Our Ref: 82018194:IP / HC
Contact: Ivo Pais / Hayden Calvey

17 March 2020

Lendlease
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Attention: Sarah Kelly

Dear Sarah,

CALDERWOOD MOD 4 APPLICATION
RESPONSE TO RMS DECEMBER 2019 COMMENTS

Cardno prepared the Response to Secretary's Environmental Assessment Requirements (SEARs) – Traffic and Transport Report (T&TR) for Lendlease for the Calderwood Urban Development Project Town Centre Yield Review. Two of the recommendations from the Traffic and Transport Report included upgrading/proposing traffic signals at the Broughton Avenue/ Illawarra Highway/ Tripoli Way Extension and Tripoli Way Extension/ Calderwood Road intersections. Cardno provided a response to comments in dated 17th September 2019.

On 15 October 2019, TfNSW (formerly RMS) requested for additional modelling to be undertaken with a revised phasing arrangement at the intersection of Broughton Avenue / Illawarra Highway / Tripoli Way Extension. Revisions to the CAD plans were also requested. Cardno provided a response to this request (26th November 2019) and demonstrated that the revised phasing arrangement (diamond phasing at Broughton Avenue / Illawarra Highway / Tripoli Way Extension) resulted in similar satisfactory level of service.

Following Cardno's submission, TfNSW have further requested a modified phasing arrangement at the intersection of Broughton Avenue / Illawarra Highway / Tripoli Way Extension (19th December 2019). The specific comments to be addressed are reproduced below:

1. *The SIDRA analysis which supports the split phasing demonstrates a better level of service and a decreased queue length (Attachment 2) compared to the diamond phasing approach (Attachment 3). The split [phasing approach in Attachment 2 includes a filter option for right turns from the Illawarra Highway; the right turn filter option needs to be removed from the modelling as TfNSW believes a filter is unlikely to be supported at this location. TfNSW, using your SIDRA model, removed the filter and replaced it with a leading right turn phase. TfNSW found some queue lengths were significantly longer with the filter.*
2. *Given the above, the proposed concept design for the split approach needs to be reconsidered, noting the above. Specifically, the lane lengths need to consider the queue lengths indicated in the SIDRA analysis and at a minimum the length must comply with Table 5.2 of Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections.*
3. *The 'Response to RMS Comments' dated 23th November 2019 states that the inclusion of pedestrian cycles on all legs was tested to demonstrate a worst case scenario and pedestrian crossings have not been provided across the Illawarra Highway on the intersection layout provided. Pedestrian crossings must be provided on all approaches.*

A meeting was held on 4th March 2020 to clarify the intention of the requested second adjustment to the phasing which resulted in the following:

- Remove filter right turns on Illawarra Highway in replacement of leading right turns. TfNSW advised that filter right turns are not a preferred arrangement.
- Revert back to split phasing on Broughton Avenue and Tripoli Way Extension (as per Cardno's original model assumption)
- Ensure pedestrian phases are provided on all approaches
- Review the queue results and ensure the concept designs comply with Austroads.

Cardno's response to the requested additional modelling is provided in the following sections. It is relevant to note that the SIDRA results presented are based on including pedestrian phases on all approaches.

1.1 Right Turn Filter

A right turn filter is an acceptable phase arrangement and is document in the TfNSW Traffic Signal Design Guide – Section 7. The Guide states the following with regard to where filters are not permitted:

A right turn must not be permitted on approaches where:

- *Sight distance is insufficient for the right turn vehicles to filter safely. The criteria for measuring the sight distance is the minimum gap sight distance, the details of which are found in the Austroads Guide to Road Design Part 4A*
- *There is more than one right turn lane*
- *It is possible for a yellow signal to be displayed to the right turn vehicles when the opposing approach has a green signal, eg the opposing approach has a trailing right turn OR the approach with the right turn has an early cut-off (ECO) (See Section 7.3.3)*
- *The 85th percentile speed of the opposing traffic, measured in free flow conditions, is greater than 70km/h and the right turn has to filter across more than two lanes.*
- *There is an adverse traffic accident history involving filtering right turn vehicles (including rear-end collisions)*
- *The opposing approach is four lanes or more wide.*

With respect to the above, the sightlines for right turn movements are satisfactory; the design is for a single right turn only; the use of trailing right turn or early cut-off is not defined at this stage; speed zone is 60km/h and therefore unlikely to be above 70km/h; there is no existing filter right turn condition to enable reference to crash data and finally, the design does not require the right turn movement to cross four lanes or more. In summary, the intersection design and existing speed conditions do not result in triggering the above prohibitive situations.

Furthermore, the Guide also specifies that a right turn phase should be provided without a right turn filter where one or more of the following conditions apply:

- Right turn vehicles cause excessive delays to other vehicles using the same approach because a right turn bay is not, or cannot be, provided
- The right turn flow exceeds 120 vehicles / hour and is opposed by at least:
    - 900 vehicles / hour for a one lane approach
    - 700 vehicles / hour / lane for a two lane approach
    - 500 vehicles / hour / lane for a three lane approach

As the design provides for dedicated right turn bays, and is utilised by less than 120 vehicles per hour, the right turn filter remains a viable phase arrangement.

1.2 Removal of Filter

Cardno has undertaken the additional SIDRA phasing request, with the removal of the filter right turn on both Illawarra Highway approaches, split phasing arrangement for the two side roads and a leading right turn for the eastbound Illawarra Highway approach. Furthermore, an additional test to implement diamond right turn on Illawarra Highway and split phasing on the Broughton Avenue and Tripoli Way Extension roads. The reference to a leading right turn arrangement within the TfNSW letter cannot be achieved for both approaches, rather this would be referred to as a split arrangement. Hence the two phasing arrangements (leading right turn for eastbound with split phasing, and diamond right turn with split phasing) have been tested to provide TfNSW flexibility.

These phase arrangements are shown in the following figures.

Figure 1-1 Diamond Right Turn with Split Phasing

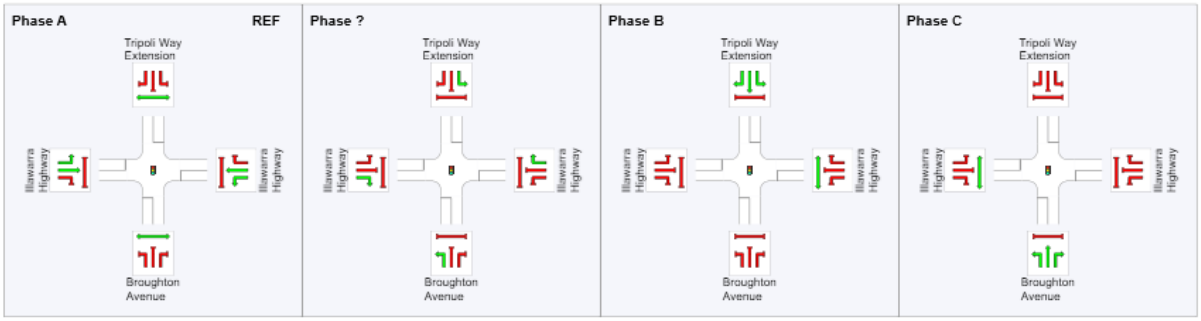
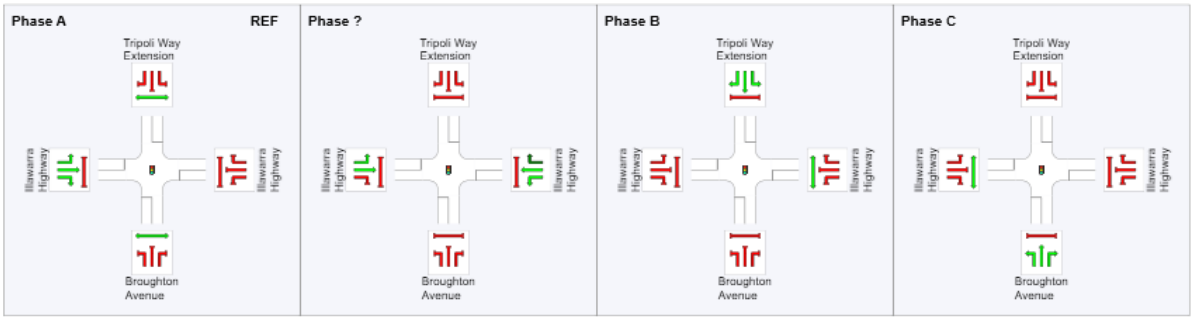


Figure 1-2 Leading Right Turn (Eastbound) with Split Phasing



The results of the above phasing arrangements are summarised in **Table 1-1** below. All models presented below consider pedestrian phases on all approaches.

