3. Characteristics of the study area and issues for route option development

3.1 Overview of the study area

The study area for the proposed Wells Crossing to Iluka Road upgrade is situated on the north coast of NSW within the local government area of Clarence Valley. It is located approximately 640 kilometres north of Sydney and 350 kilometres south of Brisbane. The study area covers approximately 64,500 hectares. It is approximately 65 kilometres long from Wells Crossing to Harwood and approximately 25 kilometres wide at its widest point, east of Grafton.

The major features within the study area are shown on **Figure 3-1**.

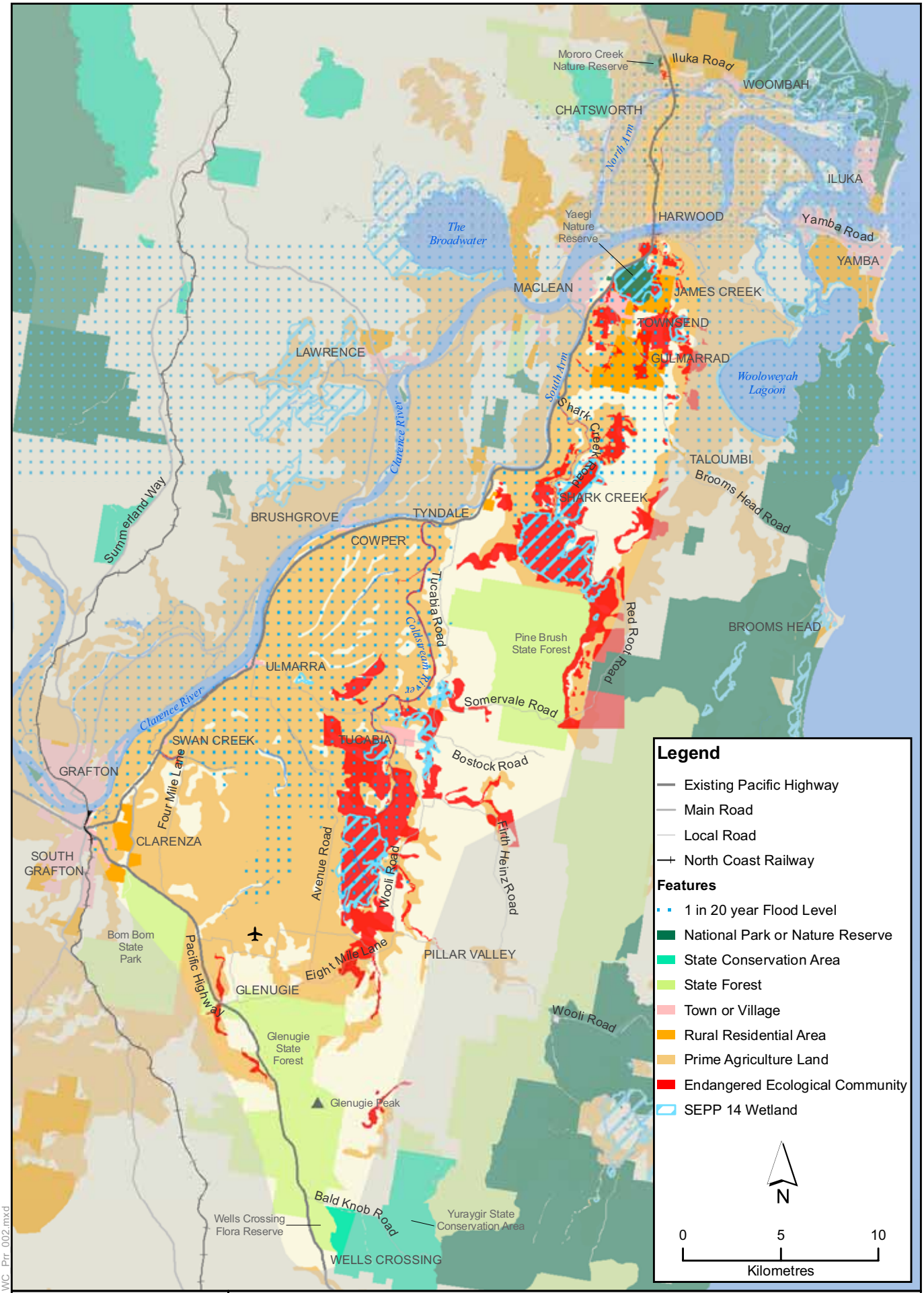
3.1.1 Wells Crossing to Harwood Bridge

From Wells Crossing to Grafton, the existing highway alignment is relatively flood free. Glenugie Peak, Grafton Airport and Glenugie and Bom Bom State Forests are major features. The western boundary of the study area from Wells Crossing to Grafton has been defined by the existing Pacific Highway, with a nominal buffer distance to the west to allow for duplication, interchanges and/or re-alignment.

The Clarence River and South Arm define the western boundary of the study area for much of the length from Grafton to Harwood Bridge and are major constraints to the development of route options. Woodford Island was considered unlikely to provide suitable conditions for a future upgrade due to environmental constraints, nature reserves, state forests, and geological conditions. The town of Maclean is a major constraint to route option development, and was excluded from the study area.

The existing Pacific Highway between Grafton and Harwood is largely flood affected. The alignment is relatively close to the Clarence River and within the floodplain for much of its length. Flooding and poor soil foundation conditions are considered to be major considerations in any potential upgrade of the existing highway.

The eastern boundary of the study area from Wells Crossing to Harwood Bridge is largely defined by steep topography and ecological constraints within the Yuraygir National Park and state forests along the Coast Range. The boundary has been located to the east of the residential and rural residential areas of Townsend, Gulmarrad and James Creek. Parts of the eastern boundary were modified and this resulted in a minor extension of the study area. This was done to provide opportunities to avoid constraints such as Pine Brush State Forest and the Shark Creek SEPP 14 wetland.



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Wells Crossing to Iluka Road
Upgrading the Pacific Highway

Figure 3-1: Major features within and around the study area

3.1.2 Harwood Bridge to Iluka Road

It is expected that the section of the project between Harwood Bridge and Iluka Road would be initially upgraded by duplicating the existing highway and existing Harwood Bridge, to create a dual carriageway road. Some local roads would continue to provide direct connections with the upgraded road. This would also involve construction of a new two lane bridge over the Clarence River at Harwood. The strategy for upgrading the section from Harwood Bridge to Iluka Road takes advantage of the potential to utilise the existing highway as part of a dual carriageway road, at least in the initial phase of upgrading the highway. Options that deviate from the existing alignment are not suitable for duplication of the existing highway, because they would result in substantial separation of the road carriageways.

Subject to traffic volumes, the highway may be upgraded to Class M in the future. This would require two new bridges and carriageways (in addition to the existing highway), with the existing Harwood Bridge and a local road to provide for traffic that does not travel on the upgraded highway. While planning for the project accommodates Class M road for the Harwood Bridge to Iluka Road section, the timing of development to that standard is uncertain and may be substantially into the future. Upgrading for the foreseeable future would involve duplication of the existing highway to create a Class A standard road rather than development of an entirely new dual carriageway in addition to the existing highway, as would be required for Class M. For this reason the focus of investigations was initially on the existing highway corridor.

