*Table 1.2 Summary of Submissions from Government Organisations **

Submission No. and Date	Individual/ Organisation	Description Of Issues	Response
1 4 March 2004	Department of Environment and Conservation, Sue Elks	• E-W Link 2 or 3 would require revocation of the Nature Reserve to allow road construction. • revocation would require an Act of Parliament, with certain environmental and social criteria applied; • other considerations include: o impacts to native vegetation and threatened species under the Threatened Species Act 1995; o Consistency with SEPP 44, SEPP 71, SEPP 14, SEPP 26 and the Native Vegetation Act; o The need for appropriate Aboriginal Heritage assessment; o Assessment of impacts to National Parks Estate o Impacts on species listed on the Commonwealth EPBC Act 1999. o Liaison with the NSW RTA in relation to the intersections with the proposed Oxley Highway, such as east Lindfield; o Consultation with Country Energy to determine whether any conditions relating to the existing services easement may prejudice E-W Link 3; o That E-W Link 3 is approximately 320m in length across the nature Reserve as opposed to 520m for E-W Link 2; o A number of potential requirements for a Nature Reserve revocation were provided.	Requirements of DEC noted. Impacts to habitats, wildlife corridors and risk of impacts to Heritage resources are incorporated into the MCA, and would be subject to detailed assessment of any adopted route.
2 8 February 2005	Department of Environment and Conservation, Greg Croft	In relation to the Purdin & Assoc Workshop outcomes report: • DEC recommends that preference should be given to the Lake Road Upgrade to meet access needs rather than establishing a road through the nature reserve that would compromise the biological integrity of the reserve. • Clarification should be reflected in the Issues and Evaluation Criteria' section of the summary that describes the NPWS position.	Requirements of DEC noted.
3 22/08/2006	Department of Lands	• Crown roads affected by the preferred route option would transfer to Council control • Crown lands acquired by Council - any EIS/REF requirements will be the responsibility of Council • The Department of Lands supports in principle the strategic planning by Council to provide the Outer Link Roads.	

* Also representatives of the NSW Member for Port Macquarie, the NSW RTA, Telstra, the NSW Police and the NSW Ambulance Service attended the key stakeholder sessions in 2004 and/or the Value Management Workshops in 2006.

Annex D

Port Macquarie Outer Link Road Options – Traffic Assessment (SMEC 2006)

Document / Report Control Form

Project Name: **Port Macquarie Outer Link Road Options – Traffic Assessment**
Project number: **3002078**
Report for: **Port Macquarie Hastings Council**

PREPARATION, REVIEW AND AUTHORISATION

Revision #	Date	Prepared by	Reviewed by	Approved for Issue by
0	8/3/2006	Mick Lyons	Khaled Abbas	Mick Lyons
1	8/5/2006	Lindsay Jacobsen	Khaled Abbas	Mick Lyons
2	18/5/2006	Lindsay Jacobsen	Mick Lyons	Mick Lyons
3	29/6/2006	Lindsay Jacobsen	Khaled Abbas	Khaled Abbas
4	04/07/2006	Lindsay Jacobsen	Khaled Abbas	Khaled Abbas

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CONTENTS

APPENDICES

1 Introduction

SMEC was engaged by Port Macquarie – Hastings Council to undertake a traffic assessment of several alternative routes for the Outer Link Road identified in the Port Macquarie Outer Link Road Route Selection Study – Revised Preliminary Route Options Report (ERM 2005). The routes include seven north-south options, four east-west options and one combined option.

This report presents the findings of the assessment and includes attachments showing the traffic modelling outputs for each of the options investigated.

2 Background

The assessment is based on traffic modelling previously undertaken by SMEC as part of the Hastings Roads & Traffic Study (SMEC 2001) and subsequent studies conducted in 2003. The traffic modelling was performed for PM peak traffic flows in 2021 and 2031. Each of the options was modelled based on the routes identified for further assessment in the ERM report. The names of the modelled routes, number of lanes and description for each route are shown in **Table 1** while the routes are shown in **Figure 1**.

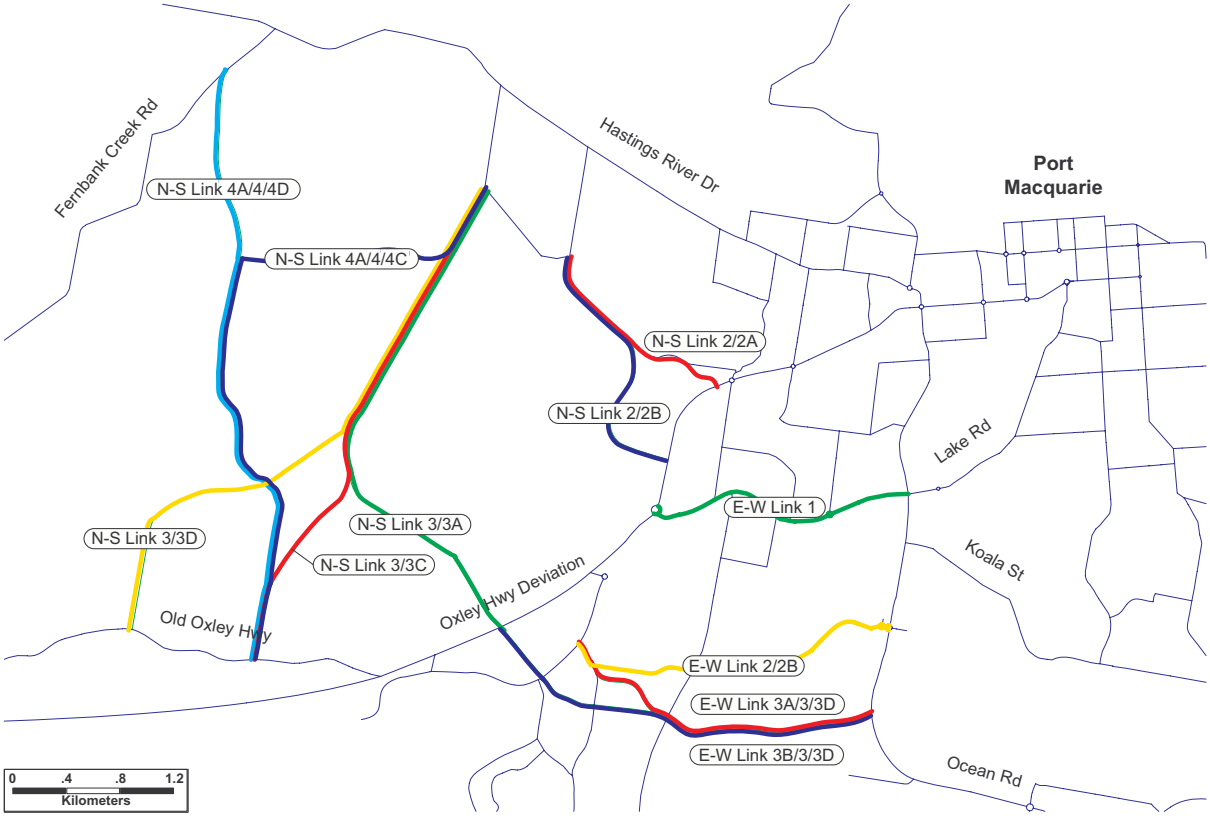


Figure 1 – Modelled Routes

Table 1 – Modelled Route Options

Option Name	Number of Lanes	Description
East-West Link 1	6	Widening of Lake Rd from four lanes to six lanes between Oxley Hwy and Ocean Dr
East-West Link 2/2B	4	Connects Ocean Dr at Greenmeadows Dr to the Old Oxley Hwy via Major Innes Rd
East-West Link 3A/3/3D	4	Connects Ocean Dr between Greenmeadows Dr and Yaluma Dr to the Old Oxley Hwy at Major Innes Rd.
East-West Link 3B/3/3D	4	Connects Ocean Dr between Greenmeadows Dr and Yaluma Dr to the Oxley Hwy Deviation, crossing the Old Oxley Hwy between Major Innes Rd and The Ruins Way
North-South Link 2/2A	2	Provides an alternative link between the town centre and the airport via Oxley Hwy attracting airport traffic off Hastings River Dr
North-South Link 2/2B	2	Connects to Oxley Hwy further to the south compared with *2A* and therefore has less diversionary impact on traffic on Hastings River Dr
North-South Link 3/3A	2	Connects the Oxley Hwy Deviation at The Ruins Way (connecting to East-West Link 3B/3/3D) to Hastings River Dr at Tuffins Ln
North-South Link 3/3C	2	Connects the Old Oxley Hwy at Lindfield Park Rd to Hastings River Dr at Tuffins Ln
North-South Link 3/3D	2	Connects the Old Oxley Hwy at Thrumster St to Hastings River Dr at Tuffins Ln
North-South Link 4A/4/4C	2	Connects the Old Oxley Hwy at Lindfield Park Rd to Hastings River Dr at Tuffins Ln
North-South Link 4A/4/4D	2	Connects the Old Oxley Hwy at Lindfield Park Rd to Hastings River Dr at Fernbank Creek Rd
Northwest-Southeast Link 3	2/4	Includes both North-South Link 3/3A and East-West Link 3B/3/3D

3 Methodology

SMEC's TransCAD strategic model provides the basis for testing the impact of the various north-south and east-west Outer Link Road options. The 2021 model reflects the full development of Thrumster and includes recent employment data provided by Council.

Table 2 – Thrumster Land Use

Thrumster Precinct	Employment (No.)
South Oxley	200
North Oxley	600
Partridge Creek	400
West Lindfield	200
STP north of Partridge Creek	20

The options to be investigated were tested separately to determine changes in traffic flows on the network during the PM peak for year 2021 and 2031.

A 2.5% per annum growth rate was applied as the growth factor for the Hastings population from 2021 to 2031. This rate was taken from the Hastings Urban Growth Strategy 2001 (HUGS 2001) report and represents a relatively high growth rate in the range of growth scenarios reported in the HUGS 2001 report. Forecast traffic flows for 2031 were estimated in the model based on this assumed growth rate.

PM peak traffic flows were prepared for each of the Outer Link Road options tested. The impact of each of the options on the road network was assessed by observing the extent of diversion of traffic from congested routes.

Travel times were also synthesised from the model for a number of specific travel routes. These were used to enable a comparison and assessment of the effect of each of the options on travel times on a number of key routes.

4 Results

4.1 Impact on Traffic Flow

Traffic flow plots showing PM peak hour flows for the Base Case and for each of the twelve options are included for 2021 in **Appendix A** and for 2031 in **Appendix B**.

East-West Link 1

The upgrade appears to cause only minor changes in traffic flows on roads in the study area.

East-West Link 2/2B

This proposal attracts traffic from Lake Road ranging from 30% to 60%. It also reduces traffic flows significantly on Jindalee Road. The inclusion of this link does not significantly affect traffic flows on Lake Road east of Ocean Drive or on Old Oxley Highway north of Lake Road. However traffic flows on old Oxley Highway west of Lake Road increase significantly.

East-West Link 3A/3/3D

This link has a similar effect as *E-W Link 2/2B*. The reduction in traffic on Ocean Rd between *E-W Link 3B/3/3D* and Lake Rd is greater than the reduction observed for *2/2B*, but the reduction in Lake Road traffic is not as great.

East-West Link 3B/3/3D

This link option has similar impacts to *E-W Link 3A/3/3D*.

North-South Link 2/2A

This link has a greater impact on east-west traffic than on north-south traffic. Traffic is diverted from roads linking Hastings River Drive and Oxley Highway such as Clifton Drive and Widderson Street. There is no significant impact on traffic levels for Oxley Highway or Hastings River Drive west of the airport.

North-South Link 2/2B

This link option has similar impacts to *N-S Link 2/2A*.

North-South Link 3/3A

This link carries less than 300 vehicles in each direction in the 2021 PM peak and around 500 vehicles in each direction in the 2031 PM peak. There is a resultant reduction of about 300 vehicles in each direction on Oxley Highway west of Lake Road.

North-South Link 3/3C

This link intersects ol Oxley Highway further to the west and results in slightly greater diversion of traffic than *N-S Link 3/3A*. It carries between 300 and 400 vehicles in each direction during the 2021 PM peak, increasing to 500-600 vehicles in each direction in the 2031 PM peak.

North-South Link 3/3D

This link carries as much traffic as *N-S Link 3/3C*, and has similar traffic impacts.

North-South Link 4A/4/4C

This link joins the existing network at the same points as *N-S Link 3/3C*, but follows a more circuitous route. The peak traffic volumes are less than 200vph in each direction in 2021 and between 250 and 350 vehicles in 2031. It reduces traffic flows on Oxley Highway north of Lake Road by a similar amount.

North-South Link 4A/4/4D

This link joins Fernbank Creek Road near Hastings River Drive and is farther west than any of the other *N-S Link* options, and therefore is less attractive. In 2021 it carries just over 100vph in total, increasing to under 400vph total in 2031. Its effect on surrounding roads and routes is minimal.

Northwest-Southeast Link 3

This link combines the benefits of both *E-W Link 3B/3/3D* and *N-S Link 3/3A* in terms of attracting traffic and relieving existing relatively congested roads. There is no significant change in impact due to the combination of these link options.

4.2 Impact on Travel Times

Three Test Routes were selected as a basis for evaluating the impact on travel times of the various outer link road proposals. The Test Routes are:

Test Route 1: Oxley Highway (at Thrumster Street) – Clifton Drive – Hastings River Drive (at Hibbard Drive East)

Test Route 2: Oxley Highway (at Thrumster Street) – Pacific Highway – Fernbank Creek Road – Hastings River Drive (Hibbard Drive East);

Test Route 3: Oxley Highway (at Wrights Road) – Lake Road – Ocean Drive (at Greenmeadows Drive)

The Test Routes are shown below.

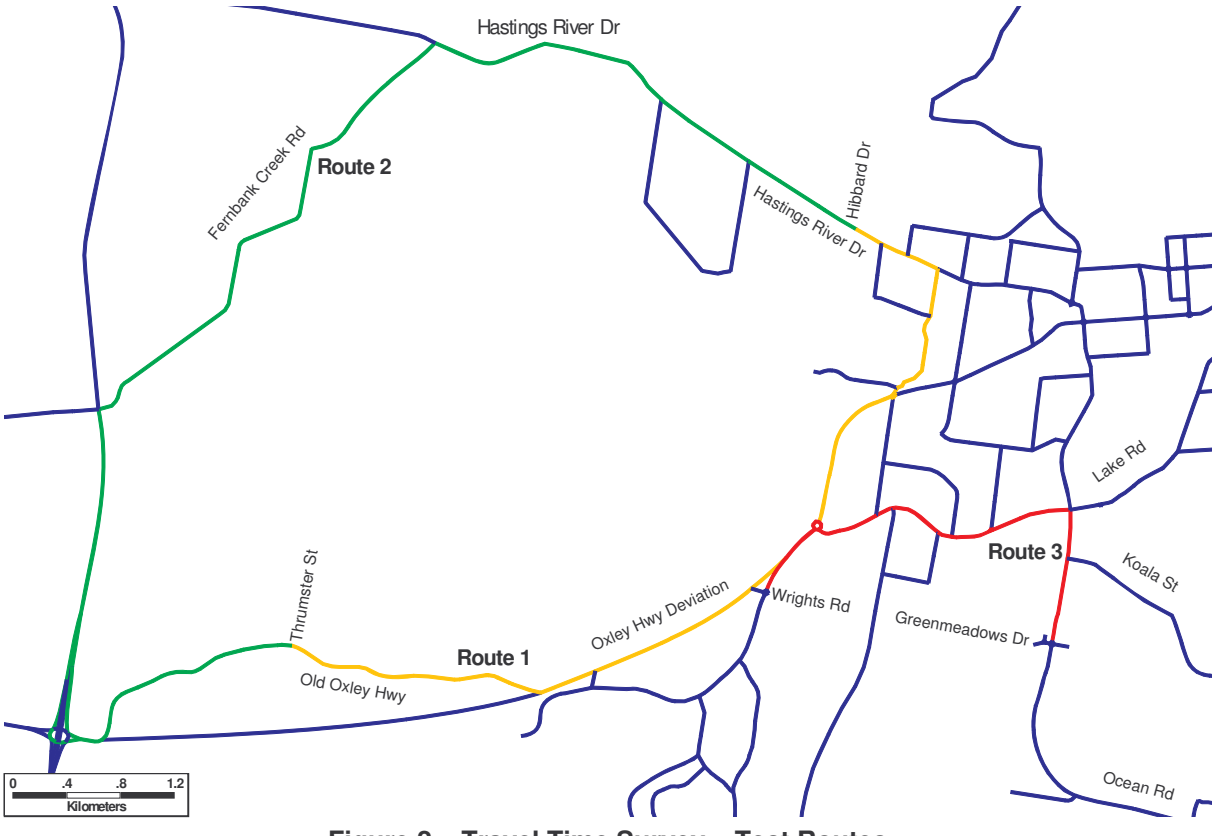


Figure 2 – Travel Time Survey – Test Routes

Travel speed is a function of the volume/capacity ratio for a particular road which in turn is a measure of the level of service of a road. Each of the outer link road proposals was tested in the model to estimate the change in travel speed for the three Test Routes relative to the Base Case. Travel times are calculated from modelled travel speeds and represent a total of the calculated travel times for each individual link along the route, therefore representing an expected travel time for a vehicle travelling along the entire route.

Average Levels of Service for each test route are shown below 2021 in **Table 3** and for 2031 in **Table 6**. Estimated travel times in seconds for the Test Routes are summarised for 2021 in **Table 4** and for 2031 in **Table 7**. A comparison of each of the options with the Base Case for each travel time survey Test Route is included for 2021 in **Table 5** and for 2031 in **Table 8**.

Table 3 – Levels of Service for 2021 PM

Option	Test Route 1		Test Route 2		TestRoute 3	
	N/B	S/B	N/B	S/B	E/B	W/B
Base Case	E	E	B	B	E	D
East-West Link 1	E	E	B	B	E	C
East-West Link 2/2B	E	E	B	B	D	C
East-West Link 3A/3/3D	E	E	B	B	D	C
East-West Link 3B/3/3D	E	E	B	B	D	C
North-South Link 2/2A	E	E	B	B	E	D
North-South Link 2/2B	E	E	B	B	E	D
North-South Link 3/3A	E	E	B	B	E	D
North-South Link 3/3C	E	E	B	B	E	D
North-South Link 3/3D	E	E	B	B	E	D
North-South Link 4A/4/4C	E	E	B	B	E	D
North-South Link 4A/4/4D	E	E	B	B	E	D
Northwest-Southeast Link 3	E	E	B	B	D	C

Table 4 – 2021 PM Peak Average Travel Times (secs)

Option	Test Route 1		Test Route 2		TestRoute 3	
	N/B	S/B	N/B	S/B	E/B	W/B
Base Case	460	483	622	627	300	258
East-West Link 1	460	477	622	627	268	231
East-West Link 2/2B	441	465	622	625	252	229
East-West Link 3A/3/3D	445	467	622	624	254	228
East-West Link 3B/3/3D	456	479	622	623	253	229
North-South Link 2/2A	442	462	614	622	303	260
North-South Link 2/2B	432	456	616	620	305	261
North-South Link 3/3A	444	471	615	624	302	257
North-South Link 3/3C	443	474	623	624	300	257
North-South Link 3/3D	442	469	625	625	300	259
North-South Link 4A/4/4C	451	477	618	623	303	258
North-South Link 4A/4/4D	404	408	622	626	302	258
Northwest-Southeast Link 3	440	466	614	618	251	230

Table 5 – 2021 PM Peak Average Travel Time Savings (secs)

Option	Test Route 1		Test Route 2		Test Route 3	
	N/B	S/B	N/B	S/B	E/B	W/B
Base Case	-	-	-	-	-	-
East-West Link 1	0	7	0	1	33	27
East-West Link 2/2B	19	18	0	2	49	29
East-West Link 3A/3/3D	15	17	0	4	46	30
East-West Link 3B/3/3D	4	5	0	4	48	29
North-South Link 2/2A	18	21	8	5	-3	-2
North-South Link 2/2B	28	27	6	7	-5	-3
North-South Link 3/3A	16	12	7	4	-2	1
North-South Link 3/3C	17	10	0	4	0	1
North-South Link 3/3D	18	15	-3	3	0	-1
North-South Link 4A/4/4C	9	6	4	4	-2	0
North-South Link 4A/4/4D	56	75	0	1	-2	0
Northwest-Southeast Link 3	20	18	8	9	50	28

Table 6 – Levels of Service for 2031 PM

Option	Test Route 1		Test Route 2		TestRoute 3	
	N/B	S/B	N/B	S/B	E/B	W/B
Base Case	F	F	C	C	F	E
East-West Link 1	F	F	C	C	E	D
East-West Link 2/2B	E	F	C	C	E	D
East-West Link 3A/3/3D	E	F	C	C	E	D
East-West Link 3B/3/3D	E	F	C	C	E	D
North-South Link 2/2A	E	F	C	C	F	E
North-South Link 2/2B	E	F	C	C	F	E
North-South Link 3/3A	E	F	C	C	F	E
North-South Link 3/3C	E	F	C	C	F	E
North-South Link 3/3D	E	F	C	C	F	E
North-South Link 4A/4/4C	F	F	C	C	F	E
North-South Link 4A/4/4D	F	F	C	C	F	E
Northwest-Southeast Link 3	E	E	C	C	E	D

Table 7 – 2031 PM Peak Average Travel Times (secs)

Option	Test Route 1		Test Route 2		Test Route 3	
	N/B	S/B	N/B	S/B	E/B	W/B
Base Case	516	548	642	656	304	286
East-West Link 1	519	543	643	656	294	253
East-West Link 2/2B	498	525	641	652	277	247
East-West Link 3A/3/3D	497	524	640	653	279	249
East-West Link 3B/3/3D	502	529	640	654	275	249
North-South Link 2/2A	498	513	634	651	303	288
North-South Link 2/2B	484	508	635	650	300	290
North-South Link 3/3A	496	523	637	653	306	285
North-South Link 3/3C	494	532	641	651	308	284
North-South Link 3/3D	488	518	641	651	307	285
North-South Link 4A/4/4C	509	538	639	654	304	287
North-South Link 4A/4/4D	510	548	645	657	306	286
Northwest-Southeast Link 3	484	506	634	647	272	248

Table 8 – 2031 PM Peak Average Travel Time Savings (secs)

Option	Test Route 1		Test Route 2		Test Route 3	
	N/B	S/B	N/B	S/B	E/B	W/B
Base Case	-	-	-	-	-	-
East-West Link 1	-3	5	-1	0	9	33
East-West Link 2/2B	18	23	2	4	27	39
East-West Link 3A/3/3D	19	25	2	3	25	37
East-West Link 3B/3/3D	14	19	2	2	29	38
North-South Link 2/2A	18	35	8	5	1	-2
North-South Link 2/2B	33	40	7	6	4	-3
North-South Link 3/3A	20	25	6	3	-2	1
North-South Link 3/3C	22	16	2	5	-4	2
North-South Link 3/3D	28	30	2	5	-3	1
North-South Link 4A/4/4C	7	11	4	2	-1	0
North-South Link 4A/4/4D	6	1	-2	-1	-2	0
Northwest-Southeast Link 3	32	42	8	9	32	38

The results show that in the 2021 and 2031 PM peak periods the most significant travel time saving is achieved by the construction of the combination of *East-West Link 3B/3/3D* and *North-South Link 3/3A*. However, taken separately, the most effective route in reducing travel time is *East-West Link 3A/3/3D.*

5 Network Performance Indicators

Several indicators of travel can be synthesised as output of the Transcad runs for the considered north –south and east-west link options. These include the number of Vehicle Kilometres Travelled (VKT), the number of Vehicle Hours Travelled (VHT). These are obtained for the PM peak. for the years 2021 and 2031, see table 9. The table shows the total number of trip accommodated in the network. Other indicators can be also computed using this output, such as average journey distance, average journey speed for each of the base case and the considered options.