Table 1-1 Removal of Right Turn Filter Eastbound Results

Model scenario	Peak	Degree of Saturation (v/c)	Average delay (sec)	Level of Service	95th % back of queue vehicles (veh)
Diamond Right Turn with Split Phasing	2036 AM Peak	0.922	47.3	D	24.4
	2036 PM Peak	0.927	48.2	D	35.9
Leading RT (Eastbound) with Split Phasing	2036 AM Peak	0.926	46.0	D	27.3
	2036 PM Peak	0.943	47.2	D	31.4

1.3 Comparison to Previous Phasing Arrangements

Referring to the previous modelled phasing arrangements and results, **Table 1-2** summarises the results to date. All models presented below consider pedestrian phases on all approaches.

Table 1-2 Comparison of Results

Model scenario	Peak	Degree of Saturation (v/c)	Average delay (sec)	Level of Service	95th % back of queue vehicles (veh)
Filter RT & Split Phasing	2036 AM Peak	0.889	29.3	C	15.1
	2036 PM Peak	0.869	32.5	C	24.3
Double Diamond RT	2036 AM Peak	0.869	41.0	C	23.2
	2036 PM Peak	0.930	41.6	C	31.5
Diamond Right Turn with Split Phasing	2036 AM Peak	0.922	47.3	D	24.4
	2036 PM Peak	0.927	48.2	D	35.9
Leading RT with Split Phasing	2036 AM Peak	0.926	46.0	D	27.3
	2036 PM Peak	0.943	47.2	D	31.4

All SIDRA modelling movement summaries summarised in **Table 1-2** are reproduced in detail in **Appendix A**.

The results show that removal of the filter right turn arrangement results in reduced performance, whereby results have moved from LoS C to LoS D. Previous phasing arrangements that either include the filter right turn on Illawarra Highway, or Double Diamond arrangement, result in LoS C.

The concept design previously developed are adequate to support the modelling results

Overall, the modelling undertaken demonstrates viable phasing arrangements for TfNSW to adopt when the intersection upgrade is implemented. There is a level of flexibility when the intersection is constructed and for the purpose of the CUDP Mod 4 application, demonstrates that TfNSW should be able to provide written acceptance of the traffic modelling undertaken to date, and support the mitigation measures provided.

Yours sincerely,

Hayden Calvey
Email: hayden.calvey@cardno.com.au
Direct: +61 2 9024 7093

APPENDIX

A

SIDRA MOVEMENT SUMMARIES

PHASING SUMMARY

Site: [Broughton Avenue/ Illawarra Highway 2036 PM - All ped phases_Filter & Split]

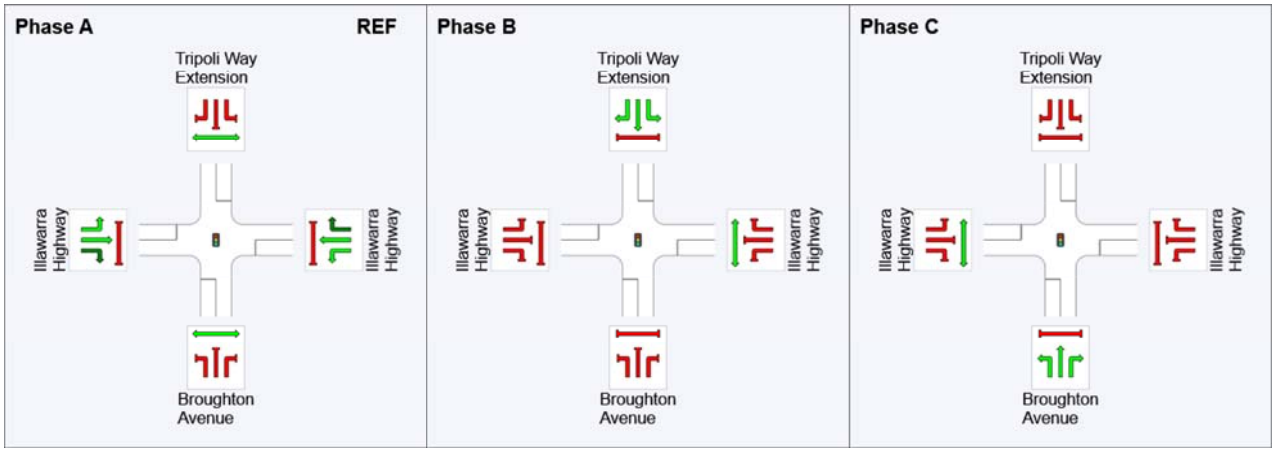
Broughton Ave/ Illawarra Hwy
Signals - Fixed Time Isolated Cycle Time = 80 seconds (Optimum Cycle Time - Minimum Delay)

Phase Times determined by the program
Phase Sequence: Three-Phase
Reference Phase: Phase A
Input Phase Sequence: A, B, C
Output Phase Sequence: A, B, C

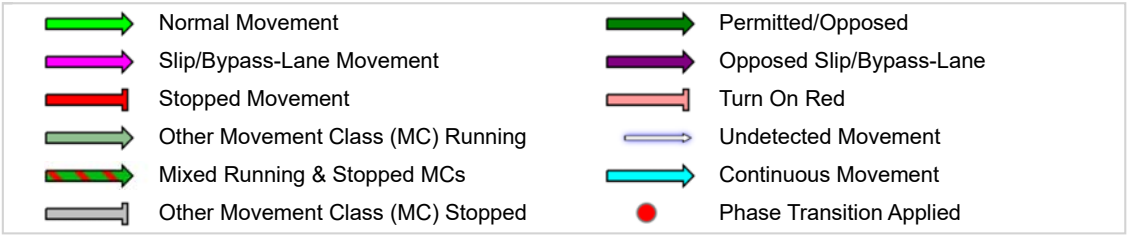
Phase Timing Results

Phase	A	B	C
Phase Change Time (sec)	0	35	63
Green Time (sec)	29	22	11
Phase Time (sec)	35	28	17
Phase Split	44%	35%	21%

See the Phase Information section in the Detailed Output report for more detailed information including input values of Yellow Time and All-Red Time, and information on any adjustments to Intergreen Time, Phase Time and Green Time values in cases of Pedestrian Actuation, Phase Actuation and Phase Frequency values (user-specified or implied) less than 100%.



REF: Reference Phase
VAR: Variable Phase



MOVEMENT SUMMARY

Site: [Broughton Avenue/ Illawarra Highway 2036 PM - All ped phases_Filter & Split]

Broughton Ave/ Illawarra Hwy
Signals - Fixed Time Isolated Cycle Time = 80 seconds (Optimum Cycle Time - Minimum Delay)

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: Broughton Avenue											
1	L2	35	3.0	0.211	41.1	LOS C	1.6	11.9	0.93	0.73	35.6
2	T1	67	17.2	0.559	36.4	LOS C	5.2	39.3	0.97	0.78	36.3
3	R2	77	4.1	0.559	42.1	LOS C	5.2	39.3	0.98	0.79	35.6
Approach		179	8.8	0.559	39.8	LOS C	5.2	39.3	0.97	0.77	35.8
East: Illawarra Highway											
4	L2	238	0.9	0.502	27.9	LOS B	9.8	69.9	0.84	0.79	41.0
5	T1	561	4.5	0.715	24.2	LOS B	16.7	121.5	0.91	0.82	42.7
6	R2	73	2.9	0.592	46.8	LOS D	3.0	21.6	1.00	0.81	33.3
Approach		872	3.4	0.715	27.1	LOS B	16.7	121.5	0.90	0.81	41.2
North: Tripoli Way Extension											
7	L2	9	11.1	0.173	29.7	LOS C	2.6	19.1	0.80	0.64	41.7
8	T1	163	5.2	0.865	32.1	LOS C	18.2	136.6	0.90	0.84	38.3
9	R2	322	9.5	0.865	45.1	LOS D	18.2	136.6	1.00	1.01	34.3
Approach		495	8.1	0.865	40.5	LOS C	18.2	136.6	0.96	0.95	35.6
West: Illawarra Highway											
10	L2	191	13.3	0.521	28.3	LOS B	10.0	75.3	0.85	0.78	41.0
11	T1	692	2.4	0.869	32.4	LOS C	24.3	173.6	0.95	0.98	38.9
12	R2	40	0.0	0.258	40.3	LOS C	1.5	10.4	0.92	0.75	35.4
Approach		922	4.6	0.869	31.9	LOS C	24.3	173.6	0.93	0.93	39.2
All Vehicles		2467	5.2	0.869	32.5	LOS C	24.3	173.6	0.93	0.88	38.8

