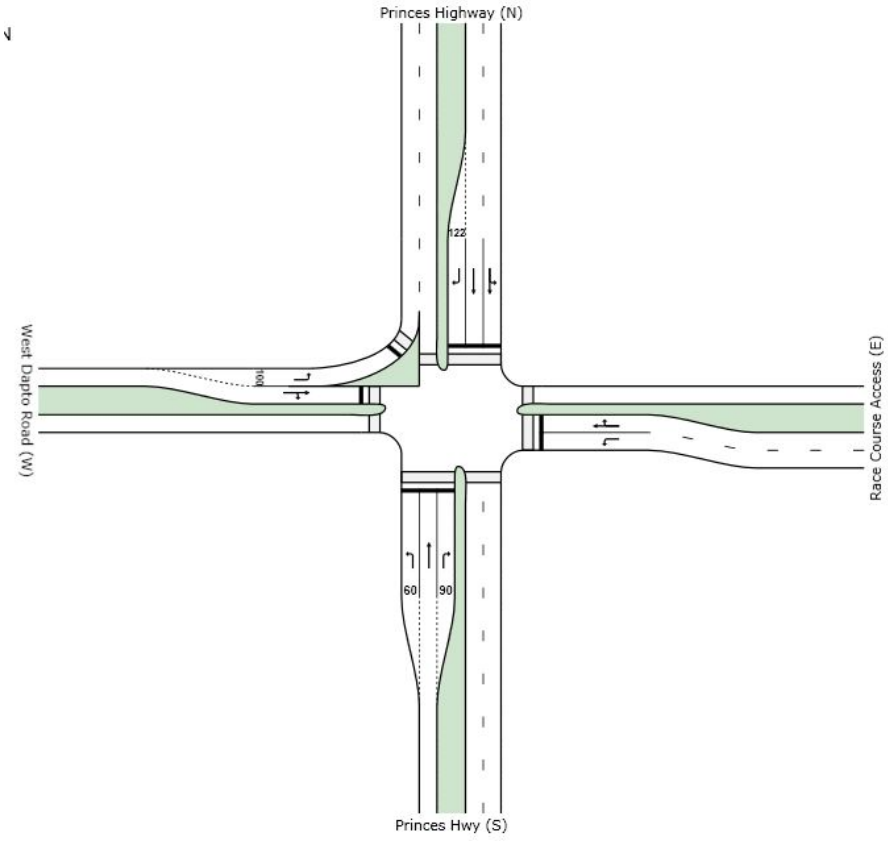

Table 5 shows the existing queue length of the West Dapto Road leg of the West Dapto / Princes Highway Intersection.

Table 5: West Dapto Road / Princes Highway Intersection – Queue Lengths (Existing)

	AM Peak Hour 95th%ile Queue (m)	PM Peak Hour 95th%ile Queue (m)
West Dapto Road (East)	24.6	17.0

The distance of the West Dapto Road / Rail Level Crossing intersection is 130m west of the West Dapto Road / Princes Highway intersection. The West Dapto Road leg of the West Dapto Road / Princes Highway intersection has a maximum queue length of 24.6m for the 2014 AM peak. This queue length is well below the distance to the rail level crossing.

4 Proposed Development

The total daily traffic generation of the proposed expansion of Wollongong Recycling and Building Supplies development at its maximum production of 230,000 tonnes per year, which would result in an equivalent of 950 vehicles per day by the year 2015. The development is currently operating with a current production of 30,000 tonnes per year with a total of 260 vehicles per day. This existing operation would have been accounted for in the traffic tube count and surveys. Therefore, the additional traffic generated with the proposed expansion is 690 vehicles per day.

ALCAM Rating

The additional traffic generated from the Wollongong Recycling and Building Supplies development is as follows:

> 690 vehicles per day

This additional traffic generated from the proposed expansion were added to the traffic tube survey data and the committed developments (traffic generated from Prixcar site, PAC Stage 2, and PAC Stage 3). This was applied for the 7 days of the extracted data from the traffic tube count survey. The results are shown below in **Table 6**.

Table 6: Total Daily Traffic Volumes (with development)

Daily Total Traffic Volume	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Existing	5,130	5,179	5,306	5,186	5,330	4,615	3,774
Developments	690	690	690	690	690	690	690
Total	**5,820**	**5,869**	**5,996**	**5,876**	**6,020**	**5,305**	**4,464**

As shown above the survey data reveals that the daily traffic volumes with development are over the ALCAM rating capacity of this railway level crossing, which is 3700. However, as discussed above, the existing survey data revealed that the daily traffic volume is already near capacity of railway level crossing ALCAM rating. With the anticipated developments for future years throughout this area this rail level crossing would only have minimal capacity to accommodate these future planned developments.

Queue Lengths

The proposed traffic generation for the expansion of the Wollongong Recycling and Building Supplies development for the AM and PM peak hour is 69 vehicles (31 light vehicles and 38 heavy vehicles).

The traffic generation from proposed expansion were added to the year 2015 base plus committed development traffic flows and also to the future base scenario in the year 2025. The traffic volumes for the future 2025 scenario were calculated based on an annual growth rate of 2.5%.

An intersection analysis was undertaken for the West Dapto Road / Rail Level Crossing and West Dapto Road / Princes Highway intersections. The assessment was undertaken for the years 2015 and 2025 (10 year horizon) for the AM and PM peak hour periods. **Table 7** show the queue lengths obtained from this analysis.

Table 7: West Dapto Road / Rail Level Crossing Intersection - Queue Lengths (with Development)

2015	AM Peak Hour 95th%ile Queue (m)	PM Peak Hour 95th%ile Queue (m)
West Dapto Road (East)	110.3	51.0
West Dapto Road (West)	59.4	102.3
2025	**AM Peak Hour 95th%ile Queue (m)**	**PM Peak Hour 95th%ile Queue (m)**
West Dapto Road (East)	128.7	63.7
West Dapto Road (West)	74.0	119.6

The Wylie Road / West Dapto Road intersection is located 370m to the west of the West Dapto Road / Rail Level Crossing intersection. The western leg of the West Dapto Road / Rail Level Crossing intersection has a maximum queue length of 119.6m (year 2025 PM peak hour), which is well below the distance of the Wylie Road intersection. The West Dapto Road / Princes Highway intersection is located 130m from the east of the West Dapto Road / Rail Level Crossing intersection. The eastern leg of the West Dapto Road / Rail Level Crossing intersection has a queue length of 128.7m (year 2025 AM peak hour), which is below the distance of the Princes Highway intersection.

The West Dapto Road / Princes Highway intersection was analysed using SIDRA intersection software. This analysis was based on AM and PM peak periods during the years 2015 and 2025 with development. **Table 8** shows the queue lengths of the West Dapto Road leg of the West Dapto Road / Princes Highway intersection.

Table 8: West Dapto Road / Princes Highway Intersection – Queue Lengths (with Development)

2015	AM Peak Hour 95th%ile Queue (m)	PM Peak Hour 95th%ile Queue (m)
West Dapto Road	38.7	70.2
2025	**AM Peak Hour 95th%ile Queue (m)**	**PM Peak Hour 95th%ile Queue (m)**
West Dapto Road	40.4	81.0

The distance of the West Dapto Road / Rail Level Crossing intersection is 130m west of the West Dapto Road / Princes Highway intersection. The West Dapto Road leg of the West Dapto Road / Princes Highway intersection has a maximum queue length of 81m, which is below the distance to the rail level crossing. Therefore, this would not result in queuing across the rail level crossing.

5 Conclusion

Cardno has assessed the rail level crossing and the impacts of queuing on the approaches to the rail level crossing and the queue from the West Dapto Road / Princes Highway intersection to the rail level crossing. The outcomes of this assessment are as follows:

> The 13 October 2014 traffic tube count that was undertaken showed that the maximum daily traffic volume that crossed the rail level crossing was 3500 vehicles. This is close to the ALCAM rating capacity of this rail level crossing which has a capacity of 3700 vehicles per day. Therefore, to consider any future proposed developments in the area, further investigations and mitigations should be considered.

