



Pacific Highway Interchange at Kings Hill
Updated Traffic Modelling Report
November 2014



KHD

KINGS HILL DEVELOPMENT

Pacific Highway Interchange at Kings Hill - Revised Concept Design

Updated Traffic Modelling and Assessment

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REVISIONS

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1 Introduction

1.1 Background

Kings Hill Development (KHD) is investigating the concept design of Kings Hill interchange with Pacific Highway as part of the Kings Hill development in North Raymond Terrace. The concept design proposes a grade separated interchange with a bridge over the Pacific Highway.

Hyder Consulting Pty Ltd (Hyder) was commissioned by Kings Hill Development (KHD) for engineering consulting services for the Kings Hill development. KHD are the major land holder in the urban release area. The project is being managed by APP Corporation Pty Ltd (APP) on behalf of Kings Hill Development.

Hyder's scope includes concept design and traffic modelling of the proposed interchange with the Pacific Highway at Kings Hill. In a letter dated 1st May 2014, the Roads and Maritime Services of NSW (Roads and Maritime) provided in principle agreement to the concept design of a grade separated interchange with a bridge over the Pacific Highway. The concept design was accompanied by a traffic modelling report prepared by Hyder, *Traffic Modelling Report for Pacific Highway Interchange at Kings Hill*, dated February 2014 (February 2014 Report).

Roads and Maritime recommended further changes to the concept design supported by the additional traffic modelling. This report documents the additional traffic modelling work undertaken addressing Roads and Maritime's issues dated 1st May 2014.

1.2 Purpose of this report

This report examines the traffic performance of the revised concept design. The report identifies traffic implications and operational performance of the interchange for ultimate Kings Hill development. When fully developed the proposed Kings Hill Urban Release Area would accommodate about 3,500 new dwellings. For the purpose of modelling, it was assumed that the site would be fully developed by 2036.

This report should be read in conjunction with the February 2012 Report prepared by Hyder. The February 2014 report documented background traffic modelling, previous concept design and level of service of the concept design. This report does not supersede the findings from the February 2014 Report; it supplements the additional modelling undertaken to satisfy the Roads and Maritime issues dated 1st May 2014.

1.3 Roads and Maritime comments on previous concept design

Roads and Maritime letter dated 01 May 2014 documents the review of Hyder's previous concept design for the proposed Pacific Highway interchange at Kings Hill. As stated in the letter, Roads and Maritime has provided in principle support for the layout of the Pacific Highway interchange at Kings Hill, subject to a number of issues being addressed (with comments in the letter outlining the issues).

Comments included in the letter that are relevant to this report are reproduced in Table 1-1 below.

Table 1-1 RMS comments on previous submission (reference: RMS letter dated 01 May 2014)

No.	Roads and Maritime comment (reproduced from letter)	Section of this report
1	Roads and Maritime's Pacific Highway office has recommended that consideration should be given to construction of a roundabout at the junction of the main town road and the off ramp in lieu of traffic signals. It is considered that roundabout would have more safety benefits than traffic signals. Roundabout will not only slow down vehicles on entry to the town centre but will also allow vehicles to safely perform weaving manoeuvres on approach to the town centre roundabout. Dual lanes would still be required on approach to the roundabout similar to the proposed design for the signalised off ramp. The proponent should prepare design and cost estimates for both the options (signalised and roundabout). RMS's preference would be to have a roundabout at the junction of the main town road and the off ramp instead of traffic signals.	Section 2.2 describes updated concept design. Section 4 summarises modelling results undertaken for revised concept.
2	Roads and Maritime is concerned regarding the proximity of the internal roundabout to the interchange and the exclusion of this roundabout from the Strategic Design Concept Reports and the Traffic Modelling Report. Roads and Maritime acknowledge that the roundabout is not part of the Interchange design; however it is concerned that the operational performance of the roundabout and its proximity (85m) to the interchange is likely to have an impact on the operation and efficiency of the interchange. <i>Comment: The submitted Paramics model has not included any internal trip distributions for the development, nor considered the impact of having commercial developments near the roundabout within such a close proximity to the interchange. The preference for RMS is to have the internal roundabout located further away from the interchange, however until further traffic modelling is undertaken, which includes internal trip distributions at full development and the impact of the commercial centre, it is difficult to determine the preferable distance required from the interchange.</i>	Section 2.2. The concept design has been modified incorporating distance between two roundabouts to 130 metres. Section 3 documents Paramics modelling updates undertaken within town centre. Section 4 documents traffic performance of interchange roundabout and town centre roundabout.
3	RMS requires the internal trip distributions (from Zone 17 to zone 18 & 19 and vice versa) at full development to be included in the Paramics model to analyse the likely queue lengths at the roundabout, particularly during the PM peak when approximately 1400 vehicles/hour will be exiting via the northbound off ramp.	Section 3 documents Paramics modelling updates undertaken within town centre. Table 4-2, Table 4-4 and Table 4-6 shows the predicted queue length for on and off ramps.

Following receipt of Roads and Maritime's letter, Hyder revised the concept design for the Pacific Highway interchange. The Paramics models have been revised in order to address the above comments.

