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DESIGN NOTE

RIVERGUMS STRUCTURE PLAN REVISION – MAY 2011
INTERSECTION PERFORMANCE ASSESSMENT - BALDIVIS ROAD/RIVERGUMS BOULEVARD, BALDIVIS ROAD/NORTHERN ACCESS

This technical note summarises further operational analysis for the Baldivis Road/Rivergums Boulevard unsignalised intersection and the proposed Baldivis Road left in left out access, to the north of the development. It is intended to inform Rockingham Council officers in their consideration of the proposed Rivergums Structure Plan amendment, and to quantify any additional traffic impact due to the proposed increase in the number of lots from 577 to 670.

The subject intersections assessed have been identified on the proposed structure plan (see **Attachment 1**) as follows:

- A, denotes the location of the intersection of Baldivis Road and Rivergums Boulevard; and
- B, denotes the location of the intersection of Baldivis Road and the Northern Access.

The discussion contained herein is brief in nature given Council officers are already aware of the project background and prior traffic modelling. The following traffic engineering matters are addressed herein:

- Updated traffic generation;
- Existing traffic demands;
- Future traffic demands;
- Directional distribution;
- SIDRA Intersection assessment; and
- Road network form.

Traffic Generation and Assignment

Traffic engineering modelling already conducted for the site has only considered the internal daily street link demands for the purposes of assessing internal amenity and capacity. The intersection analysis requires consideration of peak hour turning movement demands. For modelling purposes, assumptions were necessary to determine the existing volumes throughout the site.

The key assumptions used in the modelling are:

- Full build-out of **1432** lots;
- Increase from **577** to **670** lots, within proposed amended structure plan;
- Route choice determined by the shortest distance.

Trip generation rates adopted for assessment are as depicted in **Table 1** below.

Table 1 ***Trip Generation Rates***

Land Use	AM Peak Hour	PM Peak Hour	Daily Trip Rate
High School	0.4 trips/student	0.5 trips/student	1.72 trips/student
Primary School	0.4 trips/student	0.5 trips/student	1.29 trips/student
Local Shops	0.12 per m2	0.12 per m2	1.2 per m2
Residential	0.6 trips/dwelling	0.9 trips/dwelling	9 trips/dwelling

The broad distribution of trips generated utilised for assessment is as per **Table 2**.

Table 2 ***Trip Distribution***

Destination	AM Peak	PM Peak	Daily
External	45%	40%	80%
School	55%	50%	13%
Local Shops	0%	10%	7%

The Baldivis Road/Rivergums Boulevard intersection has been investigated for two peak hour scenarios, described as follows:

- Morning peak hour – combined commuter and school peaks;
- Evening peak hour – commuter peak hour.

Peak hour generation rates were adopted for the residential, retail and education uses in accordance with *Institution of Transport Engineers*: *Traffic Generation* documentation and traffic engineering references. The development generated traffic movements were assigned to the road network using the same methodology adopted by the previous analysis. Internalisation of vehicle trips associated primarily with the primary school and trip chaining of home-based/school trips and home-based/retail trips has also been considered. These trip reducing assumptions are again consistent with the previous analysis.

Table 3 provides a summary of the peak hour generation totals adopted for each assessment scenario.

Table 3 ***Summary of Traffic Generation - External Traffic Generation only***

	Existing Structure Plan (vph)	Proposed Structure Plan (vph)	Traffic Volume Difference (vph)
AM Peak	892	919	27
PM Peak	633	702	69

As can be seen from **Table 3**, the proposed changes to the Structure Plan do not result in a significant change in traffic volume during peak periods.

Existing Traffic Demands

A survey of existing traffic demands at the intersection of Baldivis Road and Rivergums Boulevard has not been conducted for the following reasons:

- Traffic data remains consistent with previous reports.
- Turning demands into and out of the site are of limited use given the immature and incomplete nature of the existing residential development.

Hourly and daily traffic demands for Baldivis Road (link counts) have been received from Council in the past and were used for comparative purposes to understand how the future scenario will compare to the recent past. The Council data indicates that traffic volumes along Baldivis Road were approximately 11,640vpd prior to the extension of the freeway, and have reduced significantly since the opening of the Freeway. A link capacity of approximately 14-16,000vpd would be anticipated given the current design of Baldivis Road.