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
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	21.8	LOS C	0.1	0.1	0.74	0.74
P2	East Full Crossing	53	31.6	LOS D	0.1	0.1	0.89	0.89
P3	North Full Crossing	53	24.1	LOS C	0.1	0.1	0.78	0.78
P4	West Full Crossing	53	34.3	LOS D	0.1	0.1	0.93	0.93
All Pedestrians		211	27.9	LOS C			0.83	0.83

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: [Broughton Avenue/ Illawarra Highway 2036 AM - All ped phases_Filter & Split]

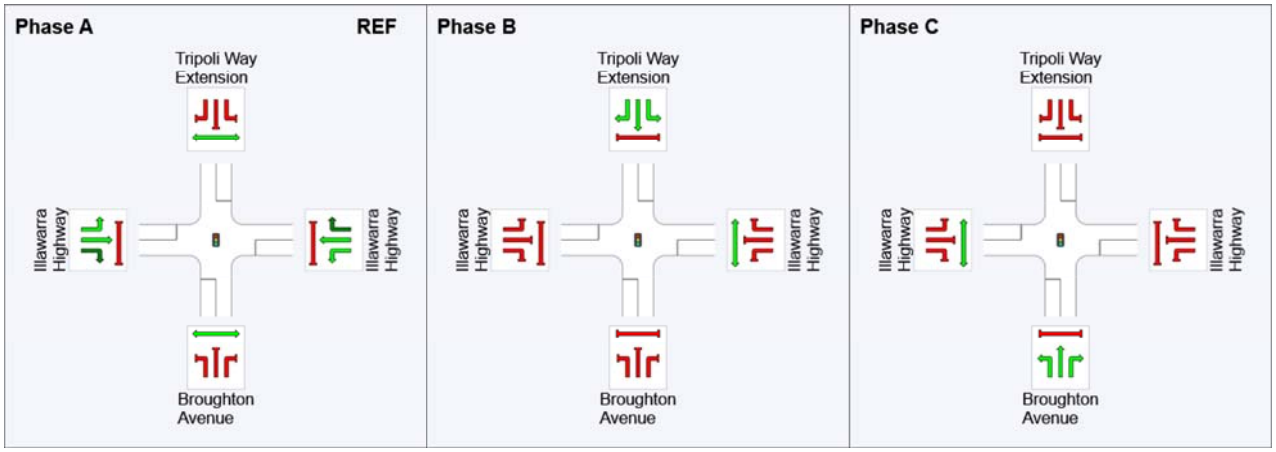
Broughton Ave/ Illawarra Hwy
Signals - Fixed Time Isolated Cycle Time = 55 seconds (Optimum Cycle Time - Minimum Delay)

Phase Times determined by the program
Phase Sequence: Three-Phase
Reference Phase: Phase A
Input Phase Sequence: A, B, C
Output Phase Sequence: A, B, C

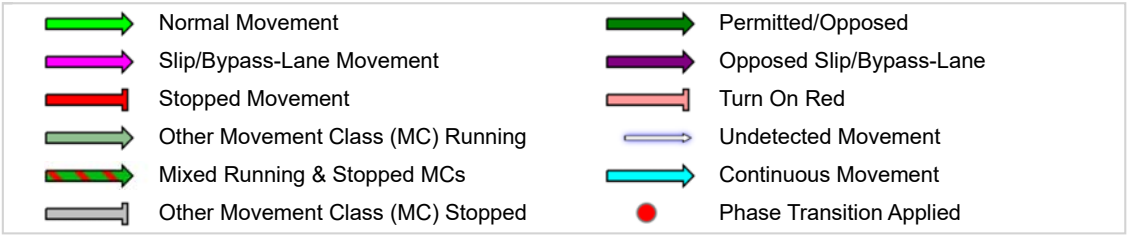
Phase Timing Results

Phase	A	B	C
Phase Change Time (sec)	0	21	38
Green Time (sec)	15	11	11
Phase Time (sec)	21	17	17
Phase Split	38%	31%	31%

See the Phase Information section in the Detailed Output report for more detailed information including input values of Yellow Time and All-Red Time, and information on any adjustments to Intergreen Time, Phase Time and Green Time values in cases of Pedestrian Actuation, Phase Actuation and Phase Frequency values (user-specified or implied) less than 100%.



REF: Reference Phase
VAR: Variable Phase



MOVEMENT SUMMARY

Site: [Broughton Avenue/ Illawarra Highway 2036 AM - All ped phases_Filter & Split]

Broughton Ave/ Illawarra Hwy
Signals - Fixed Time Isolated Cycle Time = 55 seconds (Optimum Cycle Time - Minimum Delay)

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: Broughton Avenue											
1	L2	58	1.8	0.320	26.8	LOS B	2.7	19.6	0.90	0.74	42.1
2	T1	229	4.1	0.850	28.1	LOS B	9.5	69.1	0.97	0.97	40.0
3	R2	128	4.1	0.850	35.9	LOS C	9.5	69.1	1.00	1.04	38.3
Approach		416	3.8	0.850	30.3	LOS C	9.5	69.1	0.97	0.96	39.7
East: Illawarra Highway											
4	L2	65	8.1	0.624	25.5	LOS B	7.6	56.1	0.93	0.80	43.5
5	T1	685	6.9	0.889	27.7	LOS B	15.1	111.9	0.98	1.01	41.0
6	R2	14	15.4	0.096	33.4	LOS C	0.4	2.9	0.96	0.67	37.7
Approach		764	7.2	0.889	27.6	LOS B	15.1	111.9	0.97	0.99	41.2
North: Tripoli Way Extension											
7	L2	4	0.0	0.169	26.0	LOS B	1.4	10.7	0.86	0.66	43.8
8	T1	61	12.1	0.845	21.3	LOS B	8.8	70.3	0.87	0.69	44.0
9	R2	271	17.1	0.845	36.3	LOS C	8.8	70.3	1.00	1.02	36.8
Approach		336	16.0	0.845	33.5	LOS C	8.8	70.3	0.98	0.95	38.0
West: Illawarra Highway											
10	L2	351	7.8	0.795	31.1	LOS C	10.2	76.5	0.99	0.95	38.9
11	T1	418	4.5	0.822	25.9	LOS B	12.5	90.7	1.00	1.01	42.1
12	R2	32	0.0	0.233	34.9	LOS C	0.9	6.2	0.99	0.70	37.4
Approach		800	5.8	0.822	28.5	LOS C	12.5	90.7	0.99	0.97	40.4
All Vehicles		2316	7.4	0.889	29.3	LOS C	15.1	111.9	0.98	0.97	40.2

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
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	21.0	LOS C	0.1	0.1	0.87	0.87
P2	East Full Crossing	53	21.9	LOS C	0.1	0.1	0.89	0.89
P3	North Full Crossing	53	21.9	LOS C	0.1	0.1	0.89	0.89
P4	West Full Crossing	53	21.9	LOS C	0.1	0.1	0.89	0.89
All Pedestrians		211	21.7	LOS C			0.89	0.89

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: [Broughton Avenue/ Illawarra Highway 2036 AM - All ped phases_Double Diamond]