2 Updated concept design of Pacific Highway interchange at Kings Hill

2.1 Previous concept design

The basis for Roads and Maritime comments (refer to Section 1.3) was previous concept design for the Pacific Highway Interchange at Kings Hill prepared by Hyder. The proposed interchange was designed to provide free flow movement to major eastbound and southbound traffic to and from Kings Hill development. A bridge over Pacific Highway was proposed connecting the southbound ramps with the proposed development. The intersection on the eastern side of Pacific Highway between the southbound off ramp and eastbound traffic on East West Link Road was designed as a T-intersection. On the western side of Pacific Highway the northbound ramps were designed to be 'free-flow' to and from East West Link Road. An overview of the previous interchange layout is shown in Figure 2-1.

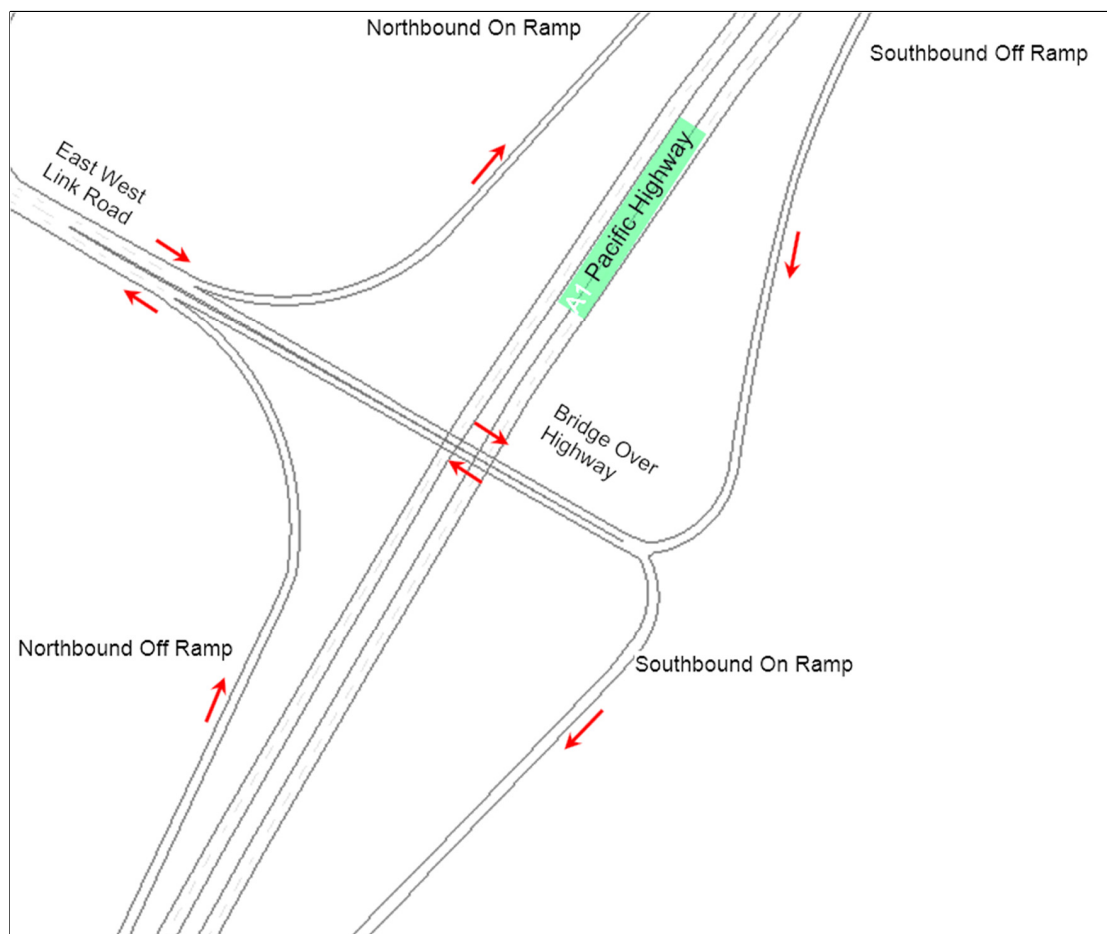


Figure 2-1 Previous concept design of Pacific Highway interchange at Kings Hill

A that time the concept design layout was not extended to the town centre road network.

2.2 Updated concept design

Following on Roads and Maritime comments, the interchange layout was updated, referred to as the “SK0016 sketch” for the purpose of this report. Figure 2-2 shows an overview of the revised concept design (SK0016 sketch) of the interchange layout.