Future Traffic Demands

The likely future traffic demand on Baldivis Road has been determined based upon recent strategic modelling conducted by the Department of Main Roads Western Australia. From distribution theory and modelling, these figures, including those generated, make up the future traffic demands associated with the proposed Rivergums Boulevard.

The future traffic demands have been evaluated for the 2021 time horizon in accordance with typical traffic engineering assumptions which investigate the impact of traffic movements at a 10 year design horizon post development opening.

The strategic modelling indicates that the daily traffic demand will increase to 9,100vpd by 2021 on Baldivis Road in the vicinity of the subject site. This demand is lower than that surveyed prior to the freeway extension. This is a key conclusion of this study given that the demand observed at the intersection in early 2009 was primarily the result of intense through traffic movements on Baldivis Road, not overly high turning movements into and out of the estate.

To ensure a conservative analysis, the through traffic demands on Baldivis Road have been adopted in accordance with the demands surveyed prior to the extension of the freeway. This demand (11,640vpd) is higher than that projected at the 2021 design horizon (9,100vpd). The SIDRA assessment therefore includes additional through traffic movements which are not likely to be on the network.

Directional Distribution

Traffic turning into and out of the subject site has been assigned to Baldivis Road in accordance with the north-south split shown in the strategic modelling.

SIDRA Intersection Assessment

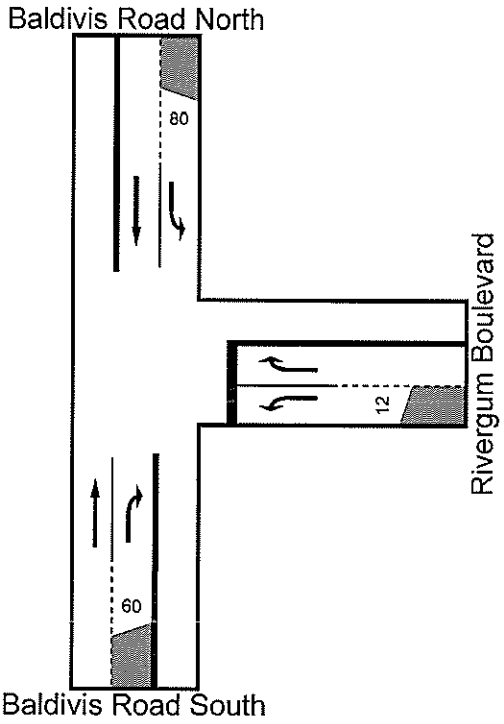
The SIDRA Intersection software suite has been used to evaluate both the future operation of the intersection during the two peak periods. Operational results are summarised for both peak periods and use the *Degree of Saturation* (DOS), *Average Delay, Level of Service* (LOS) and the *95th Percentile Queue* operational measures. These measures can be described as follows:

- **Degree of Saturation (DOS):** is the ratio of the arriving traffic to the theoretical capacity of the intersection of movement approach. DOS ranges from zero for low flow situations to one for at capacity situations. The theoretical capacity threshold for an unsignalised intersection is generally accepted as being DOS > 0.80;
- **Level of Service (LOS):** is the qualitative measure describing operational conditions within a traffic stream and the perception by motorists and/or passengers. There are 6 levels of service, designated from A to F, with LOS A representing the best operating condition (i.e. free flow) and LOS F the worst (i.e. forced or breakdown flow);
- **Average Delay:** is the average of all vehicle delays for each movement or the entire intersection. An un-signalised intersection is considered to be operating at capacity where the average delay exceeds 40 seconds for any movement;
- **95% Queue:** is the queue length below which 95% of observed queue lengths would statistically be expected to fall.

Baldivis Road/Rivergums Boulevard Intersection

Figure 1 shows the layout that was used in SIDRA to model the intersection of Baldivis Road and Rivergums Boulevard.

Figure 1 ***Baldivis Road/Rivergums Boulevard Intersection Analysis Assessed Intersection Form***



The southern approach has been constructed with sufficient pavement width such that through movements can pass a queued vehicle waiting to turn right into the site. The length of this additional pavement has been measured from aerial photography and was found to approximate 60 metres. For the purposes of modelling the intersection in SIDRA, the intersection therefore actually operates with a pseudo right turn lane.