Table 9 – Network Traffic Performance Indicators (PM Peak)

Option	2021 PM			2031 PM		
	Trips	VKT	VHT	Trips	VKT	VHT
Base Case	59698	328525.3	13763.3	76414	425750.3	19155.5
East-West Link 1	59698	328597.7	13718.5	76414	425811.6	19084.8
East-West Link 2/2B	59698	325410.0	13343.4	76414	420766.3	18361.8
East-West Link 3A/3/3D	59698	326063.3	13352.4	76414	421932.8	18395.3
East-West Link 3B/3/3D	59698	324803.2	13554.7	76414	420307.6	18332.0
North-South Link 2/2A	59698	328447.7	13691.9	76414	424604.2	19004.9
North-South Link 2/2B	59698	327078.7	13637.6	76414	424420.2	18995.3
North-South Link 3/3A	59698	327411.0	13684.5	76414	425714.4	19037.0
North-South Link 3/3C	59698	327608.1	13675.1	76414	424453.3	18972.4
North-South Link 3/3D	59698	327929.1	13700.1	76414	424311.7	19005.3
North-South Link 4A/4/4C	59698	327670.0	13694.7	76414	425737.8	19092.8
North-South Link 4A/4/4D	59698	328529.8	13744.6	76414	425999.9	19127.4
Northwest-Southeast Link 3	59698	324572.5	13281.5	76414	419657.6	18240.3

6 Conclusion

6.1.1 East-West Options

The assessment of the east-west route options shows that:

East-West Link 1 has similar peak traffic flows compared to the Base Case, however the proposed additional lanes do have a significant effect on average travel speeds and therefore result in a substantial reduction in travel times on Test Route 3.

East-West Link 2/2B provides attractive east-west alternative routes to Lake Road, avoiding the need for costly widening on Lake Road and improving accessibility through reduced traffic congestion at intersections along Lake Road. It is expected to attract about 1,000 vehicles in each direction from Lake Road in 2031, resulting in improved level of service on Lake Road and a good level of service on the proposed link.

East-West Links 3A/3/3D and *3/3B/3D* also provide attractive east-west alternative routes to Lake Road, avoiding the need for widening on Lake Road. They do not divert as much traffic as *East-West Link 2/2B*, but *Link 3B/3/3D* provides a potential connection to *North-South Link 3/3A*. They also connect to Ocean Drive further south than the other *East-West* options, and thereby provide relief to more of the length of this and other affected North-South roads.

6.1.2 North-South Options

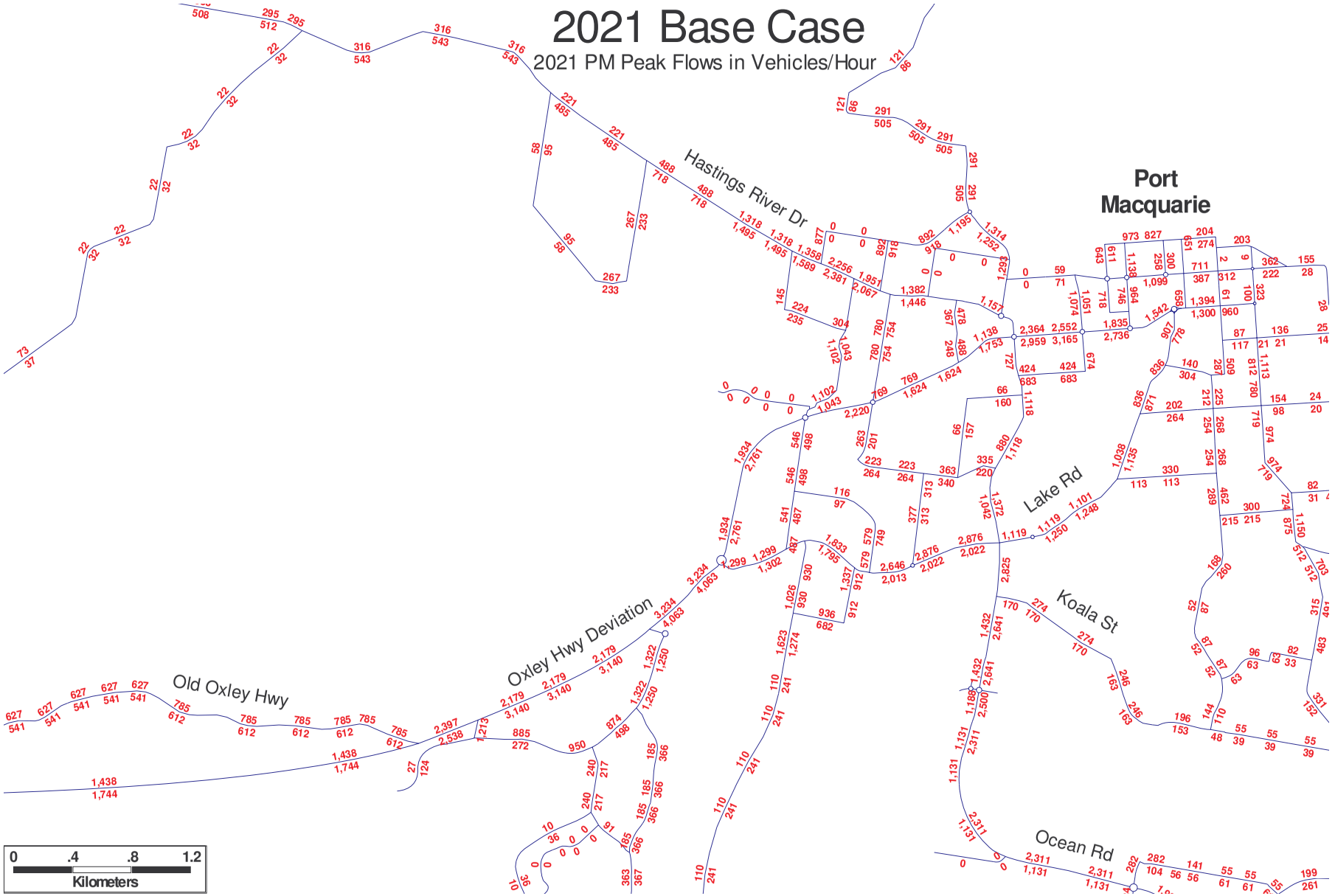
The provision of *North South Link 2/2A and 2/2B* reduces traffic flows on Hastings River Drive east of Hibbard Drive by providing alternative routes to the airport. Both routes result in significant savings in travel times for the two North-South survey Test Routes, with 2/*2B* providing the better performance.

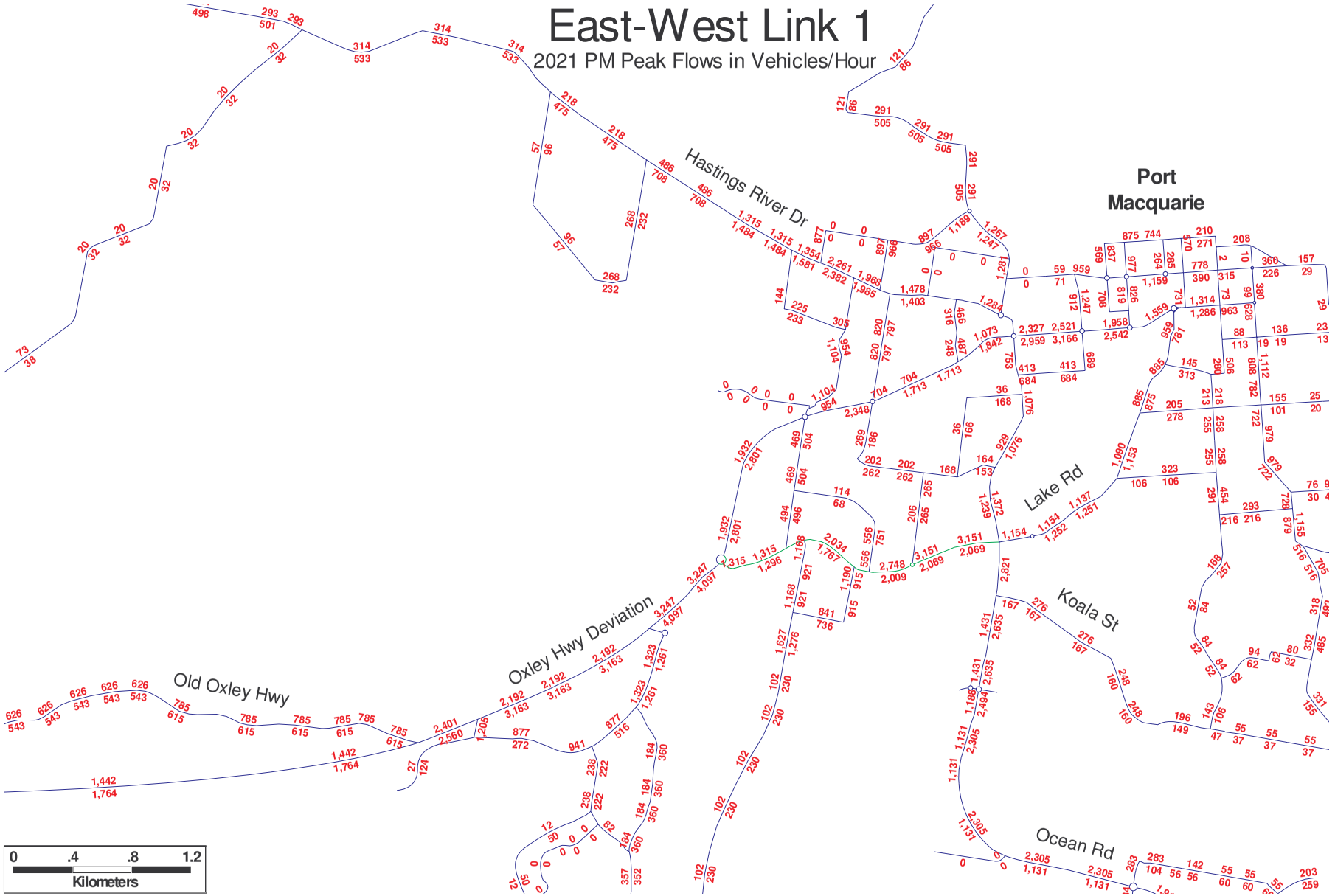
Options 3A, 3C, 3D, 4C and 4D provide direct connections between Oxley Highway and the airport and Hastings River Drive but attract relatively low volumes of traffic. In all five options there is not a significant change in travel time for Test Routes 1 and 2.

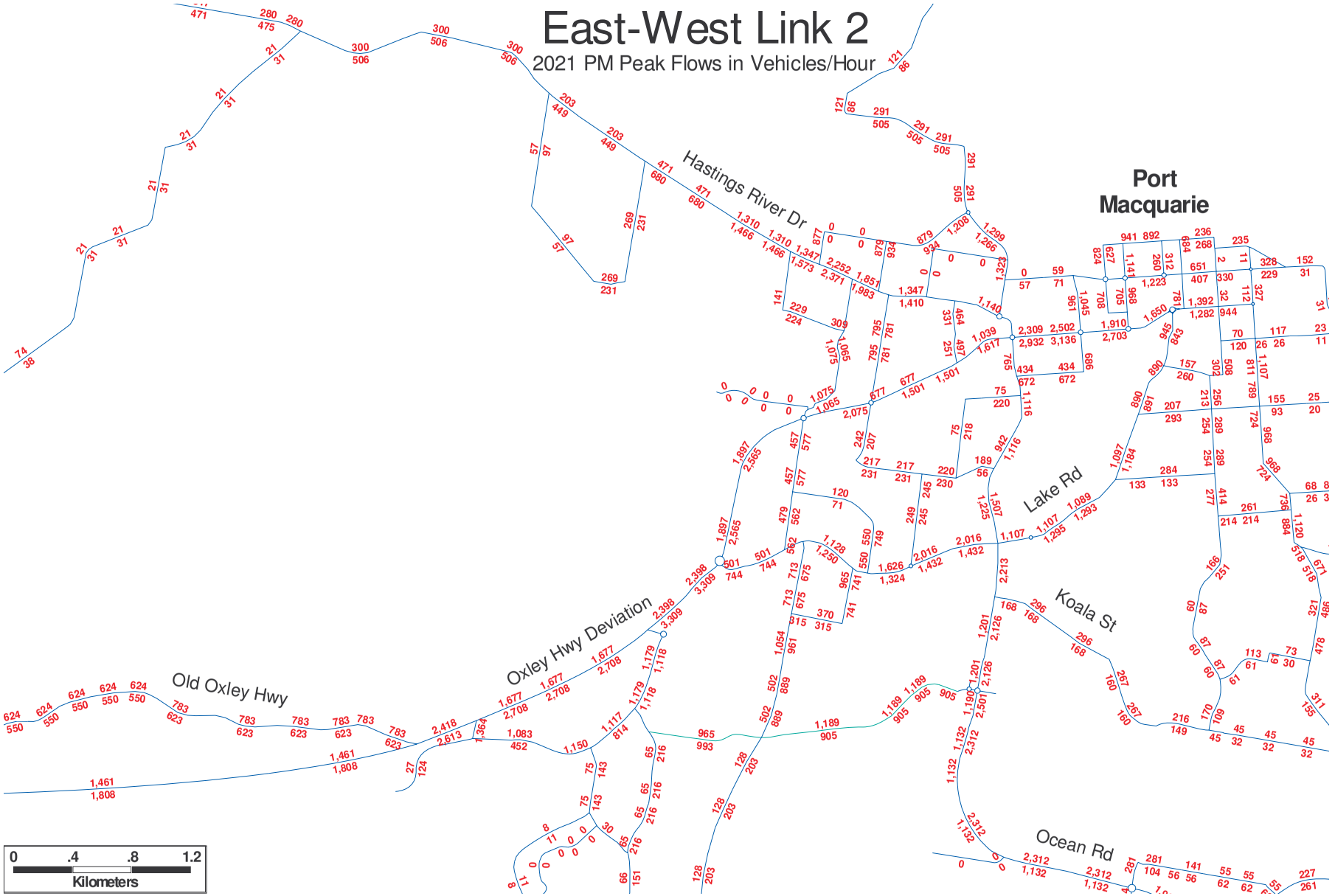
6.1.3 Combined Options

Although *North-South Link 3/3A* in isolation does not attract significant levels of traffic, the provision of this link together with *E-W Link 3B/3/3D* to form *Northwest-Southeast Option 3* results in the greatest travel time savings for all three test routes.

Appendix A 2021 PM Peak Network Traffic Flows


2021 Base Case
2021 PM Peak Flows in Vehicles/Hour
Port Macquarie
Hastings River Dr
Lake Rd
Koala St
Ocean Rd
Oxley Hwy Deviation
Old Oxley Hwy
0 .4 .8 1.2
Kilometers


East-West Link 1
2021 PM Peak Flows in Vehicles/Hour
Hastings River Dr
Port Macquarie
Lake Rd
Koala St
Ocean Rd
Oxley Hwy Deviation
Old Oxley Hwy
0 .4 .8 1.2
Kilometers


East-West Link 2
2021 PM Peak Flows in Vehicles/Hour
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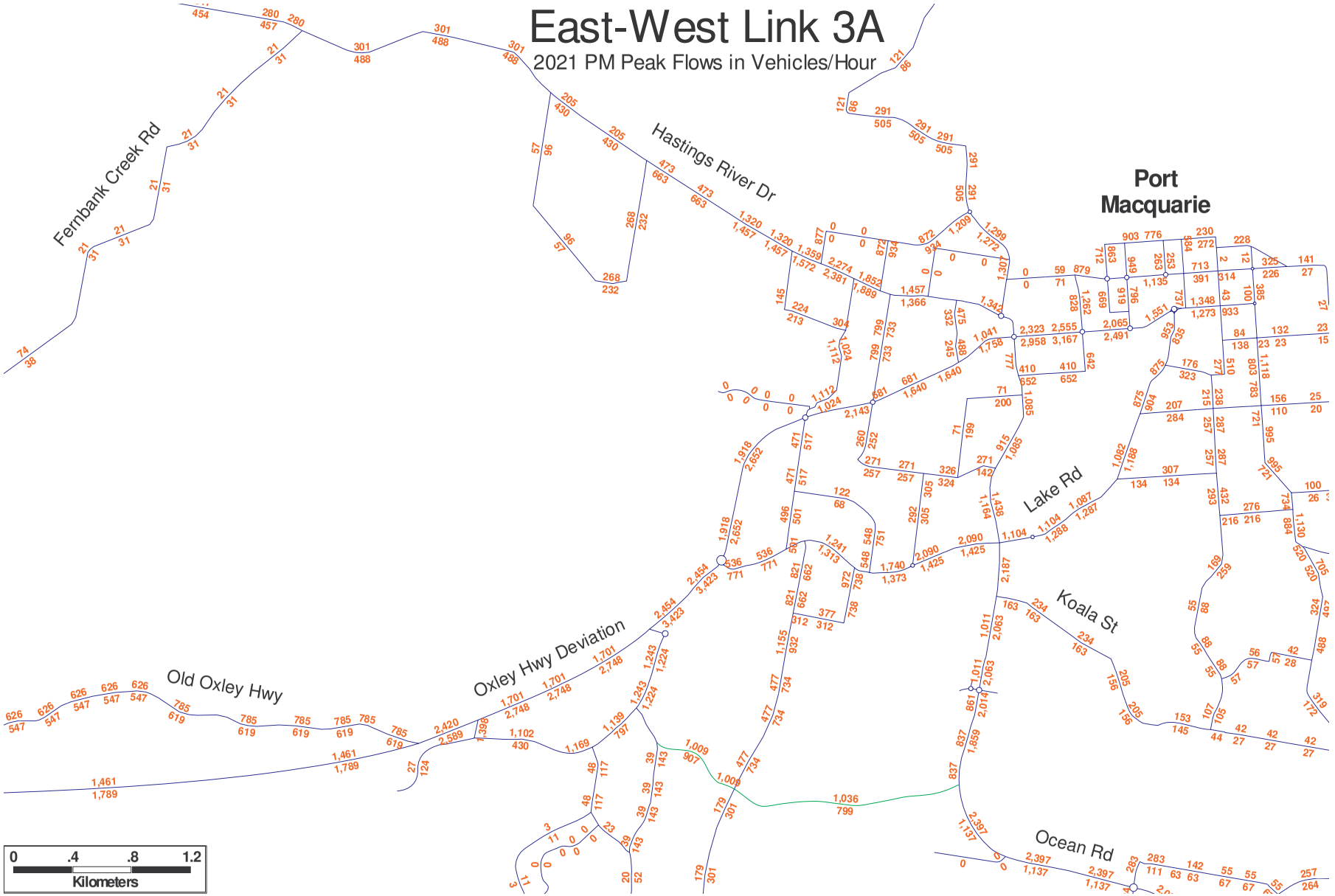
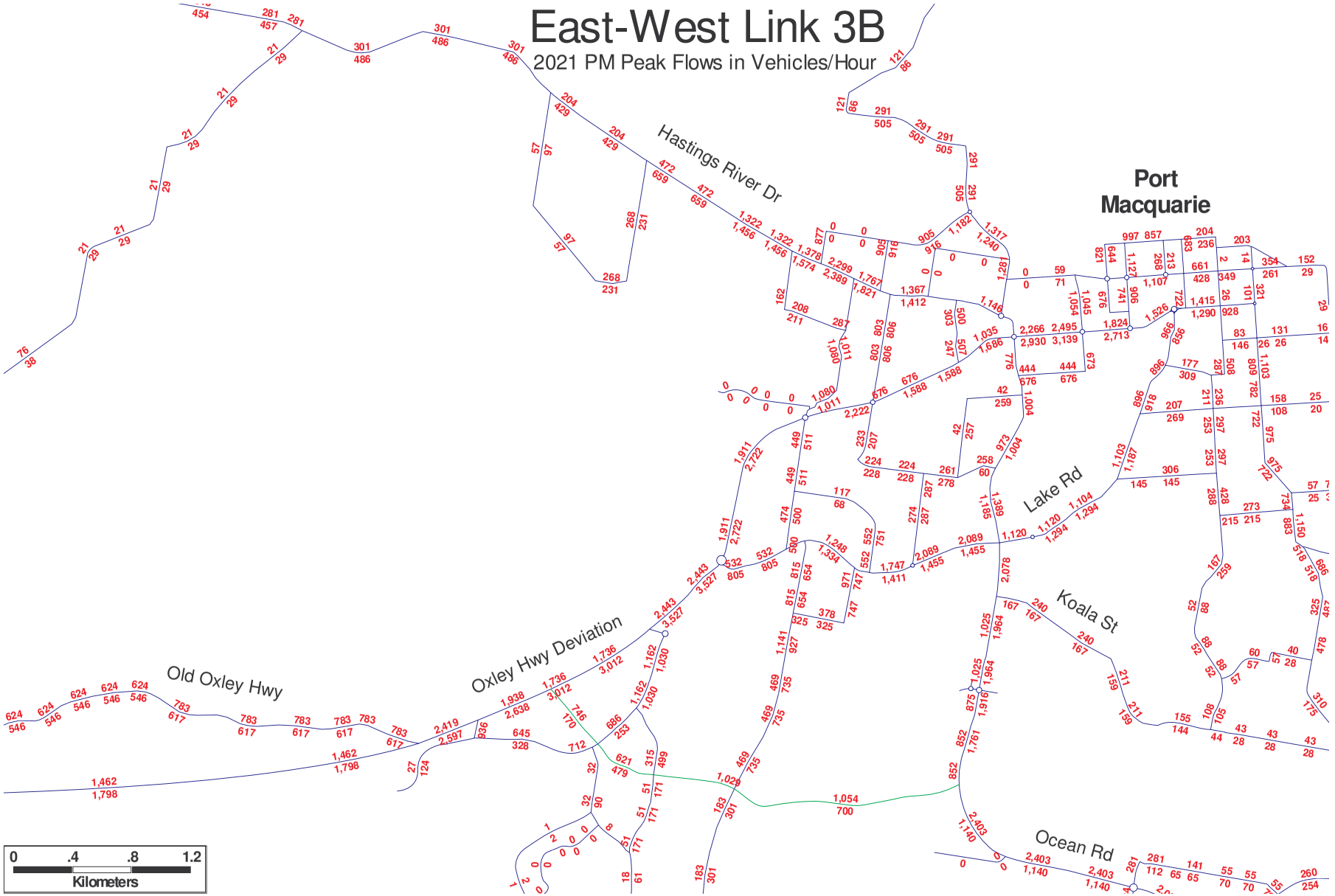
Port Macquarie
Lake Rd
Koala St
Oxley Hwy Deviation
Old Oxley Hwy
Ocean Rd
0 .4 .8 1.2
Kilometers


East-West Link 3A
2021 PM Peak Flows in Vehicles/Hour
Fernbank Creek Rd
Hastings River Dr
Port Macquarie
Lake Rd
Koala St
Ocean Rd
Oxley Hwy Deviation
Old Oxley Hwy
0 .4 .8 1.2
Kilometers


East-West Link 3B
2021 PM Peak Flows in Vehicles/Hour
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Koala St
Ocean Rd
Oxley Hwy Deviation
Old Oxley Hwy
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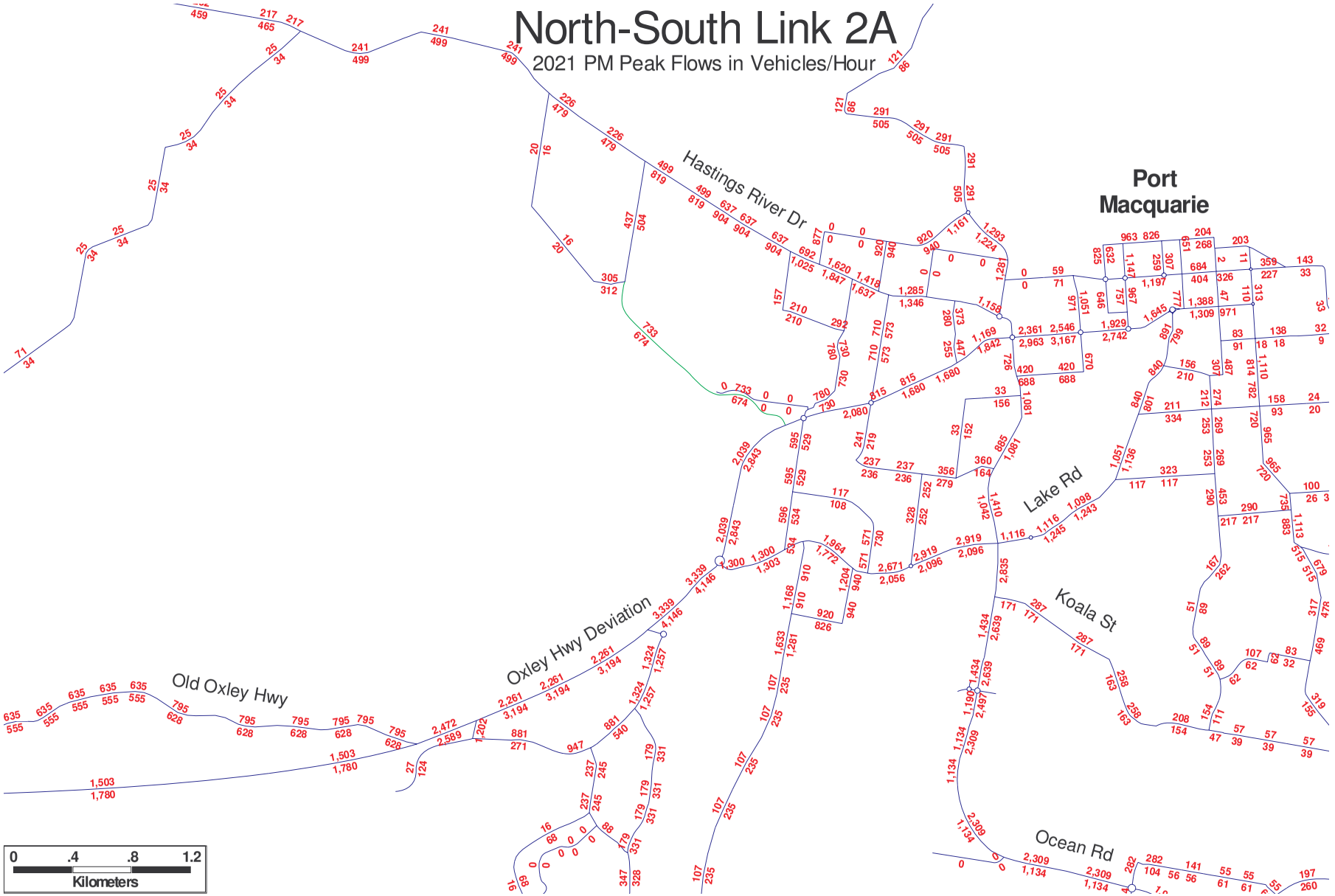
Kilometers