> The queue lengths on the approaches to the railway level crossing were sufficiently within the distances to the adjacent intersections to the east and west for the AM and PM peak periods of the years 2015 and 2025 with development.

> The worst case AM and PM peak hour queue length from the West Dapto Road / Princes Highway intersection is 81m (year 2024 PM peak hour), which is below the distance to the rail level crossing, which is 130m away.

Based on the assessment undertaken for the rail level crossing. It is clearly shown that the queue lengths on the West Dapto Road leg of the West Dapto Road / Princes Highway intersection is acceptable for the AM and PM peak periods with the proposed expansion of the Wollongong Recycling and Building Supplies development in the years 2015 and 2025 (future scenarios). This assessment was undertaken with the addition of the traffic generated from the other proposed developments (committed developments) in the vicinity of the subject site.

APPENDIX A

SURVEY DATA

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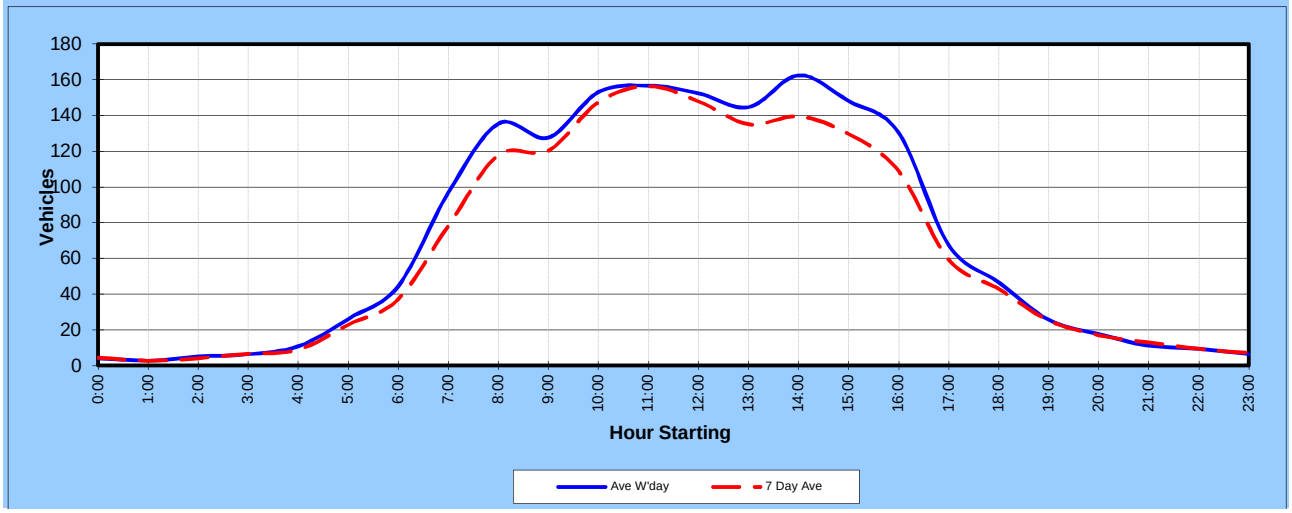
Road	West Dapto Road		
Location	adjacent to the rail crossing		
Site No.	1		
Start Date	Tuesday	7-Oct-14	
Direction	Eastbound		

Average Weekday	1691
7 Day Average	1542
Weekday Heavy's	26.6%
7 Day Heavy's	22.4%

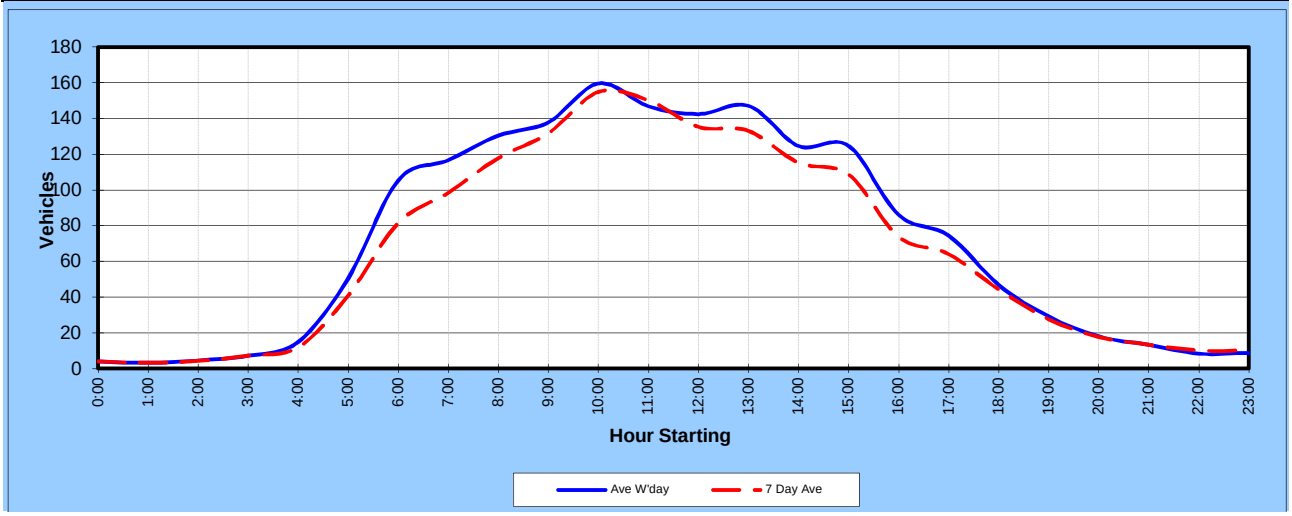
	Day of Week								
	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Ave	7 Day
Time	13-Oct	7-Oct	8-Oct	9-Oct	10-Oct	11-Oct	12-Oct	W'day	Ave
AM Peak	154	156	173	149	168	191	121		
PM Peak	160	173	160	154	177	161	112		
0:00	4	1	4	4	8	1	9	4	4
1:00	6	0	0	4	4	1	4	3	3
2:00	13	1	5	2	4	2	2	5	4
3:00	5	5	12	4	6	11	4	6	7
4:00	15	9	11	8	11	6	2	11	9
5:00	28	25	27	33	18	19	11	26	23
6:00	44	40	42	51	46	27	10	45	37
7:00	104	91	93	97	99	49	16	97	78
8:00	150	135	110	139	143	95	53	135	118
9:00	136	113	127	120	142	123	81	128	120
10:00	153	147	173	140	152	160	107	153	147
11:00	154	156	156	149	168	191	121	157	156
12:00	133	150	160	153	166	161	112	152	148
13:00	130	141	147	144	161	123	99	145	135
14:00	160	173	148	154	177	99	65	162	139
15:00	141	156	155	148	140	91	76	148	130
16:00	109	131	144	138	130	67	43	130	109
17:00	71	61	77	64	64	37	41	67	59
18:00	51	58	50	41	33	42	25	47	43
19:00	20	27	36	21	24	26	23	26	25
20:00	21	15	18	21	13	19	12	18	17
21:00	4	9	22	10	11	12	23	11	13
22:00	4	7	14	3	19	10	8	9	9
23:00	4	10	3	6	9	10	8	6	7
Total	1660	1661	1734	1654	1748	1382	955	1691	1542
% Heavies	26.9%	26.0%	25.1%	27.6%	27.2%	9.9%	3.8%	26.6%	22.4%



Road	West Dapto Road	
Location	adjacent to the rail crossing	
Site No.	1	
Start Date	Tuesday	7-Oct-14
Direction	Westbound	

Average Weekday	1705
7 Day Average	1559
Weekday Heavy's	27.2%
7 Day Heavy's	22.8%