Movement volumes are summarised in **Table 4.**

Table 4 ***Baldivis Road / Rivergums Boulevard Intersection Analysis Future Traffic Volumes- 2021 Full Build out***

	Movement	Approved Structure Plan		Proposed Structure Plan	
		AM	PM	AM	PM
Baldivis Road South	T	355	249	355	249
	R	235	194	240	216
Rivergums Boulevard	L	247	148	218	139
	R	210	126	219	139
Baldivis Road North	L	200	165	143	129
	T	336	693	336	693

Comparison tables, **Table 5** and **Table 6,** have been included to better compare the different traffic results between the approved Structure Plan and the proposed Structure Plan.

Table 5 ***Baldivis Road / Rivergums Boulevard Intersection Operation Comparison AM Peak Hour – Approved / Proposed Structure Plan***

		Approved Structure Plan				Proposed Structure Plan			
		DOS	sec	LOS	95% Queue (m)	DOS	sec	LOS	95% Queue (m)
Baldivis Road South	T	0.18	0	LOS A	0.0	0.18	0	LOS A	0.0
	R	0.21	10.6	LOS B	9.0	0.22	10.3	LOS A	8.6
Rivergums Boulevard	L	0.46	15	LOS C	16.0	0.40	14.4	LOS A	12.4
	R	0.59	26	LOS D	27.0	0.60	25.6	LOS B	27.3
Baldivis Road North	L	0.10	8.2	LOS A	0.0	0.08	8.2	LOS A	0.0
	T	0.17	0	LOS A	0.0	0.17	0	LOS A	0.0
All Vehicles		**0.59**	**8.4**	**N/A**	**27.0**	**0.60**	**8.6**	**N/A**	**27.3**

Table 6 ***Baldivis Road / Rivergums Boulevard Intersection Operation Comparison PM Peak Hour – Approved / Proposed Structure Plan***

		Approved Structure Plan				Proposed Structure Plan			
		DOS	sec	LOS	95% Queue (m)	DOS	sec	LOS	95% Queue (m)
Baldivis Road South	T	0.13	0	A	0.0	0.13	0	LOS A	0.0
	R	0.26	13	B	11.0	0.28	12.8	LOS A	11.5
Rivergums Boulevard	L	0.36	18.6	C	12.0	0.33	18.1	LOS B	10.6
	R	0.47	28.4	D	17.0	0.52	29.7	LOS C	19.6
Baldivis Road North	L	0.08	8.2	A	0.0	0.07	8.2	LOS A	0.0
	T	0.36	0	A	0..0	0.36	0	LOS A	0.0
All Vehicles		**0.47**	**6.5**	**N/A**	**17.0**	**0.52**	**6.7**	**N/A**	**19.6**

The results confirm that the intersection will operate within accepted capacity constraints. The average delay for movements turning right out of the site is moderate, below the generally accepted threshold of 40 seconds.

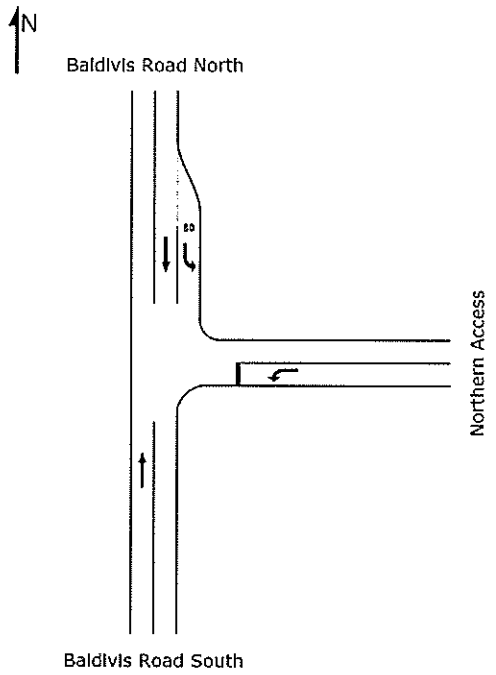
The length of Rivergums Boulevard, from the intersection with Baldivis Road to the intersection with Liloria Turn, is approximately 60 metres, and substantially longer than the projected maximum queue length. Therefore, it is unlikely that traffic operations at Rivergums Boulevard will adversely impact on adjacent intersections.

The results of the above documented SIDRA assessment confirm that the intersection will operate within normal capacity constraints during all peak hour periods.

Intersection of Baldivis Road / Northern Development Access

Figure 2 shows the layout that was used in SIDRA to model the intersection of Baldivis Road and the northern development access. The layout is designed as a left in / left out only access.