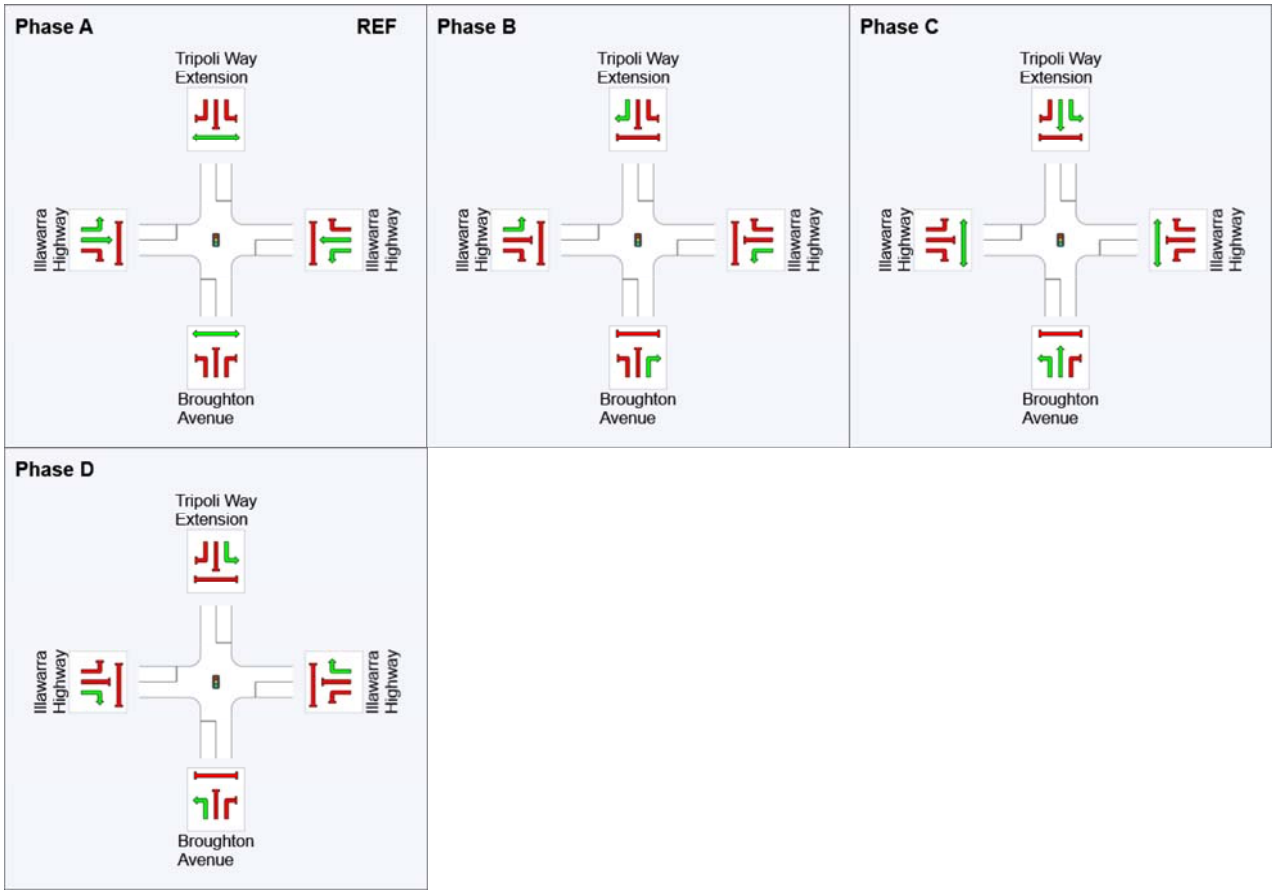
Broughton Ave/ Illawarra Hwy
Signals - Fixed Time Isolated Cycle Time = 100 seconds (User-Given Cycle Time)

Phase Times determined by the program
Phase Sequence: Three-Phase
Reference Phase: Phase A
Input Phase Sequence: A, B, C, D
Output Phase Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Phase Change Time (sec)	0	35	60	88
Green Time (sec)	29	19	22	6
Phase Time (sec)	35	25	28	12
Phase Split	35%	25%	28%	12%

See the Phase Information section in the Detailed Output report for more detailed information including input values of Yellow Time and All-Red Time, and information on any adjustments to Intergreen Time, Phase Time and Green Time values in cases of Pedestrian Actuation, Phase Actuation and Phase Frequency values (user-specified or implied) less than 100%.



REF: Reference Phase
VAR: Variable Phase

MOVEMENT SUMMARY

Site: [Broughton Avenue/ Illawarra Highway 2036 AM - All ped phases_Double Diamond]

Broughton Ave/ Illawarra Hwy
Signals - Fixed Time Isolated Cycle Time = 100 seconds (User-Given 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: Broughton Avenue											
1	L2	58	1.8	0.860	54.2	LOS D	15.2	109.6	0.98	1.00	32.5
2	T1	229	4.1	0.860	48.7	LOS D	15.2	109.6	0.98	1.00	33.0
3	R2	128	4.1	0.381	44.5	LOS D	5.6	40.5	0.92	0.79	34.0
Approach		416	3.8	0.860	48.1	LOS D	15.2	109.6	0.96	0.93	33.3
East: Illawarra Highway											
4	L2	65	8.1	0.581	37.9	LOS C	12.7	94.3	0.90	0.78	37.8
5	T1	685	6.9	0.847	39.5	LOS C	23.2	171.9	0.97	0.92	36.2
6	R2	14	15.4	0.138	56.9	LOS E	0.7	5.4	0.98	0.69	30.3
Approach		764	7.2	0.847	39.7	LOS C	23.2	171.9	0.96	0.91	36.2
North: Tripoli Way Extension											
7	L2	4	0.0	0.167	39.1	LOS C	2.6	19.8	0.84	0.66	37.9
8	T1	61	12.1	0.167	33.5	LOS C	2.6	19.8	0.84	0.66	38.6
9	R2	271	17.1	0.874	59.6	LOS E	15.2	121.7	1.00	0.98	29.7
Approach		336	16.0	0.874	54.6	LOS D	15.2	121.7	0.97	0.91	31.1
West: Illawarra Highway											
10	L2	351	7.8	0.432	28.0	LOS B	13.6	101.4	0.78	0.80	40.4
11	T1	418	4.5	0.739	34.9	LOS C	17.6	127.6	0.94	0.85	38.0
12	R2	32	0.0	0.288	57.3	LOS E	1.6	11.0	0.99	0.72	30.4
Approach		800	5.8	0.739	32.8	LOS C	17.6	127.6	0.87	0.82	38.6
All Vehicles		2316	7.4	0.874	41.0	LOS C	23.2	171.9	0.93	0.89	35.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
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	31.3	LOS D	0.1	0.1	0.79	0.79
P2	East Full Crossing	53	41.5	LOS E	0.1	0.1	0.91	0.91
P3	North Full Crossing	53	31.3	LOS D	0.1	0.1	0.79	0.79
P4	West Full Crossing	53	41.5	LOS E	0.1	0.1	0.91	0.91
All Pedestrians		211	36.4	LOS D			0.85	0.85

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: [Broughton Avenue/ Illawarra Highway 2036 PM - All ped phases_Double Diamond]

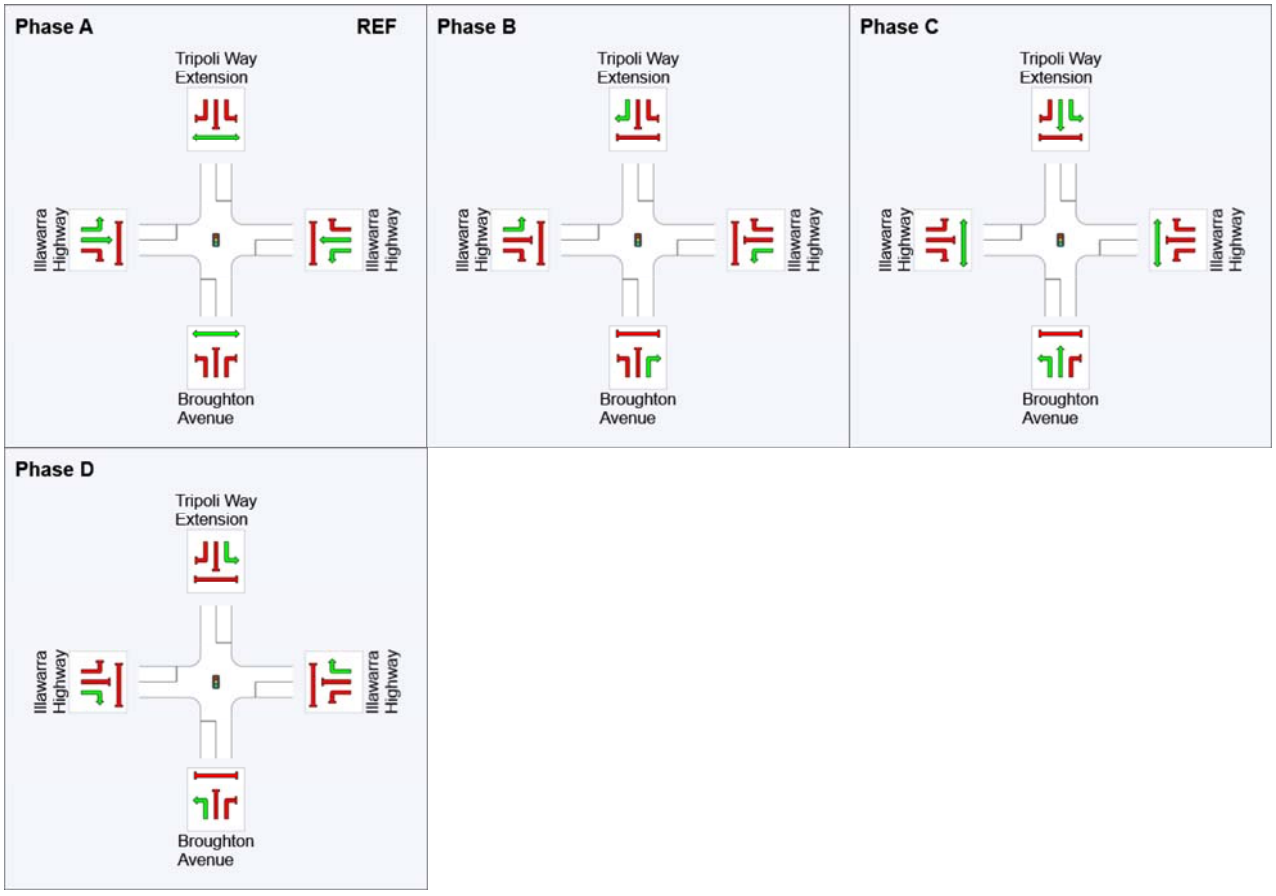
Broughton Ave/ Illawarra Hwy
Signals - Fixed Time Isolated Cycle Time = 100 seconds (User-Given Cycle Time)

Phase Times determined by the program
Phase Sequence: Three-Phase
Reference Phase: Phase A
Input Phase Sequence: A, B, C, D
Output Phase Sequence: A, B, C, D

Phase Timing Results

Phase	A	B	C	D
Phase Change Time (sec)	0	40	69	88
Green Time (sec)	34	23	13	6
Phase Time (sec)	40	29	19	12
Phase Split	40%	29%	19%	12%

See the Phase Information section in the Detailed Output report for more detailed information including input values of Yellow Time and All-Red Time, and information on any adjustments to Intergreen Time, Phase Time and Green Time values in cases of Pedestrian Actuation, Phase Actuation and Phase Frequency values (user-specified or implied) less than 100%.