As a result of community feedback on the project during the display of the route options, the RTA agreed to consider and assess options to the east of Harwood village. This involved consideration of options outside the original study area. The process of assessing options in this part of the study area is further described in **Section 6.2**.

3.2 Traffic and transportation issues

3.2.1 General traffic characteristics

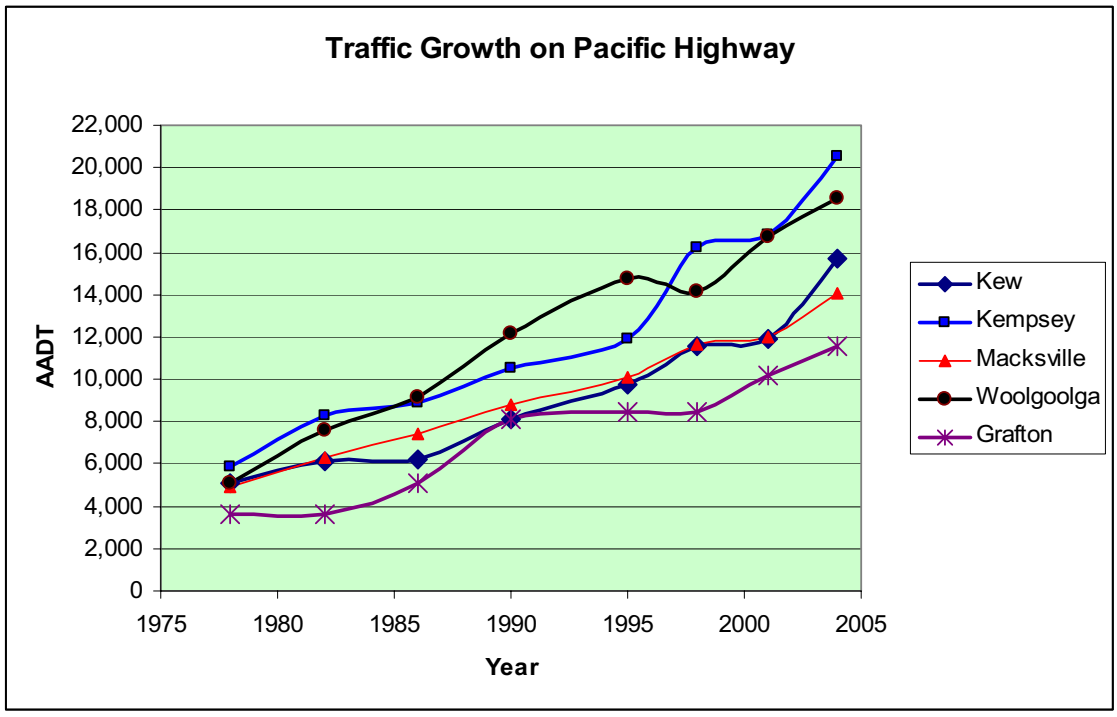
Most people living in and around the study area, including those on rural properties, would use the Pacific Highway for at least some of their regular travel, such as to reach major local destinations like Grafton. The Pacific Highway connects and serves the major centres in the Clarence Valley, which are Grafton, Maclean, Yamba and Iluka. Other towns and localities in the study area linked by the Pacific Highway include South Grafton, Swan Creek, Ulmarra, Cowper, Brushgrove and Tyndale.

Grafton is the administrative and economic centre with a population of 17,000 in 2001. Grafton is also at the crossroads of the Summerland Way, Gwydir Highway and the Pacific Highway and is an important rail and freight centre serving the region. The Clarence River and its

surrounding topography have influenced the alignment of the major roads and restricts access within the study area. The main bridge crossings of the river are at Grafton and Harwood. There are also two car ferry crossings located at Ulmarra and Lawrence.

Growth in traffic volumes is one of the key drivers of the need to upgrade the Pacific Highway. AADT volumes have grown steadily over the last 30 years along the length of the highway, and **Figure 3-2** provides some indications of the growth in Annual Average Daily Traffic[2] (AADT) volumes at key selected locations along the Pacific Highway. The Wells Crossing to Iluka Road section of the Pacific Highway has the lowest traffic volumes of any section of the highway with AADT flows between 7500 to 8000 vehicles per day measured in 2004. While current volumes are relatively low, trends in growth of long distance traffic are similar to other sections of the highway with higher volumes.

- **Figure 3-2: Traffic growth on Pacific Highway from Kew to Grafton, 1975 to 2004**



Source: Based on RTA Traffic Volume Data for Northern Region, 2004.

NB: AADT is presented as axle-pairs.

[2] Average Annual Daily Traffic (AADT) is the total volume of traffic in a calendar year, divided by 365.

For this project, the following definitions apply to the discussion of traffic using the Pacific Highway:

- Local traffic is traffic that has both an origin and a destination within the study area (but is not necessary limited to residents of the study area).
- Regional traffic is traffic that has either an origin or a destination within the study area, but not both.
- Through-traffic is traffic that enters the study area and passes all the way through on the Pacific Highway in a single journey, or makes only a short stop such as a rest break.

Approximately 30-35 per cent of the total volume of traffic on the highway is through-traffic. Local traffic makes up about 40-45 per cent of total traffic on the highway. Regional traffic makes up the remaining 25-30 per cent. This demonstrates the importance of the existing highway as a route to reach local destinations either within or near the study area.

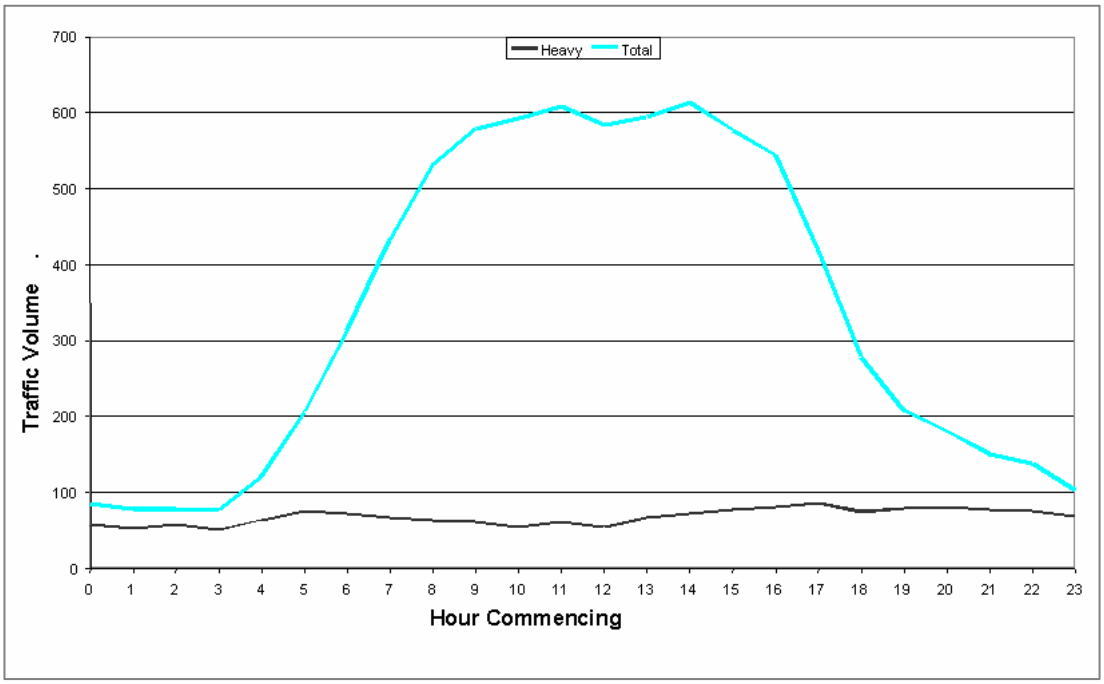
3.2.2 Day time and night time traffic

The traffic profile on the existing Pacific Highway varies significantly between day time and night time. The mix of heavy vehicles and light vehicles, and the proportion of through, local and regional traffic, also change depending on the time of day. These variations are important in the consideration of route options in terms of the performance of the upgraded highway and some associated environmental and social impacts.