Figure 2 ***Baldivis Road/Northern Development Access Intersection Analysis Assessed Intersection Form***



Traffic volumes modelled to use the northern access are shown in **Table 7**.

Table 7 ***Baldivis Road / Northern Access Intersection Analysis Future Traffic Volumes- 2021 Full Build out***

	Movement	Proposed North Access Traffic Volumes	
		AM	PM
Baldivis Road South	T	574	388
Northern Access	L	39	24
Baldivis Road North	L	61	55
	T	479	822

Table 8 and **Table 9** show the modelled intersection performance for the intersection of Baldivis Road and the proposed northern access.

Table 8 ***Baldivis Road / Northern Access Intersection Operation AM Peak Hour***

		DOS	sec	LOS	95% Queue (m)
Baldivis Road South	T	0.30	0	LOS A	0.0
Northern Access	L	0.06	13.7	LOS A	2.0
Baldivis Road North	L	0.04	8.2	LOS A	0.0
	T	0.25	0	LOS A	0.0
All Vehicles		**0.25**	**2.2**	**LOS A**	**2.0**

Table 9 ***Baldivis Road / Northern Access Intersection Operation PM Peak Hour***

		DOS	sec	LOS	95% Queue (m)
Baldivis Road South	T	0.2	0	LOS A	0.0
Northern Access	L	0.06	18.5	LOS B	2.0
Baldivis Road North	L	0.03	8.2	LOS A	0.0
	T	0.47	0	LOS A	0.0
All Vehicles		**0.47**	**2.5**	**LOS A**	**2.0**

The results confirm that the intersection will operate within accepted capacity constraints. The average delay for movements turning right out of the site is moderate, below the generally accepted threshold of 40 seconds.

By establishing a permanent left-in/left-out access to the north of Rivergums Boulevard, access to the development by southbound traffic is greatly improved, including connections for the proposed schools.

Road Network Form.

An assessment of the road network form, for the new structure plan, has been completed. The road hierarchy has been assessed in light of the changes in volume/design from the approved structure plan. The hierarchy is based on guidelines set out in Liveable Neighbourhoods.

All new/altered roads, which service R20 lots, should be designed as Access Street D under Liveable Neighbourhoods guidelines. This design includes a pavement of 5 to 6 metres, which is recommended to encourage a slower speed environment. Occasional on-street parking can be accommodated to cater for visitors, with limited impact to traffic flow.

All new/altered roads, which service R30 lots and above, should be designed as Access Street C/B, under Liveable Neighbourhoods guidelines. This design includes a pavement of 6 to 7.2 metres (7.4 metres for bus routes), which is recommended to allow for the extra on-street parking requirement of higher density lots, see **Table 10.**