North-South Link 2A
2021 PM Peak Flows in Vehicles/Hour
Hastings River Dr
Port Macquarie
Lake Rd
Koala St
Ocean Rd
Oxley Hwy Deviation
Old Oxley Hwy
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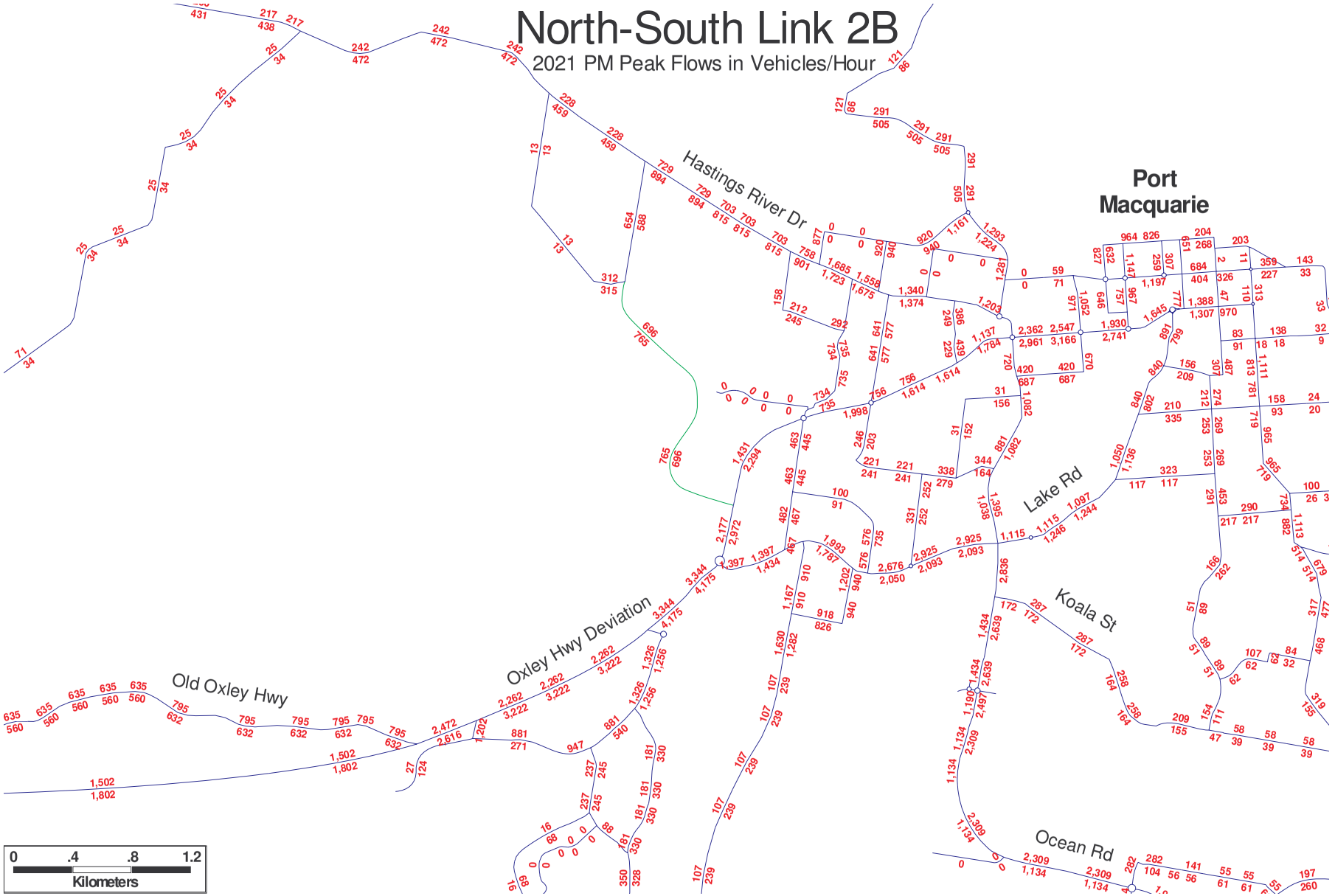
Kilometers


North-South Link 2B
2021 PM Peak Flows in Vehicles/Hour
Hastings River Dr
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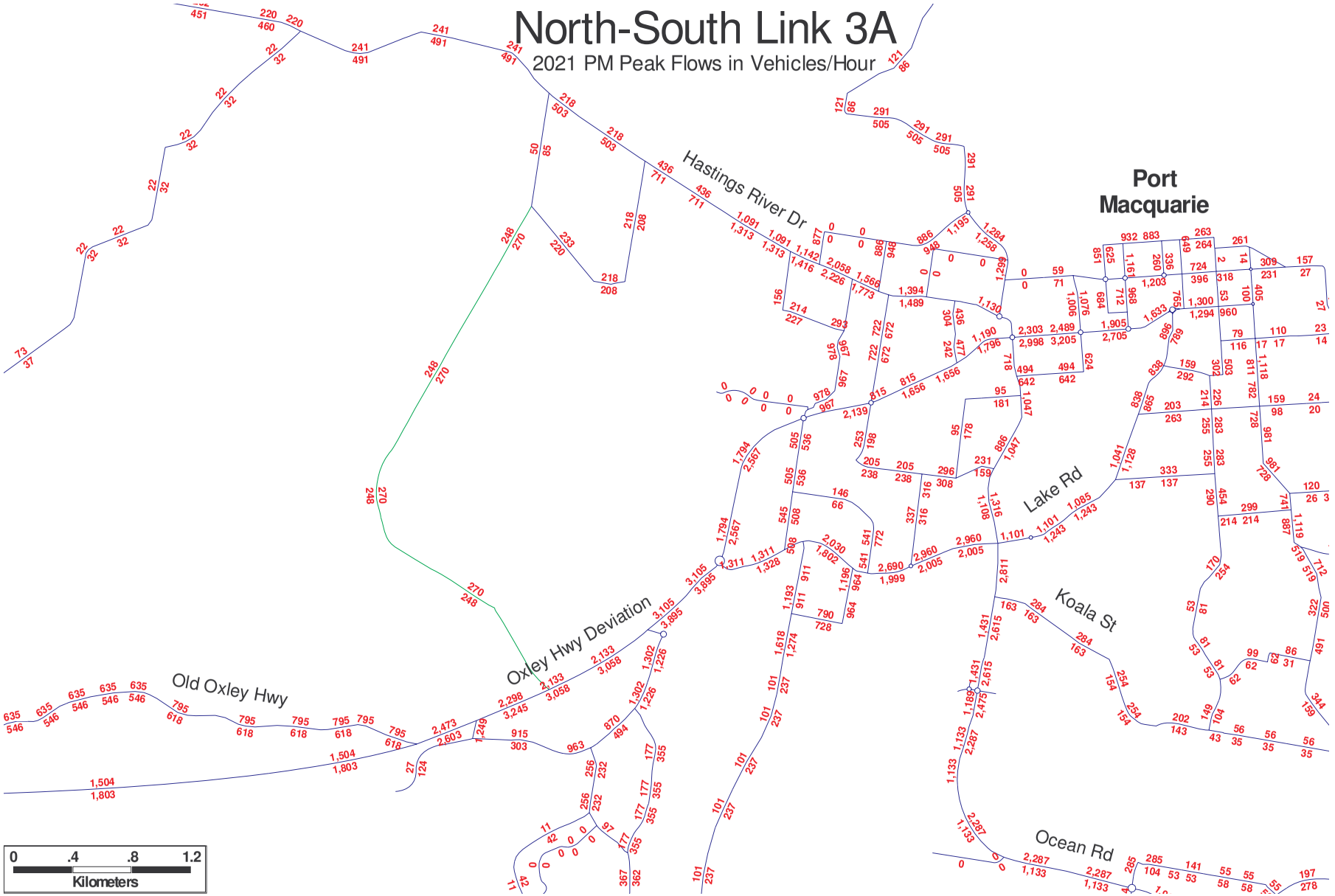
Lake Rd
Koala St
Ocean Rd
Oxley Hwy Deviation
Old Oxley Hwy
0 .4 .8 1.2
Kilometers


North-South Link 3A
2021 PM Peak Flows in Vehicles/Hour
Port Macquarie
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Lake Rd
Koala St
Ocean Rd
Oxley Hwy Deviation
Old Oxley Hwy
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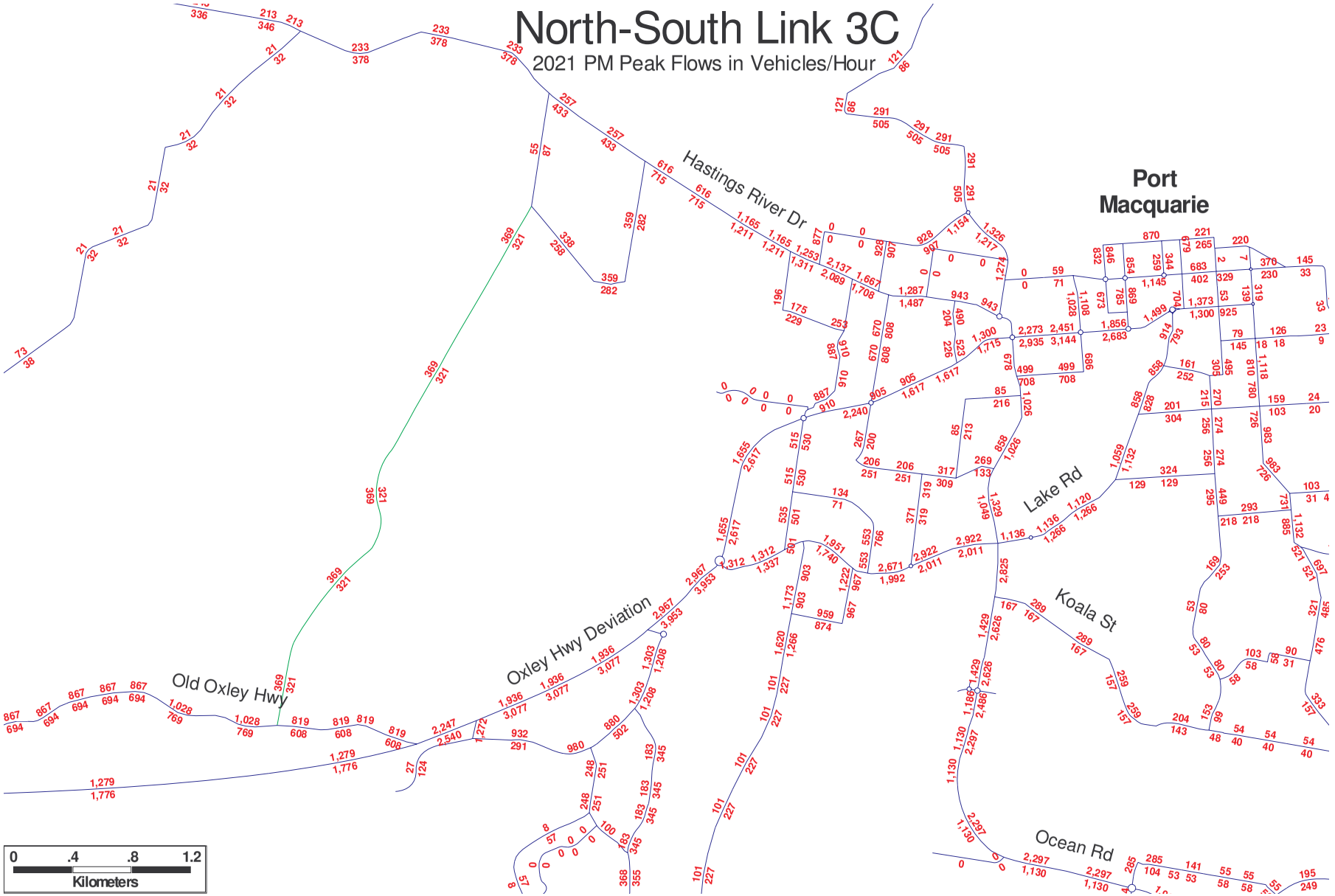
Kilometers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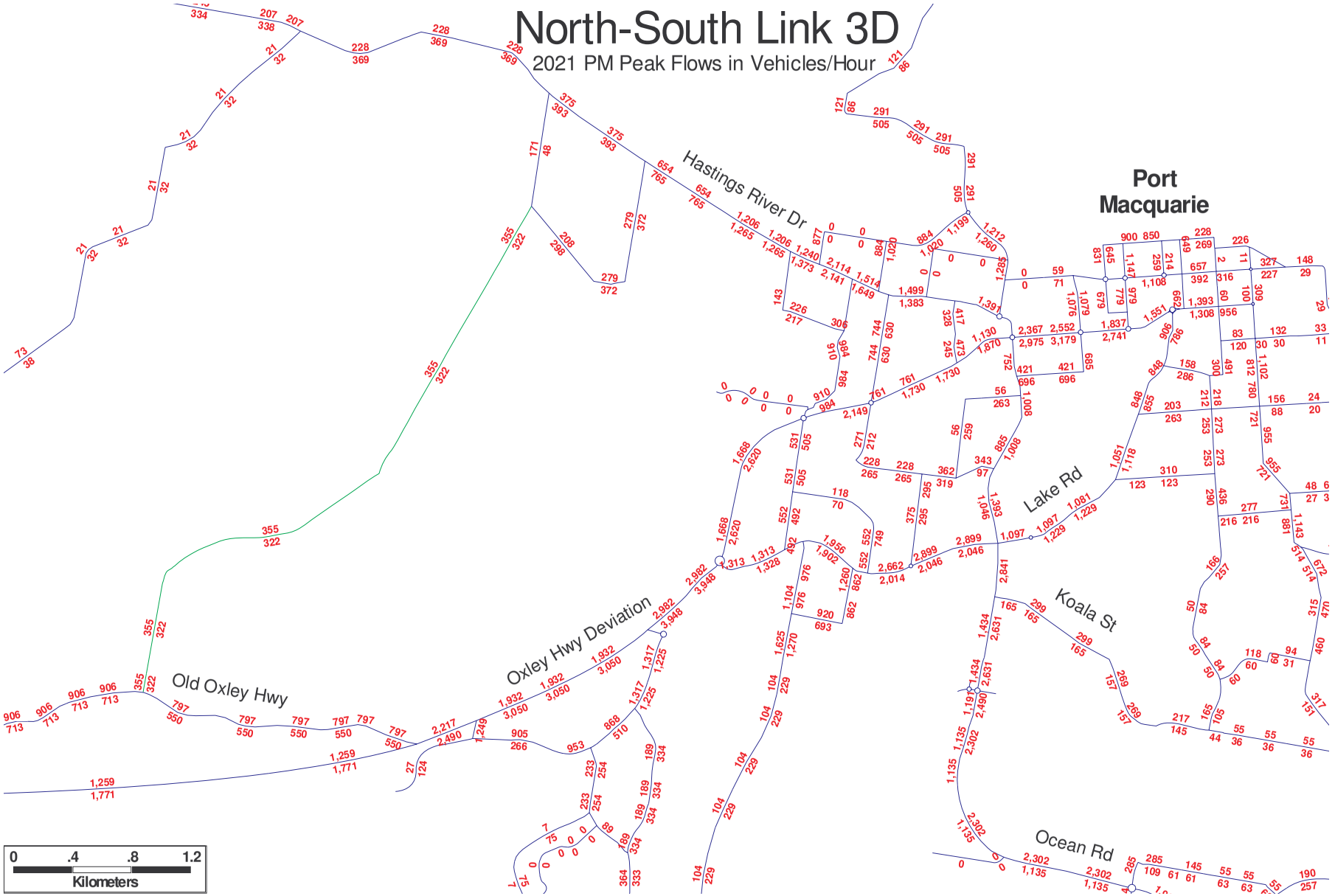
Kilometers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Ocean Rd
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Oxley Hwy Deviation
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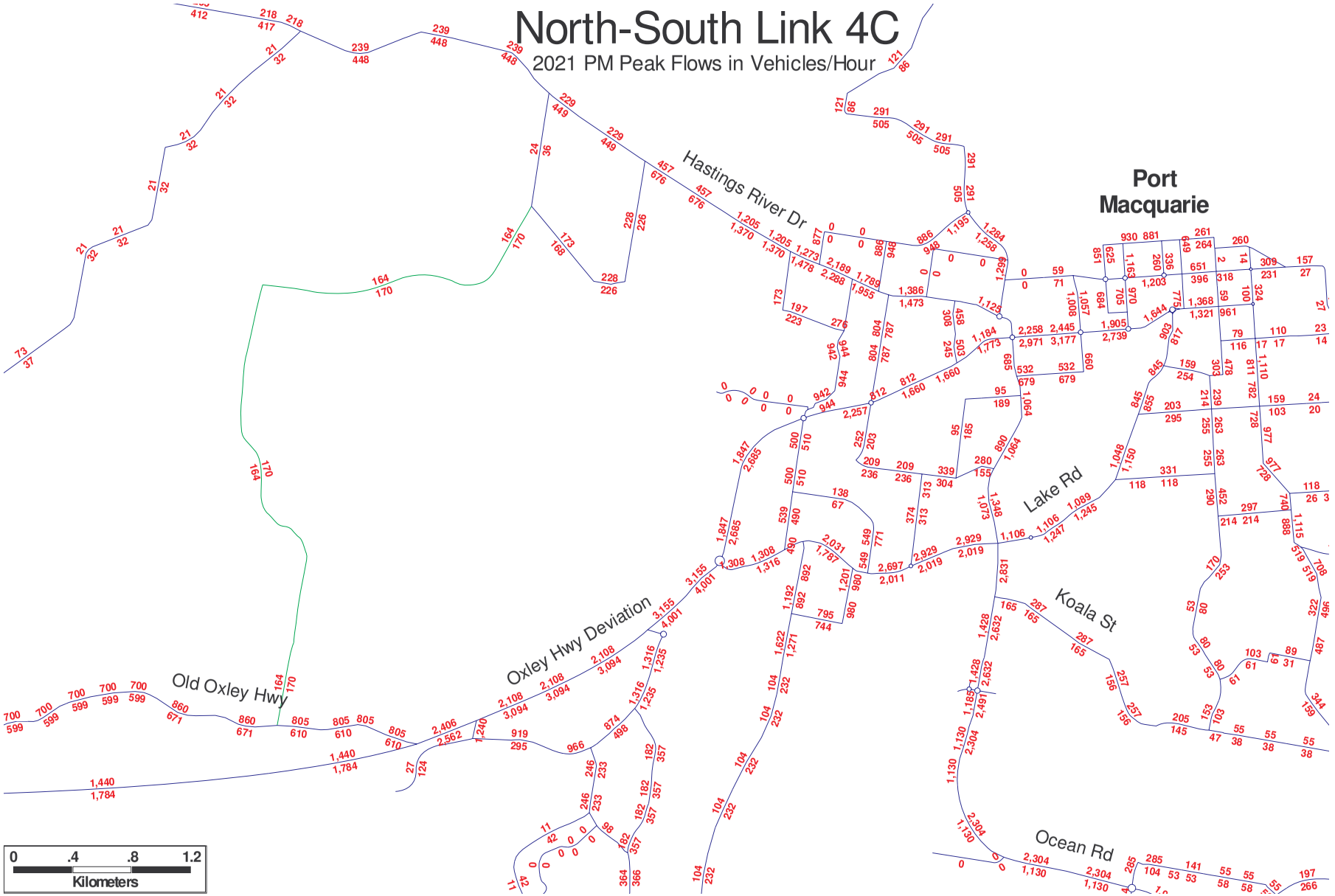
Kilometers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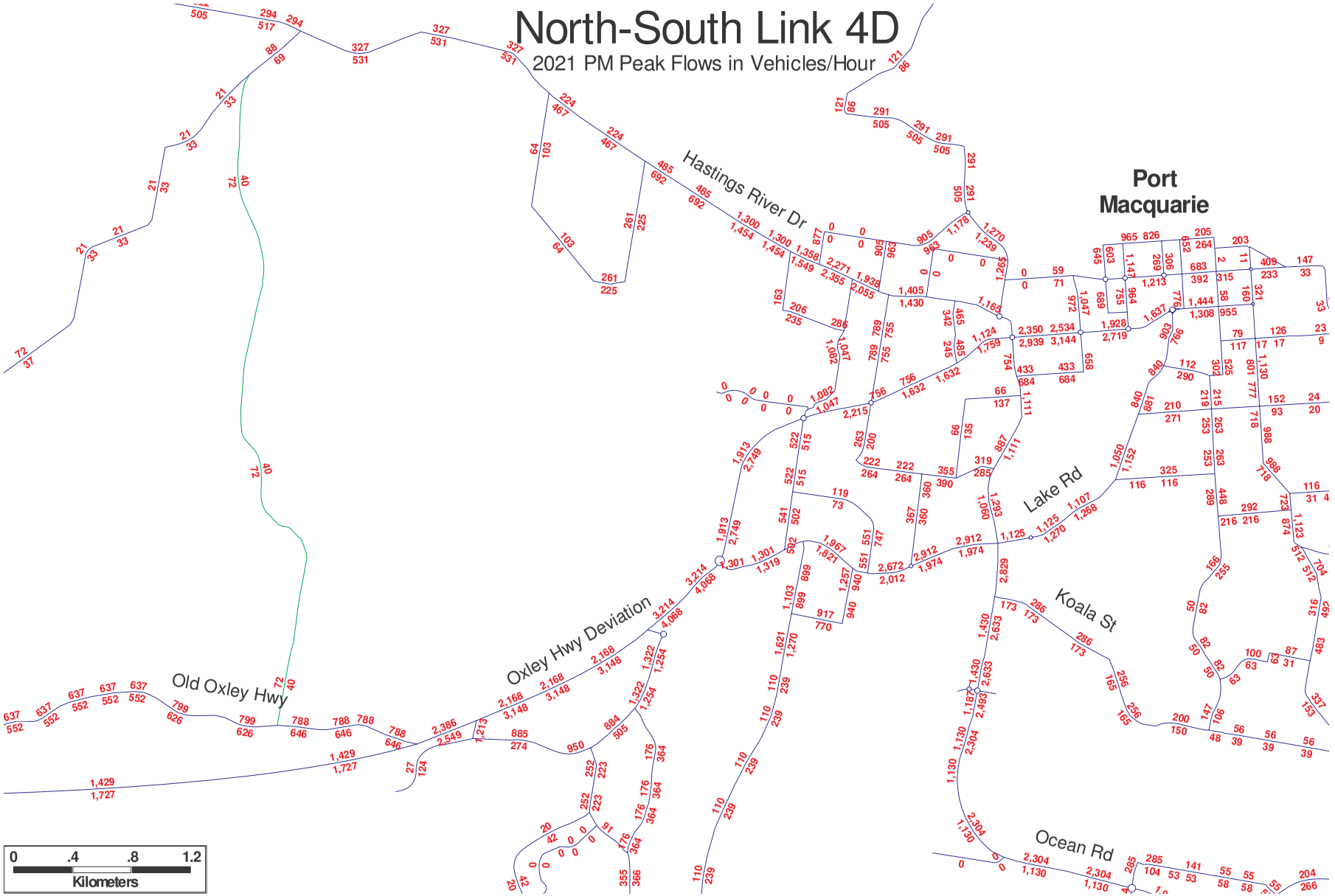
Koala St
Ocean Rd
Oxley Hwy Deviation
Old Oxley Hwy
0 .4 .8 1.2
Kilometers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Koala St
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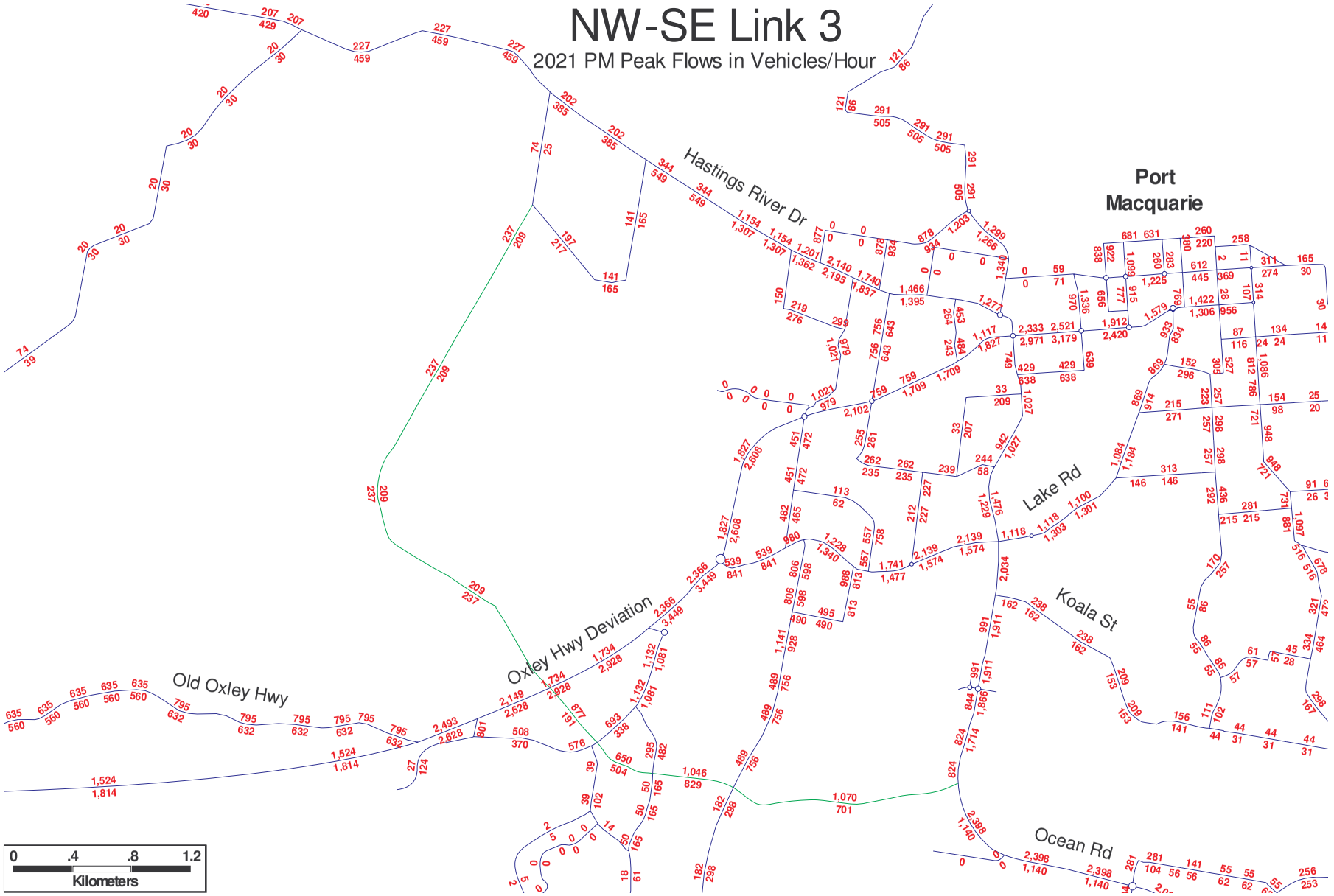
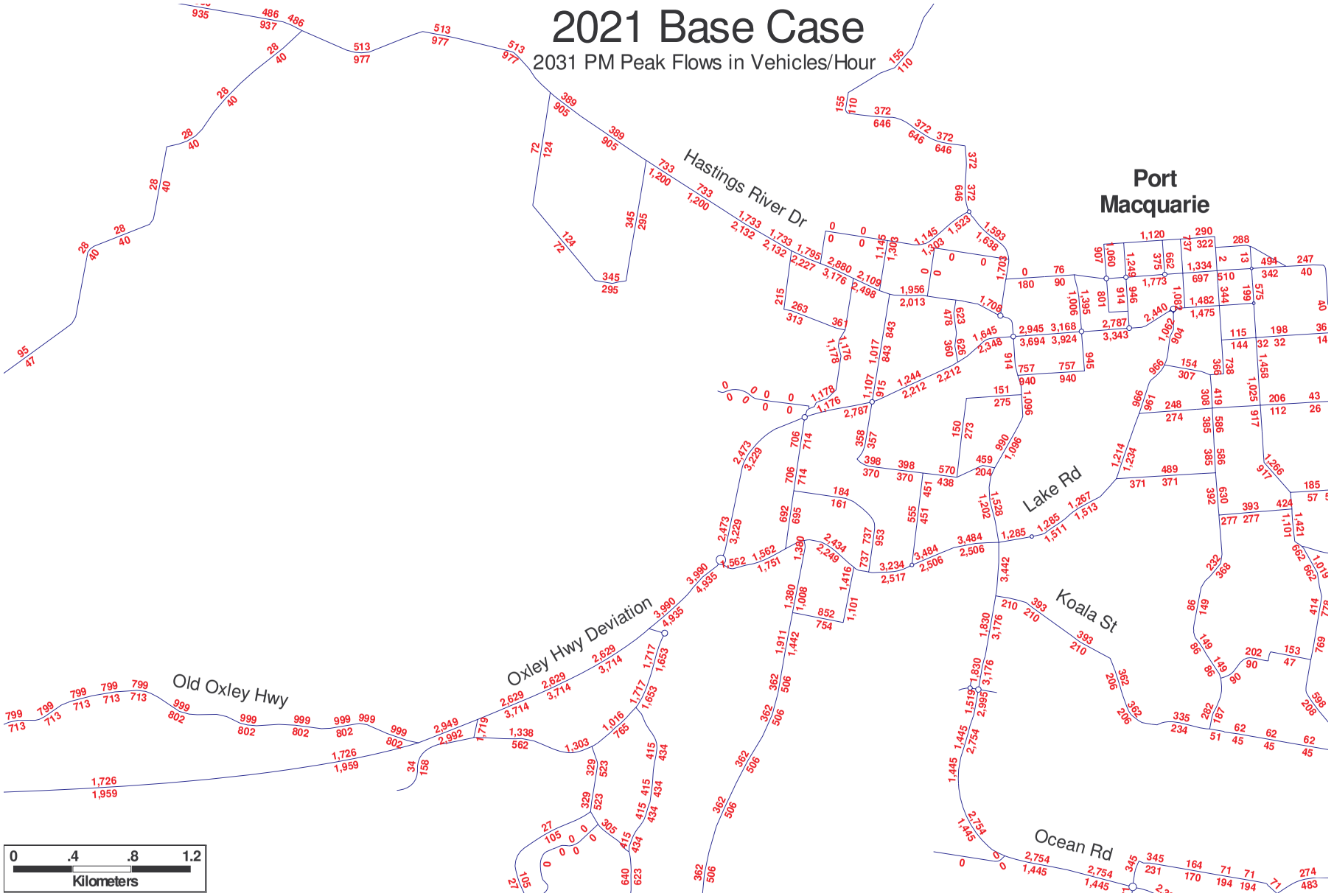
0 .4 .8 1.2
Kilometers