REF: Reference Phase
VAR: Variable Phase

Normal Movement	Permitted/Opposed
Slip/Bypass-Lane Movement	Opposed Slip/Bypass-Lane
Stopped Movement	Turn On Red
Other Movement Class (MC) Running	Undetected Movement
Mixed Running & Stopped MCs	Continuous Movement
Other Movement Class (MC) Stopped	Phase Transition Applied

MOVEMENT SUMMARY

Site: [Broughton Avenue/ Illawarra Highway 2036 PM - All ped phases_Double Diamond]

Broughton Ave/ Illawarra Hwy
Signals - Fixed Time Isolated Cycle Time = 100 seconds (User-Given 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: Broughton Avenue											
1	L2	35	3.0	0.454	49.9	LOS D	4.8	36.9	0.96	0.77	33.5
2	T1	67	17.2	0.454	44.3	LOS D	4.8	36.9	0.96	0.77	34.1
3	R2	77	4.1	0.188	39.3	LOS C	3.0	22.1	0.84	0.75	35.8
Approach		179	8.8	0.454	43.2	LOS D	4.8	36.9	0.91	0.76	34.7
East: Illawarra Highway											
4	L2	238	0.9	0.520	32.1	LOS C	13.1	93.5	0.83	0.79	39.3
5	T1	561	4.5	0.758	31.6	LOS C	20.1	146.4	0.91	0.84	39.2
6	R2	73	2.9	0.676	60.3	LOS E	3.8	27.4	1.00	0.82	29.7
Approach		872	3.4	0.758	34.1	LOS C	20.1	146.4	0.90	0.82	38.2
North: Tripoli Way Extension											
7	L2	9	11.1	0.723	53.6	LOS D	8.7	63.5	1.00	0.88	32.8
8	T1	163	5.2	0.723	48.0	LOS D	8.7	63.5	1.00	0.88	33.5
9	R2	322	9.5	0.871	56.1	LOS D	17.6	133.4	1.00	0.97	30.6
Approach		495	8.1	0.871	53.4	LOS D	17.6	133.4	1.00	0.94	31.6
West: Illawarra Highway											
10	L2	191	13.3	0.527	32.4	LOS C	12.4	93.6	0.84	0.78	39.2
11	T1	692	2.4	0.902	43.7	LOS D	31.5	224.8	0.97	1.03	34.7
12	R2	40	0.0	0.365	57.8	LOS E	2.0	14.1	1.00	0.73	30.3
Approach		922	4.6	0.902	42.0	LOS C	31.5	224.8	0.94	0.96	35.3
All Vehicles		2467	5.2	0.902	41.6	LOS C	31.5	224.8	0.94	0.89	35.4

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
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	27.4	LOS C	0.1	0.1	0.74	0.74
P2	East Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
P3	North Full Crossing	53	27.4	LOS C	0.1	0.1	0.74	0.74
P4	West Full Crossing	53	44.3	LOS E	0.1	0.1	0.94	0.94
All Pedestrians		211	35.9	LOS D			0.84	0.84

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.

MOVEMENT SUMMARY

Site: [Broughton Avenue/ Illawarra Highway 2036 PM - All ped phases_Diamond & Split]

Broughton Ave/ Illawarra Hwy
Signals - Fixed Time Isolated Cycle Time = 115 seconds (Optimum Cycle Time - Minimum Delay)

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: Broughton Avenue											
1	L2	35	3.0	0.224	31.7	LOS C	1.6	11.6	0.93	0.72	39.4
2	T1	67	17.2	0.596	46.7	LOS D	7.0	53.2	0.98	0.78	32.9
3	R2	77	4.1	0.596	59.1	LOS E	7.0	53.2	0.99	0.80	30.5
Approach		179	8.8	0.596	49.1	LOS D	7.0	53.2	0.97	0.78	32.8
East: Illawarra Highway											
4	L2	238	0.9	0.546	39.4	LOS C	15.0	106.7	0.87	0.81	36.3
5	T1	561	4.5	0.778	36.7	LOS C	24.0	174.2	0.93	0.85	37.2
6	R2	73	2.9	0.777	70.9	LOS F	4.5	32.2	1.00	0.87	27.3
Approach		872	3.4	0.778	40.3	LOS C	24.0	174.2	0.92	0.84	35.9
North: Tripoli Way Extension											
7	L2	9	11.1	0.185	39.6	LOS C	3.9	29.0	0.80	0.65	37.5
8	T1	163	5.2	0.927	49.0	LOS D	27.4	205.9	0.90	0.85	32.6
9	R2	322	9.5	0.927	70.4	LOS E	27.4	205.9	1.00	1.05	27.7
Approach		495	8.1	0.927	62.8	LOS E	27.4	205.9	0.96	0.98	29.3
West: Illawarra Highway											
10	L2	191	13.3	0.541	39.5	LOS C	14.3	108.2	0.87	0.79	36.4
11	T1	692	2.4	0.903	48.8	LOS D	35.9	256.2	0.98	1.02	33.1
12	R2	40	0.0	0.419	66.6	LOS E	2.3	16.4	1.00	0.73	28.2
Approach		922	4.6	0.903	47.7	LOS D	35.9	256.2	0.96	0.96	33.5
All Vehicles		2467	5.2	0.927	48.2	LOS D	35.9	256.2	0.94	0.91	33.3

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
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	30.0	LOS D	0.1	0.1	0.72	0.72
P2	East Full Crossing	53	41.0	LOS E	0.1	0.1	0.85	0.85
P3	North Full Crossing	53	32.2	LOS D	0.1	0.1	0.75	0.75
P4	West Full Crossing	53	51.8	LOS E	0.2	0.2	0.95	0.95
All Pedestrians		211	38.8	LOS D			0.82	0.82

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: [Broughton Avenue/ Illawarra Highway 2036 AM - All ped phases_Diamond & Split]