	Day of Week							Ave	7 Day
	Mon	Tue	Wed	Thu	Fri	Sat	Sun		
Time	13-Oct	7-Oct	8-Oct	9-Oct	10-Oct	11-Oct	12-Oct	W'day	Ave
AM Peak	160	156	161	163	161	200	116		
PM Peak	137	148	147	146	161	128	107		
0:00	7	0	4	4	5	2	6	4	4
1:00	3	1	3	4	5	2	5	3	3
2:00	4	1	6	6	6	5	2	5	4
3:00	9	6	6	9	6	9	6	7	7
4:00	18	14	17	12	14	8	1	15	12
5:00	48	54	50	53	48	26	8	51	41
6:00	112	76	114	111	114	35	9	105	82
7:00	108	131	110	120	114	75	31	117	98
8:00	137	117	117	129	152	97	76	130	118
9:00	142	128	138	145	136	134	99	138	132
10:00	160	156	158	163	161	176	110	160	155
11:00	129	145	161	138	161	200	116	147	150
12:00	125	148	141	143	155	128	107	142	135
13:00	137	144	147	146	161	115	81	147	133
14:00	110	126	133	129	125	103	80	125	115
15:00	127	131	127	122	116	75	62	125	109
16:00	80	97	81	83	89	41	45	86	74
17:00	82	95	78	62	55	39	38	74	64
18:00	41	46	56	43	48	43	33	47	44
19:00	27	16	50	29	24	23	24	29	28
20:00	17	22	16	20	15	22	12	18	18
21:00	6	16	13	14	18	14	13	13	13
22:00	3	10	9	6	14	17	12	8	10
23:00	8	8	7	11	10	14	13	9	10
Total	1640	1688	1742	1702	1752	1403	989	1705	1559
% Heavies	28.7%	26.1%	25.7%	28.7%	26.8%	9.7%	3.9%	27.2%	22.8%

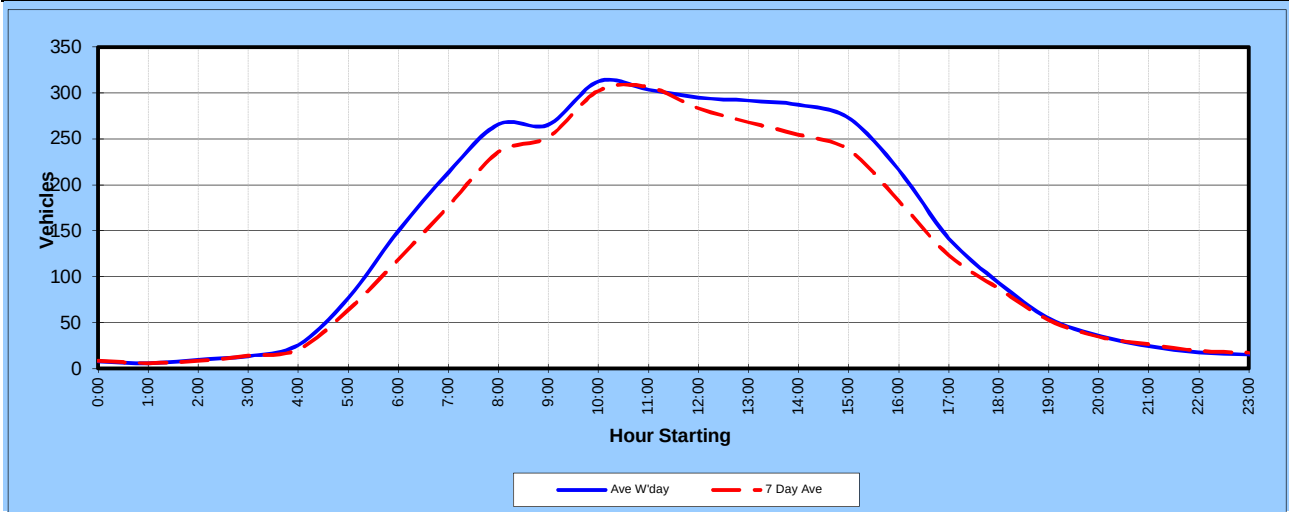


Prepared by : Austraffic

Road	West Dapto Road	
Location	adjacent to the rail crossing	
Site No.	1	
Start Date	Tuesday	7-Oct-14
Direction	Combined	

Average Weekday	3396
7 Day Average	3101
Weekday Heavy's	26.9%
7 Day Heavy's	22.6%

	Day of Week							Ave	7 Day
	Mon	Tue	Wed	Thu	Fri	Sat	Sun		
Time	13-Oct	7-Oct	8-Oct	9-Oct	10-Oct	11-Oct	12-Oct	W'day	Ave
AM Peak	313	303	331	303	329	391	237		
PM Peak	270	299	301	296	322	289	219		
0:00	11	1	8	8	13	3	15	8	8
1:00	9	1	3	8	9	3	9	6	6
2:00	17	2	11	8	10	7	4	10	8
3:00	14	11	18	13	12	20	10	14	14
4:00	33	23	28	20	25	14	3	26	21
5:00	76	79	77	86	66	45	19	77	64
6:00	156	116	156	162	160	62	19	150	119
7:00	212	222	203	217	213	124	47	213	177
8:00	287	252	227	268	295	192	129	266	236
9:00	278	241	265	265	278	257	180	265	252
10:00	313	303	331	303	313	336	217	313	302
11:00	283	301	317	287	329	391	237	303	306
12:00	258	298	301	296	321	289	219	295	283
13:00	267	285	294	290	322	238	180	292	268
14:00	270	299	281	283	302	202	145	287	255
15:00	268	287	282	270	256	166	138	273	238
16:00	189	228	225	221	219	108	88	216	183
17:00	153	156	155	126	119	76	79	142	123
18:00	92	104	106	84	81	85	58	93	87
19:00	47	43	86	50	48	49	47	55	53
20:00	38	37	34	41	28	41	24	36	35
21:00	10	25	35	24	29	26	36	25	26
22:00	7	17	23	9	33	27	20	18	19
23:00	12	18	10	17	19	24	21	15	17
Total	3300	3349	3476	3356	3500	2785	1944	3396	3101
% Heavies	27.8%	26.1%	25.4%	28.2%	27.0%	9.8%	3.9%	26.9%	22.6%