Approximately 95 per cent of light vehicles travel on the highway during daylight hours. Approximately 50 per cent of heavy vehicles travel on the highway at night. This means that the proportion of heavy vehicles to light vehicles on the road during the night is much greater than during the day.

Figure 3-3 shows the profile throughout a typical 24 hour period of all traffic and all heavy vehicles, on the highway south of Grafton. Heavy vehicles constitute a majority of traffic during the early morning and late at night. The percentage of heavy vehicles is as high as 75 per cent in the early hours of the morning, and as low as nine per cent at around 10am. Compared to the total traffic profile, the volume of heavy vehicles is relatively constant, but is lowest during the night and highest in the late afternoon. A similar pattern was observed at the other Pacific Highway survey sites.

- **Figure 3-3: Hourly traffic profile on the Pacific Highway south of Grafton, October 2004**



The majority of local traffic uses the highway during daylight hours. The peak in overall traffic volumes is between the hours of 7am and 5pm. This is consistent with high levels of local activity during the day. While a proportion of night time traffic would be local, the majority is expected to be through traffic. The majority of night time heavy vehicles are large, long distance vehicles.

3.2.3 Characteristics of heavy vehicle usage

Ongoing improvements to the highway have reduced travel times and increased heavy vehicle growth on the Pacific Highway. Long distance heavy vehicles (eg. between Sydney and Brisbane) use either the Pacific Highway or the New England Highway. Traditionally, long distance heavy vehicles had preferred the New England Highway. The Pacific Highway, however, is becoming increasingly efficient as a heavy vehicle route as more towns are bypassed and distances are reduced, leading to travel time and fuel cost savings.

The number of heavy vehicles on the highway has been growing at between three and five per cent per annum over the last 10 years. The Pacific Highway was approved as a full B-Double route from Hexham to the Queensland border in 2002. There are currently about 1000 long distance heavy vehicles using the Pacific Highway each day. Heavy vehicles make up 20 per cent of the traffic on the existing highway, and about half of these vehicles are long-distance

trucks travelling through the study area. Between 10 per cent and 11 per cent of total traffic on the highway is made up of long distance six, eight and nine axle trucks.

Heavy vehicles are a significant component of the overall traffic profile of the highway. Freight growth is projected to increase since it is related to economic development, particularly growth in consumer demand. In addition to long distance heavy vehicles that use the highway as a route between capital cities, increased demand for heavy vehicle movements to and from local destinations will be driven by population growth along the north coast. The Pacific Highway is therefore important for freight movement both through the area and to service population centres along the highway. Upgrading the Pacific Highway is required to improve freight transport efficiency and to cater for increasing heavy vehicle volumes and larger heavy vehicles (more B-doubles and other articulated heavy vehicles are using the highway).

3.2.4 Performance of the existing transport network

The Pacific Highway in the study area varies in capacity between one lane and two lanes in each direction. The theoretical capacity based on the single lane sections is about 1200 vehicles per hour. The Level of Service (LoS) of a road varies from A (good) to E (poor), depending on the number of lanes, traffic volume, and the frequency of intersections and junctions[3]. The LoS of the highway in this section is typically at values B to C with lower levels during summer holidays and some busy weekends.

Overall, the performance of the Pacific Highway in terms of travel time, safety and transport costs is influenced by a wide range of factors. These include:

- The sections that pass through towns where local traffic and through traffic mix and reduced speed limits are required for safety reasons.
- Poor alignments or road conditions that require reduced speed limits or advisory speed signs.
- Conflicts between local and through traffic as the Pacific Highway is the main access route between many towns along the route and carries a high proportion of local traffic.
- Congestion in peak holiday periods, particularly in and around towns that the highway still passes through.

[3] A roadway with Level of Service D is operating close to its limit of stable flow, with all drivers being severely restricted and their freedom to select their desired speed and to manoeuvre in the traffic stream. At Level of Service E traffic volumes are close to or at capacity and there is virtually no freedom to select desired speeds or manoeuvre in the traffic stream.

- Direct access from private properties to the highway, which creates potential conflict points and can limit access for property owners during peak periods.
- Delays caused by incidents such as flooding, accidents, and opening bridges (eg. Harwood Bridge).
- A relatively indirect route for through traffic (but that connects towns and provides access for local and regional traffic).

All the above factors contribute to the need to upgrade the Pacific Highway to meet the strategic objectives established for the corridor.

3.2.5 Future travel demand

Overall travel demand on the Pacific Highway

Projected future growth in traffic is a key driver of the need to upgrade the Pacific Highway. The need to upgrade this section of the highway must also be considered in the context of overall traffic growth and the need to provide a high standard road from Hexham to the Queensland border. Different factors affect the growth of light vehicle and heavy vehicle traffic, and of through traffic as opposed to local or regional traffic. Growth in local and regional light vehicles is mainly influenced by local population growth. Growth in through traffic may be expected to follow long-term growth rates, while a key determinant of heavy vehicle traffic growth is economic development, commonly indicated by Gross Domestic Product (GDP).

The population of the region has been increasing at an average rate of 0.9 per cent per year between 1991 and 2001. Traffic growth on the highway has been increasing faster, at an average rate of 2.0 per cent pa over the last 20 years. Based on the five year period between 1998 and 2003, traffic growth has been increasing at 4.7 per cent per annum, partly as a result of higher economic growth and partly as a result of improvements on other sections of the Pacific Highway. **Table 3-1** presents historical and forecast growth rates of traffic on the Pacific Highway and population in the Clarence Valley. These have been used to predict traffic volumes on the highway.

- **Table 3-1: Population and Pacific Highway Traffic Growth Rates in the Clarence Valley, 1996-2041**

	Annual Growth Rate (%)			
	1990 - 2001	2001 – 2021	2021 - 2031	2031 – 2040
Population	0.9	0.9 – 1.3	0.9 – 1.3	0.9 – 1.3
Local Traffic	1.4	1.7	1.7	1.7
Through-traffic	2.0(1)	4.7	2.0	2.0
Commercial Vehicles	-	4.0	3.5	3.0

(1) From 1998 to 2003 growth rate was 4.7 per cent pa. The long run traffic growth trend has been 2.0 per cent pa from 1978 to 1998.

Projected traffic growth for all vehicles on the Pacific Highway is presented in **Table 3-2**. Continued growth in all traffic (local and long distance) is projected in the study area over the next 20-40 years. The AADT for all vehicles is forecast to nearly double over the period from 2004 to 2041. Numbers of freight vehicles are forecast to more than double in number to over 3500 trucks per average day, which would represent 25 per cent of the daily traffic volumes in 2041, south of Grafton.