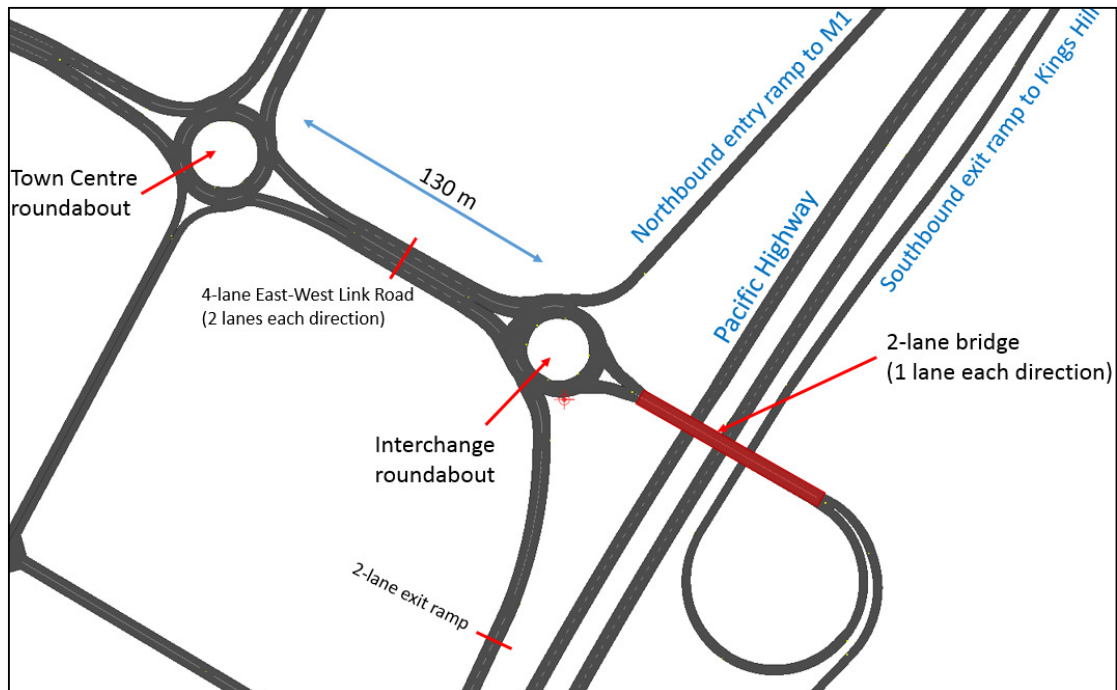


Figure 2-2 Updated concept design of Pacific Highway interchange at Kings Hill – SK0016 sketch

As shown above, the updated layout maintains the ‘diamond’ interchange configuration with a bridge over the Pacific Highway. Updates and changes from the previous concept design include (as per Roads and Maritime recommendations):

- Southbound on/off ramps – free-flow ramps with a ‘trumpet’ configuration on the eastern side of the Highway.
- Northbound on/off ramps – a dual lanes roundabout within the interchange (referred to as the “Interchange Roundabout”) located along the East West Link Road. The proposed roundabout would have substantial safety benefits allowing vehicles to safely perform weaving manoeuvres on approach to town centre roundabout.
- Extending the traffic model to incorporate the town centre dual lanes roundabout servicing the East-West Link Road and the town centre road network. The town centre dual lanes roundabout is located approximately 130 metres west of the interchange; and
- a two lane bridge (one lane in each direction) over the Pacific Highway.

Table 2-1 summarises the changes between the previous and updated interchange designs for each area.

Table 2-1 Comparison of Pacific Highway interchange designs: previous and updated designs

Area	Previous concept design SK0013 sketch	Updated concept design SK0016 sketch
Southbound on/off-ramps	T-intersection, with major movement as southbound on-ramp	Trumpet arrangement, with free-flow movements on and off
Northbound on/off-ramps	Free-flow movements for on and off ramps	Interchange Roundabout. The proposed roundabout would have substantial safety benefits allowing vehicles to safely perform weaving manoeuvres on approach to town centre roundabout.
Town Centre Junction (junction of East-West Link Rd and the town centre roads)	85 m in the interchange concept design;	2-lane roundabout, located 130 metres from the “interchange roundabout”
Bridge over the Pacific Highway	Two lanes (one lane in each direction)	Two lanes (one lane in each direction)

3 Model updates

During the concept design assessment, a Paramics model was developed to facilitate a more in depth analysis of the operational impacts of the Kings Hill interchange with the Pacific Highway. The Paramics models have been updated in line with Roads and Maritime comments. The interchange has been extended towards further west incorporating the town centre internal traffic distributions. The Paramics models have been updated at full development for future year 2036 traffic conditions, for both morning (AM) peak and afternoon (PM) peak periods:

Figure 3-1 shows the Paramics modelling updates undertaken to town centre. The internal trip distributions have been included at full development. The queue lengths have been assessed at both roundabouts. Detailed modelling results on interchange performance are documented in Section 4.

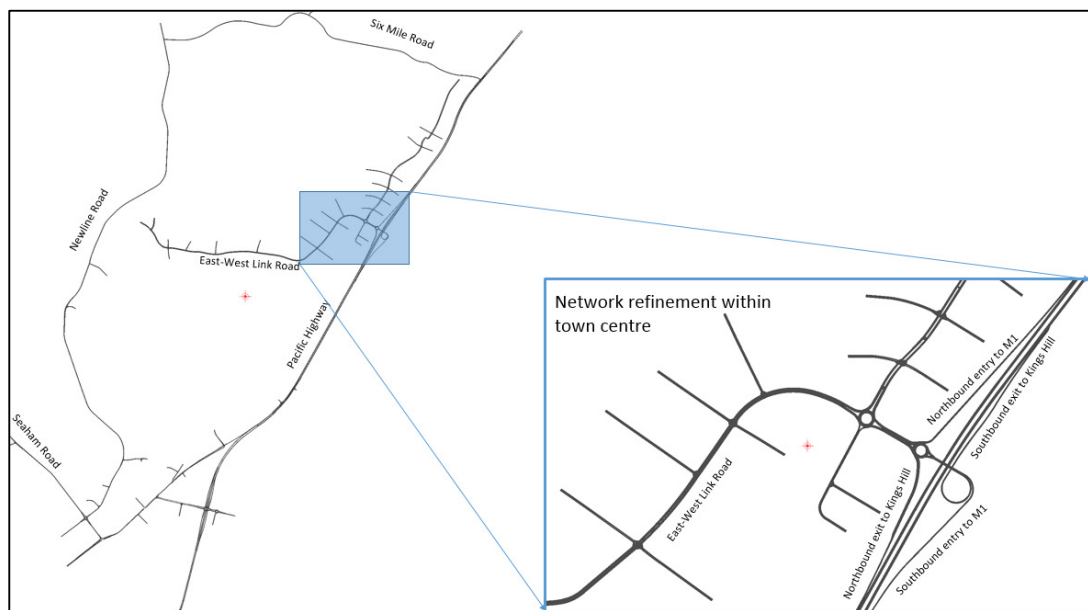


Figure 3-1 Paramics network for the study area

3.1 Key assumptions

Generally, the revised modelling methodology was based on the same approach and key assumptions used in the previous assessment and documented in the Hyder report *Traffic Modelling Report for Pacific Highway Interchange at Kings Hill*, dated February 2014.