APPENDIX B

SIDRA RESULTS

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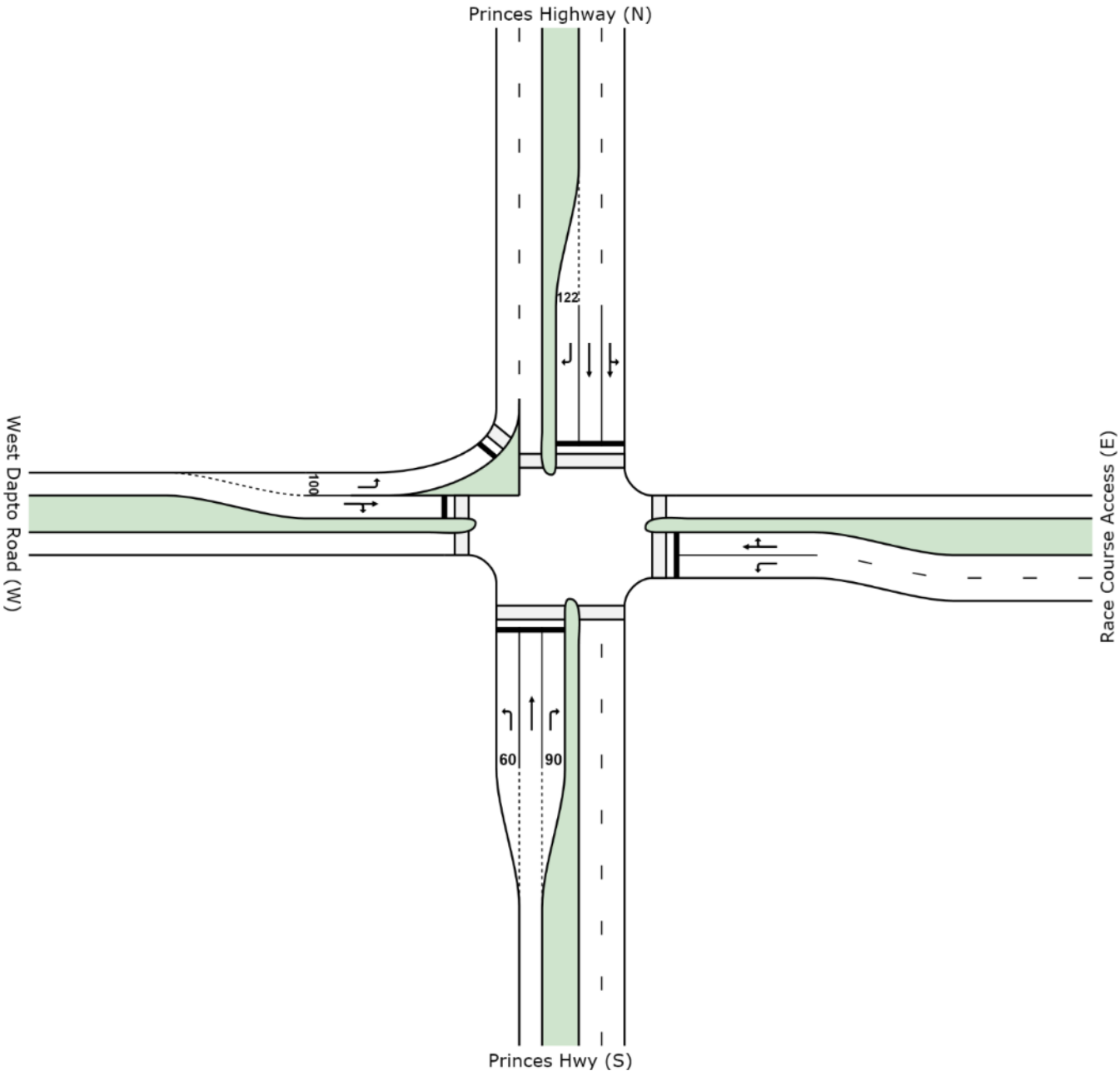
SITE LAYOUT

Site: West Dapto Road & Princes Hwy - 2014 Base AMPH

West Dapto Road & Princes Highway
Signals - Fixed Time



MOVEMENT SUMMARY

Site: West Dapto Road & Princes Hwy - 2014 Base AMPH

West Dapto Road & Princes Highway
Signals - Fixed Time Cycle Time = 130 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Princes Hwy (S)											
1	L2	21	40.0	0.028	22.9	LOS B	0.6	5.8	0.50	0.69	44.1
2	T1	399	6.6	0.694	41.0	LOS C	21.9	161.9	0.93	0.81	42.1
3	R2	37	3.0	0.122	45.2	LOS D	1.8	12.7	0.78	0.74	36.5
Approach		457	7.8	0.694	40.5	LOS C	21.9	161.9	0.90	0.80	41.7
East: Race Course Access (E)											
4	L2	21	3.0	0.084	57.6	LOS E	1.2	8.4	0.90	0.71	31.7
5	T1	5	3.0	0.142	53.9	LOS D	2.3	16.4	0.89	0.74	33.8
6	R2	37	3.0	0.142	55.4	LOS D	2.3	16.4	0.89	0.74	32.6
Approach		63	3.0	0.142	56.0	LOS D	2.3	16.4	0.89	0.73	32.4
North: Princes Highway (N)											
7	L2	53	3.0	0.183	22.7	LOS B	5.8	42.2	0.54	0.54	50.2
8	T1	318	5.6	0.183	15.7	LOS B	5.8	42.6	0.54	0.49	58.7
9	R2	314	19.8	0.707	51.0	LOS D	16.6	135.7	0.95	0.94	34.7
Approach		684	11.9	0.707	32.4	LOS C	16.6	135.7	0.73	0.70	44.1
West: West Dapto Road (W)											
10	L2	298	14.0	0.216	8.5	LOS A	1.4	12.5	0.16	0.64	60.9
11	T1	26	3.0	0.193	52.8	LOS D	2.8	24.6	0.90	0.74	33.9
12	R2	25	26.0	0.193	58.1	LOS E	2.8	24.6	0.90	0.74	32.7
Approach		349	14.0	0.216	15.4	LOS B	2.8	24.6	0.27	0.65	54.3
All Vehicles		1554	10.8	0.707	31.9	LOS C	21.9	161.9	0.68	0.72	44.6

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	South Full Crossing	53	59.3	LOS E	0.2	0.2	0.96	0.96
P2	East Full Crossing	53	37.0	LOS D	0.1	0.1	0.76	0.76
P3	North Full Crossing	53	59.3	LOS E	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	34.8	LOS D	0.1	0.1	0.73	0.73
P4S	West Slip/Bypass Lane Crossing	53	0.5	LOS A	0.0	0.0	0.12	0.12
All Pedestrians		263	38.2	LOS D			0.70	0.70

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

PHASING SUMMARY

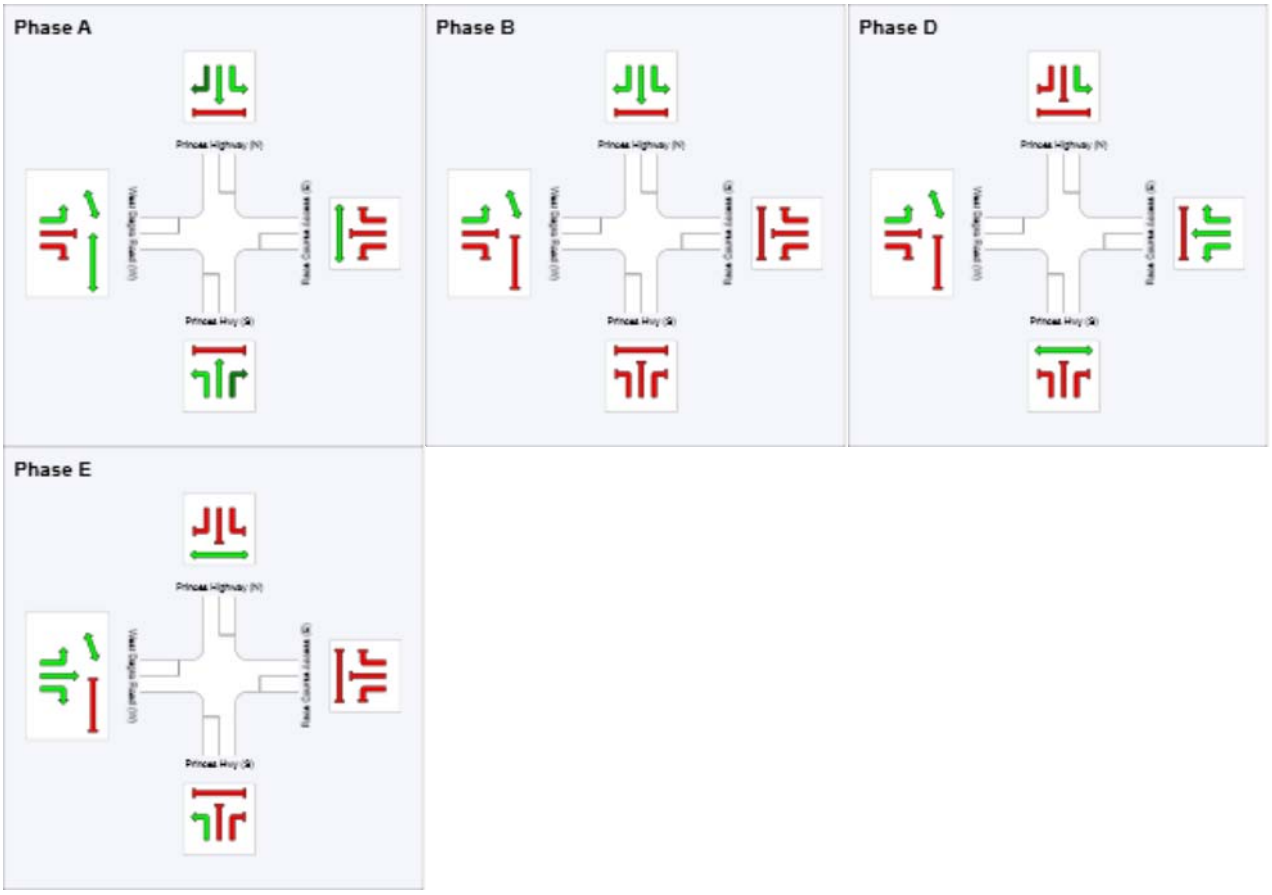
Site: West Dapto Road & Princes Hwy - 2014 Base AMPH