Further detail of the approach to forecasting traffic volumes is provided in the *Traffic and Transport Working Paper* (RTA, 2006j).

- **Table 3-2: Forecast Traffic Volumes (AADT(1)) on the Pacific Highway 2004-2041**

Location	2004	2011	2021	2031	2041
Pacific Highway, South of Grafton					
Light	6600	7810	9550	10,740	11,940
Heavy	1630	2090	2740	3320	3800
Total	**8230**	**9900**	**12,290**	**14,060**	**15,740**
% Heavy	20%	21%	22%	24%	24%
Pacific Highway, South of Maclean					
Light	6050	7080	8550	9640	10,730
Heavy	1530	1970	2580	3130	3580
Total	**7580**	**9050**	**11,130**	**12,770**	**14,310**
% Heavy	20%	22%	23%	25%	25%
Pacific Highway, South of Woodburn					
Light	5340	6330	7750	8710	9680
Heavy	1620	2070	2720	3290	3770
Total	**6960**	**8400**	**10,470**	**12,000**	**13,450**
% Heavy	23%	25%	26%	27%	28%

(1) AADT = Average Annual Daily Traffic (takes into account seasonal variations).

Predicted traffic composition in 2021

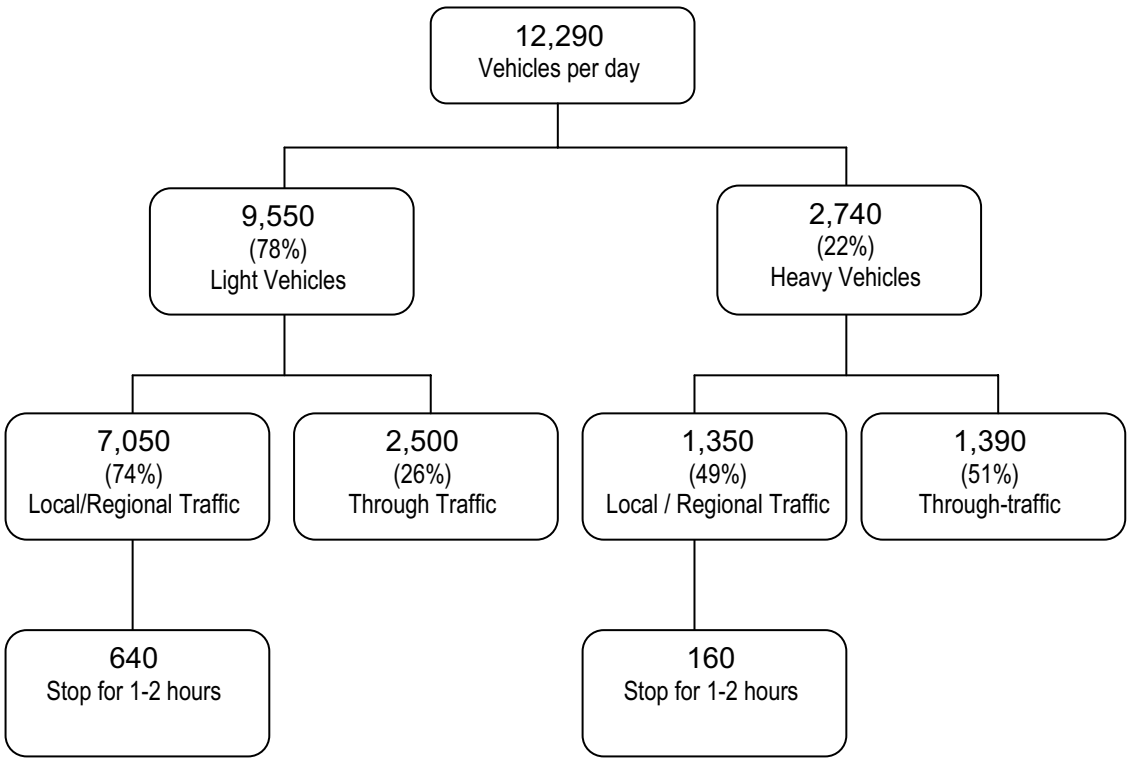
2021 has been adopted as the future year traffic volume for the assessment of the route options. **Figure 3-4** shows the predicted composition of traffic on the Pacific Highway (without the upgrade) south of Grafton in 2021.

Of the 12,290 (AADT) vehicles predicted to use the highway on an average weekday, about 68 per cent would be classified as local and regional traffic. Long-distance traffic, travelling through the study area, would make up about 32 per cent of the daily volume.

Of the 12,290 vehicles per day, 2740 are predicted to be heavy vehicles (22 per cent of total volume). About 49 per cent of these would be local or regional traffic. The remaining 51 per cent of truck trips would be long-distance articulated vehicles. Of the 1390 trucks that would be through traffic, all of these would be six to nine axle trucks. About 160 of these vehicles would stop for up to two hours in the study area for reasons such as rest breaks.

About 74 per cent of light vehicles would be local and regional traffic. About 26 per cent of light vehicles would be through-traffic.

- **Figure 3-4: Predicted composition of traffic south of Grafton, 2021**



Freight movement

Future freight vehicle volumes on the Pacific Highway will be influenced by a number of factors, including mode split between road, sea and rail, and growth in demand for goods and services, both by populations along the highway, and demand at either end of the corridor (Sydney-Newcastle and South East Queensland) and beyond.

The forecast growth in road freight of four per cent per annum over the next 15-20 years is likely to outstrip the current two to three per cent per annum growth in rail traffic. Therefore, the projected rail mode share is most likely to fall below current levels (10 per cent).

In order for rail to compete effectively with road freight, significant investment in track and signalling would be required to reduce travel times and offset the double handling of containers at final destinations. It is therefore unlikely that the existing mode share would change into the future in favour of rail[4]. The proportion of total freight carried by rail is likely to decrease over the long term, as road transport becomes more efficient due to infrastructure improvements.

The volume of heavy vehicles travelling on the Pacific Highway is therefore projected to increase substantially into the future. Heavy vehicle trips, both interstate trips and to service populations on the north coast, are both predicted to grow strongly, as a result of north coast population growth and general growth in freight transport demand.

3.3 Road safety

As part of the review of safety on the existing highway, recorded crash data on the existing highway within the study area (from April 2000 to March 2005) and sections of the Pacific Highway that have previously been upgraded have been reviewed. This includes sections such as Yelgun to Chinderah and Bulahdelah to Coolongolook. More detail of the crash analysis undertaken for the project is provided in the *Traffic and Transport Working Paper* (RTA, 2006j).

3.3.1 Safety on the existing highway in the study area

On the Pacific Highway within the study area, there were 334 crashes recorded during the period from 2000 to 2005, at an average of 67 crashes per year. Crash rates are commonly expressed in terms of crashes per 100 Million Vehicle Kilometres Travelled (100 MVKT). To calculate an annual VKT figure, the volume of traffic using a length of road in a year (the AADT multiplied by 365) is multiplied by the length of the road.