A summary of the key assumptions applied for the trip generation and distributions are summarised below:

- when fully developed the proposed Kings Hill Urban Release Area would accommodate about 3,500 new dwellings and 7.5ha of mixed-use/retail land-uses;
- for the purpose of modelling, it is assumed that site will be fully developed by 2036;
- trip generation of future land-uses are based on RMS Guidelines;
- a 25% factor for 'self-containment trips' within the subdivision was assumed, in accordance with RMS guidelines; and

- trip distributions to and from Kings Hill development were retained in line with previous assumptions. About 80% of development traffic will access to the external road network via the eastern interchange with Pacific Highway and about 20% development traffic will access via the Newline Road.

Future network changes (to ultimate year 2036) at full development were retained as per the previous assessment:

- full closure of Six Mile intersection on Pacific Highway;
- full closure of the existing access to Riding for the Disabled;
- access to the above is assumed to be provided through the proposed interchange;
- introduction of the grade separated Kings Hill interchange with Pacific Highway; and
- introduction of a priority controlled 'T' intersection with Newline Road to provide access for the development traffic.

Growth rates for background traffic growth were retained as per the previous assessment:

- background growth to 2036 on the Pacific Highway is assumed to be 2% per annum; and
- for other roads background growth is assumed to be 1% per annum.

4 Modelling results

4.1 Future Turning movements

The future turning volumes at full development for 2036 are prepared for Kings Hill interchange for both AM and PM peak periods. The future traffic volumes at the town centre intersection are also shown.

Figure 4-1 and Figure 4-2 show 2036 AM and PM turning movement volumes for Kings Hill development – full development conditions.