West Dapto Road & Princes Highway
Signals - Fixed Time Cycle Time = 130 seconds (Practical Cycle Time)

Phase times determined by the program
Sequence: Variable Phasing
Movement Class: All Movement Classes
Input Sequence: A, B, D, E
Output Sequence: A, B, D, E

Phase Timing Results

Phase	A	B	D	E
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	47	76	103
Green Time (sec)	41	23	21	21
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	47	29	27	27
Phase Split	36 %	22 %	21 %	21 %



Normal Movement
Permitted/Opposed
Slip/Bypass-Lane Movement
Opposed Slip/Bypass-Lane
Stopped Movement
Turn On Red
Other Movement Class Running
Other Movement Class Stopped
Mixed Running & Stopped Movement Classes
Undetected Movement
Phase Transition Applied

SIDRA INTERSECTION 6

MOVEMENT SUMMARY

Site: West Dapto Road & Princes Hwy - 2014 Base PMPH

West Dapto Road & Princes Highway
Signals - Fixed Time Cycle Time = 110 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Princes Hwy (S)											
1	L2	21	40.0	0.026	18.9	LOS B	0.5	4.6	0.46	0.68	46.3
2	T1	399	6.6	0.703	35.4	LOS C	18.8	139.1	0.93	0.81	45.0
3	R2	37	3.0	0.124	40.7	LOS C	1.5	11.0	0.79	0.74	38.2
Approach		457	7.8	0.703	35.1	LOS C	18.8	139.1	0.90	0.80	44.4
East: Race Course Access (E)											
4	L2	21	3.0	0.071	46.9	LOS D	1.0	6.9	0.87	0.70	35.0
5	T1	5	3.0	0.121	43.1	LOS D	1.9	13.4	0.85	0.74	37.5
6	R2	37	3.0	0.121	44.7	LOS D	1.9	13.4	0.85	0.74	36.0
Approach		63	3.0	0.121	45.3	LOS D	1.9	13.4	0.86	0.72	35.8
North: Princes Highway (N)											
7	L2	53	3.0	0.217	25.7	LOS B	5.8	42.6	0.63	0.60	48.2
8	T1	318	5.6	0.217	18.7	LOS B	5.9	43.0	0.63	0.56	56.0
9	R2	215	19.8	0.699	50.0	LOS D	10.8	88.4	0.98	0.89	35.0
Approach		585	10.6	0.699	30.8	LOS C	10.8	88.4	0.76	0.68	45.4
West: West Dapto Road (W)											
10	L2	274	14.0	0.204	8.6	LOS A	1.3	11.4	0.19	0.64	60.8
11	T1	26	3.0	0.141	41.6	LOS C	2.0	17.0	0.86	0.72	37.9
12	R2	19	26.0	0.141	47.0	LOS D	2.0	17.0	0.86	0.72	36.5
Approach		319	13.8	0.204	13.6	LOS A	2.0	17.0	0.28	0.65	55.9
All Vehicles		1424	10.1	0.703	29.0	LOS C	18.8	139.1	0.70	0.72	46.5

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	South Full Crossing	53	49.3	LOS E	0.2	0.2	0.95	0.95
P2	East Full Crossing	53	32.9	LOS D	0.1	0.1	0.77	0.77
P3	North Full Crossing	53	49.3	LOS E	0.2	0.2	0.95	0.95
P4	West Full Crossing	53	30.6	LOS D	0.1	0.1	0.75	0.75
P4S	West Slip/Bypass Lane Crossing	53	0.6	LOS A	0.0	0.0	0.15	0.15
All Pedestrians		263	32.5	LOS D			0.71	0.71

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

PHASING SUMMARY

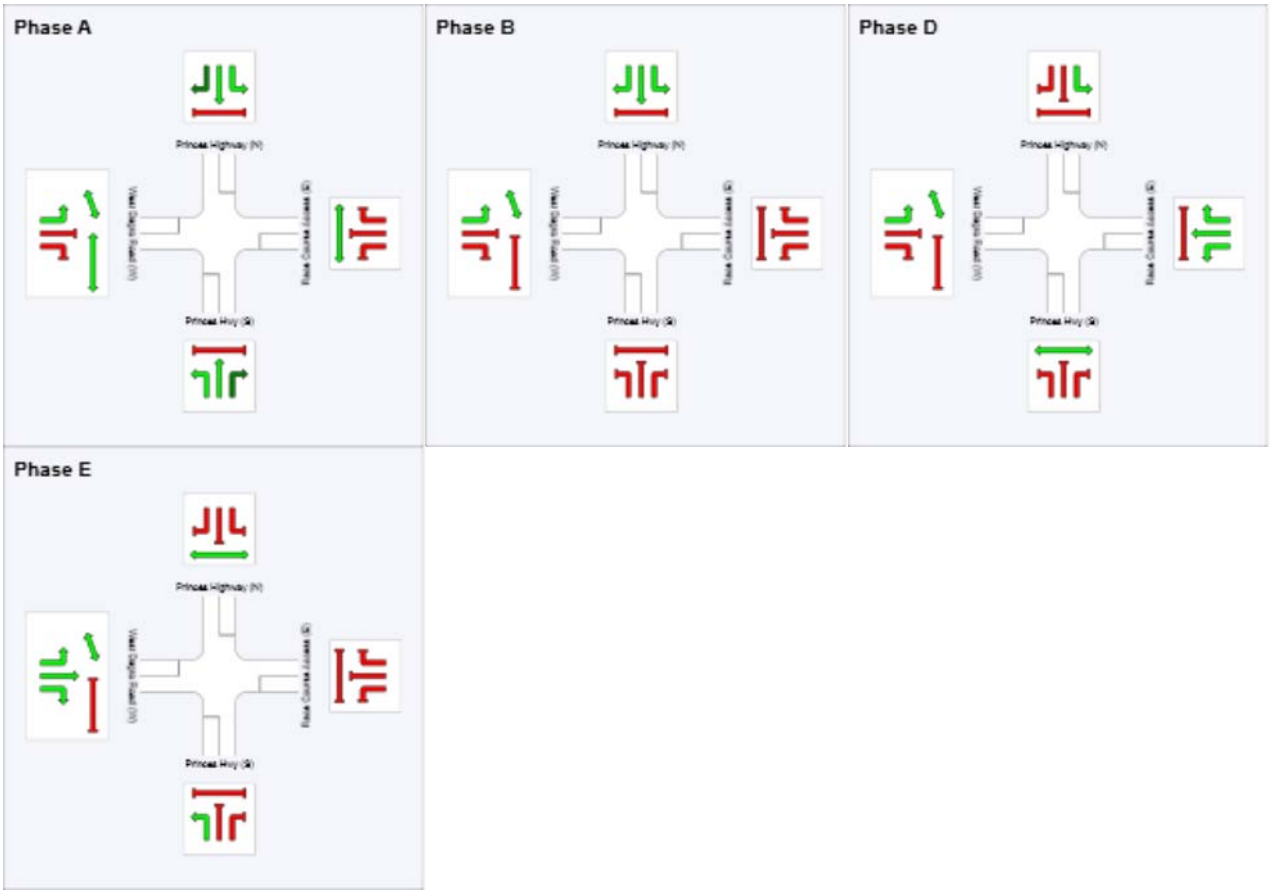
Site: West Dapto Road & Princes Hwy - 2014 Base PMPH