NW-SE Link 3
2021 PM Peak Flows in Vehicles/Hour
Hastings River Dr
Port Macquarie
Lake Rd
Oxley Hwy Deviation
Old Oxley Hwy
Koala St
Ocean Rd
0 .4 .8 1.2
Kilometers

Appendix B 2031 PM Peak Network Traffic Flows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Koala St
Ocean Rd
Oxley Hwy Deviation
Old Oxley Hwy
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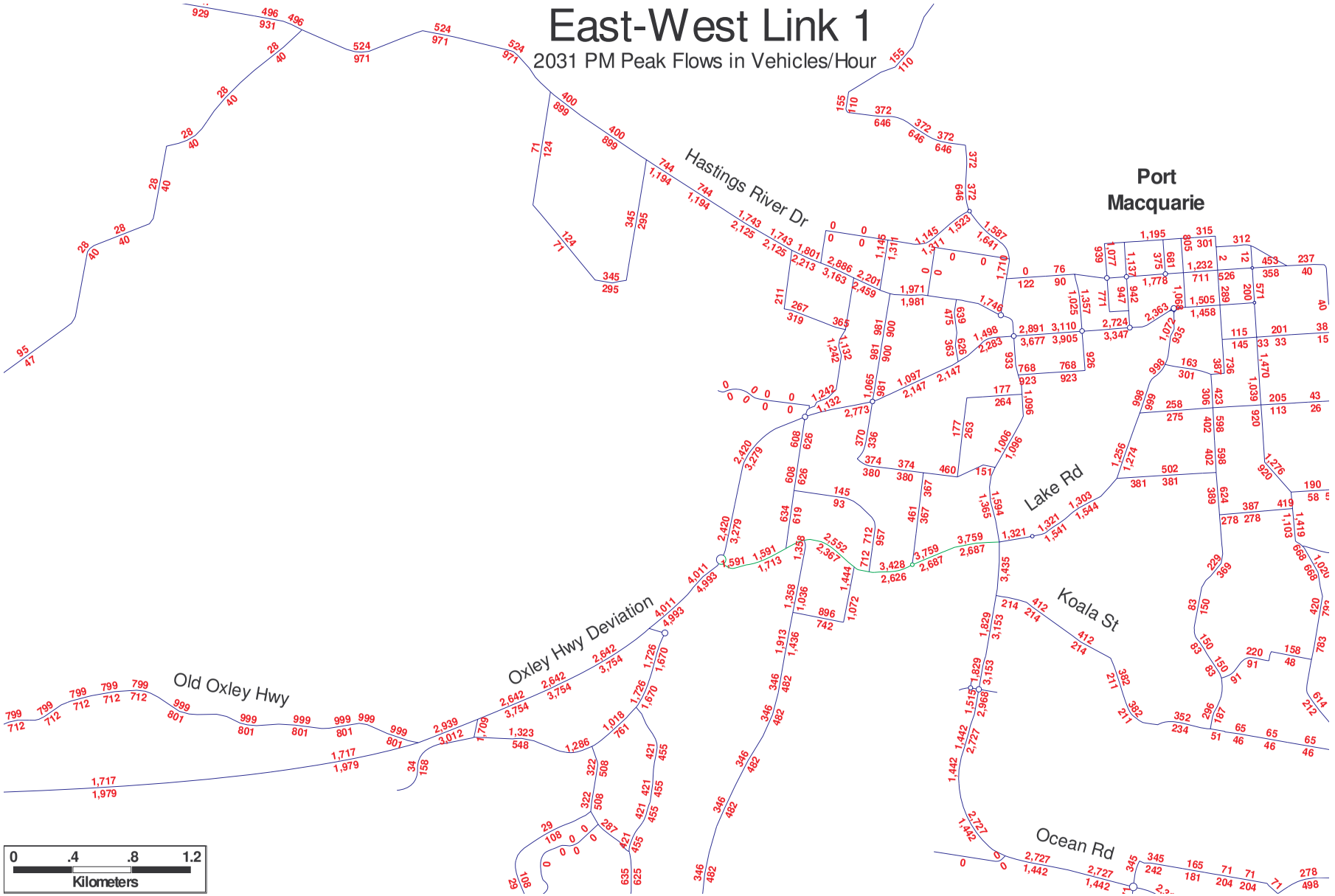
Kilometers


East-West Link 1
2031 PM Peak Flows in Vehicles/Hour
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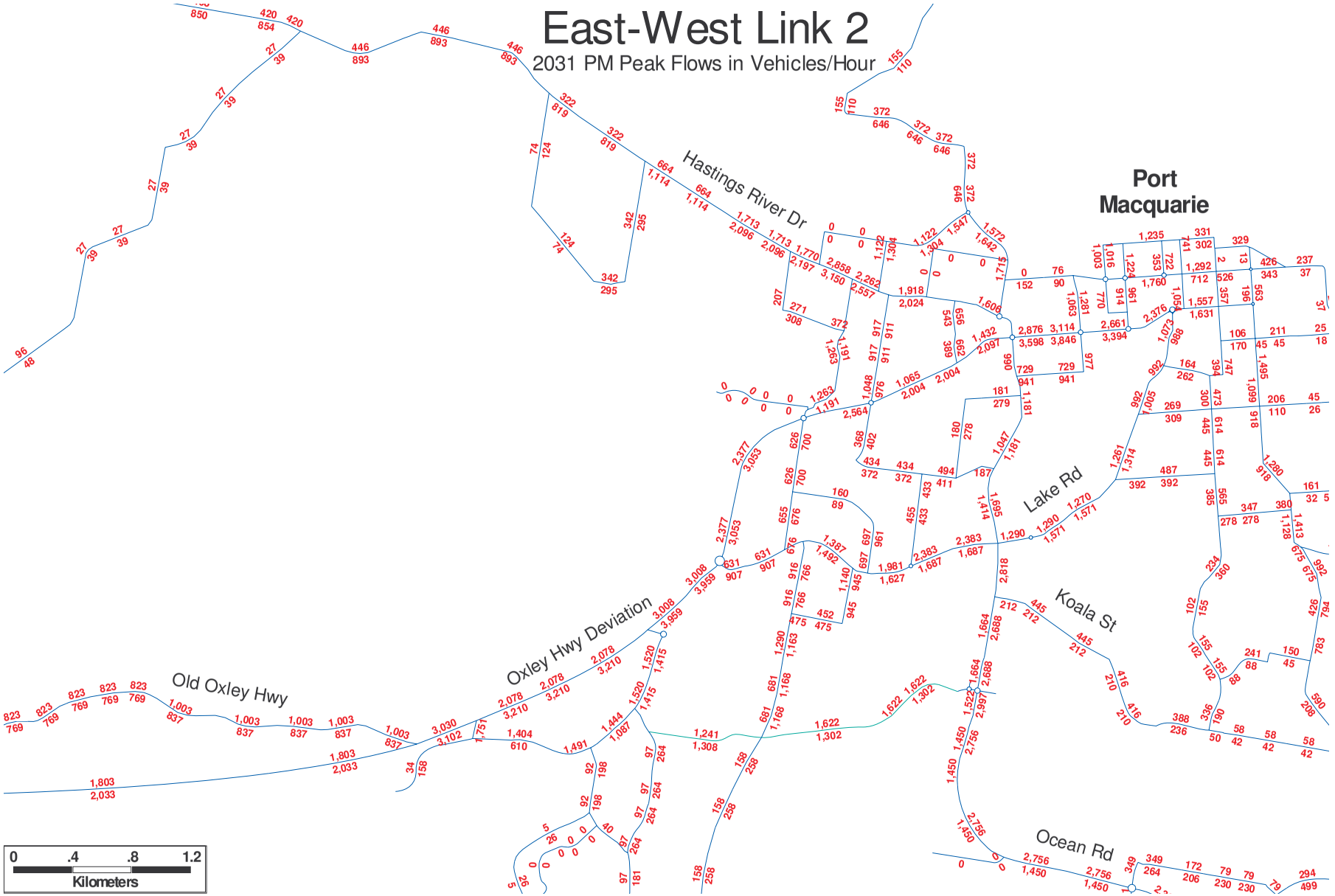
Lake Rd
Koala St
Ocean Rd
Oxley Hwy Deviation
Old Oxley Hwy
0 .4 .8 1.2
Kilometers


East-West Link 2
2031 PM Peak Flows in Vehicles/Hour
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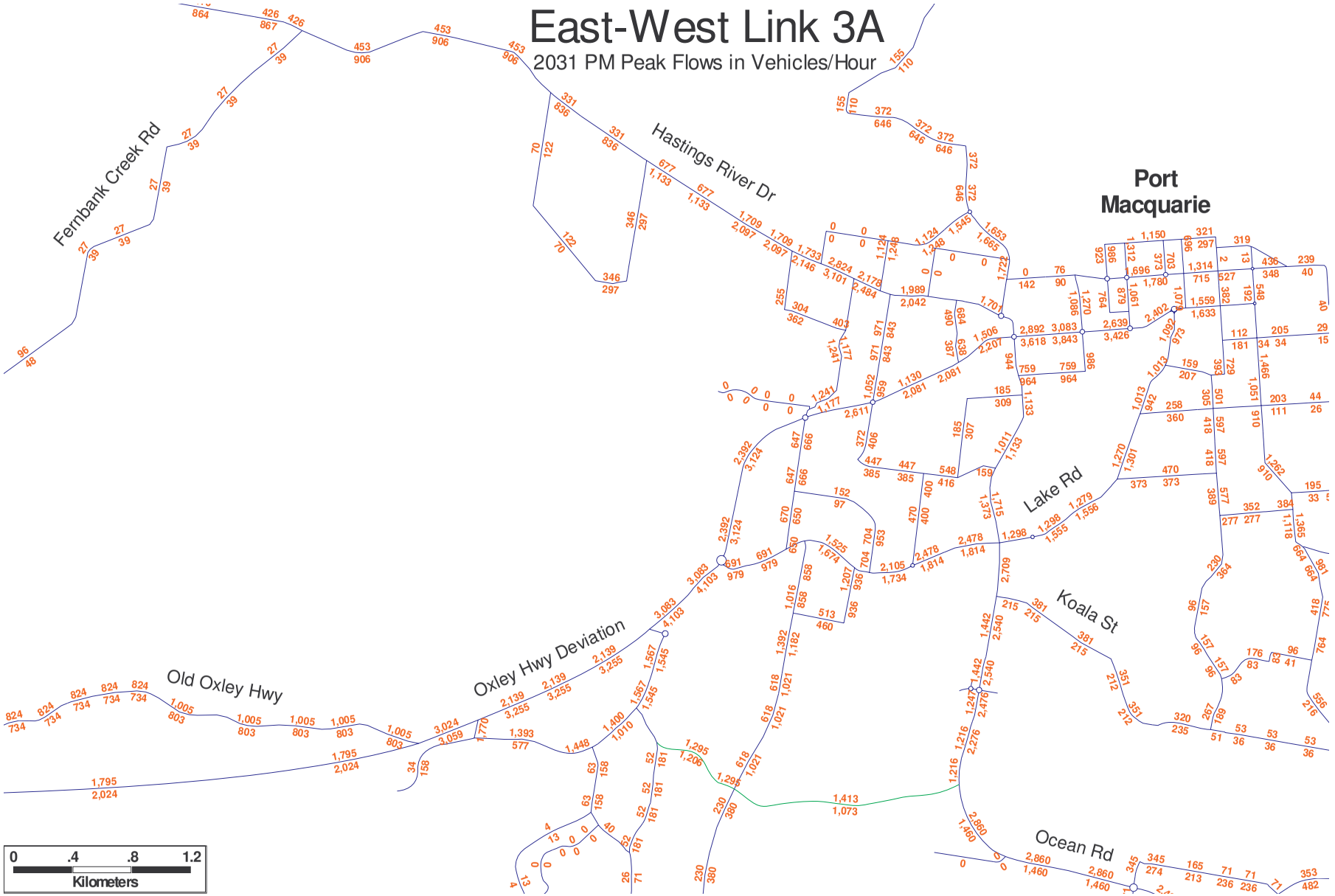
Port Macquarie
Lake Rd
Koala St
Ocean Rd
Oxley Hwy Deviation
Old Oxley Hwy
0 .4 .8 1.2
Kilometers


East-West Link 3A
2031 PM Peak Flows in Vehicles/Hour
Fernbank Creek Rd
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Port Macquarie
Lake Rd
Koala St
Ocean Rd
Old Oxley Hwy
Oxley Hwy Deviation
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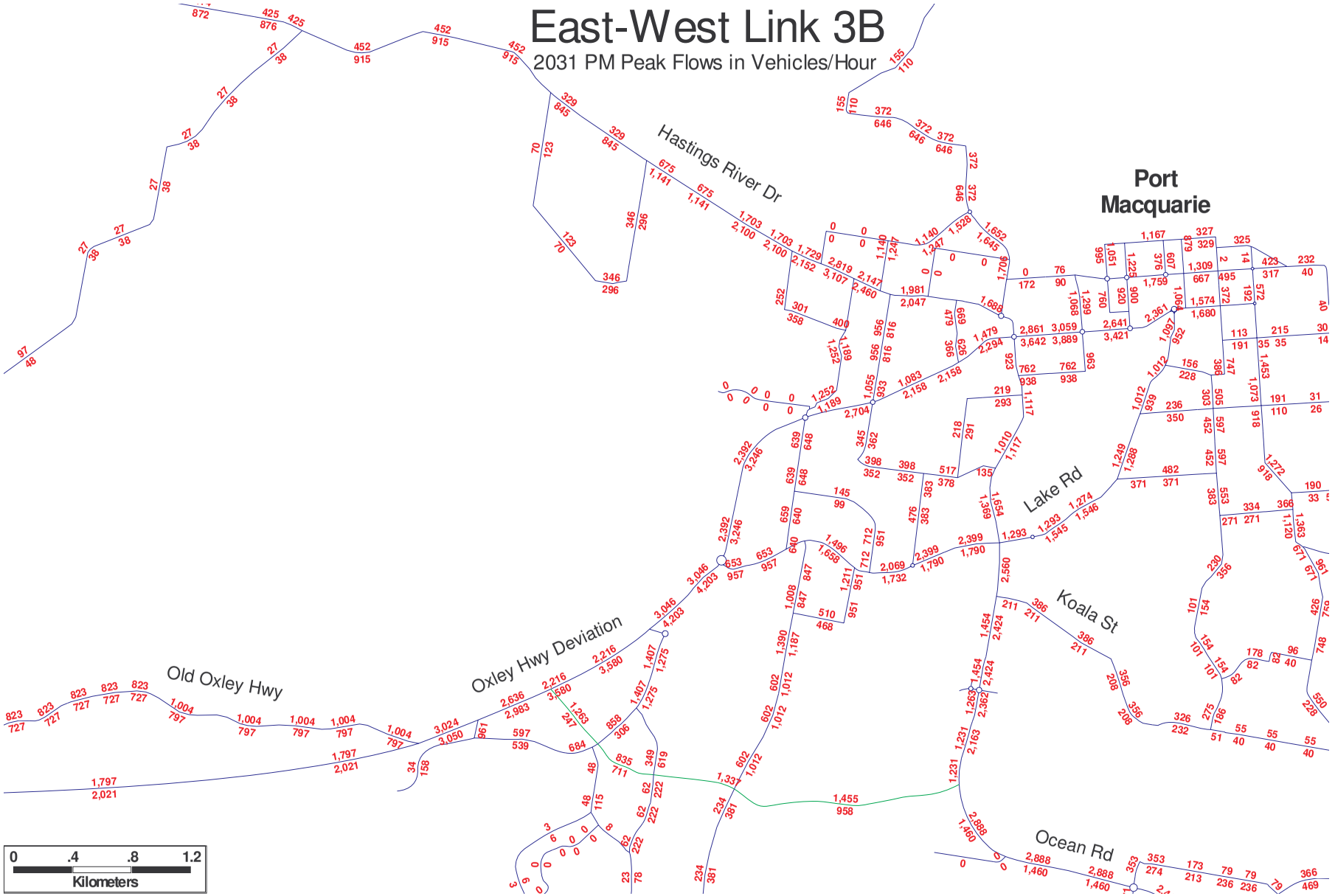
Kilometers