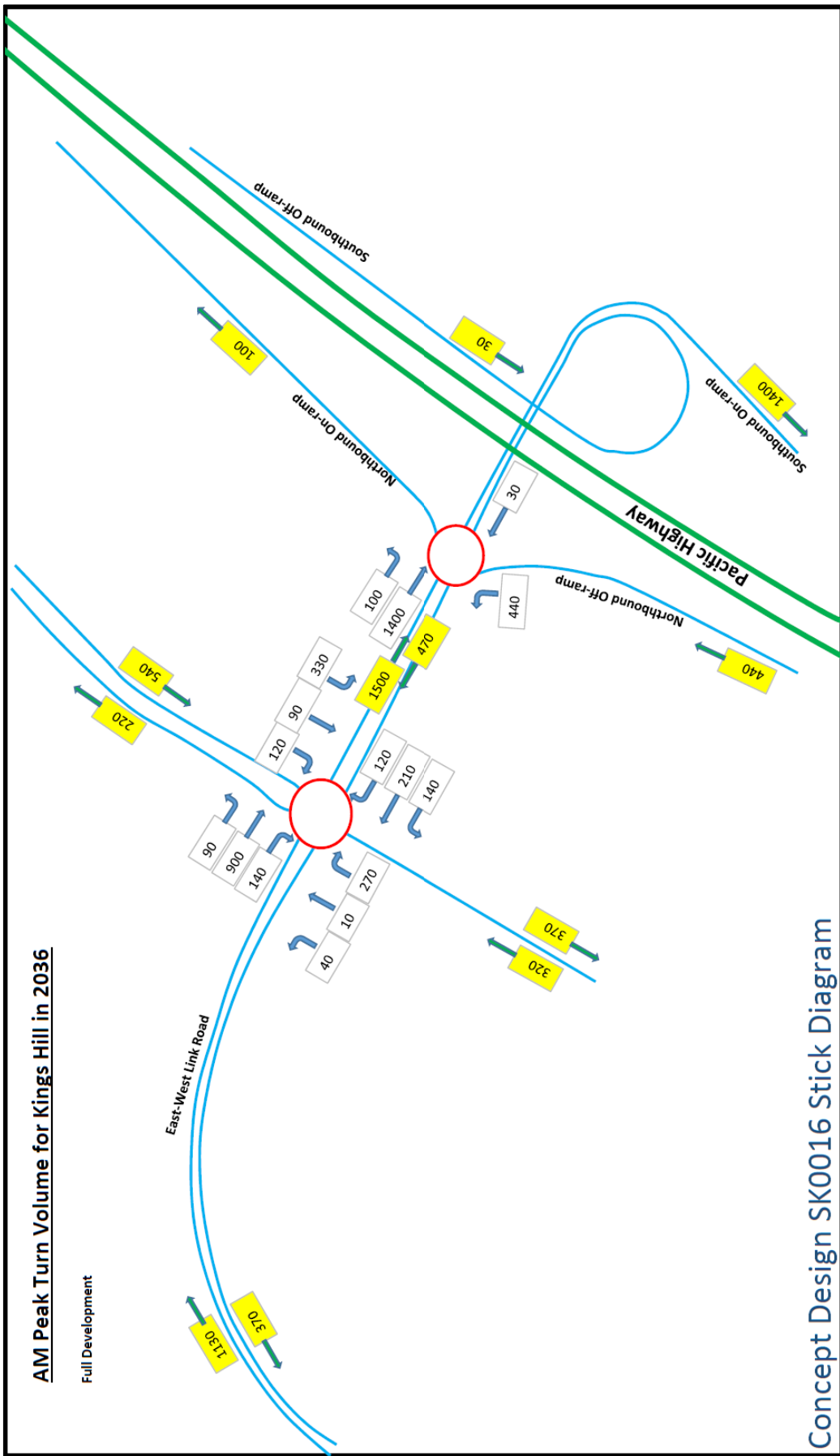


Figure 4-1 Turning movement volumes – Kings Hill (full development conditions) 2036 AM peak

AM Model – F:\AA006855\Traffic Modelling\Parameters\Model\2036 AM_SCA_TZ23_24102014

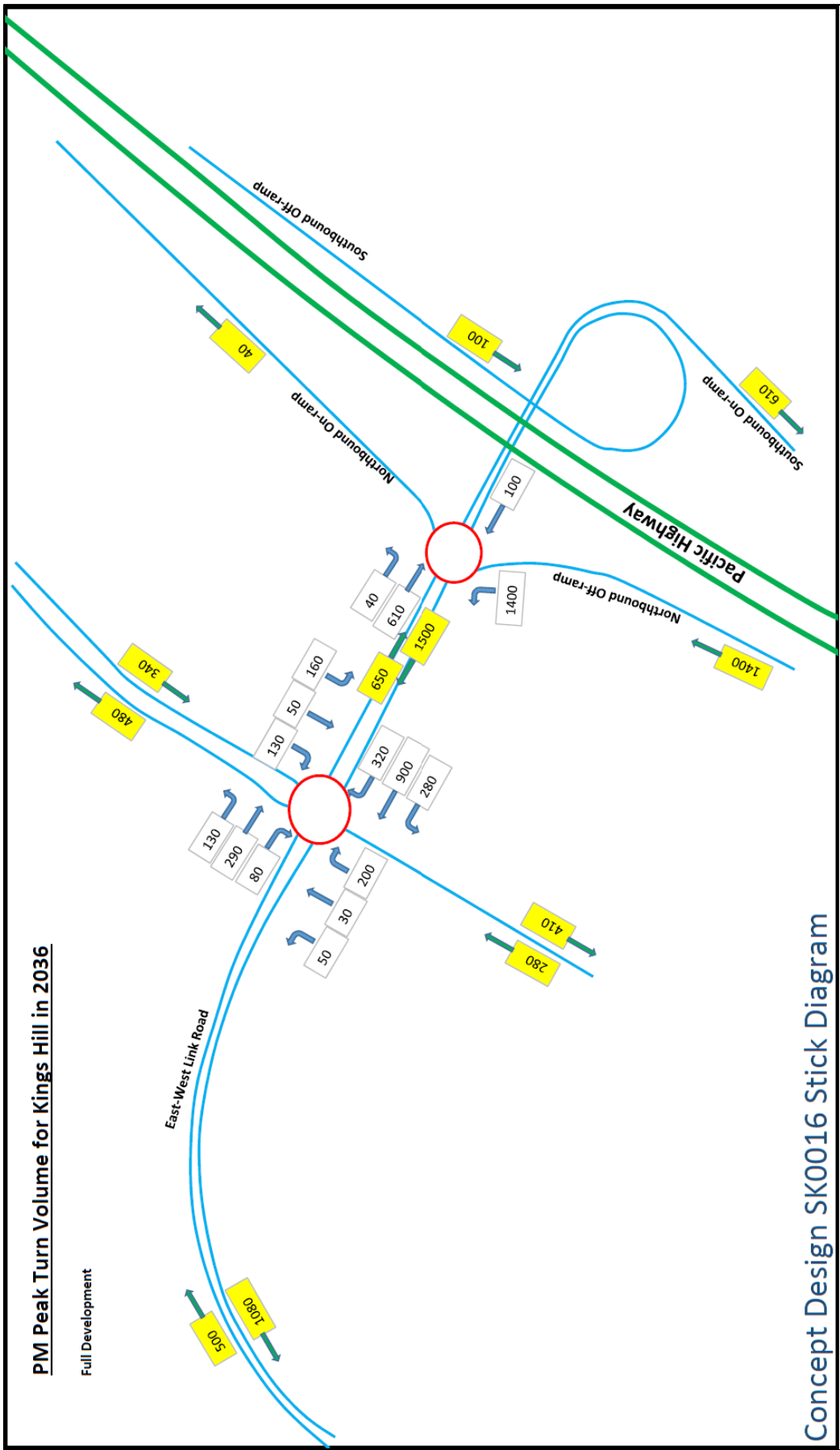


Figure 4-2 Turning movement volumes – Kings Hill (full development conditions) – 2036 PM peak

PM Model – F:\AA006855\Traffic Modelling\Parameters\Model\2036_PM_ScA_TZ23_24102014

4.2 Scenarios tested

The traffic performance of the revised concept has been tested for three scenarios, described below.