West Dapto Road & Princes Highway
Signals - Fixed Time Cycle Time = 110 seconds (Practical Cycle Time)

Phase times determined by the program
Sequence: Variable Phasing
Movement Class: All Movement Classes
Input Sequence: A, B, D, E
Output Sequence: A, B, D, E

Phase Timing Results

Phase	A	B	D	E
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	40	56	83
Green Time (sec)	34	10	21	21
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	40	16	27	27
Phase Split	36 %	15 %	25 %	25 %



Normal Movement
Permitted/Opposed
Slip/Bypass-Lane Movement
Opposed Slip/Bypass-Lane
Stopped Movement
Turn On Red
Other Movement Class Running
Other Movement Class Stopped
Mixed Running & Stopped Movement Classes
Undetected Movement
Phase Transition Applied

MOVEMENT SUMMARY

Site: West Dapto Road & Princes Hwy - 2015 Base + Dev AMPH

West Dapto Road & Princes Highway
Signals - Fixed Time Cycle Time = 150 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Princes Hwy (S)											
1	L2	89	40.0	0.131	30.5	LOS C	3.6	33.5	0.59	0.74	40.4
2	T1	408	6.6	0.852	58.6	LOS E	29.4	217.8	0.97	0.92	35.0
3	R2	37	3.0	0.133	53.1	LOS D	2.1	14.9	0.80	0.74	33.8
Approach		535	11.9	0.852	53.5	LOS D	29.4	217.8	0.89	0.88	35.7
East: Race Course Access (E)											
4	L2	21	3.0	0.096	68.4	LOS E	1.4	9.9	0.92	0.71	29.0
5	T1	5	3.0	0.164	64.7	LOS E	2.7	19.5	0.91	0.74	30.7
6	R2	37	3.0	0.164	66.3	LOS E	2.7	19.5	0.91	0.74	29.7
Approach		63	3.0	0.164	66.9	LOS E	2.7	19.5	0.91	0.73	29.6
North: Princes Highway (N)											
7	L2	53	3.0	0.169	20.5	LOS B	5.9	42.9	0.47	0.49	51.8
8	T1	326	5.6	0.169	13.5	LOS A	5.9	43.5	0.47	0.44	60.9
9	R2	475	19.8	0.858	66.1	LOS E	29.4	240.9	1.00	1.06	30.3
Approach		854	13.3	0.858	43.2	LOS D	29.4	240.9	0.76	0.79	38.7
West: West Dapto Road (W)											
10	L2	345	14.0	0.249	8.6	LOS A	2.0	17.0	0.16	0.64	60.9
11	T1	26	3.0	0.291	64.7	LOS E	4.3	38.7	0.93	0.76	30.4
12	R2	39	26.0	0.291	70.0	LOS E	4.3	38.7	0.93	0.76	29.4
Approach		411	14.4	0.291	18.0	LOS B	4.3	38.7	0.29	0.66	52.3
All Vehicles		1862	12.8	0.858	41.4	LOS C	29.4	240.9	0.70	0.78	39.7

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	South Full Crossing	53	69.3	LOS F	0.2	0.2	0.96	0.96
P2	East Full Crossing	53	44.2	LOS E	0.2	0.2	0.77	0.77
P3	North Full Crossing	53	69.3	LOS F	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	41.9	LOS E	0.2	0.2	0.75	0.75
P4S	West Slip/Bypass Lane Crossing	53	0.4	LOS A	0.0	0.0	0.11	0.11
All Pedestrians		263	45.0	LOS E			0.71	0.71

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

PHASING SUMMARY

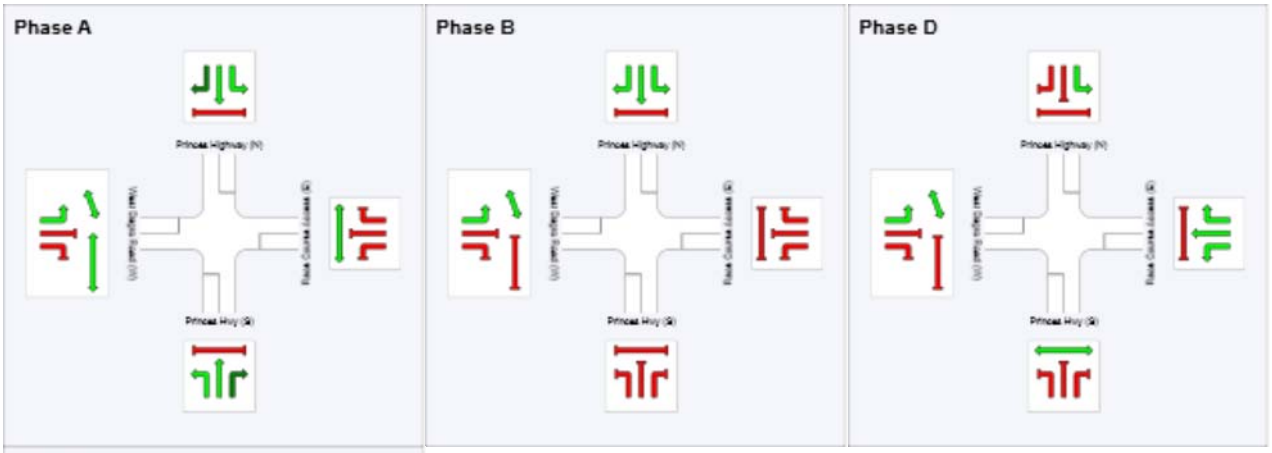
Site: West Dapto Road & Princes Hwy - 2015 Base + Dev AMPH

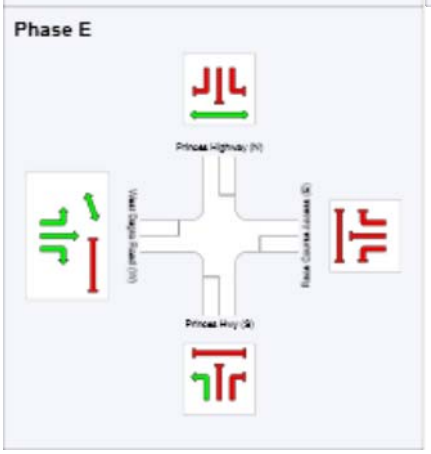
West Dapto Road & Princes Highway
Signals - Fixed Time Cycle Time = 150 seconds (Practical Cycle Time)

Phase times determined by the program
Sequence: Variable Phasing
Movement Class: All Movement Classes
Input Sequence: A, B, D, E
Output Sequence: A, B, D, E

Phase Timing Results

Phase	A	B	D	E
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	50	96	123
Green Time (sec)	44	40	21	21
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	50	46	27	27
Phase Split	33 %	31 %	18 %	18 %





MOVEMENT SUMMARY

Site: West Dapto Road & Princes Hwy - 2015 Base + Dev PMPH

West Dapto Road & Princes Highway
Signals - Fixed Time Cycle Time = 140 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Princes Hwy (S)											
1	L2	55	40.0	0.082	29.2	LOS C	2.0	19.0	0.58	0.72	41.0
2	T1	355	6.6	0.750	49.8	LOS D	22.1	163.1	0.96	0.84	38.3
3	R2	37	3.0	0.204	58.8	LOS E	2.2	15.5	0.87	0.75	32.1
Approach		446	10.4	0.750	48.0	LOS D	22.1	163.1	0.90	0.82	38.0
East: Race Course Access (E)											
4	L2	21	3.0	0.090	63.0	LOS E	1.3	9.1	0.91	0.71	30.3
5	T1	5	3.0	0.153	59.3	LOS E	2.5	18.0	0.90	0.74	32.2
6	R2	37	3.0	0.153	60.8	LOS E	2.5	18.0	0.90	0.74	31.1
Approach		63	3.0	0.153	61.4	LOS E	2.5	18.0	0.90	0.73	30.9
North: Princes Highway (N)											
7	L2	53	3.0	0.298	22.8	LOS B	10.8	79.2	0.55	0.53	50.7
8	T1	586	5.6	0.298	15.8	LOS B	10.9	79.9	0.55	0.50	58.9
9	R2	421	19.8	0.764	52.4	LOS D	22.1	180.9	0.95	0.99	34.2
Approach		1060	11.1	0.764	30.7	LOS C	22.1	180.9	0.71	0.70	45.5
West: West Dapto Road (W)											
10	L2	429	14.0	0.313	8.7	LOS A	2.6	22.9	0.19	0.65	60.8
11	T1	26	3.0	0.505	61.8	LOS E	7.4	70.2	0.96	0.80	30.9
12	R2	89	26.0	0.505	67.2	LOS E	7.4	70.2	0.96	0.80	29.9
Approach		545	15.4	0.505	20.8	LOS B	7.4	70.2	0.35	0.68	50.1
All Vehicles		2115	11.8	0.764	32.7	LOS C	22.1	180.9	0.66	0.72	44.1