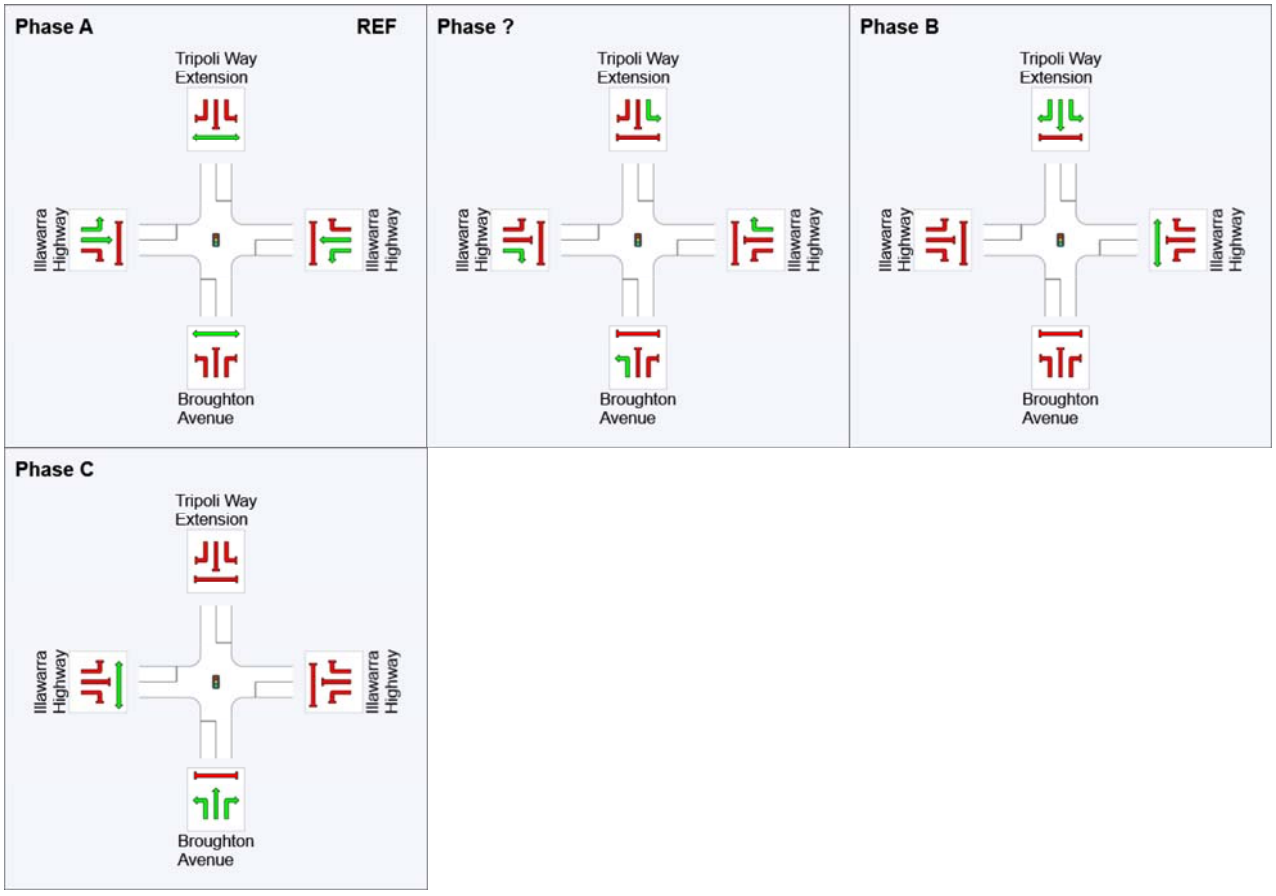
Broughton Ave/ Illawarra Hwy
Signals - Fixed Time Isolated Cycle Time = 93 seconds (Optimum Cycle Time - Minimum Delay)

Phase Times determined by the program
Phase Sequence: Three-Phase
Reference Phase: Phase A
Input Phase Sequence: A, ?, B, C
Output Phase Sequence: A, ?, B, C

Phase Timing Results

Phase	A	?	B	C
Phase Change Time (sec)	0	31	43	66
Green Time (sec)	25	6	17	21
Phase Time (sec)	31	12	23	27
Phase Split	33%	13%	25%	29%

See the Phase Information section in the Detailed Output report for more detailed information including input values of Yellow Time and All-Red Time, and information on any adjustments to Intergreen Time, Phase Time and Green Time values in cases of Pedestrian Actuation, Phase Actuation and Phase Frequency values (user-specified or implied) less than 100%.



REF: Reference Phase
VAR: Variable Phase

MOVEMENT SUMMARY

Site: [Broughton Avenue/ Illawarra Highway 2036 AM - All ped phases_Diamond & Split]

Broughton Ave/ Illawarra Hwy
Signals - Fixed Time Isolated Cycle Time = 93 seconds (Optimum Cycle Time - Minimum Delay)

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: Broughton Avenue											
1	L2	58	1.8	0.344	34.1	LOS C	4.5	32.2	0.87	0.78	39.1
2	T1	229	4.1	0.913	44.5	LOS D	14.6	105.5	0.93	0.97	33.9
3	R2	128	4.1	0.913	60.1	LOS E	14.6	105.5	0.96	1.09	30.5
Approach		416	3.8	0.913	47.9	LOS D	14.6	105.5	0.93	0.98	33.4
East: Illawarra Highway											
4	L2	65	8.1	0.637	38.5	LOS C	12.4	92.3	0.94	0.81	37.7
5	T1	685	6.9	0.907	44.4	LOS D	24.4	180.8	0.98	1.00	34.6
6	R2	14	15.4	0.129	52.9	LOS D	0.6	5.0	0.97	0.69	31.4
Approach		764	7.2	0.907	44.0	LOS D	24.4	180.8	0.97	0.98	34.8
North: Tripoli Way Extension											
7	L2	4	0.0	0.184	40.0	LOS C	2.3	18.0	0.87	0.68	37.5
8	T1	61	12.1	0.922	36.3	LOS C	15.8	126.4	0.88	0.71	37.3
9	R2	271	17.1	0.922	64.8	LOS E	15.8	126.4	1.00	1.06	28.6
Approach		336	16.0	0.922	59.3	LOS E	15.8	126.4	0.98	0.99	30.0
West: Illawarra Highway											
10	L2	351	7.8	0.818	47.2	LOS D	16.8	125.5	1.00	0.93	33.2
11	T1	418	4.5	0.856	43.0	LOS D	20.7	150.3	1.00	1.02	35.2
12	R2	32	0.0	0.268	53.3	LOS D	1.5	10.2	0.99	0.72	31.5
Approach		800	5.8	0.856	45.2	LOS D	20.7	150.3	1.00	0.97	34.1
All Vehicles		2316	7.4	0.922	47.3	LOS D	24.4	180.8	0.98	0.98	33.5

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
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	31.1	LOS D	0.1	0.1	0.82	0.82
P2	East Full Crossing	53	40.8	LOS E	0.1	0.1	0.94	0.94
P3	North Full Crossing	53	33.6	LOS D	0.1	0.1	0.85	0.85
P4	West Full Crossing	53	38.9	LOS D	0.1	0.1	0.92	0.92
All Pedestrians		211	36.1	LOS D			0.88	0.88

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: [Broughton Avenue/ Illawarra Highway 2036 AM - All ped phases_Eastbound LRT & Split]

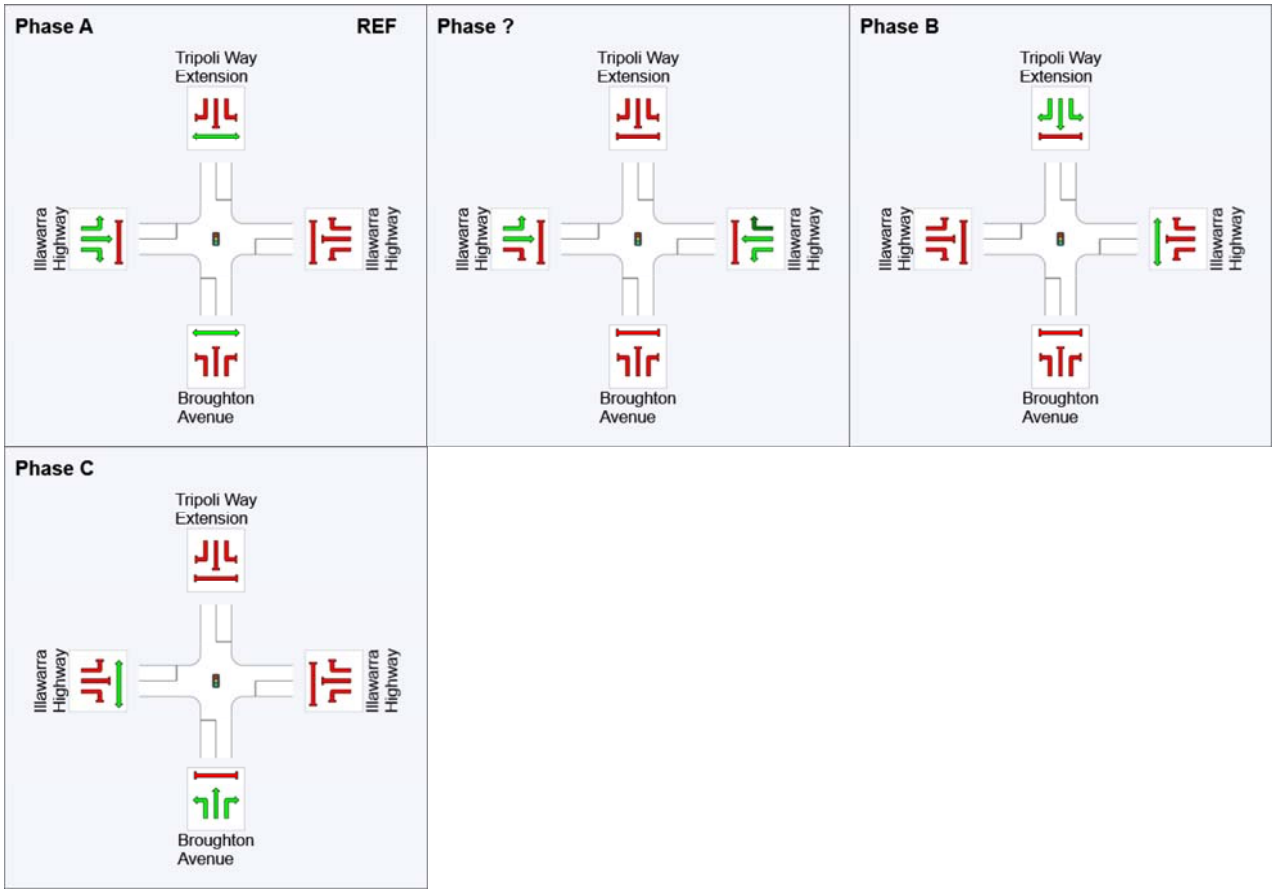
Broughton Ave/ Illawarra Hwy
Signals - Fixed Time Isolated Cycle Time = 108 seconds (Optimum Cycle Time - Minimum Delay)