- Scenario A tested dual lanes roundabout at the junction of the town centre road and northbound on/off ramps. A dual lanes roundabout is proposed at the town centre about 130 m from interchange roundabout (see previous Figure 2-2 for a schematic layout). The network performance of scenario A was tested for 2036 with full development (at 3,500 dwellings). The modelling results from Scenario A identified capacity problems at the northern and southern approaches of the town centre roundabout. Two additional scenarios, B and C, were tested with reduced dwellings and further modifications to the town centre roundabout.
- Scenario B is a variation to scenario A, but tested with lower dwelling numbers than ultimate 3,500 dwellings. The trigger point (in terms of dwellings) has been identified that will provide acceptable level of service to both interchange roundabout and town centre roundabout.
- Scenario C is a variation to scenario A, but identifies the ultimate intersection control and footprint required at the town centre intersection. Scenario C has identified the need for traffic signals at town centre intersection for ultimate 3,500 dwellings.

The modelling analysis has identified that up to 2,500 dwellings will provide acceptable level of service at town centre roundabout. After 2,500 dwellings, a traffic signal is required at the town centre intersection.

Detailed modelling results of three scenarios A to C are described in the following section.

4.2.1 Scenario A

Scenario A description

Scenario A was prepared for the updated concept design, the SK0016 sketch (as shown in Figure 2-2), with full development conditions.

Scenario A interchange performance and findings

The interchange performance in future year 2036 for scenario A is summarised in Table 4-1.

Table 4-1 Interchange performance, Scenario A – full development in 2036 conditions

Intersections	Approach	AM peak		PM peak	
		Average delay	LOS	Average delay	LOS
Town Centre Junction (roundabout)	North access (N)	209 sec	F	7 sec	A
	East-West Link Road (E)	13 sec	A	40 sec	C
	South access (S)	10 sec	A	85 sec	F
	East-West Link Road (W)	10 sec	A	7 sec	A
	Entire Intersection (Worst Movement for roundabout)	209 sec	F #	85 sec	F #
Interchange Roundabout	Southbound on/off-ramps (E)	3 sec	A	5 sec	A
	Northbound off-ramp (S)	4 sec	A	47 sec	D
	East-West Link Road (W)	27 sec	B	4 sec	A
	Entire Intersection (Worst Movement for roundabout)	27 sec	B #	47 sec	D #

Note:

- (1) LOS = Level of Service, # = Intersection LOS
- (2) AM Model – F:\AA006855\Traffic Modelling\Paramics\Model\2036_AM_ScA_TZ23_24102014
- (3) PM Model – F:\AA006855\Traffic Modelling\Paramics\Model\2036_PM_ScA_TZ23_24102014

The result shown in Table 4-1 indicates that the town centre roundabout intersection will experience capacity problems (delays between 85 sec and 209 sec with Level of Service 'F') on the northern approach during the AM peak period and southern approach during the PM peak period. The traffic delay to the town centre intersection (northern and southern approaches) does not suggest any adverse impact to the roundabout interchange operation and its ramps with the Pacific Highway. The Paramics modelling suggests that queue length will contain within the turning bays provided in the concept design. Table 4-2 below shows the predicted queue length for scenario A for both roundabouts.

Table 4-2 Queue length on each approach in 2036, Scenario A

Intersections	Approach	AM peak	PM peak
		Queue length (m)	
Town Centre Junction (roundabout)	North access (N)	410	30
	East-West Link Road (E)	50	100
	South access (S)	60	100
	East-West Link Road (W)	60	30
Interchange Roundabout	Southbound on/off-ramps (E)	0	20
	Northbound off-ramp (S)	30	170
	East-West Link Road (W)	90	20

Note:

- (1) AM Model – F:\AA006855\Traffic Modelling\Paramics\Model\2036_AM_ScA_TZ23_24102014
- (2) PM Model – F:\AA006855\Traffic Modelling\Paramics\Model\2036_PM_ScA_TZ23_24102014

4.2.2 Scenario B

Scenario B description

Based on the results from Scenario A, a further scenario was undertaken to understand the performance of the interchange based on the SK0016 sketch but with reduced development at the Kings Hill site.

There was no reduction made to mixed-use/retail GFA (7.5 ha). The intersection footprints were retained as per Scenario A (i.e. the road layout was as shown in Figure 2-2).

Scenario B interchange performance and findings

The interchange performance in future year 2036 for Scenario B is summarised in Table 4-3

Table 4-3 Interchange performance, Scenario B –up to 2,500 dwellings in 2036 conditions

Intersections	Approach	AM peak		PM peak	
		Average delay	LOS	Average delay	LOS
Town Centre Junction (roundabout)	North access (N)	30 sec	C	6 sec	A
	East-West Link Road (E)	12 sec	A	27 sec	B
	South access (S)	8 sec	A	22 sec	B
	East-West Link Road (W)	8 sec	A	6 sec	A
	Entire Intersection (Worst Movement for roundabout)	30 sec	C #	27 sec	B #
Interchange Roundabout	Southbound on/off-ramps (E)	4 sec	A	5 sec	A
	Northbound off-ramp (S)	4 sec	A	12 sec	A
	East-West Link Road (W)	15 sec	B	4 sec	A
	Entire Intersection (Worst Movement for roundabout)	15 sec	B #	12 sec	A #

Note:

- (1) LOS = Level of Service, # = Intersection LOS
- (2) AM Model – F:\AA006855\Traffic Modelling\Paramics\Model\2036_AM_ScB_TZ23_24102014
- (3) PM Model – F:\AA006855\Traffic Modelling\Paramics\Model\2036_PM_ScB_TZ23_24102014

Table 4-3 indicates that for Scenario B, the performance of the town centre roundabout improves substantially. The model predicts LOS 'C' and 'B' for the AM and PM peak periods, with acceptable delays to all approaches. The interchange roundabout will provide level of service between A and B. The modelling analysis has identified that up to 2,500 dwellings will provide acceptable level of service at town centre roundabout. The Paramics modelling suggests that queue length will contain within the turning bays provided in interchange concept design.