East-West Link 3B
2031 PM Peak Flows in Vehicles/Hour
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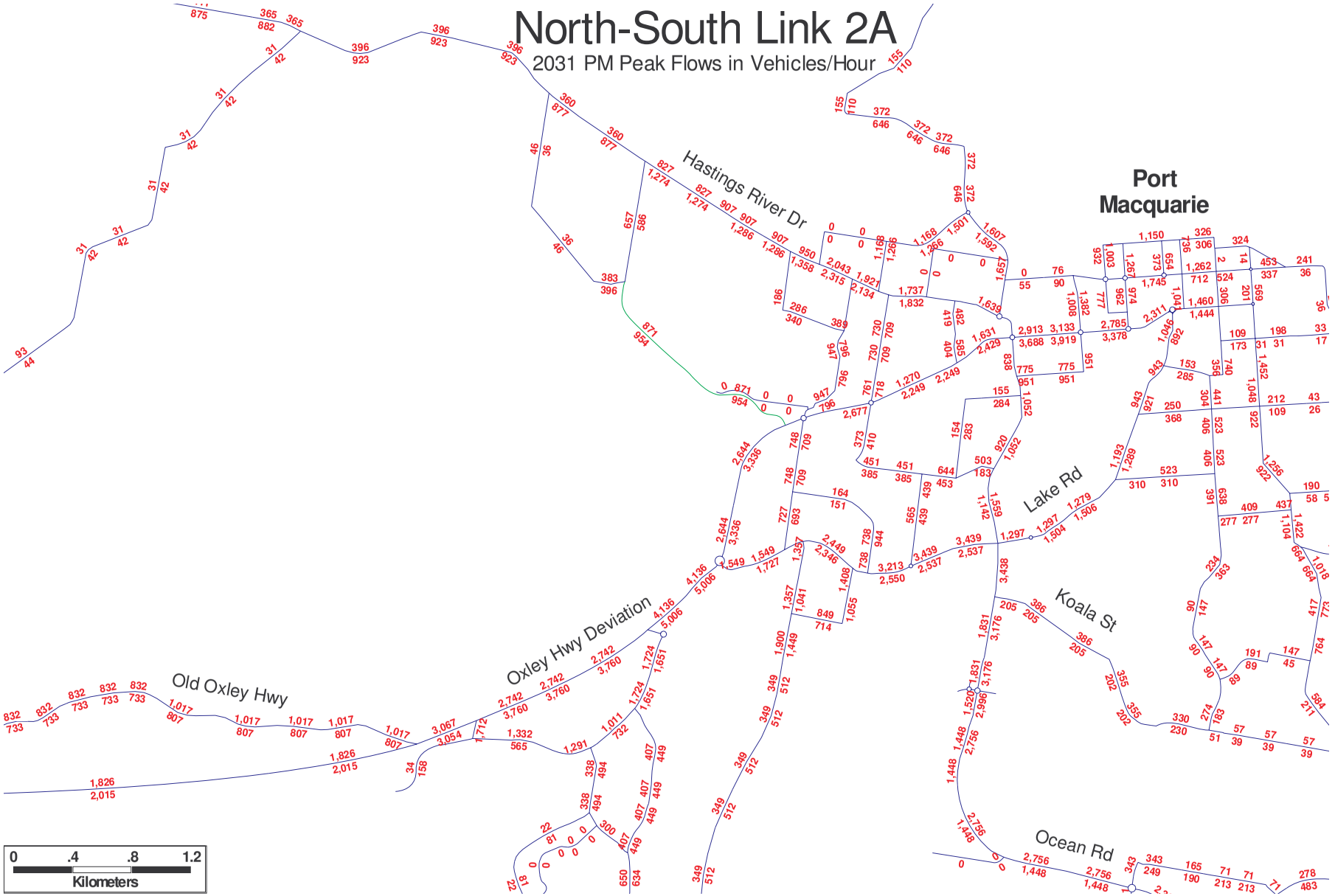
Koala St
Ocean Rd
Oxley Hwy Deviation
Old Oxley Hwy
0 .4 .8 1.2
Kilometers


North-South Link 2A
2031 PM Peak Flows in Vehicles/Hour
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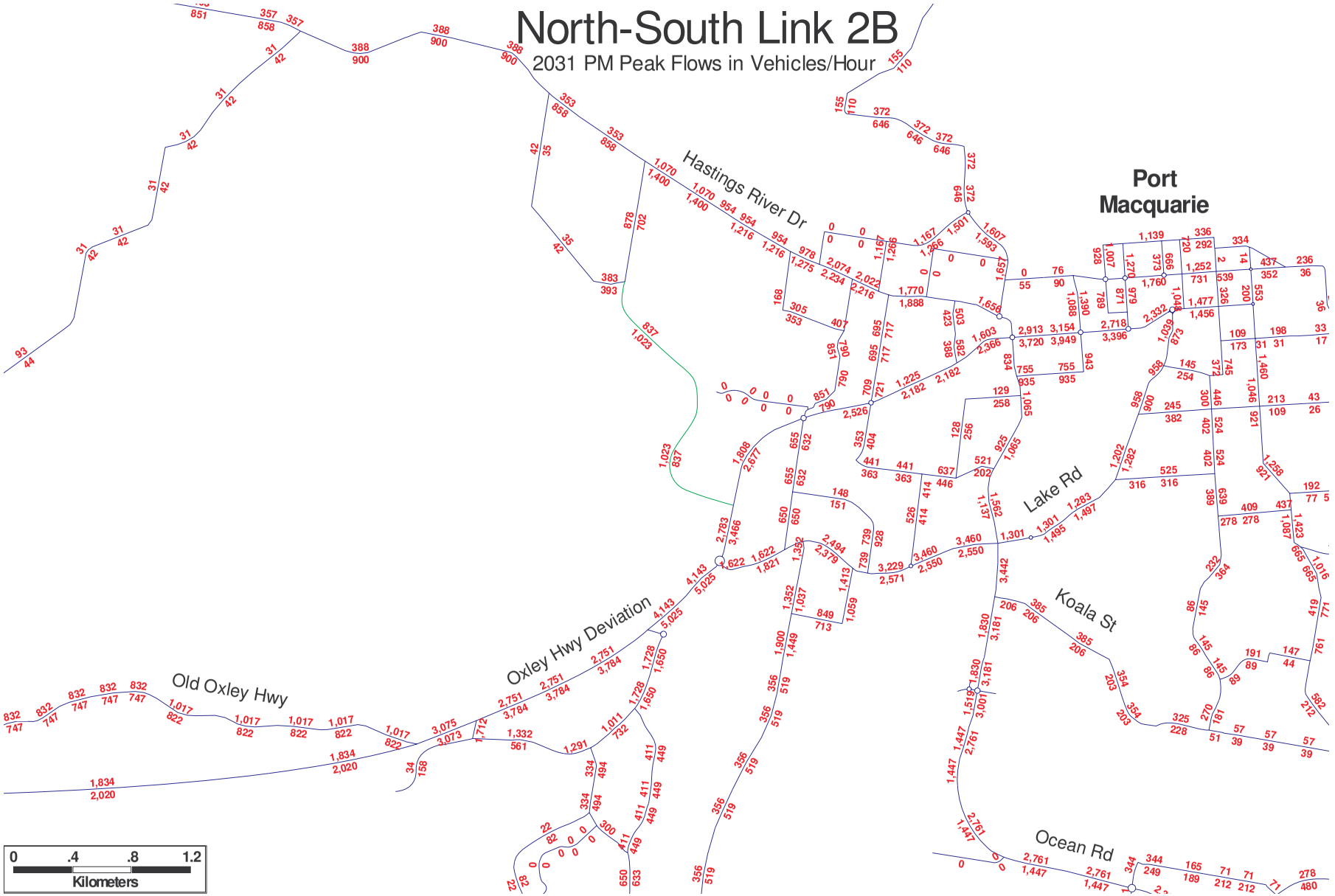
Lake Rd
Koala St
Ocean Rd
Oxley Hwy Deviation
Old Oxley Hwy
0 .4 .8 1.2
Kilometers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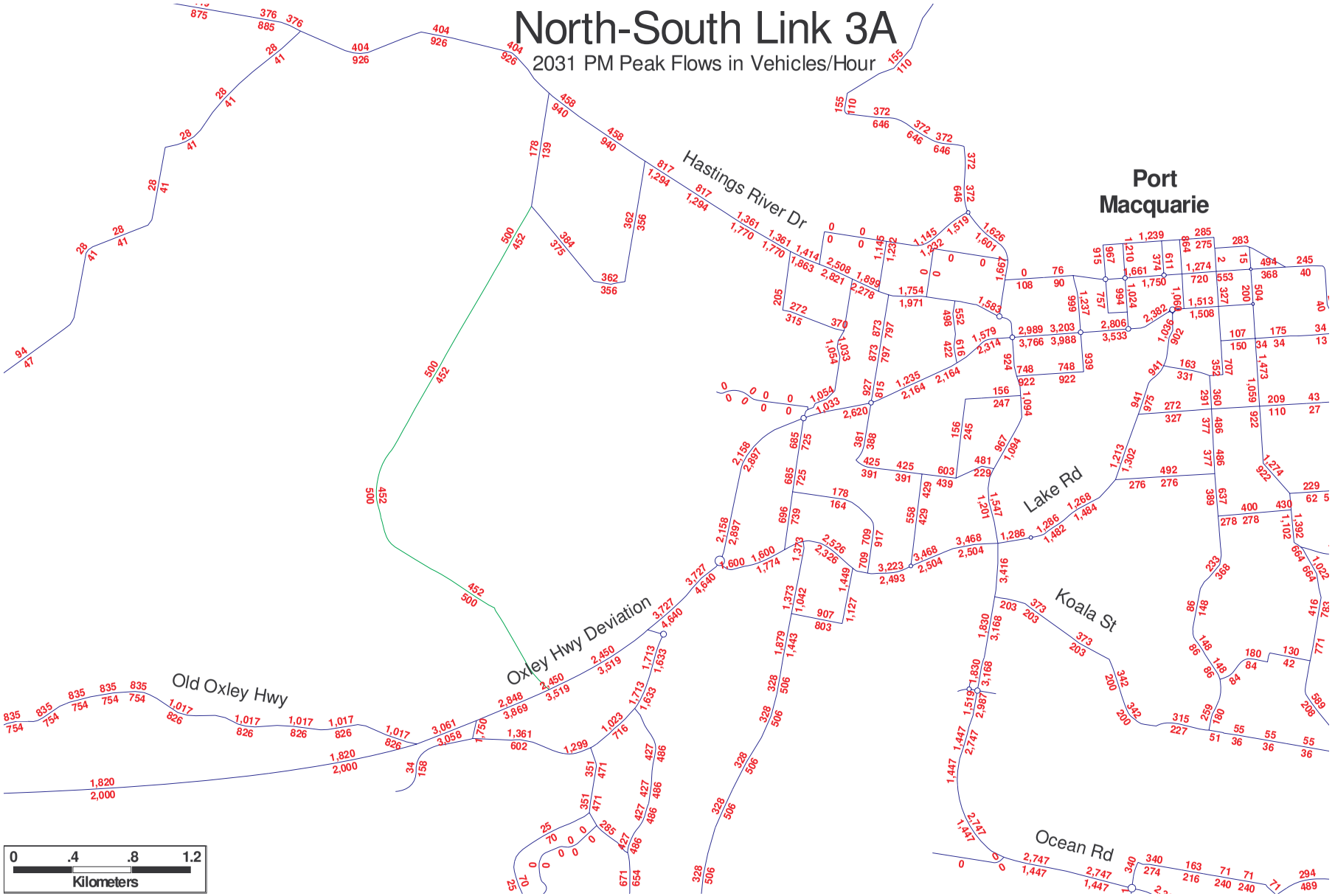
2031 PM Peak Flows in Vehicles/Hour
Hastings River Dr
Port Macquarie
Lake Rd
Koala St
Ocean Rd
Oxley Hwy Deviation
Old Oxley Hwy
0 .4 .8 1.2
Kilometers


North-South Link 3A
2031 PM Peak Flows in Vehicles/Hour
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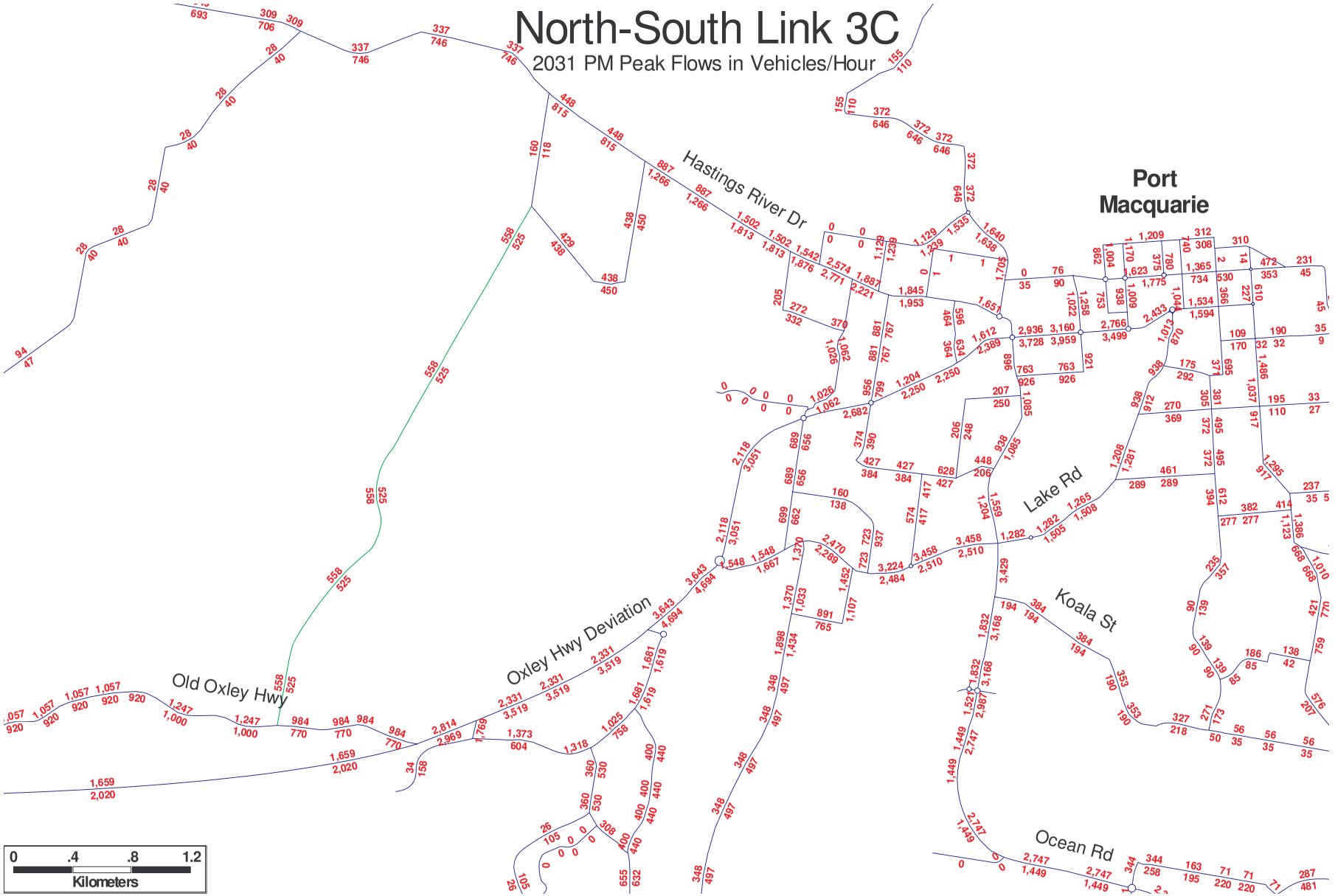
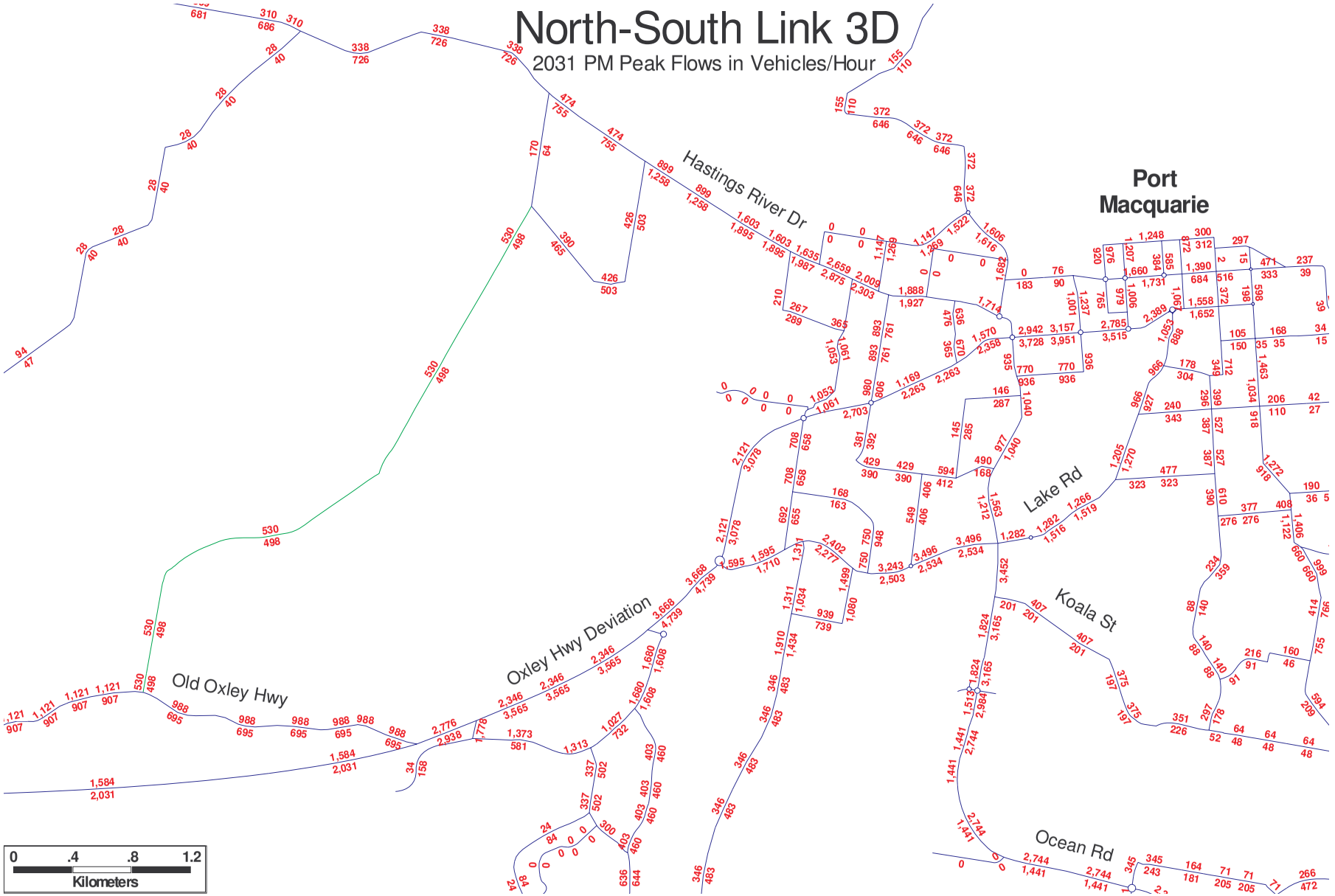
Port Macquarie
Lake Rd
Koala St
Ocean Rd
Oxley Hwy Deviation
Old Oxley Hwy
0 .4 .8 1.2
Kilometers


North-South Link 3C
2031 PM Peak Flows in Vehicles/Hour
Hastings River Dr
Port Macquarie
Lake Rd
Koala St
Ocean Rd
Old Oxley Hwy
Oxley Hwy Deviation
0 .4 .8 1.2
Kilometers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2031 PM Peak Flows in Vehicles/Hour
Hastings River Dr
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Lake Rd
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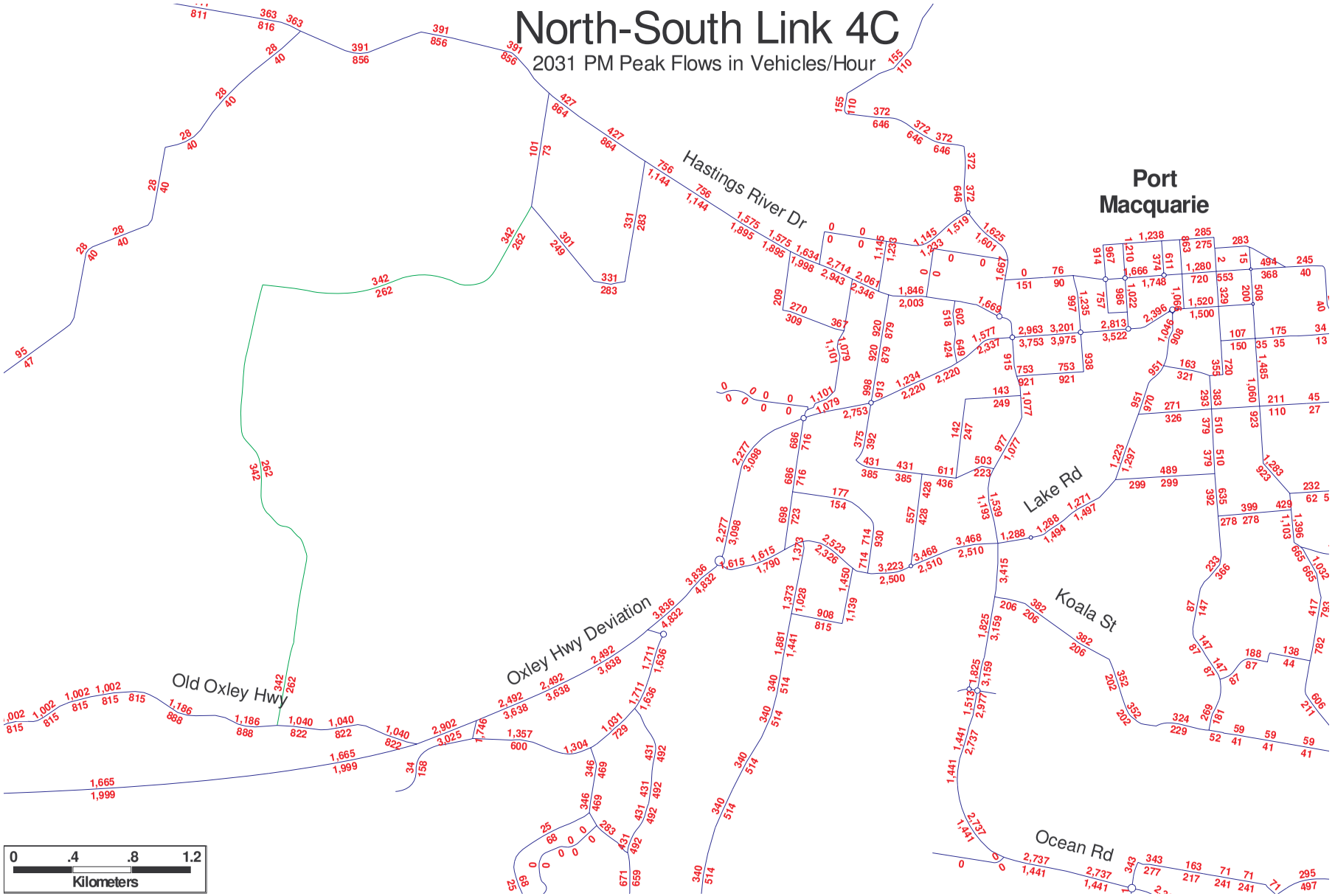
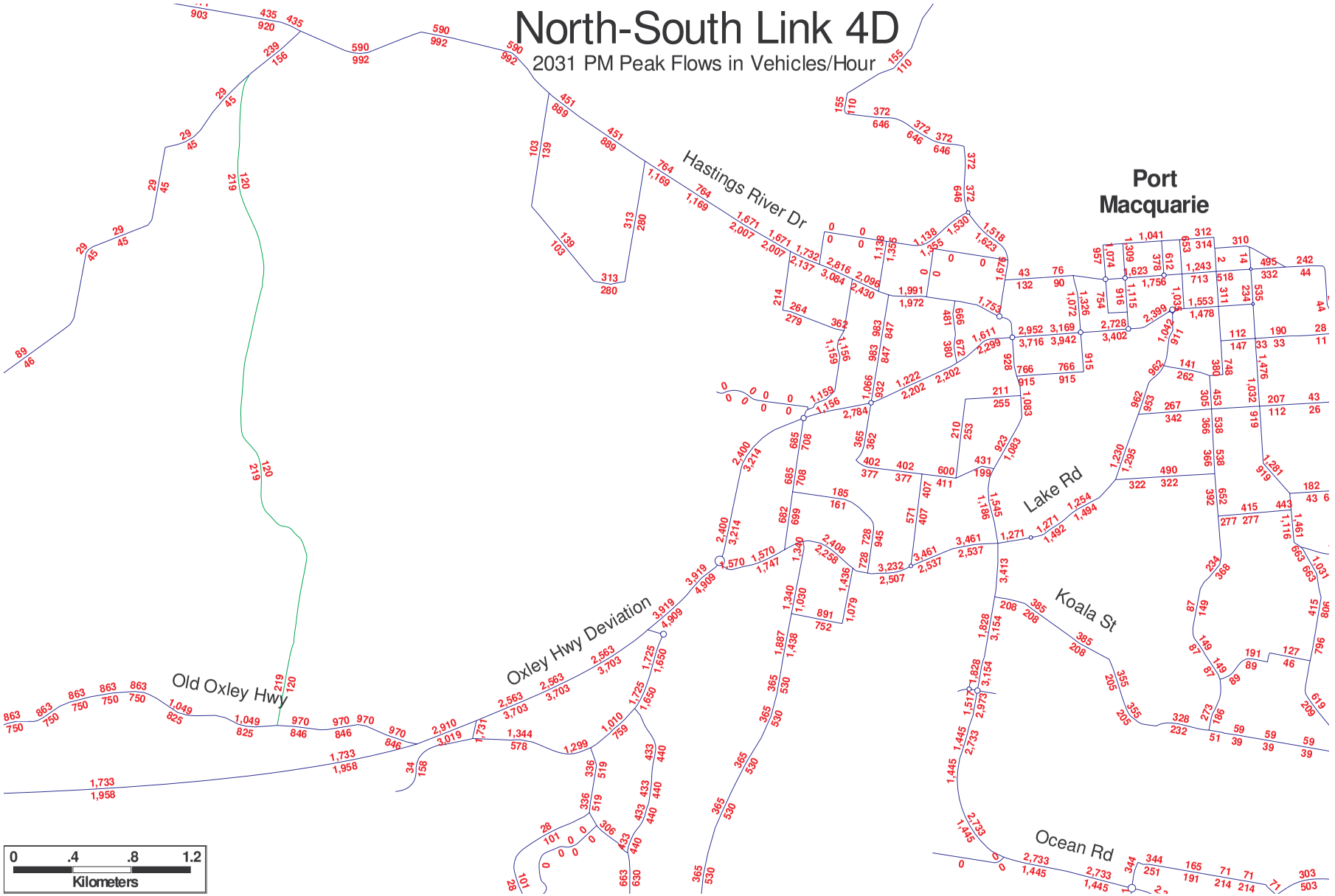
0 .4 .8 1.2
Kilometers