The average crash rate for the existing highway between Wells Crossing and Iluka Road is about 28 crashes per 100 MVKT, but ranges from 18.5 to 41.4 crashes per 100 MVKT on various sections of the highway within the study area[5]. Of these, 28 per cent involved at least one heavy vehicle. Given that approximately 20 per cent of vehicles are heavy vehicles, this

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[4] ARTC is responsible for implementing planned rail improvements under Auslink and ARTC's improvement program. Significant investment in rail would be required to reduce rail transit times to equal road transit times, in order to increase the mode share to rail freight. However, the level of the proposed funding is not likely to allow the necessary travel time savings to compete with road transport in the Brisbane – Sydney corridor.

[5] The average crash rate of 32 per 100 MVKT referenced in the *Route Options Development Report* (RTA, October 2005) was based on data from 2000 – 2003 only.

rate is high compared to the rate for all vehicles. The overall crash rate for heavy vehicles (crashes involving heavy vehicles per 100 million kilometres travelled by heavy vehicles) is approximately 37 per 100 MVKT.

Crashes are recorded as either fatal, injury or non-casualty (tow-away). During the five year period covered by the crash data, there were:

- 12 fatal crashes (four per cent of the total), resulting in 14 fatalities and this equates to a rate of 1.1 per 100 MVKT.
- 122 crashes (36 per cent of total) where an injury was recorded and this equates to a rate of 10.5 per 100 MVKT.
- 200 crashes (60 per cent of total) where there were no injuries recorded.

The RTA collects data in relation to crashes including location, weather conditions, time of day and type of day (eg. public holiday, school holiday, weekday or weekend). Analysis of these data revealed the following:

- There is no specific pattern to the location of crashes along the highway, such as at intersections, and no particular accident 'black spots' are evident from the data.
- The majority of accidents (approximately 70 per cent) occur in fine weather, indicating that weather conditions are not a key determinant of road safety on the existing highway.
- The proportion of crashes occurring during the Christmas and Easter holiday periods and on public holidays is higher than at other times of the year, indicating that higher traffic volumes or lack of familiarity with road conditions may be a factor in some accidents.
- Approximately two-thirds of accidents occur during daylight hours, between 6am and 6pm.
- The highest numbers of fatalities occur between the hours of 12 midnight and 6am and between 12 midday and 6pm.
- Approximately two-thirds of injury accidents occur during daylight hours and this is likely to be related to the higher volume of vehicles using the road during the day.

Consideration was also given to the type of crash, such as vehicles running off the road, head on collisions, and crashes at intersections. That analysis indicates that fatalities occur in a range of crash types. About one-third of fatal crashes are head on collisions, and upgrading the highway to dual carriageway would effectively avoid these crashes. Fatalities at intersections would also be reduced as a result of limiting access to interchanges and grade separated intersections. Crashes resulting from vehicles running off the road contribute to a high proportion of fatal and injury crashes. The rate of these crashes would be reduced through a higher standard road alignment, and the severity of these would be reduced as a result of removing hazards on the road side (such as trees).

3.3.2 Crash rates on upgraded sections of the Pacific Highway

Crash rates from the available crash records (over the period 2000 to 2005) for all sections of the Pacific Highway that have been upgraded to dual carriageway standard have been reviewed to determine average crash rates for projects that are currently operating at a standard similar to that proposed for the upgraded highway between Wells Crossing and Iluka Road. The average rates for Class M standard road sections based on this recorded data are:

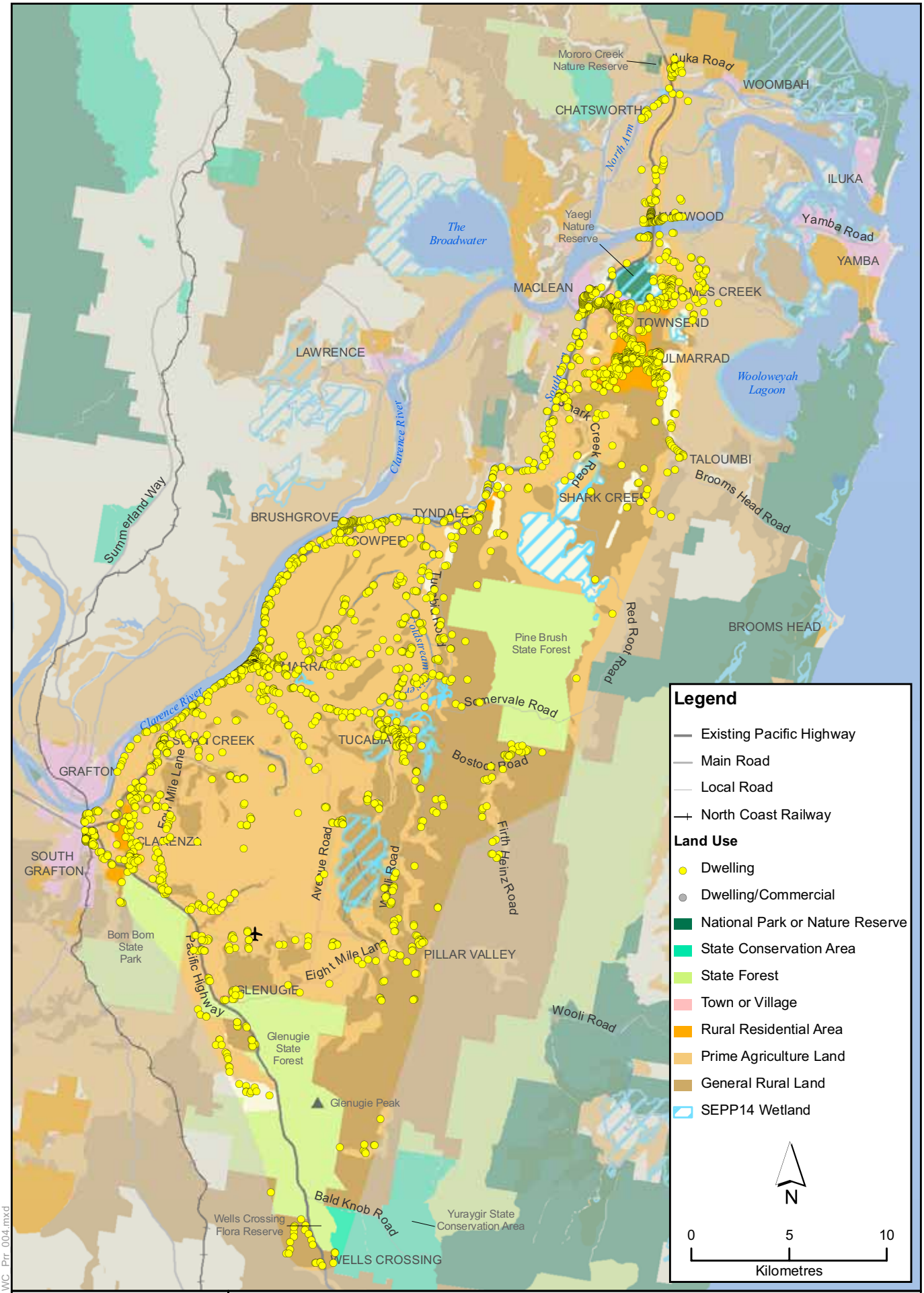
- All crashes: 18.8 per 100 MVKT.
- Injuries: 8.3 per 100 MVKT.
- Fatalities: 0.23 per 100 MVKT.