Phase Times determined by the program
Phase Sequence: Three-Phase
Reference Phase: Phase A
Input Phase Sequence: A, ?, B, C
Output Phase Sequence: A, ?, B, C

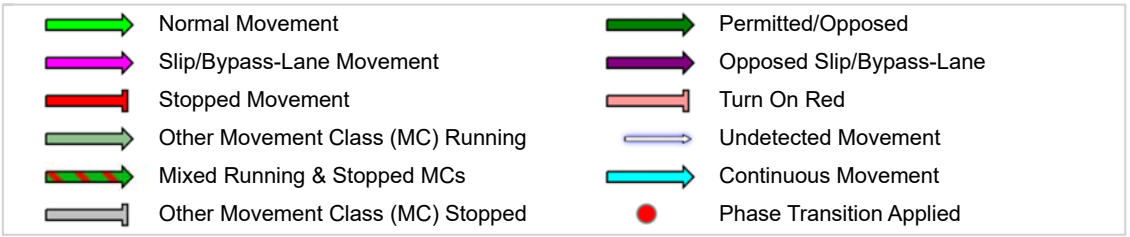
Phase Timing Results

Phase	A	?	B	C
Phase Change Time (sec)	0	18	53	79
Green Time (sec)	12	29	20	23
Phase Time (sec)	18	35	26	29
Phase Split	17%	32%	24%	27%

See the Phase Information section in the Detailed Output report for more detailed information including input values of Yellow Time and All-Red Time, and information on any adjustments to Intergreen Time, Phase Time and Green Time values in cases of Pedestrian Actuation, Phase Actuation and Phase Frequency values (user-specified or implied) less than 100%.



REF: Reference Phase
VAR: Variable Phase



MOVEMENT SUMMARY

Site: [Broughton Avenue/ Illawarra Highway 2036 AM - All ped phases_Eastbound LRT & Split]

Broughton Ave/ Illawarra Hwy
Signals - Fixed Time Isolated Cycle Time = 108 seconds (Optimum Cycle Time - Minimum Delay)

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: Broughton Avenue											
1	L2	58	1.8	0.345	45.8	LOS D	5.8	41.4	0.90	0.75	34.7
2	T1	229	4.1	0.915	55.4	LOS D	18.0	130.6	0.97	0.99	30.8
3	R2	128	4.1	0.915	67.3	LOS E	18.0	130.6	0.99	1.09	28.8
Approach		416	3.8	0.915	57.8	LOS E	18.0	130.6	0.97	0.99	30.6
East: Illawarra Highway											
4	L2	65	8.1	0.636	43.5	LOS D	14.5	108.0	0.94	0.81	35.8
5	T1	685	6.9	0.906	49.7	LOS D	27.3	202.1	0.98	0.99	32.9
6	R2	14	15.4	0.074	39.4	LOS C	0.6	4.5	0.78	0.70	35.5
Approach		764	7.2	0.906	49.0	LOS D	27.3	202.1	0.97	0.97	33.2
North: Tripoli Way Extension											
7	L2	4	0.0	0.185	46.1	LOS D	2.7	20.9	0.88	0.68	35.3
8	T1	61	12.1	0.926	42.6	LOS D	18.0	144.6	0.89	0.71	35.1
9	R2	271	17.1	0.926	72.7	LOS F	18.0	144.6	1.00	1.04	26.9
Approach		336	16.0	0.926	66.9	LOS E	18.0	144.6	0.98	0.98	28.2
West: Illawarra Highway											
10	L2	351	7.8	0.497	31.2	LOS C	13.7	102.3	0.79	0.81	38.8
11	T1	418	4.5	0.541	23.8	LOS B	15.9	115.9	0.78	0.68	43.2
12	R2	32	0.0	0.207	57.4	LOS E	1.6	11.4	0.97	0.72	30.4
Approach		800	5.8	0.541	28.3	LOS B	15.9	115.9	0.79	0.74	40.5
All Vehicles		2316	7.4	0.926	46.0	LOS D	27.3	202.1	0.91	0.89	33.9

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
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	48.3	LOS E	0.2	0.2	0.95	0.95
P2	East Full Crossing	53	47.3	LOS E	0.2	0.2	0.94	0.94
P3	North Full Crossing	53	48.3	LOS E	0.2	0.2	0.95	0.95
P4	West Full Crossing	53	44.6	LOS E	0.1	0.1	0.91	0.91
All Pedestrians		211	47.1	LOS E			0.93	0.93

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: [Broughton Avenue/ Illawarra Highway 2036 PM - All ped phases_Eastbound LRT & Split]

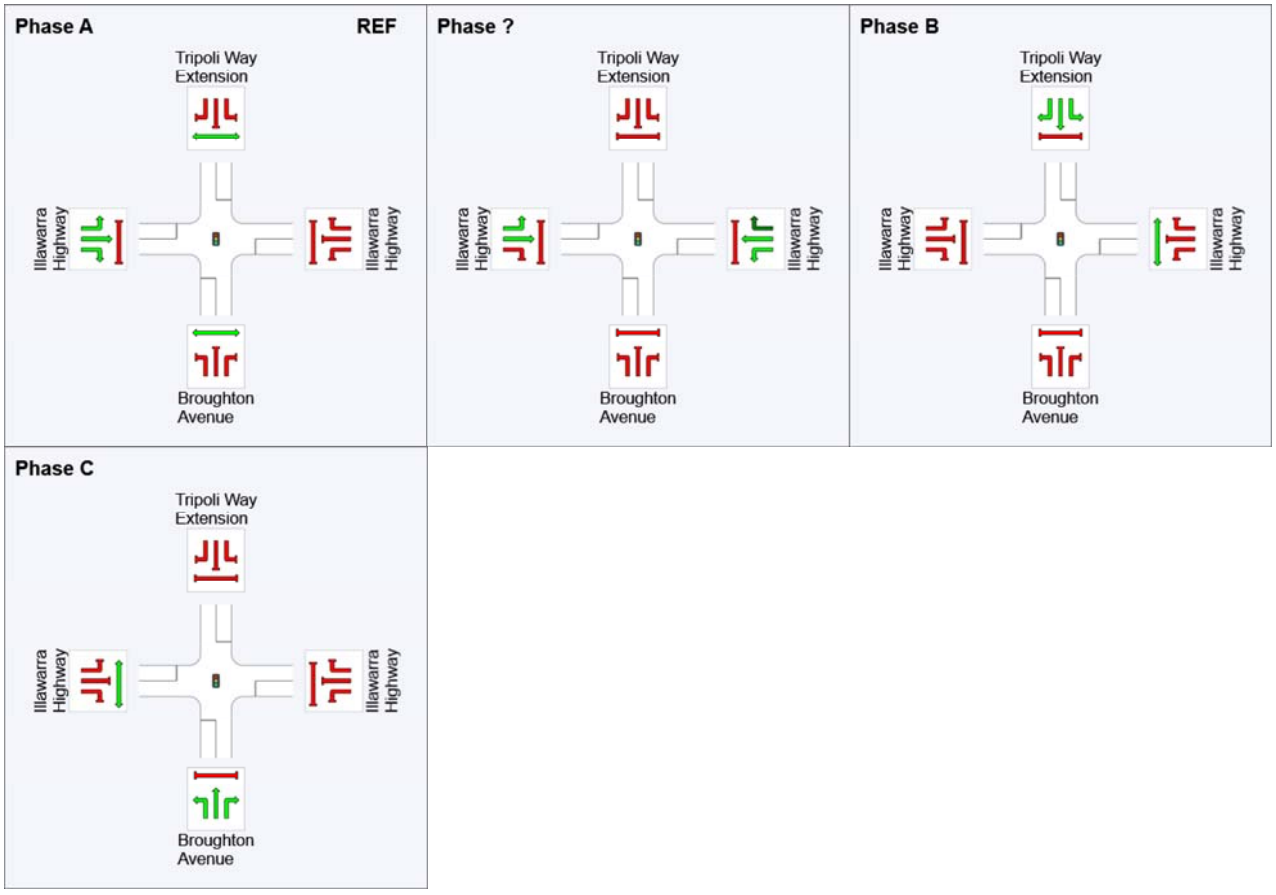
Broughton Ave/ Illawarra Hwy
Signals - Fixed Time Isolated Cycle Time = 115 seconds (Optimum Cycle Time - Minimum Delay)

Phase Times determined by the program
Phase Sequence: Three-Phase
Reference Phase: Phase A
Input Phase Sequence: A, ?, B, C
Output Phase Sequence: A, ?, B, C

Phase Timing Results

Phase	A	?	B	C
Phase Change Time (sec)	0	19	58	95
Green Time (sec)	13	33	31	14
Phase Time (sec)	19	39	37	20
Phase Split	17%	34%	32%	17%

See the Phase Information section in the Detailed Output report for more detailed information including input values of Yellow Time and All-Red Time, and information on any adjustments to Intergreen Time, Phase Time and Green Time values in cases of Pedestrian Actuation, Phase Actuation and Phase Frequency values (user-specified or implied) less than 100%.