Table 4-4 below shows the predicted queue length for scenario B for both roundabouts.

Table 4-4 Queue length on each approach in 2036, Scenario B

Intersections	Approach	AM peak	PM peak
		Queue length (m)	
Town Centre Junction (roundabout)	North access (N)	90	20
	East-West Link Road (E)	50	70
	South access (S)	60	60
	East-West Link Road (W)	40	30
Interchange Roundabout	Southbound on/off-ramps (E)	0	20
	Northbound off-ramp (S)	30	60
	East-West Link Road (W)	80	10

Note:

- (1) AM Model – F:\AA006855\Traffic Modelling\Paramics\Model\2036_AM_ScB_TZ23_24102014
- (2) PM Model – F:\AA006855\Traffic Modelling\Paramics\Model\2036_PM_ScB_TZ23_24102014

4.2.3 Scenario C

Scenario C description

Based on the results from Scenarios A and B, a third scenario was undertaken to determine potential opportunities associated with modifying the SK0016 sketch in order to improve capacity, particularly at the town centre roundabout intersection.

For Scenario C, traffic signals are tested for the town centre intersection, instead of a roundabout. An overview of the road layout adopted for Scenario C is shown in Figure 4-3.

The lane configurations for the interchange roundabout were retained as per Scenario A.

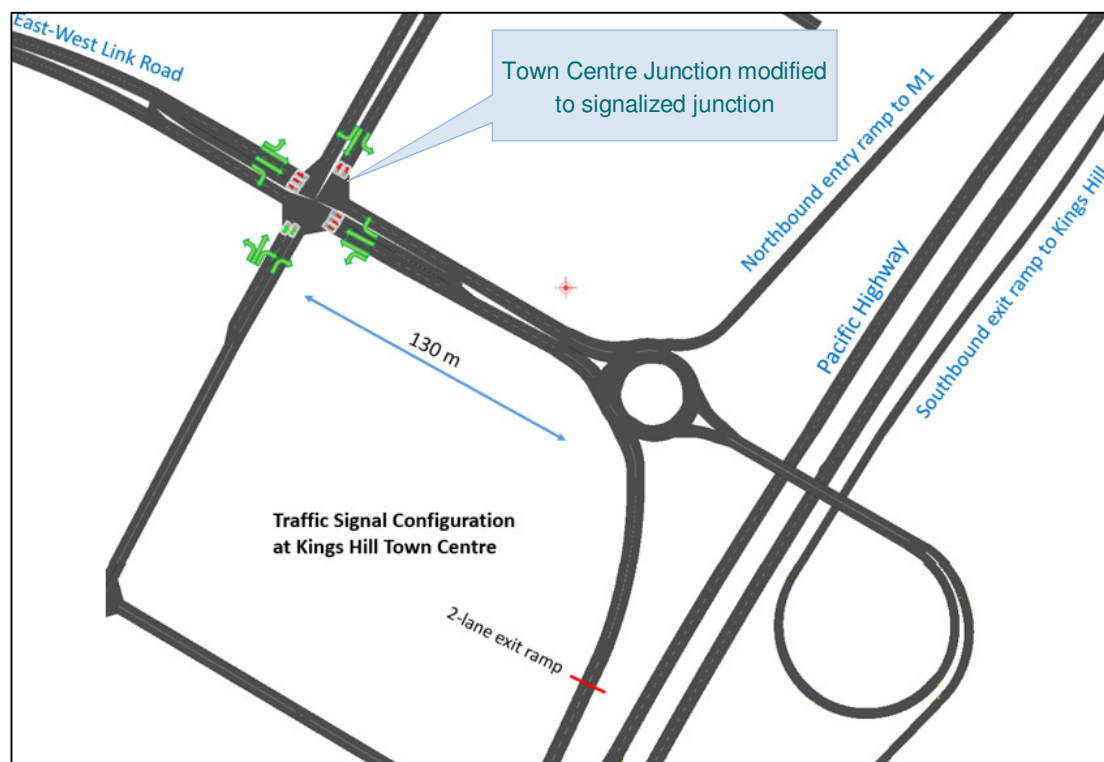


Figure 4-3 Proposed modification to Pacific Highway interchange at Kings Hill – traffic signals at town centre

Scenario C interchange performance and findings

The interchange performance in future year 2036 for scenario C is summarised in Table 4-5.