3.4 Land use and planning issues

Existing land use is illustrated on **Figure 3-5**. Existing land use in the study area is predominantly rural. The range of productive uses reflects the diverse topography, geology and soils, and ecology of the area. Farming has traditionally centred on timber felling, broad scale cropping, dairying and grazing activities. However, diversification into niche production such as orchards, organic farming and small scale crops is occurring and has potential for growth.

Settlement patterns

Settlement is concentrated in towns and villages along the Pacific Highway and Clarence River, such as Grafton, South Grafton, Swan Creek, Ulmarra, Cowper, Brushgrove, Tyndale and Maclean. In more recent years, additional population growth has occurred in rural residential areas and rural small holdings, resulting in growth in semi-urban areas at the fringes of larger towns, and other more scattered rural communities. Localities and areas of concentrated rural settlements include Clarenza, Wells Crossing, Glenugie, Pillar Valley, Tucabia, Townsend, Gulmarrad, Taloumbi, Harwood, Chatsworth and Woombah.



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Wells Crossing to Iluka Road
Upgrading the Pacific Highway

Figure 3-5: Land use in the study area

Key issues associated with settlement patterns in the study area are:

- Potential impacts on densely populated areas including towns and villages and the high concentration of population generally in the west of the study area along the existing Pacific Highway.
- Impacts on the semi-rural character of rural residential areas and other locations of more dispersed settlement, where people have chosen to locate often for amenity reasons associated with isolation, peace and quiet.
- Potential for fragmentation of communities as a result of new road development.

Agriculture

Grazing land extends across much of the southern section of the study area, to around Cowper, and throughout the east of the study area. Beef and dairy cattle are the predominant stock. Sugar cane farming is the predominant rural land use in the low lying lands north from approximately Cowper. Harwood and Chatsworth Islands are almost entirely occupied by cane farming. Harwood mill is the main sugar mill in the area and all cane from the district is processed there. Maintenance of access routes from surrounding cane farms to the Harwood mill is an important consideration in limiting impacts on the cane industry.

Horticulture is also an important part of the local agricultural economy. A variety of fruit, nut and berry crops are grown in the area. Other uses include plant nurseries, forage crops, cereals and vegetables. The Clarence Valley is also one of the main soybean cropping areas on the north coast. There are a number of certified organic farms and farmers that are working towards achieving organic certification for their properties.

Key issues related to agricultural production in the study area include:

- The needs of the sugar industry, including:
  - Specific growing conditions for sugar cane, in particular the duration of inundation of cane fields during and following flooding and the potential for road development to change flooding behaviour.
  - Loss of high value productive cane land, in particular land generally adjacent to the existing Pacific Highway that has better flood immunity.
  - Changes to the size and shape of paddocks that may impact on the efficiency of harvesting.
  - Access requirements across the highway and between properties.
  - The location of and access to cane pads

  - Access to and from Harwood mill during harvesting to ensure that cane is transported efficiently.
- Impacts on dairy farms and grazing properties including:
  - Loss of higher ground with better flood immunity, particularly as this land typically contains farm infrastructure such as sheds, yards and houses and provides refuge for stock during floods.
  - Potential changes to flooding behaviour and the risk that this presents to rural property owners.
  - Changes to access arrangements within properties and between properties, particularly for movement of stock on a seasonal basis or during floods.
  - Loss of the highly productive prime agricultural land that is typical of much of the floodplain, particularly adjacent to the Clarence River.
  - Impacts on properties outside the floodplain that are used on a seasonal basis, or during flood or drought periods.
  - Impacts on designated flood refuges.
- Impacts on smaller scale rural production and niche production, much of which is located in the east of the study area on land that is not considered prime agricultural land, including impacts on organic producers or on the potential to achieve organic certification.

Forestry

State forests occupy substantial areas within the south and east of the study area and include Glenugie State Forest, Newfoundland State Forest (including the Wells Crossing Flora Reserve), Bom Bom State Forest and Pine Brush State Forest. There are also two plantations on private land in the study area and advice from the community indicates that forestry on private land (particularly in the east of the study area) contributes to the viability of some farms that are also used for grazing.

Land use activities within state forests include timber harvesting, conservation, scientific research and recreation. Forest Management Zones have been adopted by NSW Forests to assist in the management of these assets, and identify areas for harvesting, mixed management and conservation or recreational purposes. Significant areas of the state forests in the study area are zoned for conservation purposes.

Key issues for forestry and state forests are:

- Loss of forested areas that contribute to the economy of the area through timber harvesting, both on private land and in State Forests.
- Impacts on the recreational and conservation values of State Forests.

- Statutory requirements in relation to acquisition of land within state forests for the new road reserve.

National parks, state conservation areas and nature reserves

Three areas of land reserved under the *National Parks and Wildlife Act, 1974* are located within the study area:

- The Yuraygir State Conservation Area is a large reserve that joins the Yuraygir National Park and Newfoundland State Forest, and is partly within the study area. It is former state forest land that has been transferred to the national parks estate.
- The Yaegl Nature Reserve near Maclean is entirely within the study area. It is a large wetland that is also identified under SEPP 14, and contains relatively high quality remnant floodplain and wetland vegetation communities, also likely to be listed under the *Threatened Species Conservation Act* 1995.
- The Mororo Creek Nature Reserve is located to the west of the Pacific Highway in the vicinity of the Iluka Road intersection, partly within the study area.

As these areas have been secured for conservation purposes under legislation they present a substantial constraint to route option development. Statutory processes in relation to the acquisition of land that is part of the national parks estate are a key issue for route option development in addition to the ecological and cultural values of these lands.

Highway related land uses

The historical development of towns and other settlements in the area has been focused on major rivers and roads. The Pacific Highway is the major land-based transport route in the area, providing for local and regional access. Both local and through traffic generate demand for a range of services and facilities including petrol, meals, accommodation and repairs. Many of these rely on passing trade, and as such are situated on the highway to benefit from direct access and exposure. The main highway related uses include:

- Service stations in locations including South Grafton, Swan Creek, Ulmarra, Tyndale, south of Maclean, and north of Harwood.
- Motels and caravan parks at South Grafton, Ulmarra and Tyndale.
- Convenience food outlets at South Grafton, Ulmarra, Tyndale and service stations.
- Tourist related uses such as the Ferry Park visitors centre and restaurant south of Maclean, the visitor information centre at South Grafton, hotels at Ulmarra, Brushgrove and Harwood, and tourist focused shops, cafes and restaurants in Ulmarra.

There are a number of issues associated with highway related businesses. Businesses that are currently directly accessible from the existing highway would be likely to experience a loss of trade as a result of limited access from the upgraded highway. This is an issue for all route options because access to and from the upgraded highway would be restricted.

New businesses may want to locate around interchanges to capitalise on improved regional accessibility that will eventuate from the Pacific Highway upgrade program as a whole, and this project specifically. This may lead to increased demand for land for industrial purposes and service centres, particularly in locations with relatively direct access to the upgraded highway.

Businesses that are not located directly on the highway may also be impacted as a result of changes in accessibility. The business community in the Clarence Valley is concerned that options that move the highway further from Grafton (and other centres) could result in both a reduction in passing trade and a loss of local trade to centres such as Coffs Harbour. However, evidence from other towns where through traffic has been removed indicates that benefits to local businesses can result from bypasses, although these may take some time to be realised.