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Distance m	Prop. Queued	Effective Stop Rate per ped
P1	South Full Crossing	53	64.3	LOS F	0.2	0.2	0.96	0.96
P2	East Full Crossing	53	44.1	LOS E	0.2	0.2	0.79	0.79
P3	North Full Crossing	53	64.3	LOS F	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	41.7	LOS E	0.2	0.2	0.77	0.77
P4S	West Slip/Bypass Lane Crossing	53	0.5	LOS A	0.0	0.0	0.11	0.11
All Pedestrians		263	43.0	LOS E			0.72	0.72

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

PHASING SUMMARY

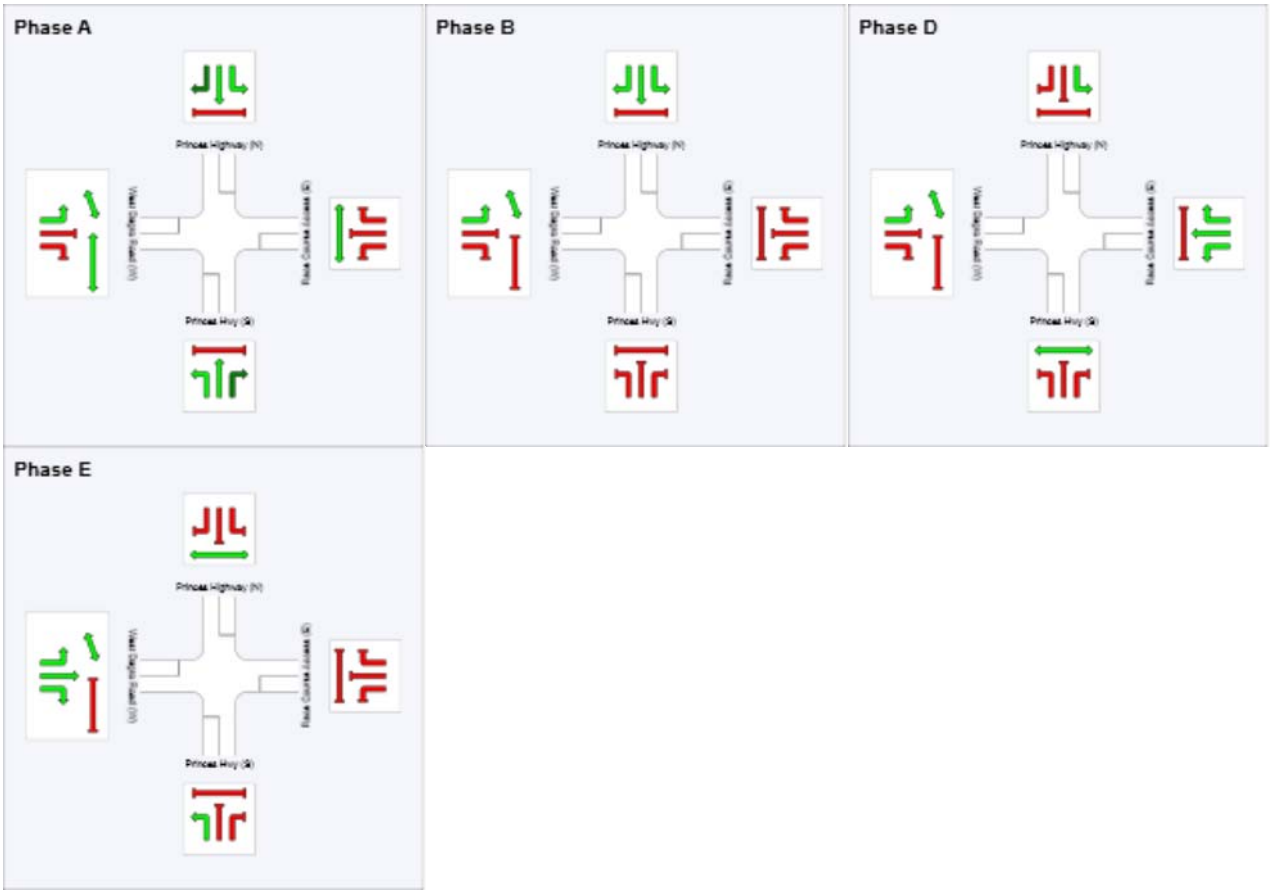
Site: West Dapto Road & Princes Hwy - 2015 Base + Dev PMPH

West Dapto Road & Princes Highway
Signals - Fixed Time Cycle Time = 140 seconds (Practical Cycle Time)

Phase times determined by the program
Sequence: Variable Phasing
Movement Class: All Movement Classes
Input Sequence: A, B, D, E
Output Sequence: A, B, D, E

Phase Timing Results

Phase	A	B	D	E
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	44	86	113
Green Time (sec)	38	36	21	21
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	44	42	27	27
Phase Split	31 %	30 %	19 %	19 %



MOVEMENT SUMMARY

Site: West Dapto Road & Princes Hwy - 2025 Base + Dev AMPH

West Dapto Road & Princes Highway
Signals - Fixed Time Cycle Time = 150 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Princes Hwy (S)											
1	L2	91	40.0	0.124	28.2	LOS B	3.4	32.1	0.56	0.73	41.4
2	T1	524	6.6	0.962	84.0	LOS F	46.9	346.6	1.00	1.12	28.1
3	R2	37	3.0	0.143	51.1	LOS D	2.0	14.7	0.78	0.75	34.5
Approach		652	11.0	0.962	74.4	LOS F	46.9	346.6	0.92	1.04	29.8
East: Race Course Access (E)											
4	L2	21	3.0	0.079	65.1	LOS E	1.3	9.6	0.89	0.71	29.8
5	T1	5	3.0	0.138	61.4	LOS E	2.6	18.9	0.89	0.74	31.6
6	R2	37	3.0	0.138	63.0	LOS E	2.6	18.9	0.89	0.74	30.5
Approach		63	3.0	0.138	63.6	LOS E	2.6	18.9	0.89	0.73	30.4
North: Princes Highway (N)											
7	L2	53	3.0	0.200	19.5	LOS B	7.1	51.8	0.46	0.47	52.8
8	T1	417	5.6	0.200	12.5	LOS A	7.2	52.6	0.46	0.43	62.0
9	R2	515	19.8	0.977	109.8	LOS F	45.8	375.0	1.00	1.20	22.3
Approach		984	12.9	0.977	63.8	LOS E	45.8	375.0	0.74	0.83	31.9
West: West Dapto Road (W)											
10	L2	411	14.0	0.279	8.2	LOS A	1.6	14.1	0.12	0.62	61.2
11	T1	26	3.0	0.265	61.5	LOS E	4.5	40.4	0.91	0.76	31.2
12	R2	43	26.0	0.265	66.8	LOS E	4.5	40.4	0.91	0.76	30.2
Approach		480	14.5	0.279	16.4	LOS B	4.5	40.4	0.23	0.64	53.5
All Vehicles		2179	12.4	0.977	56.5	LOS D	46.9	375.0	0.69	0.85	34.2