Table 4-5 Interchange performance, Scenario C –full development in 2036 conditions

Intersections	Approach	AM peak		PM peak	
		Average delay	LOS	Average delay	LOS
Town Centre Junction (traffic signal)	North access (N)	69	E	32	C
	East-West Link Road (E)	32	C	27	B
	South access (S)	61	E	36	C
	East-West Link Road (W)	39	C	40	C
	Entire Intersection (Average for signals)	48	D #	31	C #
Interchange Roundabout	Southbound on/off-ramps (E)	3	A	5	A
	Northbound off-ramp (S)	4	A	16	B #
	East-West Link Road (W)	35	C #	8	A
	Entire Intersection (Worst Movement for roundabout)	35	C #	16	B #

Note:

(1) LOS = Level of Service, # = Intersection LOS

(2) AM Model – F:\AA006855\Traffic Modelling\Paramics\Model\2036_AM_ScC_TZ23_24102014

(3) PM Model – F:\AA006855\Traffic Modelling\Paramics\Model\2036_PM_ScC_TZ23_24102014

Table 4-5 indicates that the traffic signals at the town centre intersection improved network performance substantially, with overall Level of Service 'D' and 'C' during the AM and PM peak periods. The interchange roundabout shows level of service between B and C. The Paramics modelling suggests that queue length will contain within the turning bays provided in interchange concept design. Table 4-6 below shows the predicted queue length for scenario C for traffic signals at town centre and roundabout at interchange.

Table 4-6 Queue length on each approach in 2036, Scenario C

Intersections	Approach	AM peak	PM peak
		Queue length (m)	
Town Centre Junction (traffic signals)	North access (N)	190	0
	East-West Link Road (E)	50	80
	South access (S)	60	0
	East-West Link Road (W)	110	40
Interchange Roundabout	Southbound on/off-ramps (E)	0	20
	Northbound off-ramp (S)	30	70
	East-West Link Road (W)	100	30

Note:

(1) AM Model – F:\AA006855\Traffic Modelling\Paramics\Model\2036_AM_ScC_TZ23_24102014

(2) PM Model – F:\AA006855\Traffic Modelling\Paramics\Model\2036_PM_ScC_TZ23_24102014

5 Conclusions and recommendations

5.1 Key findings

This updated Traffic Modelling Report has been prepared by the Hyder Consulting Pty Ltd (Hyder) to support the concept design of a proposed interchange with Pacific Highway as part of the Kings Hill Urban Release Area in North Raymond Terrace. The updated modelling has been commissioned by the Kings Hill Development (KHD) as the major land holder in the release area. The study provides recommendations on the ultimate interchange footprint required to cater for expected traffic from Kings Hill Urban Release Area.

In a letter dated 1st May 2014, the Roads and Maritime Services of NSW (Roads and Maritime) provided in principle agreement to the concept design of a grade separated interchange with a bridge over the Pacific Highway. The concept design was accompanied by a traffic modelling report prepared by Hyder, *Traffic Modelling Report for Pacific Highway Interchange at Kings Hill, dated February 2014 (February 2014 Report)*.

Roads and Maritime recommended further changes to the concept design supported by the additional traffic modelling. This report documents the additional traffic modelling work undertaken addressing Roads and Maritime's issues dated 1st May 2014. The updated concept design has been prepared addressing the Roads and Maritime comments. The revised interchange design provides free-flow movement for the southbound traffic from the Kings Hill development. A two lane bridge (one lane in each direction) over the Pacific Highway is proposed connecting the southbound ramps with the proposed development. On the western side of Pacific Highway the northbound on and off ramps are accessed via a roundabout located within the interchange. A roundabout is also proposed at town centre located approximately 130 metres west of the interchange roundabout.

When fully developed the proposed Kings Hill Urban Release Area would accommodate about 3,500 new dwellings. For the purpose of modelling, it was assumed that site would be fully developed by 2036. The Paramics models have been updated in line with Roads and Maritime comments. The interchange has been extended towards further west incorporating the town centre internal traffic. The models have been updated at full development for future year 2036 traffic conditions, for both morning (AM) peak and afternoon (PM) peak periods.

The traffic performance of the revised concept has been tested for three scenarios. Scenario A tested a roundabout at town centre road and northbound on/off ramps. In scenario A network, a second roundabout is tested at the town centre. The network performance of scenario A was tested for 2036 at full development (3,500 dwellings). The modelling results from scenario A identified capacity problems at the northern and southern approaches of the town centre roundabout.

Two additional scenarios, B and C, were tested with reduced dwellings and further modifications to the town centre roundabout. Scenario B is a variation to scenario A, but tested with lower dwelling numbers than ultimate 3,500 dwellings. A trigger point (in terms of dwellings) has been identified that will provide acceptable level of service to both interchange roundabout and town centre roundabout. Scenario C is a variation to scenario A, but identifies the ultimate intersection control and footprint required at the town centre intersection at full development.

Hyder's updated modelling assessment has found that:

- At western end of the interchange a dual lanes roundabout with northbound on/off ramps would provide acceptable level of service between B and C at full development.

- The dual lanes roundabout at the town centre (which is about 130 metres from interchange roundabout) would provide acceptable level of service B and C up to 2,500 dwellings.
- After 2,500 dwellings are built and occupied, a traffic signal replacing the town centre roundabout would be required.
- The traffic signals would provide level of service C and D at town centre intersection at full 3,500 developments.

5.2 Recommendations

The following recommendations are made to the revised concept design of the Pacific Highway interchange at Kings Hill:

- a two lane bridge (one lane in each direction) over the Pacific Highway as ultimate upgrade;
- a free-flow 'trumpet' arrangement for the southbound on/off ramps on the eastern side of the Pacific Highway;
- a dual lanes roundabout on the western side of the Pacific Highway along the East West Link Road for the northbound on/off ramps;
- the town centre intersection providing access between the interchange and the Kings Hill development should be configured as dual lanes roundabout at opening;
- once the 2,500 dwellings are developed and occupied, a new traffic generation survey is recommended. At this point time, modelling analysis identified the need for traffic signals replacing town centre roundabout after 2,500 dwellings are built.