REF: Reference Phase
VAR: Variable Phase

MOVEMENT SUMMARY

Site: [Broughton Avenue/ Illawarra Highway 2036 PM - All ped phases_Eastbound LRT & Split]

Broughton Ave/ Illawarra Hwy
Signals - Fixed Time Isolated Cycle Time = 115 seconds (Optimum Cycle Time - Minimum Delay)

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: Broughton Avenue											
1	L2	35	3.0	0.244	58.4	LOS E	2.3	16.9	0.96	0.74	30.4
2	T1	67	17.2	0.647	54.1	LOS D	7.6	57.7	0.99	0.81	30.8
3	R2	77	4.1	0.647	59.9	LOS E	7.6	57.7	1.00	0.83	30.3
Approach		179	8.8	0.647	57.4	LOS E	7.6	57.7	0.99	0.80	30.5
East: Illawarra Highway											
4	L2	238	0.9	0.662	44.6	LOS D	17.3	123.1	0.94	0.83	34.6
5	T1	561	4.5	0.943	61.8	LOS E	31.4	228.6	0.99	1.10	29.6
6	R2	73	2.9	0.461	49.5	LOS D	3.7	26.8	0.91	0.79	32.5
Approach		872	3.4	0.943	56.1	LOS D	31.4	228.6	0.97	1.00	31.1
North: Tripoli Way Extension											
7	L2	9	11.1	0.186	40.4	LOS C	3.9	28.8	0.81	0.65	37.2
8	T1	163	5.2	0.929	49.9	LOS D	27.6	207.5	0.90	0.85	32.3
9	R2	322	9.5	0.929	70.8	LOS F	27.6	207.5	1.00	1.05	27.6
Approach		495	8.1	0.929	63.3	LOS E	27.6	207.5	0.96	0.98	29.1
West: Illawarra Highway											
10	L2	191	13.3	0.416	29.7	LOS C	12.2	91.8	0.74	0.73	40.4
11	T1	692	2.4	0.694	25.9	LOS B	24.6	175.7	0.82	0.75	41.8
12	R2	40	0.0	0.252	60.5	LOS E	2.2	15.3	0.97	0.73	29.6
Approach		922	4.6	0.694	28.1	LOS B	24.6	175.7	0.81	0.74	40.8
All Vehicles		2467	5.2	0.943	47.2	LOS D	31.4	228.6	0.91	0.89	33.6

Site Level of Service (LOS) Method: Delay (RTA NSW). Site LOS Method is specified in the Parameter Settings dialog (Site tab).
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	51.8	LOS E	0.2	0.2	0.95	0.95
P2	East Full Crossing	53	41.0	LOS E	0.1	0.1	0.85	0.85
P3	North Full Crossing	53	51.8	LOS E	0.2	0.2	0.95	0.95
P4	West Full Crossing	53	51.8	LOS E	0.2	0.2	0.95	0.95
All Pedestrians		211	49.1	LOS E			0.92	0.92

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: [Broughton Avenue/ Illawarra Highway 2036 AM - All ped phases_Diamond & Split]

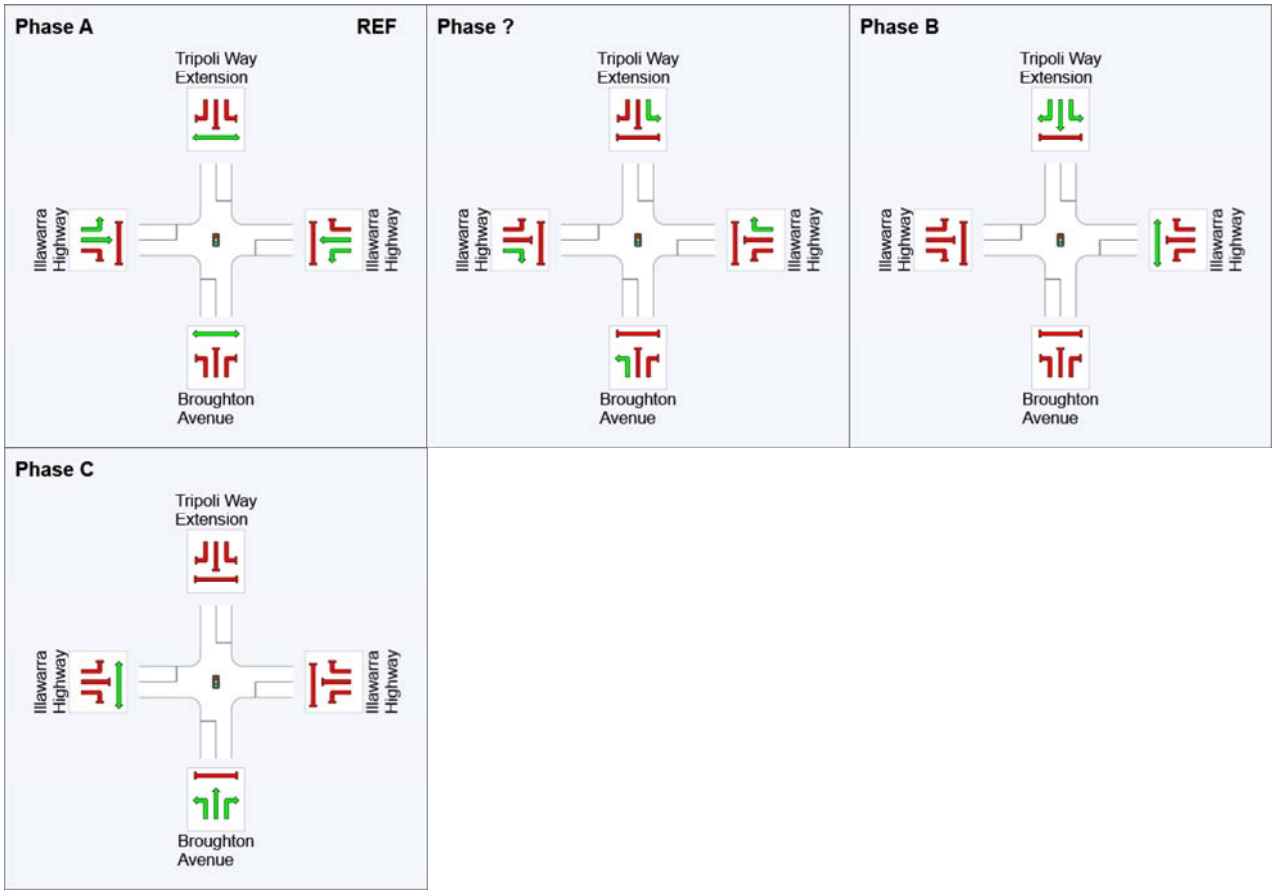
Broughton Ave/ Illawarra Hwy
Signals - Fixed Time Isolated Cycle Time = 93 seconds (Optimum Cycle Time - Minimum Delay)

Phase Times determined by the program
Phase Sequence: Three-Phase
Reference Phase: Phase A
Input Phase Sequence: A, ?, B, C
Output Phase Sequence: A, ?, B, C

Phase Timing Results

Phase	A	?	B	C
Phase Change Time (sec)	0	31	43	66
Green Time (sec)	25	6	17	21
Phase Time (sec)	31	12	23	27
Phase Split	33%	13%	25%	29%

See the Phase Information section in the Detailed Output report for more detailed information including input values of Yellow Time and All-Red Time, and information on any adjustments to Intergreen Time, Phase Time and Green Time values in cases of Pedestrian Actuation, Phase Actuation and Phase Frequency values (user-specified or implied) less than 100%.



REF: Reference Phase
VAR: Variable Phase