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	South Full Crossing	53	69.3	LOS F	0.2	0.2	0.96	0.96
P2	East Full Crossing	53	42.7	LOS E	0.2	0.2	0.75	0.75
P3	North Full Crossing	53	69.3	LOS F	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	40.4	LOS E	0.2	0.2	0.73	0.73
P4S	West Slip/Bypass Lane Crossing	53	0.4	LOS A	0.0	0.0	0.11	0.11
All Pedestrians		263	44.4	LOS E			0.70	0.70

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

PHASING SUMMARY

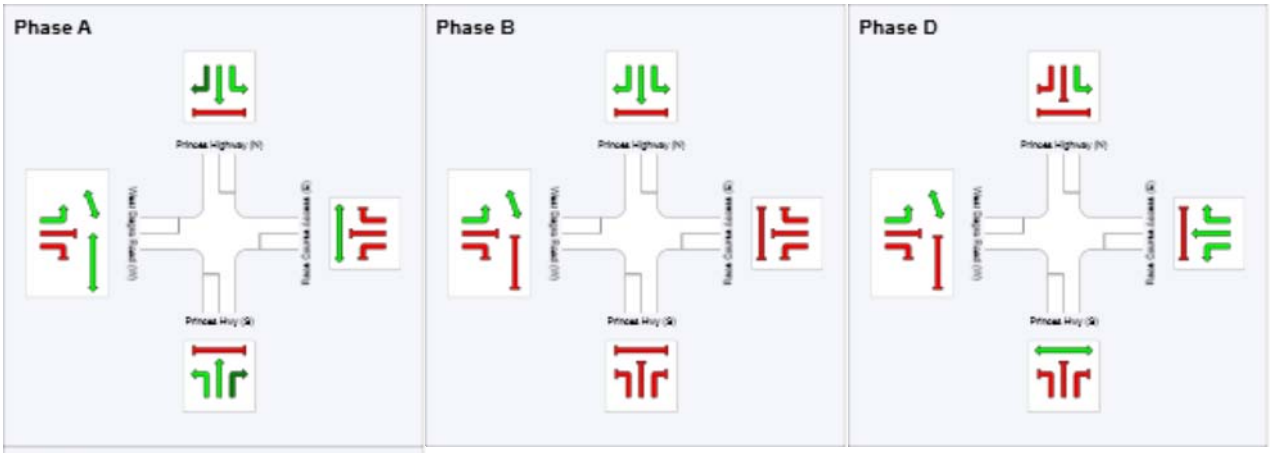
Site: West Dapto Road & Princes Hwy - 2025 Base + Dev AMPH

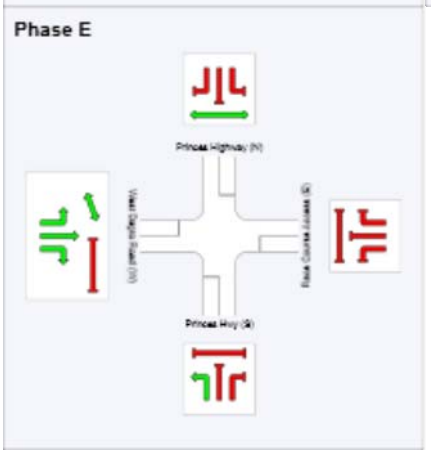
West Dapto Road & Princes Highway
Signals - Fixed Time Cycle Time = 150 seconds (Practical Cycle Time)

Phase times determined by the program
Sequence: Variable Phasing
Movement Class: All Movement Classes
Input Sequence: A, B, D, E
Output Sequence: A, B, D, E

Phase Timing Results

Phase	A	B	D	E
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	52	96	123
Green Time (sec)	46	38	21	21
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	52	44	27	27
Phase Split	35 %	29 %	18 %	18 %





MOVEMENT SUMMARY

Site: West Dapto Road & Princes Hwy - 2025 Base + Dev PMPH

West Dapto Road & Princes Highway
Signals - Fixed Time Cycle Time = 150 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Princes Hwy (S)											
1	L2	58	40.0	0.086	30.5	LOS C	2.3	21.4	0.58	0.72	40.4
2	T1	455	6.6	0.927	75.0	LOS F	38.0	281.2	1.00	1.05	30.2
3	R2	37	3.0	0.247	64.3	LOS E	2.4	17.0	0.89	0.76	30.6
Approach		549	9.9	0.927	69.6	LOS E	38.0	281.2	0.95	1.00	31.1
East: Race Course Access (E)											
4	L2	21	3.0	0.096	68.4	LOS E	1.4	9.9	0.92	0.71	29.0
5	T1	5	3.0	0.164	64.7	LOS E	2.7	19.5	0.91	0.74	30.7
6	R2	37	3.0	0.164	66.3	LOS E	2.7	19.5	0.91	0.74	29.7
Approach		63	3.0	0.164	66.9	LOS E	2.7	19.5	0.91	0.73	29.6
North: Princes Highway (N)											
7	L2	53	3.0	0.356	22.5	LOS B	14.3	104.9	0.54	0.52	51.1
8	T1	749	5.6	0.356	15.5	LOS B	14.4	105.7	0.54	0.50	59.2
9	R2	491	19.8	0.923	83.3	LOS F	35.8	293.3	1.00	1.13	26.5
Approach		1293	10.9	0.923	41.6	LOS C	35.8	293.3	0.71	0.74	40.2
West: West Dapto Road (W)											
10	L2	477	14.0	0.343	8.6	LOS A	3.0	26.4	0.19	0.65	60.8
11	T1	26	3.0	0.572	68.0	LOS E	8.5	81.0	0.98	0.81	29.3
12	R2	96	26.0	0.572	73.4	LOS F	8.5	81.0	0.98	0.81	28.4
Approach		599	15.4	0.572	21.6	LOS B	8.5	81.0	0.35	0.68	49.6
All Vehicles		2504	11.6	0.927	43.6	LOS D	38.0	293.3	0.68	0.78	39.1

Level of Service (LOS) Method: Delay (RTA NSW).
Vehicle movement LOS values are based on average delay per movement
Intersection and Approach LOS values are based on average delay for all vehicle movements.
SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.
Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Movement Performance - Pedestrians

Mov ID	Description	Demand Flow ped/h	Average Delay sec	Level of Service	Average Back of Queue Pedestrian ped	Average Back of Queue Distance m	Prop. Queued	Effective Stop Rate per ped
P1	South Full Crossing	53	69.3	LOS F	0.2	0.2	0.96	0.96
P2	East Full Crossing	53	45.0	LOS E	0.2	0.2	0.78	0.78
P3	North Full Crossing	53	69.3	LOS F	0.2	0.2	0.96	0.96
P4	West Full Crossing	53	42.7	LOS E	0.2	0.2	0.75	0.75
P4S	West Slip/Bypass Lane Crossing	53	0.4	LOS A	0.0	0.0	0.11	0.11
All Pedestrians		263	45.3	LOS E			0.71	0.71

Level of Service (LOS) Method: SIDRA Pedestrian LOS Method (Based on Average Delay)
Pedestrian movement LOS values are based on average delay per pedestrian movement.
Intersection LOS value for Pedestrians is based on average delay for all pedestrian movements.

PHASING SUMMARY

Site: West Dapto Road & Princes Hwy - 2025 Base + Dev PMPH

West Dapto Road & Princes Highway
Signals - Fixed Time Cycle Time = 150 seconds (Practical Cycle Time)

Phase times determined by the program
Sequence: Variable Phasing
Movement Class: All Movement Classes
Input Sequence: A, B, D, E
Output Sequence: A, B, D, E

Phase Timing Results

Phase	A	B	D	E
Reference Phase	Yes	No	No	No
Phase Change Time (sec)	0	49	96	123
Green Time (sec)	43	41	21	21
Yellow Time (sec)	4	4	4	4
All-Red Time (sec)	2	2	2	2
Phase Time (sec)	49	47	27	27
Phase Split	33 %	31 %	18 %	18 %