Extractive industries and mines

There are several areas where quarrying operations are concentrated within the study area. These are generally in the more elevated topography, although there is some evidence of quarrying on the floodplain, possibly for sand. There are no known mining operations in the study area. The main extractive resources in the study area are sand and gravel. The main active quarrying areas are located in the hilly areas south of Pillar Valley, south of Tyndale, and within the small range and between Gulmarrad and James Creek. The Department of Primary Industries (Minerals) has advised of a quarry in the Shark Creek Range that has substantial potential for future provision of extractive material including road base and aggregate. The key issue related to extractive industries is the potential sterilisation of resources. Consumption of resources in road construction is also an issue in terms of local and regional resource availability for other activities.

3.5 Social and local economic issues

3.5.1 Community issues

The community has expressed strong views about the project on a wide range of issues. The community within and around the study area is diverse and changing. There is a long history of settlement in the study area, and many residents are also farmers, families or business operators that have an ongoing association with the area. The area has also experienced substantial growth associated with more widespread trends in migration to the north coast from interstate or other parts of NSW. These residents have been in the area for a shorter period of time, but have

formed strong links with the area, placing high value on the rural or bushland amenity, remoteness and the way of life.

Many of the issues for route development that are relevant to the community are related to land use and settlement patterns as discussed in **Section 3.3.2**. A broad range of issues have been identified as important by the community. The majority of those who have commented on the project support the concept of upgrading the highway, but have raised specific concerns in relation to potential impacts. Key issues of importance to the local community include:

- Developing a safe road network.
- Acquisition of homes and property.
- Fragmentation and severance of communities, including communities of relatively low density settlement, such as Pillar Valley and Bostock Road.
- Changes to the character and amenity of the local area.
- Impacts on business.
- Impacts on rural production.
- Impacts on heritage and culture.
- Conservation of the important ecological values of the area.
- Pollution including air, noise and water.

The range of issues raised by the community is indicative of the challenges associated with the project. Areas that are less densely settled have important values to the community because they are isolated and typically contain areas of high ecological value. These features have attracted many residents to these areas, but are at odds with the development of a major new road. The value of living in a relatively remote, quiet and undeveloped area is important for many residents of the study area.

Conversely, areas that are more densely settled, such as along the existing highway, are important to those communities because in many cases the land is tied to income generation and because there are lifestyle attractions associated with living in a rural or riverside location. Many of the residents along the existing highway have lived there for generations and traffic volumes have increased gradually over time, incrementally reducing amenity. Upgrading the highway through closely settled areas has the potential to impact on a much greater number of people, and to interrupt community structures and settlement patterns that have developed over a long period of time.

3.5.2 Heritage

Heritage investigations for the project have been conducted by Navin Officer Heritage Consultants. The *Cultural Heritage Assessment Working Paper* (RTA, 2006b) provides further detail of heritage assessments undertaken to date.

Aboriginal heritage and culture

The study area is situated within the areas of interest of the Grafton-Ngerrie Local Aboriginal Land Council and Yaegl Local Aboriginal Land Council. The Birrigan-Gargle Local Aboriginal Land Council boundary is to the east of the study area. The general region is also recognised as part of the Barangayir Nation Aboriginal community, which is represented in the Grafton area by the Barraway Wajid Traditional Owners group. Several tribal and elders groups also have an interest in the study area, including the Garby Elders, Nungera Cooperative Society, the Ulungundahi Elders Group and the Yamboora Aboriginal Corporation. There are current Native Title claims over some areas of the study area, including the waters of the lower Clarence River and associated tributaries. There are several land holdings particularly in the north of the study area that are owned by LALCs and other Aboriginal organisations.

The two major tribal groups in the study area are the Gumbainggar and the Yaygir, though the exact boundaries of these groups are unclear. These areas are bounded to the north by the Badjelong (Bandjalong) tribal group and the south by the Dangaddi tribal group.

From the findings of previous archaeological studies, consultations with Aboriginal groups and general knowledge of Aboriginal settlement patterns on the north coast, a predictive model was developed for the study area to determine the likely occurrence of indigenous heritage sites. **Figure 3-6** illustrates the broad-scale predictive model developed for the study area, with the moderate to high sensitivity areas described in **Table 3-3**. Further detail of the approach to development of the predictive model is provided in the *Cultural Heritage Working Paper* (RTA, 2006b).

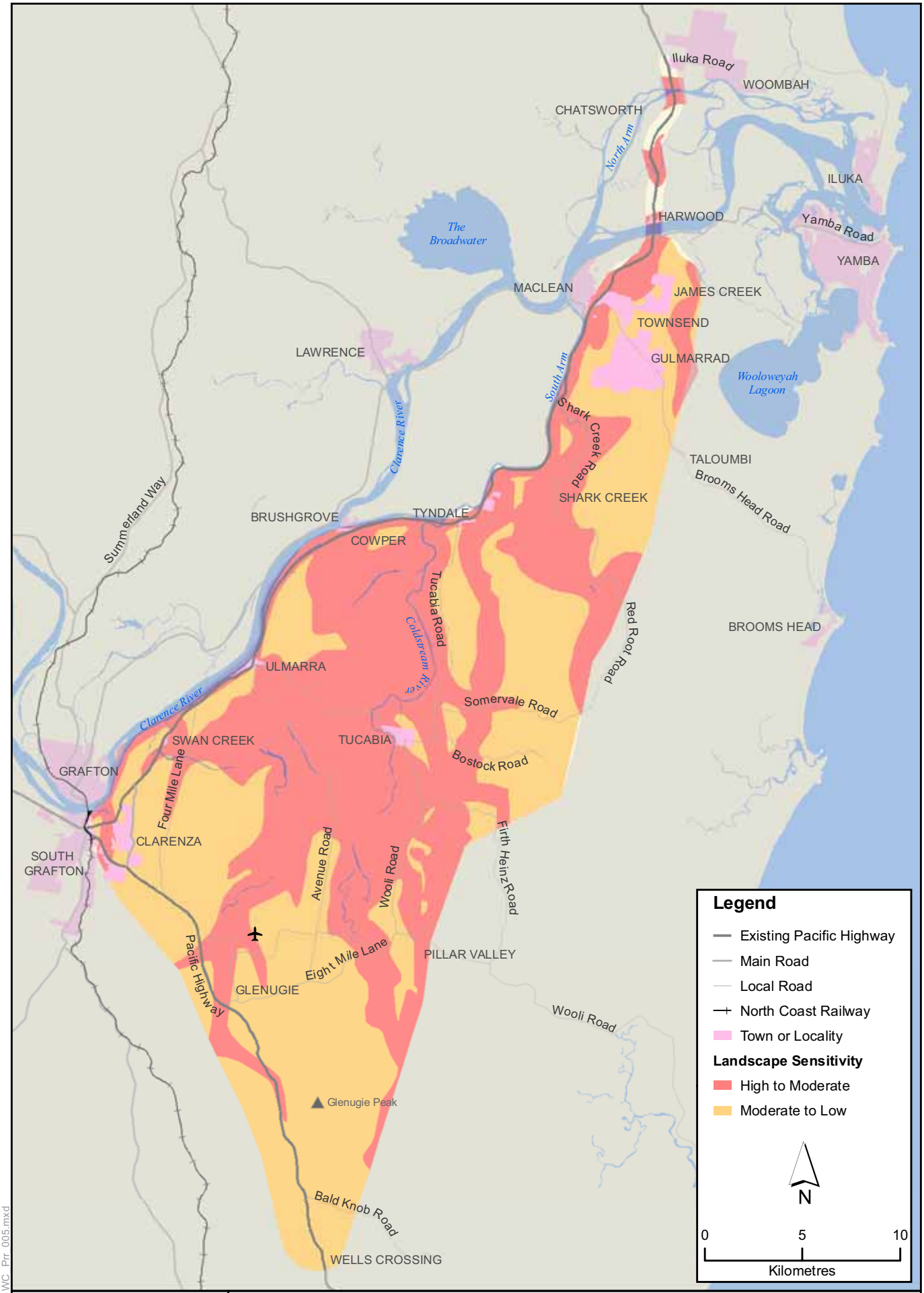

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Figure 3-6: Predictive model for Aboriginal heritage sites in the study area