North-South Link 4C
2031 PM Peak Flows in Vehicles/Hour
Hastings River Dr
Port Macquarie
Lake Rd
Koala St
Ocean Rd
Oxley Hwy Deviation
Old Oxley Hwy
0 .4 .8 1.2
Kilometers


North-South Link 4D
2031 PM Peak Flows in Vehicles/Hour
Hastings River Dr
Port Macquarie
Lake Rd
Koala St
Ocean Rd
Oxley Hwy Deviation
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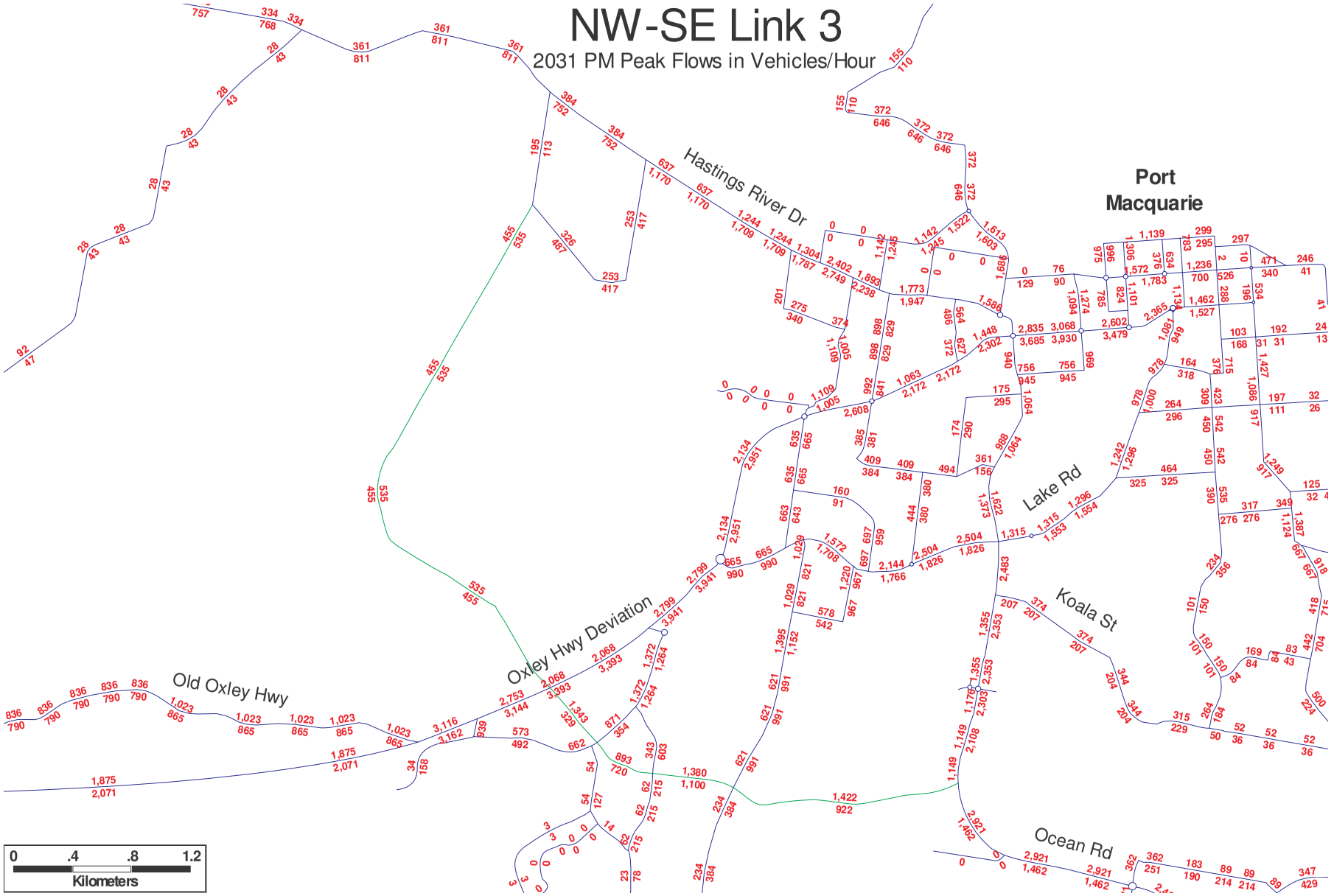
0 .4 .8 1.2
Kilometers


NW-SE Link 3
2031 PM Peak Flows in Vehicles/Hour
Hastings River Dr
Port Macquarie
Lake Rd
Oxley Hwy Deviation
Old Oxley Hwy
Koala St
Ocean Rd
0 .4 .8 1.2
Kilometers

Annex E

Road User Benefit Cost Analysis

Road User Benefit Cost Analysis

E.1 BACKGROUND

A Road User Benefit Cost Analysis (RUBCA) was utilised to compare preliminary Outer Link Road route options for further consideration. The aim of the analysis was to enable shortlisting of the preliminary options based on the degree of cost-effectiveness in terms of benefits to road users.

E.2 METHODOLOGY

E.2.1 Approach

The Road User Benefit cost analysis (RUBCA) includes consideration of the annual costs and benefits of the following parameters:

- Construction cost;
- ongoing maintenance cost;
- accident cost savings;
- vehicle operating cost savings; and
- travel time savings.

The basic calculation is a ratio of benefits divided by costs in a commensurate unit of value. These were compared to the 'do nothing' option, detailed below.

All benefits and costs were converted to year 2006 values to be consistent with 2005 values provided by the RTA plus inflation, and discounted over time using a 7% discount rate. The period of assessment was a 30-year design life.

The following elements of the BCA were utilised in this initial assessment:

- future road network scenarios in terms of travel times and travel distances for the network based on SMEC (2006);
- road construction and acquisition costs – unit rates per metre or road and land acquisition were assumed;

- maintenance costs based on RTA (1999) and other Council analyses; and
- benefits over time calculated using methodology from RTA (1999) and use of economic analysis parameters for 2005 (RTA 2006).

E.2.2 "Do Nothing Option"

The do nothing option was selected as:

- for east-west routes: the continued use of Lake Road to link Ocean Drive with the Oxley Highway. This included the full implementation of the Lake Road (West) upgrade as proposed by Port Macquarie-Hastings Council, with a four lane divided road throughout. It was assumed that all construction costs for the road upgrade would be incurred prior to the period assessed in this BCA; and
- for north-south routes: the continued use of both Clifton Drive as the primary north-south link between the Oxley Highway and Hastings River Drive for traffic generated to the west of Clifton Drive.

It was assumed maintenance activities on these roads would continue into the future.

E.2.3 Traffic Volumes

Future traffic volumes were assumed to remain consistent with strategic-level analyses for year 2021 and 2031 conditions undertaken by SMEC (2006). The traffic generation from future Area 13 development precincts was also estimated by SMEC (2006). An annual expansion factor of 1600 was used to estimate annual traffic flows from the modelled PM peak hour scenarios.

To represent increases in traffic over time, sample traffic volumes were assumed for:

- year 2021 SMEC results: period 2021 to 2030;
- year 2031 SMEC results: period 2031 to 2040; and
- linear projection of 2031 results compares to year 2021: period of 2041 to 2051.

E.2.4 Components

Components of the BCA were calculated as outlined below:

Construction and Land Acquisition

Costs were calculated using the unit rates in *Table E.1*. Estimated costs of installing road noise mitigation treatments (eg barriers, bunding) adjacent to all existing residential zones were included.

Table E.1 Unit Costs for Construction Cost and Land Acquisition: Benefit Cost Analysis

Component	Unit	Cost ($yr 2006)
Residential noise treatments	per linear metre (one side of road)	1,500
Rural land Acquisition	$/ha	100,000
Residential & Industrial Acquisition	$/ha	5,000,000
SEPP 14 wetland (wetland replacement cost)	$/ha	1,500,000
Upgrade Road	$/m	1500
New Road Build	$/m	1,500 (two lane) 3,000 (four lane)
Peired Bridge	$/m	25,000
Box Culvert	$ each	300,000
Major Intersection	$ each	500,000
Minor Intersection	$ each	300,000
Construction of New Road in Flood-prone Land and Acid Sulphate Soils	$/m	Additional 150 (two lane) 300 (four lane)
Road Upgrade in Flood-prone Land and Acid Sulphate Soils	$/m	Additional 150 (two lane) 300 (four lane)

Additional costs of construction in flood-prone land (as mapped by Port Macquarie-Hastings Council) and land with relatively high acid sulphate soil risk (classes 1 to 3) were included at the rates indicated in *Table E.1*.

Maintenance Costs

Maintenance costs were calculated per metre of road length based on a 19m road pavement, with costs over time discounted at 7% annually. Maintenance costs of the upgraded Lake Road were calculated at twice this rate due to the increased road width.

Accident Cost

Savings due to a change in accident risk were calculated based on values from the RTA economic analysis manual, as indicated in *Table E.2*.

Table E.2 ***Accident Costs for Roadway Types***

Road Type	Unit	Rate
Local/sub-arterial	$(2006)/MVKT	69,100
Arterial	$(2006)/MVKT	45,100

1. MVKT = Million vehicle kilometres travelled

Source: RTA (2006)

All values were discounted over time to year 2006 NPV.

Vehicle Operating Costs and Travel Time Savings

Vehicle operating cost and travel time savings were estimated using unit cost values from the RTA Economic Analysis Manual as indicated in *Table E.3*. The SMEC (2006) data on total network vehicle travel time was used in the analysis of each option.

Table E.3 ***Vehicle Operating Costs and Travel Time Savings***

Component	Unit	Rate
Average vehicle operating cost	$(2006)/km	0.19
Time Value per hour	$(2006)/hr	22.04

Source: based on RTA (2006)

All values were discounted over time to year 2006 NPV.

Benefits for N-S Link 1 (not modelled by SMEC) were estimated based on the average benefits per road user for Lake Road. This was estimated at

E.3 *RESULTS*

The results of the road user benefit cost analysis are summarised in

Table E.4 and *Table E.5* below.

They indicate the following:

The results indicated the following:

- East-West Routes:

- With the exceptions of E-W Links 1 and 4, all link road options exhibited a net road user benefit of over 4:1 in terms of accident risk, travel time and travel cost over the analysis period; and

- E-W Link 3A/D was the link with the highest calculated return on investment, with a BCR of 9.64, marginally higher than E-W Link 2B (9.03).

- North-South Routes:

  - six of the ten new link road options (N-S Link 1, 2B, 2C, 3A, 4A and 4B) exhibited a net road user benefit of *less than* 4:1 over the analysis period;

  - when combined with E-W link 3A, N-S Link 3A exhibited BCR of 6.9, making it potentially viable; and

  - of the North-South routes, N-S Link 3C was found to provide the most favourable BCR (7.38).

E.4 OUTCOMES

The outcomes of the preliminary BCA are:

- it is recommended that the following options be removed from further consideration based purely on failure to perform on economic grounds:

  - East-West links: E-W Link 4; and

  - North-South Links: N-S Link 1, 2C and 4A.

- East-West Link 1 represents the only option that does not cross the Lake Innes Nature Reserve, and should therefore be retained as a route option for further examination; and

- the North-South Link 3A should only be considered in conjunction with E-W Link 3B.

Table E.4 Road User BCA, East-West Outer Link Road Preliminary Route Options

Route	Construction Cost	Maintenance Costs	Accident Cost Saving *	Travel Time Savings *	Operating Cost Savings *	NPV	Benefit Cost Ratio
Base Case	0	706	0	0	0	-706	-
E-W Link1	11062	1288	-63	28583	-268	4045	2.29
E-W Link2A	69759	819	4089	303678	17272	254460	4.61
E-W Link2B	35137	841	4089	303678	17272	289060	9.03
E-W Link3A/D	31148	881	3162	292398	13357	276887	9.64
E-W Link3A/E	54508	1187	3162	292398	13357	253223	5.55
E-W Link3B/D	39495	881	4591	271719	19393	255327	7.32
E-W Link3B/E	39359	1227	4591	271719	19393	255116	7.29
E-W Link3C/D	43451	1243	4591	271719	19393	251010	6.62
E-W Link3C/E	43302	1590	4591	271719	19393	250811	6.59
E-W Link4	102894	1969	4591	271719	19393	190840	2.82

* saving over base case

Table E.5 Road User BCA, North-South Outer Link Road Preliminary Route Options

Route	Construction Cost	Maintenance Costs	Accident Cost Saving *	Travel Time Saving *	Operating Cost Saving *	NPV	Benefit Cost Ratio
Base Case	0	371	0	0	0	-371	-
N-S Link1	33179	741	-23	7106	-98	-26936	0.21
N-S Link2A	10909	554	689	56241	2913	48380	5.22
N-S Link2B	21951	659	1333	69132	5630	53486	3.37
N-S Link2C	26143	1067	458	48313	1935	23497	1.86
N-S Link3A	12300	1115	458	48313	1935	37291	3.78
N-S Link3B	11375	942	1106	68302	4671	61762	6.01
N-S Link3C	9241	802	1106	68302	4671	64036	7.38
N-S Link3D	10321	803	1061	54233	4484	48654	5.37
N-S Link4A	7501	715	-145	11513	-611	2541	1.31
N-S Link4B	9479	881	343	30941	1450	22375	3.16
N-S Link 3A+ E-W Link 3B/D	50946	1996	5055	349571	21355	323039	7.10

* saving over base case

Annex F

Multi-Criteria Assessment

Multi-Criteria Analysis

F.1 INTRODUCTION

F.1.1 Background

Multi-Criteria Analysis (MCA) is a decision-support tool used for prioritisation of alternate scenarios where there are a significant number of impacts that are not able to be incorporated into a benefit-cost analysis. Such impacts are primarily social and environmental impacts that are either impractical or impossible to value in dollar terms using information available at this point in time. This is described in economic terms as where the market price mechanism is not well-functioning, known as market failure (RTA 1999).

MCA allows for a form of multi-dimensional assessment that is unable to be achieved through traditional benefit cost analysis alone. While there is ongoing research and data collection within Australia in the field of economics to generate dollar-equivalent values for environmental externalities generated by roads (eg AUSTROADS 2003), such work is still quite general and based primarily on a simplistic average dollar-based cost per kilometre rate. Application of such costs would not incorporate local spatial variations in impacts and as such, an MCA technique was used to more accurately account for these externalities rather than the general illustrative methodology presented by AUSTROADS (2003).

In this project MCA was selected as an assessment technique to augment a traditional benefit cost analysis. The aim was to provide further information on externalities that are unable to be given a dollar value to allow a better-informed decision on which route option is preferred based on social and environmental grounds.

The process of MCA, as with all strategic economic analyses, is subject to limitations. These are described below in relation to this project.

F.1.2 Limitations of MCA

While the application of Benefit Cost Analysis has a relatively standard methodology for application in the evaluation of road projects, the use of MCA is still emerging as a technique. A comprehensive discussion of the limitations of Multi-criteria Analysis is provided by BTE (1999). These have been considered in the methodology adopted in this study, and are summarised in *Table F.1* below.

Table F.1 *Summary of Limitations of the Multi-Criteria Assessment Technique and Techniques Adopted to Address Limitations*

Limitation Identified	Addressed through
Assessment methodology: MCA does not yet have a standard approach or technique for application compared to BCA	• Use of both BCA and MCA in route shortlisting and prioritisation • Thorough description of all methodologies used, with limitations identified.
Selection of Attributes: Attributes (impacts) selected for consideration are sometimes selected based on ability to assess (i.e. data availability or other factors)	• Consideration of all known impacts that are unable to be readily included in a detailed BCA assessment. • This limitation applies to BCA methodologies also (eg obtainable dollar values).
Absolute Costs and Benefits: Some methodologies do not consider absolute value/impact	• Use of both absolute (pre-weighted) and weighted results. • This limitation also applies to application of the benefit-cost ratio as an indicator.
Double Counting: MCA can be prone to double counting between attributes (impacts), magnifying some attributes compared to others	• Aim for use of mutually-exclusive criteria only. • Also applicable to BCA. methodologies
Scoring: can lead to loss of relative magnitude of attribute (impact)	• Ratio scale technique preferred
Scoring: use of qualitative (estimated) values for attributes	• Use of key indicators relevant to each measure of impact. • Clearly outline all assumptions.
Allocation of Weightings: Values based results only	• Use of both absolute and weighted results. Clearly outline all assumptions. • Undertake sensitivity test on weightings systems to determine the effects on the analysis
Value over Time: difficult to incorporate into MCA	• Use of BCA for economic attributes. • All relevant MCA attributes uniformly valued at $2006 values, where available.

Notes:
BCA – Benefit Cost Analysis
MCA – Multi-Criteria Analysis

F.2 METHODOLOGY

F.2.1 Overall Approach

Common MCA methodologies, as applied to road projects, are outlined in the RTA's *Economic Analysis Manual* (1999). These are further discussed by BTE (1999).

The primary methodology adopted in this study is based on the Goals Achievement Matrix (GAM) method, where each impact or benefit to the

general community is allocated a rating. A weighting system is commonly applied in the GAM method, and has been adopted for use in this study to further provide information to prioritise road route options for shortlisting.

The methodology presented herein represents a revised MCA, incorporating additional components identified though initial consultation with Key Stakeholders.

The methodology adopted in this study was as follows:

1. determine a set of mutually-exclusive environmental and social criteria separate to economic and engineering parameters, considered in the BCA;

2. determine the relative impact or benefit of each Link Road route in terms of key indicators for each criterion;

3. present unweighted results in summary form;

4. determine a weighting system in conjunction with Council staff to apply a subjective set of relative values to each impact/benefit; and

5. apply weightings to the key indicators within each criterion and present results in summary .

This allows for two types of information to be considered:

- absolute impact; and
- weighted impacts based on values established by professional strategic planning staff.

F.2.2 MCA Assessment Criteria

A set of relevant key criteria was developed following a review of similar studies undertaken on major road and infrastructure projects. Environmental and social issues relevant to the study area were compiled as indicated in *Table F.2* below. Mutually exclusive criteria were developed from this list of issues.

Table F.2 ***Potential Environmental and Social Issues for Consideration in a Major Road Construction, Port Macquarie Outer Link Roads***

Environmental Issues	Social Issues
• Acid Sulphate Soils • Removal and Disturbance of Native Vegetation • Removal and Disturbance of Threatened Species Habitat • Removal and Disturbance of Threatened Species Individuals, Populations and Communities • Disruption of Flora and Fauna Movement and Propagation Corridors • Direct or Indirect Water Quality Impacts • Noise and Vibration Impacts to Flora and Fauna • Air Quality Impacts to Residences • Impacts to Flooding to Residences and Businesses • Short-term Construction Stage Impacts • Increase in Soil Erosion Risk	• Land Acquisition Impacts to Communities, including severance • Land Acquisition Impacts to Agricultural Production • Change to Road Safety Risk to Pedestrians • Pedestrian/Cyclist Access • Noise and Vibration Impacts to Residences • Air Quality Impacts to Residences • Visual Impact • Displacement of Houses • Aboriginal Heritage Impacts • Non-aboriginal Heritage Impacts • Impacts to Existing Business Operation • Access to Properties • Short-term Construction Stage Impacts • Public Transport Provision • Potential to service existing and proposed residential and commercial nodes
Note: These issues are not ordered nor mutually exclusive	

F.2.3 Key Criteria Utilised

The following mutually exclusive key criteria were adopted for use in the MCA process. Only mutually exclusive criteria can be used in the multi-criteria analysis to avoid double counting of particular parameters which may bias assessment results.

Environmental Key Criteria

Environmental Key Criteria adopted for use in the MCA focus on permanent reduction in ecological diversity and function. They are presented below in *Table F.3*.

Table F.3 ***Environmental Key Criteria Selected for Use in Preliminary Route Option Assessment***

Criteria	Factors in Consideration	Rating Range
Removal of Native Vegetation	Removal of forest, heath, swampland, fauna habitat	-10 (maximum impact) to +10 (maximum net benefit)
Disruption of Fauna Movement Corridors	Koala Movements, Fragmentation of Habitats, increasing traffic volumes in existing fauna corridors	-10 (maximum impact) to +10 (maximum net benefit)
Potential for Water Quality or wetland function impacts	Proximity to water courses, wetlands, Changes to hydrological regimes	-10 (maximum impact) to +10 (maximum net benefit)

The following environmental issues were not considered mutually exclusive from other key indicators:

- acid sulphate soils, noise impacts, air quality, soil compaction and erosion: measures to mitigate impacts of these issues are available and are included as a 'cost of mitigation' (engineering & economic analysis within the BCA); and

- impacts to biodiversity, threatened species habitats, populations and individuals is related to the conservation significance of vegetation removed/fragmentation/disturbed and disruption of corridor function.

Social Key Criteria

The key criteria selected for use as social indicators for the MCA are indicated in *Table F.4*.

Table F.4 ***Social Key Criteria Selected for Use in Preliminary Route Option Assessment***

Criteria	Factors in Consideration	Rating Range
Community Safety Risk	Increase in safety risk due to new roads adjacent to sensitive land uses.	-10 (maximum increase in safety risk) to +10 (maximum decrease of safety risk)
Property Access and Severance	Future access to property and businesses.	-10 (minimum improved access opportunities, maximum severance) to +10 (maximum benefit opportunities for access provision, minimum severance)
Visual Impact	Impacts to visual environment	-10 (maximum impact) to +10 (maximum net benefit)
Displacement of Houses and Property	Number of houses, businesses and private allotments within road reserve to be wholly or partly acquired	-10 (maximum impact) to 0 (no change)
Supports Council Adopted Planned Land Use Strategies	Existing Master Plans, proposed infrastructure and environmental conservation areas	0 (minimum compliance with strategies) to +10 (maximum compliance with strategies)
Heritage	Impacts to Aboriginal and Non-aboriginal heritage sites or artefacts	-10 (maximum potential risk of impact) to 0 (minimal risk of impact)

F.2.4 Adopted Weightings

These criteria were attributed weightings in consultation with Port Macquarie-Hastings Council staff to allow a comparison. These were provided as a percentage of the total weighting or 100% for environmental and social impacts separately.

The weightings presented *in Table F.5* were proposed for use by Council staff in consultation with ERM.

Table F.5 Proposed Weightings, Multi-criteria Analysis

Environmental		Social	
Criteria	**Wt (%)**	**Criteria**	**Wt (%)**
Removal of Native Vegetation	40	Community Safety (pedestrians, schools)	25
Disruption of Fauna Movement Corridors	40	Access	15
Potential for Water Quality or wetland function impacts	20	Visual Impact	15
		Displacement of Houses and Property	20
		Supports Planned Land Use	15
		Heritage	10
Total	**100%**	**Total**	**100%**

These weightings are not comparable between categories (i.e. environmental versus social), but provide an indication of the relative importance of each criterion in the overall consideration of impacts.