Table 10 ***Road Network Form***

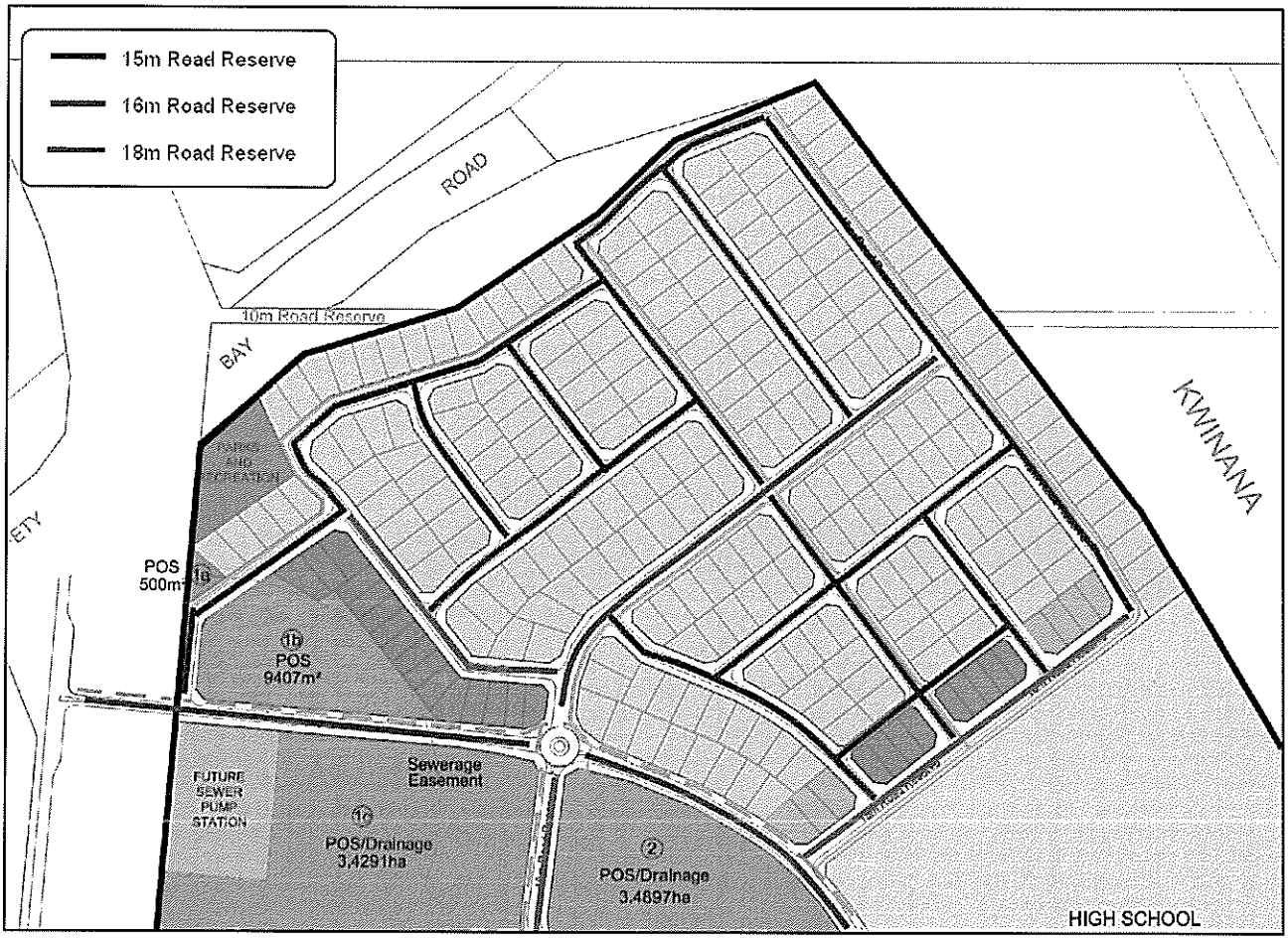
Modelled Traffic Flow	Road Classification – Liveable Neighbourhoods	Street Characteristics	Recommended Road Reserve
< 1,000 vpd	Access Street D	Pavement 5 to 6 metres, Narrower access street as there is minimal on street parking demand, reduces traffic speeds.	15 metres.
1,000 vpd to 3,000 vpd	Access Street B/C	Pavement 6 to 7.2 metres. (7.4 metres for bus routes) Allows on-street parking bays or wider pavement for parking.	16 – 18 metres

vpd – Vehicles Per Day

Due to the limited traffic volume change, previous road form recommendations, other than suggested in this report, should remain valid and unchanged in the new proposed structure plan.

Cardno has applied the above guidelines to the proposed Structure Plan amendment with the changes to road form shown in **Figure 3.**

Figure 3 *Recommended changes to the Road Form*



Conclusions

Based upon the assessment documented herein, the following conclusions are drawn:

- In regards to the Baldivis Road/Rivergums Boulevard intersection, the conclusions of the traffic engineering assessment and SIDRA analysis are that the subject intersection will continue to work at a satisfactory level at the 2021 design horizon. This result is made possible given the demands on Baldivis Road have fallen significantly post extension of the freeway.
- No upgrading beyond the intersection forms already proposed will be necessary from a peak hourly operational perspective prior to 2021.
- It has been shown that the maximum queue length along Rivergums Boulevard is significantly shorter than the distance to Liloria Turn. Therefore, it is unlikely that traffic operations at the Baldivis Road/Rivergums Boulevard intersection will adversely impact on adjacent intersections.
- Due to the limited traffic volume change, the previous road form recommendations remain valid and can remain unchanged in the new structure plan.
- Establishing a permanent left-in/left-out access to the north of Rivergums Boulevard results in little change to traffic operations at Baldivis Road / Rivergums Boulevard, while significantly improving access to the development for southbound traffic, including connection to the proposed schools.