These ratings were subject to a sensitivity analysis to examine the effect of the weightings on the final results. This is further discussed below.

F.2.5 Rating Method

The method used for rating options was a scale of -10 to +10, where:

- -10 is the option with greatest negative impact to environmental or social risk;
- 0 was provided for those options with no change to risk compared to the current situation;
- +10 was attributed to the route option with most positive benefit; and
- remaining options were scaled between the values of -10 and +10, depending on their relative impacts between the minimum and maximum.

This method offers a technique to compare between route options to allow prioritisation based on non-quantifiable issues. The aim of which is to allow shortlisting of routes to a preferred option.

Rating methods of this type suffer from the following key limitations, which should be noted when interpreting results:

- the absolute level of impacts are not fully considered once ratings are applied due to a rating of -10 being applied to the worst case rating. Ratings are instead a relative indication of impacts; and

- ratings cannot account for absolute 'showstopper' impacts that may effectively remove options from consideration altogether.

F.2.6 Application of Ratings – Environmental Risk

Removal of Native Vegetation

This criterion recognises the importance of mature vegetation to environmental sustainability and the relationship to biodiversity, including threatened flora and fauna species, populations and communities.

Areas of vegetation to be impacted were estimated using vegetation mapping completed for Council by Cooper & Associates & ECOGRAPH (Draft, 1999). It was assumed that all vegetation within the road reserve would be removed or significantly disturbed as part of the road construction works.

Ratings for conservation value for vegetation in the study area were used to further refine the assessment and account for the various conservation priorities inherent in vegetation present. Ecological and conservation significance categories are based on those proposed by Cooper & Associates & ECOGRAPH (Draft, 1999). To allow these categories to be incorporated into a rating system, an ERM ecologist provided a relative weighting for different vegetation types. These are outlined below in *Table F.6*, with weightings for vegetation significance indicated.

Table F.6 ***Strategic Weightings Awarded for Vegetation Conservation Significance in the Study Area***

Category of Vegetation (Cooper & Associates & ECOGRAPH (Draft) 1999)	**Notes**	**Weighting Awarded for Strategic Analysis**
Existing Nature Reserves	Including Lake Innes Nature Reserve	2
Regional Significant Type 1	Includes large forested areas	1
Regional Significant Type 2	Includes Smaller Forested areas	0.8
Core Ecological Type 1	Habitat Value for Threatened Species or Endangered Ecological Communities	2
Core Ecological Type 2	Habitat Value for Threatened Species	1.5
Other Significant Area	Includes unmapped wetland areas	1.5
Isolated/Disturbed	Small Remnants or disturbed vegetation	0.5

Note: Vegetation Significance rating provided by ERM based on Cooper & Associates & ECOGRAPH (Draft, 1999).

It is noted that vegetation mapping does not account for some key wetland areas in the Partridge Creek Catchment not mapped as 'Coastal Wetlands' under NSW SEPP No. 14. These areas have been studied in several reports (ERM 2002a, DLWC 2002) with the presence of several threatened species reliant on the wetland and grassland habitat present in this area. An additional calculation to include such areas in the 'Other Significant Area' category was undertaken for relevant North-South links. Additional assessment is included for potential impacts relating to wetland function, as described below.

Also, there have been several listings of Endangered Ecological Communities since 2002, being consistent with swamp forest/casuarina and wetland communities. These were added to Core Ecological Type 1 where relevant.

Results

A summary of the result from the comparative analysis of effects to vegetation is provided below in *Table F.7*.

The results, after applying the strategic weightings to the vegetation removed under each option, indicated:

- E-W Link 1 is preferable for the east-west links, with links involving sub-link E posing a greater loss of more significant vegetation; and
- N-W Links 4A the most preferable, particularly when compared to those links crossing significant Partridge Creek wetland areas.

Table F.7 Comparison of Outer Link Road Preliminary Route Options: Native Vegetation Removal

Link	Sub link	NPWS	Regionally Significant Areas (ha)		Core Ecological Areas (ha)		Isolated/ Disturbed (ha)	Total Vegetation Removed (ha)	Rated Significance of Ecological Impact	Rating Awarded
			Type 1	Type 2	Type 1	Type 2				
Base Case		0						0.00	0	0.0
E-W Link1 (Upgraded)	-	0.816			0.05			0.87	1.732	-1.5
E-W Link2	E-W Link2A	1.759		1.11	0.472			3.34	5.35	-4.7
	E-W Link2B	1.759		1.8	0.472			4.03	5.902	-5.2
E-W Link3	E-W Link3A/D	1.04			0.79			1.83	3.66	-3.2
	E-W Link3A/E	1.04			4.489			5.53	11.058	-9.8
	E-W Link3B/D	1.04			0.89			1.93	3.86	-3.4
	E-W Link3B/E	1.04			4.598			5.64	11.276	-10.0
	E-W Link3C/D	1.03		0.72	0.18			1.93	2.996	-2.7
	E-W Link3C/E	1.03		0.72	3.6			5.35	9.836	-8.7
E-W Link4	-	0.07	6.13	0.67	0.64			7.51	8.086	-7.2
Base case	-	0						0.00	0	0.0
N-S Link1	-	0						0.00	0	0.0
N-S Link2	N-S Link2A	0			2.47			2.47	4.94	-5.2
	N-S Link2B	0			4.09			4.09	8.18	-8.7
	N-S Link2C	0	1.16		4.09		0.2	5.45	9.44	-10.0
N-S Link3	N-S Link3A	0	2.98	0.55	0.97	1.01		5.51	6.875	-7.3
	N-S Link3B	0	2.98	0.55	1.21	0.58		5.32	6.71	-7.1
	N-S Link3C	0	2.98		0.45	0.76		4.19	5.02	-5.3
	N-S Link3D	0	2.98		1.59	0.14		4.71	6.37	-6.7
N-S Link4	N-S Link4A	0		0.32	0.23	0.11		0.66	0.881	-0.9
	N-S Link4B	0	0.97		1.69	1.45	1.27	5.38	7.16	-7.6

F.2.7 Disruption of Fauna Movement Corridors

Methodology

A subjective analysis was undertaken to compare the potential effects of each route in terms of impacts to fauna movement corridors. It has been established that roads pose impediments to fauna movements in terms of:

- road attributed mortality (road kill) - related to traffic volumes, speed, awareness of drivers, and habitat near roadways;
- physical barriers to movement – fencing, road batters;
- physiological effects – traffic noise and headlights disrupt certain species; and
- fragmentation – some species have limited gap acceptance and will not cross significant habitat gaps.

As fragmentation of habitat has been assessed in consideration of vegetation removal, this assessment will focus on the other barriers to movement posed by a new or upgraded road.

Primary species of concern that have been recognised as present in the study area are detailed in *Table F.8*.

Table F.8 Potential Species Subject to Corridor Impacts

Species/Fauna Groups	Notes	Examples of Status
Koala	Commonly observed in the locality	Threatened Species
Possums and Larger Marsupials	A range of relatively common terrestrial and arboreal marsupial species present	Generally Common throughout
Small Marsupials and Native Rodents	Several threatened species present	Threatened Species: • Eastern Chestnut Mouse – Partridge Creek • Brush-Tailed Phascogale – Forested Areas
Nocturnal Birds Species	Several threatened species of Owl are known to be present in the locality	Threatened Species: • Eastern Grass Owl – Partridge Creek • Powerful, Barking, Masked Owl – Forested areas
Reptiles & Amphibians	Several species of threatened frog occurs throughout the area	Threatened Species: • Green & Golden Bellfrog • Green Thighed Frog • Wallum Froglet

Of particular importance in terms of corridor function is the local movements of Koalas. Ecological investigations conducted as part of the EIS for the proposed Link Road identified core koala habitat within that study area (ERM 2000). This determination was based on the presence of adult males and females, and juveniles within the study area, suggesting the occurrence of a resident breeding population. Previous surveys in the study area by NPWS (1994) also recorded the presence of koalas, providing further evidence of a resident population.

Connell Wagner (2000) mapped the location of important regional and local habitat links for koalas within the coastal area of Hastings LGA. There are several points at which preliminary routes cross such links:

- Kooloonbung Creek – a local link extends along the creek between Lake Innes and Port Macquarie CBD; and

- Partridge Creek area – Koala movement corridors north-south and east-west from the forested area immediately west of the airport are identified as local links.

These movement corridors are indicated on *Figure 19*.

It is noted that the potential impact of a new road varies according to the level of mitigation possible. This includes fauna under/overpasses, exclusion fencing and bridge structures. It was assumed that mitigation potential was limited in areas with relatively flat topography, which includes much of the study area.

The intensification of an existing road route (eg Lake Road) was assumed to have a lesser effect than the construction of a new road.

Results

The results of the subjective assessment are summarised in *Table F.9*.

Table F.9 Comparison of Outer Link Road Preliminary Route Options: Wildlife Corridor

Link	Sub link	Upgrade Road (m)	New Road (m)	Bridges (m)	Notes – including known corridors	Potential for Mitigation	Rating
Base Case		0	0	0		none	0
E-W Link1 (Upgraded)	-	2069	0	0	Interface between NR and Urban Areas	none	-2.0
E-W Link2	E-W Link2A	1000	1400	425	New Kooloonbung Creek Crossing	Bridge Over Kooloonbung Ck	-4.2
	E-W Link2B	555	1910	425	New Kooloonbung Creek Crossing	Bridge Over Kooloonbung Ck	-5.0
E-W Link3	E-W Link3A/D	494	2089	290	New Kooloonbung Creek Crossing	Bridge Over Kooloonbung Ck	-5.3
	E-W Link3A/E	362	3115	290	New Kooloonbung Creek Crossing	Bridge Over Kooloonbung Ck	-7.4
	E-W Link3B/D	244	2338	290	New Kooloonbung Creek Crossing	Bridge Over Kooloonbung Ck	-5.7
	E-W Link3B/E	112	3485	290	New Kooloonbung Creek Crossing	Bridge Over Kooloonbung Ck	-8.0
	E-W Link3C/D	427	3215	290	New Kooloonbung Creek Crossing	Bridge Over Kooloonbung Ck	-7.7
	E-W Link3C/E	295	4363	290	New Kooloonbung Creek Crossing	Bridge Over Kooloonbung Ck	-10.0
E-W Link4		2255	3516	270	New Kooloonbung Creek Crossing	Bridge Over Kooloonbung Ck	-9.6
Base case	-	0	0	0	-	-	0.0
N-S Link1		1086	0	0	Urban Areas	none	0.0
N-S Link2	N-S Link2A	1058	28	0	Crossing Binnacle Land	none	-0.9
	N-S Link2B	820	1553	500	Crossing Binnacle Land	Bridge along Oxley Highway	-4.5
	N-S Link2C	1058	1315	0	Crossing Binnacle Land	none	-0.4
N-S Link3	N-S Link3A	755	3813	0	Crosses Partridge Ck, utilises existing airport boundary	underpasses possible	-10.0
	N-S Link3B	755	4021	0	Crosses Partridge Ck, utilises existing airport boundary	underpasses possible	-10.5
	N-S Link3C	755	3281	0	Crosses Partridge Ck, utilises existing airport boundary	underpasses possible	-8.7
	N-S Link3D	755	2679	0	Crosses Partridge Ck, utilises existing airport boundary	underpasses possible	-7.2
N-S Link4	N-S Link4A	1680	1758	0	Crosses Partridge Ck (west)	underpasses possible	-5.7
	N-S Link4B	755	2683	0	Crosses Partridge Ck (west)	underpasses possible	-0.7

F.2.8 Potential for Water Quality and/or Wetland Function

Methodology

An assessment of the potential impact of a new road route through or adjacent to wetland areas was undertaken given the occurrence of significant wetland areas (Kooloonbung Creek, Partridge Creek) in the locality

In the assessment it was assumed that the potential impact to wetlands and water quality is directly related to:

- the area of disturbance of wetlands, as defined by SEPP 14 boundaries, assumed by calculating the area of road reserve of each option within these areas;
- areas of wetlands known to exist that are outside SEPP 14 wetland boundaries (eg Partridge Creek wetlands); and
- the number of creek crossings.

Results

A summary of wetland assessment results are provided in *Table F.10*.

These indicate greater potential impacts posed by those routes with greater crossing lengths over Kooloonbung Creek (East-West Links) or through Partridge Creek Areas (North-South Links.)

Table F.10 Comparison of Outer Link Road Preliminary Route Options: Potential Water Quality and Wetland Impacts

Link	Sub link	SEPP 14 Areas (ha)	Culv -erts	Other wetland Areas	Notes	Rating
Base Case		0	0		none	0
E-W Link1 (Upgraded)	-	0.00	1		Minor encroachment on Kooloonbung Creek	-1
E-W Link2	E-W Link2A	1.30	1		Bridge over Kooloonbung Creek ~425m	-10
	E-W Link2B	1.30	4		Bridge over Kooloonbung Creek ~425m	-9
E-W Link3	E-W Link3A/D	0.87	1	Dams near Greenmeadows Dr	Bridge over Kooloonbung Creek ~290m	-6
	E-W Link3A/E	4.05	1	Dams near Greenmeadows Dr	Bridge over Kooloonbung Creek ~290m	-7
	E-W Link3B/D	0.87	0	Dams near Greenmeadows Dr	Bridge over Kooloonbung Creek ~290m	-6
	E-W Link3B/E	4.05	0	Dams near Greenmeadows Dr	Bridge over Kooloonbung Creek ~290m	-7
	E-W Link3C/D	0.85	1	Dams near Greenmeadows Dr	Bridge over Kooloonbung Creek ~290m	-6
	E-W Link3C/E	4.03	1	Dams near Greenmeadows Dr	Bridge over Kooloonbung Creek ~290m	-7
E-W Link4		0.82	4		Bridge over Kooloonbung Creek ~270m	-5
Base case	-	0	0		none	0
N-S Link 1		0	0	-	Urban areas	0
N-S Link2	N-S Link2A	0.18	2	Binnacle wetland	Creek across Boundary St	-3
	N-S Link2B	0.18	2	Binnacle wetland	Creek across Boundary St	-3
	N-S Link2C	2.44	5	Binnacle wetland	Creek across Boundary St	-10
N-S Link3	N-S Link3A	0.99	3	2.3km across Sthn Partridge Ck wetlands	Creek at Tuffins Lane	-7
	N-S Link3B	1.30	4	1.2km across Sthn Partridge Ck wetlands	Creek at Tuffins Lane	-8
	N-S Link3C	0.76	3	0.6km across Sthn Partridge Ck wetlands	Creek at Tuffins Lane	-6
	N-S Link3D	1.49	2	0.6km across Sthn Partridge Ck wetlands	Creek at Tuffins Lane	-9
N-S Link4	N-S Link4A	0	2		Partridge Creek Crossing	-2
	N-S Link4B	0	4	0.6km across Sthn Partridge Ck wetlands	Two Partridge Creek Crossings, Tuffins La	-9

F.3 SOCIAL KEY CRITERIA

F.3.1 Community Safety

Methodology

In comparing between the various route options, it was considered that new roads near to larger-scale, sensitive land uses may pose increased risk to the community in terms of pedestrian and general community safety. Such land uses would include:

- **Schools,** including St Paul's Catholic, St Columba Anglican, Port Macquarie Adventist and the new approved school adjacent to Major Innes Drive,
- **residential areas,** including the areas of Greenmeadows, Sanctuary Springs, Major Innes, Kingfisher Road, Lady Nelson Drive and Sherwood Estate; and
- existing and approved **aged care facilities**.

Separation of pedestrian generating land uses was also considered, including links between residential areas and school, commercial areas and between residential areas.

Results

The results of the comparison of community safety between route options is presented in *Table F.11*.

Table F.11 Comparison of Outer Link Road Preliminary Route Options: Community Safety

Link	Sub link	Adjacent to Sensitive Land Uses	Separating pedestrian-generating Land Uses	Rating
Base Case		Oxley Highway Residential areas	Catholic School campus, Lake Road Commercial Land Use	0
E-W Link1 (Upgraded)	-	Oxley Highway Residential areas	Catholic School Campus, Lake Road Commercial Land Use	0.0
E-W Link2	E-W Link2A	Catholic School campus, Kingfisher Road and Greenmeadows (north) residential areas	Catholic School-residential areas	-7.0
	E-W Link2B	Catholic School, Greenmeadows (north) Residential area	Catholic School-residential areas	-6.0
E-W Link3	E-W Link3A/D	To rear of Anglican School, Greenmeadows Residential Area (central)	Greenmeadows Residential Area	-4.0
	E-W Link3A/E	To rear of Anglican School, Greenmeadows Residential Area (south), Adventist School	negligible impact	-6.0
	E-W Link3B/D	To rear of St Anglican School, Greenmeadows Residential Area (central)	Greenmeadows Residential Area, Innes Peninsula Residential Area, Anglican School	-7.0
	E-W Link3B/E	To rear of St Anglican School, Greenmeadows Residential Area (south), Adventist School	Innes Peninsula Proposed Residential Area, Anglican School-Innes Residential areas	-7.0
	E-W Link3C/D	Anglican School, Greenmeadows Residential Area (central)	Greenmeadows Residential Area, Anglican School-Innes Residential areas	-8.0
	E-W Link3C/E	Anglican School, Greenmeadows Residential Area (south), Adventist School	Innes Peninsula Proposed Residential Area, Anglican School-Innes Residential areas	-7.0
E-W Link4		Emerald Drive and Innes Peninsula Residential Areas, Anglican School	Emerald Drive and Innes Peninsula Residential Areas, Anglican -Innes Peninsula Residential Areas	-10.0
Base case	-	Clifton Drive & Widderson Street Residential Areas, Westport Primary	Clifton Drive & Widderson Street Residential Areas, Westport Primary-Residential Areas	0
N-S Link1		Clifton Drive Residential Area	Clifton Drive Residential Area	-10.0
N-S Link2	N-S Link2A	Lady Nelson Drive Residential Areas, Racecourse	Racecourse-Residential Areas	-5.0
	N-S Link2B	Raceview Cl Residential Areas, Racecourse	Racecourse-Residential Areas	-4.0
	N-S Link2C	Sherwood Estate Residential Areas, Racecourse	minor impact	-3.0
N-S Link3	N-S Link3A	Tuffins Lane Residential Areas, Lindfield Park Road	minor impact	-2.0
	N-S Link3B	Tuffins Lane Residential Areas	minor impact	-2.0
	N-S Link3C	Tuffins Lane Residential Areas	minor impact	-2.0
	N-S Link3D	Tuffins Lane Residential Areas	minor impact	-2.0
N-S Link4	N-S Link4A	minor impact	minor impact	-1.0
	N-S Link4B	minor impact	minor impact	-1.0

F.3.2 Access

Methodology

An assessment of impacts to access resulting from the Outer Link Road Route construction was undertaken in terms of:

- impacts to property and business access;
- disruption to existing local road access; and
- in rural areas of N-S Link options, driveways to residences.

The level of impact was related to the number of residential and commercial allotments affected, both directly and indirectly.

This assessment excluded all properties marked for potential land acquisition as a result of the particular route adoption. This reduces the number of properties directly affected by the routes significantly.

Indirect effects were noted where access intersections from the proposed arterial route to local roads would be required. This was considered to pose a reduced amenity to the future residents of such areas.

It was also assumed that:

- the Lake Road route option for east-west links would pose impacts to business access from increased traffic volumes and the construction of a divided carriageway;
- north-south road links would generally retain property accesses directly to the road in rural areas; and
- development in Area 13 and existing large allotments in residential zones would be constructed so as to avoid road frontage for new developments.

Results

An overall value for each option was awarded given the findings of key indicators summarised in *Table F.12*

Table F.12 Comparison of Outer Link Road Preliminary Route Options: Potential Access Impacts

Link	Sub link	No Residential Lots Directly Affected	No Commercial Lots Affected	No Residential Lots Indirectly Affected	Other Notes	Rating
Base Case		-	-		-	0
E-W Link1 (Upgraded)	-	1	33	57	Number of commercial a premises higher number	-3.5
E-W Link2	E-W Link2A	0	3	38	Catholic School Intersection	-1.5
	E-W Link2B	0	3	24	Catholic School Intersection	-1.0
E-W Link3	E-W Link3A/D	0	2	114+ mobile home park	Aged Care Facility Access	-6.5
	E-W Link3A/E	0	1	49	-	-2.0
	E-W Link3B/D	2	1	65+ mobile home park	Severs proposed residential area	-4.5
	E-W Link3B/E	2	1	0	Severs proposed residential area	-0.5
	E-W Link3C/D	1	2	250+ mobile home park	Anglican School Access	-10.0
	E-W Link3C/E	1	2	0	-	-0.5
E-W Link4		0	1	approx 500	Anglican School Access	-10.0
Base case	-	-	-		-	0
N-S Link1		-	5	74+	road alterations, Clifton Area reduced carparking area, racecourse	-10.0
N-S Link2	N-S Link2A	5	12	0	Racecourse Access	-3.0
	N-S Link2B	5	12	0	-	-2.5
	N-S Link2C	5	12	0	-	-2.0
N-S Link3	N-S Link3A	8	2	0	-	-1.5
	N-S Link3B	5	2	0	-	-1.0
	N-S Link3C	5	2	0	-	-1.0
	N-S Link3D	5	2	0	-	-1.0
N-S Link4	N-S Link4A	2	0	0	-	-0.5
	N-S Link4B	5	2	-	-	-1.0

It was found that the greatest access impacts for East-West link options were likely to occur along those options through the Greenmeadows Drive area. For North-South links, Route 2A was found to pose the greatest potential access disruption, primarily due to effects on the racecourse.

F.3.3 Visual Impact

Methodology

Impacts to visual environment posed by each option were assessed and compared. The assessment of visual significance of areas potentially affected by potential route options is relevant to:

- the proximity and density of sensitive viewpoints to the route; and
- the level and type of change to the visual environment.

Sensitive viewpoints can be regarded as locations from which people view a given site that forms a visually significant element to the existing landscape character. These locations typically include roads, houses, tourist destinations, and beaches, parks and other areas frequented by the public.

It is noted that both new roads and road upgrades would be subject to landscaping and incorporation of vegetation screens to other development where possible.

Results

Results of the comparison between route options is summarised in *Table F.13*.

In terms of visual impact, E-W Link Routes incorporating sub-links 3C and 3E were rated as the highest impact, and the Lake Road upgrade with the minimum impact. For N-S Links, those routes closer to residential areas and the racecourse were rated at higher impact than those through rural areas.

Table F.13 Comparison of Outer Link Road Preliminary Route Options: Visual Assessment

Link	Sub link	Sensitive viewpoints	Impact Type	Impact Level	Rating
Base Case					
E-W Link1 (Upgraded)	-	none	Road Intensification	Low	-2
E-W Link2	E-W Link2A	Greenmeadows Drive & Kingfisher Rd Residential Areas;	Road Intensification & New Road	Med-Low	-4
	E-W Link2B	Greenmeadows Drive Residential Areas;	Road Intensification & New Road	Med-Low	-3
E-W Link3	E-W Link3A/D	Greenmeadows Drive Residential Areas, Anglican School;	Road Intensification & New Road	Medium	-5
	E-W Link3A/E	Greenmeadows Residential Village and Residential Areas, Anglican School;	Primarily New Road	High	-8
	E-W Link3B/D	Greenmeadows Drive Residential Areas, Anglican School;	Road Intensification & New Road	Medium	-5
	E-W Link3B/E	Greenmeadows Village and Residential Areas, Anglican School;	Primarily New Road	High	-8
	E-W Link3C/D	Innes Peninsula and Greenmeadows Residential Areas, Anglican School;	Primarily New Road	Very High	-9
	E-W Link3C/E	Innes Peninsula and Greenmeadows Village and Residential Areas, Anglican School;	Primarily New Road	Very high	-10
	E-W Link4	Emerald Drive and Innes Peninsula Residential Areas	Road Intensification & New Road	Very High	-10
Base case	-	-	none		0
N-S Link1		Clifton Residential Areas	Road Intensification	Medium	-5
N-S Link2	N-S Link2A	Racecourse, Clifton Residential Areas	Primarily New Road	High	-8
	N-S Link2B	Racecourse, Sherwood Estate Residences	Primarily New Road	Very High	-9
	N-S Link2C	Racecourse, Sherwood Estate Residences	Primarily New Road	High	-10
N-S Link3	N-S Link3A	Lindfield Park Road	Primarily New Road	High	-8
	N-S Link3B	Area 13	Primarily New Road	Medium	-5
	N-S Link3C	Area 13	Primarily New Road	Medium	-5
	N-S Link3D	Area 13	Primarily New Road	Medium	-6
N-S Link4	N-S Link4A	Area 13, Fernbank Creek Road	Road Intensification & New Road	Medium-Low	-3
	N-S Link4B	Area 13, Fernbank Creek Road	Primarily New Road	Med-High	-7

F.3.4 Displacement of Houses and Property

Methodology

It is recognised that the acquisition of land for a road route may pose social impacts in terms of displacement of residents and severance of properties. It is these two parameters that were used in the assessment of this criterion.

Results

The results of the assessment are provided in *Table F.14*.

Table F.14 Comparison of Outer Link Road Preliminary Route Options: Potential Displacement of Houses and Property Impacts

Link	Sub link	Acquisition		Partially Affected		Other Notes	Rating
		Residences	Commercial & Civic Properties	Residences	Commercial & Civic Properties		
Base Case		0	0				
E-W Link1 (Upgraded)	-	0	0	0	13	various commercial properties affected	-1
E-W Link2	E-W Link2A	34	1	1	2	Kingfisher Road Residences	-7
	E-W Link2B	14	1	1	2		-4
E-W Link3	E-W Link3A/D	13	1	3	2	Some loss of primary production	-4
	E-W Link3A/E	1* (see note)	1	3	1	Impacts to residential village, Some loss of primary production	-2
	E-W Link3B/D	13	2	3	1	Impact to approved School Site, some loss of primary production	-3
	E-W Link3B/E	1* (plus residential village)	1	3	1	Impact to approved School Site plus residential village	-2
	E-W Link3C/D	13	1	11	1	Impact to School Site, Golf Course, some loss of primary production	-3
	E-W Link3C/E	1* (plus residential village)	1	7	1	Impact to School Site, Golf Course, residential village	-2
E-W Link4		90	0	16	3		-10
Base case	-	0					0
N-S Link1		58	0	0	5		-10
N-S Link2	N-S Link2A	9	0	3	9		-6
	N-S Link2B	0	0	3	9		-1
	N-S Liunk2C	0	0	3	9	Potential impacts to mobile home village	-1
N-S Link3	N-S Link3A	4	0	3	3		-3
	N-S	2	0	3	2		-2

Link	Sub link	Acquisition		Partially Affected		Other Notes	Rating
	Link3B N-S Link3C	2	0	3	2		-2
	Link3D N-S Link3D	2	0	3	2		-2
N-S Link4	Link4A N-S Link4A	0	0	2	2		-1
	Link4B N-S Link4B	0	0	3	2		-1

Taking into consideration the impact to current properties, the E-W-link 2A (Kingfisher Road) would displace the most number of dwellings. Of north-south links, N-S Link 2A (via Lady Nelson Drive) was found to have the greatest potential impact in this criterion.

F.3.5 Supports Planned Land Use

Methodology

Lands occupied by proposed routes are subject to various land use strategies used by Council. The plans that apply at the time of writing this document are:

- SMEC Hastings Roads and Traffic Study 2001;
- *Hastings LEP 2001*;
- Port Macquarie Airport Master Plan and further planning;
- Area 13 Master Plan;
- DCP 27 - Airport Lands: The Binnacle Project; and
- DCP 45 – Innes Peninsula.

Routes were assessed on their compliance (from 0 to 10), indicating potential benefits of the routes in achieving strategic planning outcomes.

Results

The relevant assessment results are indicated in *Table F.15*.

Table F.15 Comparison of Outer Link Road Preliminary Route Options: Consistency with Existing Planning Strategies and Documents

Link	Sub link	Compliance with Strategic Planning	Value Awarded
Base Case			
E-W Link1 (Upgraded)	-	None, Does not provide Outer Link Road (as per SMEC), would provide traffic relief	1
E-W Link2	E-W Link2A	Allows 'Outer Link' Road (different location) and Jindalee Road extension. Does not allow for Kingfisher Road residential land use	4
	E-W Link2B	Allows 'Outer Link' Road (different location) and Jindalee Road extension.	5
E-W Link3	E-W Link3A/D	Allows 'Outer Link' Road (Innes Peninsula DCP).	10
	E-W Link3A/E	Allows 'Outer Link' Road (Innes Peninsula DCP), winding alignment	9
	E-W Link3B/D	Allows 'Outer Link' Road (SMEC), Not in accordance with Innes DCP	6
	E-W Link3B/E	Allows 'Outer Link' Road (SMEC), winding alignment, Not in accordance with Innes DCP	5
	E-W Link3C/D	Allows 'Outer Link' Road (SMEC), Not in accordance with Innes DCP	4
	E-W Link3C/E	Allows 'Outer Link' Road (SMEC), Not in accordance with Innes DCP, winding alignment	3
E-W Link4		Allows 'Outer Link' Road (SMEC), Not in accordance with Innes DCP, winding alignment	2
Base case	-	none	0
N-S Link1		none	1
N-S Link2	N-S Link2A	Could link to airport expansion, Not linked directly to E-W link	3
	N-S Link2B	Could link to airport expansion, Not linked directly to E-W link	3
	N-S Link2C	Could link to airport expansion, Allows 'Outer Link' Road (SMEC)	8
N-S Link3	N-S Link3A	Allows 'Outer Link' Road (SMEC), Potential conflict with Airport and Rifle Range	4
	N-S Link3B	Provides for Area 13, Potential conflict with Airport and Rifle Range	4
	N-S Link3C	Provides for Area 13, Potential conflict with Airport and Rifle Range	4
	N-S Link3D	Provides for Area 13, Potential conflict with Airport and Rifle Range	4
N-S Link4	N-S Link4A	Provides for Area 13 (indirect), Proposed Sancrox Industrial Area, Proposed Sporting fields	10
	N-S Link4B	Provides for Area 13 (indirect), Proposed Sporting fields	8

F.3.6 Heritage

Methodology

Previous heritage investigations and predictive models developed for Area 13 by Collins (1995) were used to compare the potential for heritage impacts posed by each route.

Sites and items of aboriginal heritage significance are present throughout the Partridge Creek area. Predictive modelling indicated the potential for sites across the floodplain and in areas where disturbance due to urban development, fruit cultivation, grazing and complete vegetation clearance had not occurred.

It is noted that as part of the approval process for any new road construction or road upgrade that an assessment of heritage significance is required under the *National Parks & Wildlife Act 1974*. The comparison between routes is only to gauge the comparative risk of heritage impacts to areas which may or may not occur along a particular route.

It was considered that the risk of disturbance to heritage sites and artefacts is related to several key indicators:

- area of road reserve in undisturbed areas;
- area of vegetation removal required; and
- traversing known areas of heritage significance.

It was assumed no non-aboriginal heritage impacts are likely from any of the routes under consideration given:

- no known heritage items are located near the proposed routes: and
- existing residences potentially affected by the routes were constructed within the last 50 years, representing negligible potential for heritage values.

Results

A comparison of the potential risk of impacts sites or items of heritage significance is provided in *Table F.16*.

The E-W Link 3C/E and E-W Link B/E were determined to pose the greatest risk to heritage of the east-west links. Of north-south routes, several links through the Partridge Creek area posed the greatest risk.

Table F.16 Comparison of Outer Link Road Preliminary Route Options: Potential for Aboriginal Heritage Impacts

Link	Sub link	Length of new road	Area of Vegetation to be Removed (ha)	Other Notes	Rating
Base Case		0	0.00		0
E-W Link1 (Upgraded)	-	0	0.87		-1
E-W Link2	E-W Link2A	1400	3.34	Impacts to Kooloonbung Creek	-4.5
	E-W Link2B	1910	4.03	Impacts to Kooloonbung Creek	-5.5
E-W Link3	E-W Link3A/D	2089	1.83	Impacts to Kooloonbung Creek	-3.5
	E-W Link3A/E	3115	5.53	Impacts to Kooloonbung Creek	-8
	E-W Link3B/D	2338	1.93	Impacts to Kooloonbung Creek	-4
	E-W Link3B/E	3485	5.64	Impacts to Kooloonbung Creek	-8
	E-W Link3C/D	3215	1.93	Impacts to Kooloonbung Creek	-4.5
	E-W Link3C/E	4363	5.35	Impacts to Kooloonbung Creek	-9
E-W Link4		3516	7.51	Impacts to Kooloonbung Creek	-10
Base case	-	0	0.00		0
N-S Link1		1086	0.00		-1
N-S Link2	N-S Link2A	2373	2.47		-4
	N-S Link2B	2821	4.09		-4.5
N-S Link3	N-S Link3A	4568	5.51	Partridge Creek Areas	-10
	N-S Link3B	4776	5.32	Partridge Creek Areas	-9.5
	N-S Link3C	4036	4.19	Partridge Creek Areas	-9
	N-S Link3D	3434	4.71	Partridge Creek Areas	-1.6
N-S Link4	N-S Link4A	3438	0.66	Partridge Creek Areas	-2
	N-S Link4B	3062	5.68	Partridge Creek Areas	-8.6

F.4 OVERALL RESULTS

Results from each criterion were compiled to form separate matrices for environmental and social parameters. The results are indicated below.

F.4.1 *Summary of Environmental Impacts*

The following table (*Table F.17*) summarises the overall ratings and the weighted value awarded to each impact as a result of the analyses described above.

Table F.17 Overall Results, Comparison of Environmental Assessment Criteria

Link	Sub link	Removal of Native Vegetation	Disruption of Fauna Movement Corridors	Potential for Water Quality or wetland function impacts	Weighted Rating
	Weighting:	**0.4**	**0.4**	**0.2**	
Base Case		0	0.0	0	**0.0**
E-W Link1 (Upgraded)	-	**-1.5**	**-2.0**	**-1**	**-1.6**
E-W Link2	E-W Link2A	-4.7	-4.2	-10	**-5.6**
	E-W Link2B	-5.2	-5.0	-9	**-5.9**
E-W Link3	E-W Link3A/D	-3.2	-5.3	-6	**-4.6**
	E-W Link3A/E	-9.8	-7.4	-7	**-8.3**
	E-W Link3B/D	-3.4	-5.7	-6	**-4.8**
	E-W Link3B/E	-10.0	-8.0	-7	**-8.6**
	E-W Link3C/D	-2.7	-7.7	-6	**-5.3**
	E-W Link3C/E	-8.7	-10.0	-7	**-8.9**
E-W Link 4		-7.2	-9.6	-5	**-7.7**
Base case	-	0.0	0.0	0	**0.0**
N-S Link1		**0.0**	**0.0**	**0**	**0.0**
N-S Link2	N-S Link2A	-5.2	-0.9	-3	**-3.1**
	N-S Link2B	-8.7	-4.5	-3	**-5.9**
	N-S Link2C	-10.0	-0.4	-10	**-6.2**
N-S Link3	N-S Link3A	-7.3	-10.0	-7	**-8.3**
	N-S Link3B	-7.1	-10.5	-8	**-8.6**
	N-S Link3C	-5.3	-8.7	-6	**-6.8**
	N-S Link3D	-6.7	-7.2	-9	**-7.4**
N-S Link4	N-S Link4A	-0.9	-5.7	-2	**-3.1**
	N-S Link4B	-7.6	-0.7	-9	**-5.1**

Note: Orange Cells indicate most preferred options

The assessment of potential environmental impacts indicated the following:

- for East-West Links:
  - upgrading Lake Road (E-W Link1) provided the least environmental impacts (overall rating -1.6), being preferred across all three environmental criterion;

- E-W Link3A/D produced the next best rating (-4.6), with Link 3 posing the second preferred crossing points of Kooloonbung Creek given the existing disturbance to the creek posed by the utility services easement; and

- Routes involving Sublink 'E' of E-W Link 3 posed the greatest environmental impacts.

- For North-South Links:

  - N-S Link 1 was preferable overall and in terms of all environmental criterion;

  - N-S Link 2A and 4A were ranked equal overall in terms of preference; and

  - Route based on N-S Link 3 (west of the airport) posed the greatest environmental impacts.

F.4.2 Summary of Social Impacts

The following table (*Table F.18*) indicates the value awarded to each impact as a result of the analyses described above.

The assessment of potential social impacts indicated the following:

- for East-West Links:

  - upgrading Lake Road provided the most reduced social impacts in terms of community safety, visual impacts and heritage. It also was preferred overall (rated -2.4) compared to the other route options;

  - the second most preferred route was the E-W Link 3A/D, rated at -3.0; and

  - E-W link 3C/D posed the greatest level of social impact (-7.0).

- For North-South Links:

  - N-S Link 4A poses little potential social impacts (rated 0.1), being preferred over five of the six social criteria and overall;

  - generally western routes through rural land (N-S Links 3 and 4) posed limited potential for social impacts as they generally avoided residences, although with some potential risk to heritage;

N-S Link 1 posed the greatest potential social impacts due to impacts top Clifton Drive. N-S Link 2A posed the secondmost greatest social impacts due to proximity to Lady Nelson Drive and the Racecourse.

Table F.18 Overall Results, Comparison of Social Assessment Criteria

Link	Sub link	Comm-unity Safety	Access	Visual Impact	Displace-ment of Houses and Property	Supports Planned Land Use	Heritage	Total
	Weighting	**0.25**	**0.15**	**0.15**	**0.2**	**0.15**	**0.1**	
Base Case		0	0	0	0	0	0	0.0
E-W Link1	-	**0**	-3.5	**-2**	-1	1	**-1**	**-1.0**
E-W Link2	E-W Link2A	-7	-1.5	-4	-7	4	-4.5	-3.8
	E-W Link2B	-6	-1	-3	-4	5	-5.5	-2.7
E-W Link3	E-W Link3A/D	-4	-6.5	-5	-4	**10**	-3.5	-2.4
	E-W Link3A/E	-6	-2	-8	**-2**	9	-8	-2.9
	E-W Link3B/D	-7	-4.5	-5	-3	6	-4	-3.3
	E-W Link3B/E	-7	**-0.5**	-8	**-2**	5	-8	-3.5
	E-W Link3C/D	-8	-10	-9	-3	4	-4.5	-5.3
	E-W Link3C/E	-7	**-0.5**	-10	**-2**	3	-9	-4.2
E-W Link4	-	-10	-10	-10	-10	2	-10	-8.2
Base case	-	0	0	0	0	0	0	0
N-S Link1	-	-10	-10	-5	-10	0	-1	-6.9
N-S Link2	N-S Link2A	-5	-3	-5	-4	3	-4	-3.2
	N-S Link2B	-4	-2.5	-8	**-1**	3	-4.5	-2.8
	E-W Link 2C	-3	-2	-9	**-1**	8	-10	-2.4
N-S Link3	N-S Link3A	-2	-1.5	-10	-3	4	-10	-3.2
	N-S Link3B	-2	-1	-8	-2	4	-9.5	-2.6
	N-S Link3C	-2	-1	-5	-2	4	-9	-2.1
	N-S Link3D	-2	-1	-5	-2	4	**-1.6**	-1.4
N-S Link4	N-S Link4A	**-1**	**-0.5**	-6	**-1**	**10**	-2	**-0.1**
	N-S Link 4B	**-1**	-1	**-3**	**-1**	8	-8.6	-0.7

Note: Orange Cells indicate most preferred options

F.5 SENSITIVITY ANALYSIS

F.5.1 Methodology

It is recognised that the above ratings are subject to influence from the weightings selected across criteria in the summary tables.

As such, a sensitivity analysis was undertaken to determine the effects of the weightings. This was undertaken adopting equal weightings for each criterion to examine the effects on the overall ratings awarded.

Additionally, an assessment was undertaken discarding the social criterion 'supports planned land use'. This was undertaken to reflect the difference between actual social impacts (eg displacement, access) compared to this particular criterion which could be argued as having a limited actual influence on actual social attributes. To ensure it is not unreasonably influencing the remainder of the analysis, a scenario was completed with it removed from the weightings system. Weightings were left unchanged between the remaining route options.

F.5.2 Results

Results of the sensitivity analyses are provided in *Table F.19* below.

Table F.19 ***Sensitivity Test 1 Comparison of Environmental Assessment Criteria Under an Equal Weighting System***

Link	Sub link	Removal of Native Vegetation	Disruption of Fauna Movement Corridors	Potential for Water Quality or wetland function impacts	Weighted Rating
	Weighting:	**0.33**	**0.33**	**0.33**	
Base Case		0.0	0.0	0	0.0
E-W Link1 (Upgraded)	-	**-1.5**	**-2.0**	**-1**	**-1.5**
E-W Link2	E-W Link2A	-4.7	-4.2	-10	**-6.3**
	E-W Link2B	-5.2	-5.0	-9	**-6.3**
E-W Link3	E-W Link3A/D	-3.2	-5.3	-6	**-4.8**
	E-W Link3A/E	-9.8	-7.4	-7	**-8.0**
	E-W Link3B/D	-3.4	-5.7	-6	**-5.0**
	E-W Link3B/E	-10.0	-8.0	-7	**-8.3**
	E-W Link3C/D	-2.7	-7.7	-6	**-5.4**
	E-W Link3C/E	-8.7	-10.0	-7	**-8.5**
E-W Link 4		-7.2	-9.6	-5	**-7.2**
Base case	-	0.0	0.0	0	**0.0**
N-S Link1		**0.0**	**0.0**	**0**	**0.0**
N-S Link2	N-S Link2A	-5.2	-0.9	-3	**-3.0**
	N-S Link2B	-8.7	-4.5	-3	**-5.3**
	E-W Link 2C	-10.0	-0.4	-10	**-6.7**

Link	Sub link	Removal of Native Vegetation	Disruption of Fauna Movement Corridors	Potential for Water Quality or wetland function impacts	Weighted Rating
N-S Link3	N-S Link3A	-7.3	-10.0	-7	**-8.0**
	N-S Link3B	-7.1	-10.5	-8	**-8.5**
	N-S Link3C	-5.3	-8.7	-6	**-6.6**
	N-S Link3D	-6.7	-7.2	-9	**-7.6**
N-S Link4	N-S Link4A	-0.9	-5.7	-2	**-2.8**
	N-S Link4B	-7.6	-0.7	-9	**-5.7**

Note: Orange Cells indicate most preferred options

This analysis indicated no change to the preferred options for each link (E-W Link1, N-S Link 4A). The ratings were slightly varied by the change in weightings, but generally the results were still similar when examined in relative terms.

Table F.20 Sensitivity Test 2: Comparison of Social Assessment Criteria Under an Equal Weighting System

Link	Sub link	Comm-unity Safety	Access	Visual Impact	Displace-ment of Houses and Property	Supports Planned Land Use	Heritage	Total
	Weighting	**0.163**	**0.163**	**0.163**	**0.163**	**0.163**	**0.163**	**0.98**
Base Case		0	0	0	0	0	0	**0.0**
E-W Link1 (Upgraded)	-	0	-3.5	-2	-1	1	-1	**-1.1**
E-W Link2	E-W Link2A	-7	-1.5	-4	-7	4	-4.5	**-3.3**
	E-W Link2B	-6	-1	-3	-4	5	-5.5	**-2.4**
E-W Link3	E-W Link3A/D	-4	-6.5	-5	-4	10	-3.5	**-2.1**
	E-W Link3A/E	-6	-2	-8	-2	9	-8	**-2.8**
	E-W Link3B/D	-7	-4.5	-5	-3	6	-4	**-2.9**
	E-W Link3B/E	-7	-0.5	-8	-2	5	-8	**-3.3**
	E-W Link3C/D	-8	-10	-9	-3	4	-4.5	**-5.0**
	E-W Link3C/E	-7	-0.5	-10	-2	3	-9	**-4.2**
E-W Link4		-10	-10	-10	-10	2	-10	
Base case	-	0	0	0	0	0	0	**0.0**
N-S Link1	-	-10	-10	-5	-10	0	-1	**-5.9**
N-S Link2	N-S Link2A	-5	-3	-5	-4	3	-4	**-2.9**
	N-S Link2B	-4	-2.5	-8	**-1**	3	-4.5	**-2.8**
	E-W Link 2C	-3	-2	-9	**-1**	8	-10	**-2.8**
N-S Link3	N-S Link3A	-2	-1.5	-10	-3	4	-10	**-3.7**

Link	Sub link	Comm-unity Safety	Access	Visual Impact	Displace-ment of Houses and Property	Supports Planned Land Use	Heritage	Total
	N-S Link3B	-2	-1	-8	-2	4	-9.5	**-3.0**
	N-S Link3C	-2	-1	-5	-2	4	-9	**-2.4**
	N-S Link3D	-2	-1	-5	-2	4	**-1.6**	**-1.2**
N-S Link4	N-S Link4A	**-1**	**-0.5**	-6	**-1**	**10**	-2	**-0.1**
	N-S Link4B	**-1**	-1	**-3**	**-1**	8	-8.6	**-1.1**

Note: Orange Cells indicate most preferred options

In a similar fashion to the change in environmental ratings, this analysis indicated no change to the preferred option (Lake Road Upgrade, rated -1.9) in social terms. Other rankings were affected, however, with E-W Link 2B being second preference as the second-ranked overall rating.

Table F.21 ***Sensitivity Test 3: Comparison of Social Assessment Criteria Without Support Planned Land Use Criterion***

Link	Sub link	Commu-nity Safety	Access	Visual Impact	Displacement of Houses and Property	Heritage	Total
	Weighting	**0.25**	**0.15**	**0.15**	**0.2**	**0.1**	**0.85**
Base Case		0	0	0	0	0	**0.0**
E-W Link1 (Upgraded)	-	0	-3.5	-2	-1	-1	**-1.1**
E-W Link2	E-W Link2A	-7	-1.5	-4	-7	-4.5	**-4.4**
	E-W Link2B	-6	-1	-3	-4	-5.5	**-3.5**
E-W Link3	E-W Link3A/D	-4	-6.5	-5	-4	-3.5	**-3.9**
	E-W Link3A/E	-6	-2	-8	-2	-8	**-4.2**
	E-W Link3B/D	-7	-4.5	-5	-3	-4	**-4.2**
	E-W Link3B/E	-7	-0.5	-8	-2	-8	**-4.2**
	E-W Link3C/D	-8	-10	-9	-3	-4.5	**-5.9**
	E-W Link3C/E	-7	-0.5	-10	-2	-9	**-4.6**
E-W Link4		-10	-10	-10	-10	-10	**-8.5**
Base case	-	0	0	0	0	0	**0.0**
N-S Link1	-	-10	-10	-5	-10	**-1**	**-6.9**
N-S Link2	N-S Link2A	-5	-3	-5	-4	-4	**-3.7**
	N-S Link2B	-4	-2.5	-8	**-1**	-4.5	**-3.2**
	E-W Link 2C	-3	-2	-9	**-1**	-10	**-3.6**
N-S Link3	N-S Link3A	-2	-1.5	-10	-3	-10	**-3.8**
	N-S Link3B	-2	-1	-8	-2	-9.5	**-3.2**
	N-S Link3C	-2	-1	-5	-2	-9	**-2.7**
	N-S Link3D	-2	-1	-5	-2	-1.6	**-2.0**
N-S Link4	N-S Link4A	**-1**	**-0.5**	-6	**-1**	-2	**-1.6**
	N-S Link4B	**-1**	-1	**-3**	**-1**	-8.6	**-1.9**

The removal of this criterion from consideration did not change the two preferred options in terms of minimal social impacts (Lake Road Upgrade and N-S Link 4A). The relative ratings of the options were affected in terms of:

- a general lowering of all ratings due to the removal of the calculated benefit (scaled from 0 to +10); and
- E-W Link2B was found to be the second-most preferable of the east-west links (rated -3.5) under this scenario compared to the previous second-most rated option E-W LinkA/D (rated -3.9).

F.5.3 Discussion of Overall Results

The MCA assessment of potential environmental and social impacts of the preliminary Outer Link Road routes indicates the following:

East-West Links

Route E-W Link 1 (upgrade of Lake Road) poses most preferable route in terms of minimising potential environmental and social impacts. It has the advantage, in environmental terms, of being the only existing crossing of Kooloonbung Creek and hence poses reduced a reduced overall environmental impact.

Of the remaining options, E-W Link 3A/D was the next preferable options in terms of potential environmental and social impacts. This route is fairly direct and allows for a crossing of Kooloonbung Creek at the existing utility crossing ("Corduroy").

Other options exhibited poorer environmental and social performance due to alternate creek crossing points (Links 2A, 2B), additional potential impacts to residences and access and/or not following adopted strategic planning instruments.

North-South Links:

N-S Link 4A was found to be the most preferable Link Road route in terms of minimising social impacts. This has the advantage of a large proportion of the route alignment being located along an existing access track through Council-owned land. Additionally, it is located in a rural area and would link to the Area 13 residential growth area.

N-S Link 1 posed minimal environmental impacts, being situated within an existing urban area. However social impacts were the greatest of North-South options considered due to the disturbance to the Clifton area.

The eastern Link Road Routes 2A and 2B also have a reduced environmental impact but impose greater potential social impacts due to proximity to existing residential development and recreational facilities (racecourse).

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