- **Table 3-3: Areas of archaeological sensitivity within the study area**

Sensitivity Classification	Broad Scale landforms
High to moderate archaeological sensitivity	■ Valley floor topography associated with the margin of the Clarence River, major creeks and wetland basins. ■ Locally elevated topography on the valley floor. ■ Lowland ranges - low ranges adjacent to and bordering the valley floor. ■ Sandstone exposures within the Escarpment Ranges. ■ Locally elevated valley floor topographies in the narrow valleys which transect the escarpment ranges. ■ Glenugie Peak.
Moderate to low archaeological sensitivity.	■ Upper and mid-valley ranges. ■ Lesser riparian zones. ■ Valley floor and lowland range topographies associated with intermittent or lesser water sources. ■ Relatively level crest topographies in the escarpment ranges.

Field surveys were undertaken over a period of five days in April 2005 across the study area to sample a range of topographies such as hills and ridges, floodplains, river and creek margins and associated terraces. The ability to obtain representative sampling across the entire study area was somewhat constrained by property access issues. The survey concentrated on areas of high visibility, such as vehicle and stock tracks, contour banks, areas of erosion and ploughed or denuded ground. Previously recorded sites were also inspected by archaeologists to confirm their location and status. The field survey identified 17 sites within the study area, in addition to the nine sites already recorded on the Aboriginal Heritage Information Management System (AHIMS) register.

In addition, a further four sites are known in the study area from previous studies. However, these are not recorded on the AHIMS database as they are finds from property owners that were brought forward to archaeologists, and their location cannot be accurately determined. These items are artefact scatters and Potential Archaeological Deposits (PADs).

The majority of sites are recorded from the lower lying floodplain sections of the study area, although some sites have also been identified in the foothills and hill slopes. These findings are broadly consistent with the predictive modelling described in **Table 3-3**.

Consultation with local Aboriginal groups was undertaken as part of the route options heritage investigations. These consultations indicated the presence of locations and features in and around the study area that have cultural significance to the Aboriginal people of the area. These include:

- Glenugie Peak.
- Clarence Peak (outside the study area to the east).

- A site in the Clarence River at Tyndale.
- The Pillar Valley and Pillar Ridge area.
- Camp sites at Wells Crossing, Bom Bom, the old Grafton Racecourse and Ulmarra.
- Ceremonial sites located to the east of the study area, south of Maclean, and walking routes to these sites that pass through the study area, including through the Gulmarrad area.

The potential for indigenous heritage sites within the study area may well be greater than indicated by the results of investigations. The history of Aboriginal occupation of the study area is well documented, and the findings of some studies suggest that the limited records from the study area result more from a lack of investigations than a low concentration of sites. Particularly high sensitivity areas include major river margins, ridge and spur-line crests and other locally elevated areas. In addition, local Aboriginal community representatives have advised of areas of cultural significance within or near the study area. As such, despite the relatively low number of records for the study area, the study area is generally considered to have high archaeological potential. At a broad scale, the floodplain areas in the west of the study area are considered to have greater potential than the forested coastal ranges and slopes of the eastern part of the study area.

The Aboriginal groups consulted for this project have requested that the exact locations of some areas of cultural sensitivity and Aboriginal sites not be made public. For this reason, details for individual sites are not reported here, nor in the *Cultural Heritage Working Paper* (RTA, 2006b). Sites recorded during the field survey have been reported to the Department of Environment and Conservation (NSW DEC) for inclusion in the AHIMS register.

Key indigenous heritage issues for the project include:

- The need to avoid direct impacts on areas of identified cultural significance, as these are particularly important to the local Aboriginal community.
- Identification and avoidance (where practical) of impacts on Aboriginal sites.
- Ongoing consultation with the Aboriginal groups that have an interest in the study area, to ensure that these issues are carried through the development of the project.

European heritage

References to the Clarence River are made as early as 1799 by Matthew Flinders, who anchored his sloop in the river estuary and described Aboriginal huts on the riverbank.

The first official exploration by settlers was in 1839. The Clarence River district was eventually opened up by the cedar cutters harvesting the timbers along the river. By 1845 much of the

lower reaches of the river had been taken over by the cedar trade (Rich 1990). Shortly after the first cedar getters settled in the region a village grew in the area of the city of Grafton.

Timber cutters were soon followed by pastoralists and station properties were established in the Grafton area in the 1840s. The gold rushes in the latter 1800s and the Robertson Land Acts from 1861 brought a dramatic increase in the population. The large leasehold pastoral runs were replaced by the closer settlement of small selectors, their holdings eventually impacting on even marginal country in the upper tributary valleys.

Ulmarra town prospered with the introduction of the dairy industry after the collapse of the sugar mill. Ulmarra wharf was a major pick-up point for steam and sailing vessels serving the Sydney markets. The town thrived until improved roads and technology ended its role as a major river port.

There are 14 heritage listed sites within, or immediately adjacent to, the study area, and the locations of these are shown on **Figure 3-7**. Of these, one is listed on the Register of the National Estate, two are listed on the State Heritage Register, one is shown on the register of the National Trust of Australia (NSW), eight are listed on the Maclean LEP 2001, two are listed on the RTA Heritage and Conservation Register, and one is listed on the Ulmarra LEP 1992.

Field survey for European heritage was undertaken concurrently with indigenous heritage survey in April 2005. A further 16 historical sites, with potential heritage significance, were identified during field surveys and are illustrated at **Figure 3-7**. These sites are believed to be in excess of 50 years old and if so are protected as relics under Section 139 of the NSW *Heritage Act 1977*. However, they are not currently recorded on any local, state or national heritage lists. Further assessment is required to determine their potential heritage significance in accordance with relevant heritage legislation, and would be undertaken as part of the detailed Environmental Assessment of the preferred route.

Clarence Valley Council has undertaken a community based heritage study for the former Maclean Council area (Clarence Valley Council 2006b) and has provided records within Harwood village to the project team. This includes current statutory listings and sites that have been identified as having potential heritage values, but which are not yet incorporated into statutory listings. These potential heritage items include:

- Harwood village conservation area (from Morpeth Street east to the mill).
- Harwood mill, recommended for listing as an item of State significance under the *NSW Heritage Act, 1977*.
- Beardmore Tug, off Mill Street.
- Tram tracks, Mill Street.

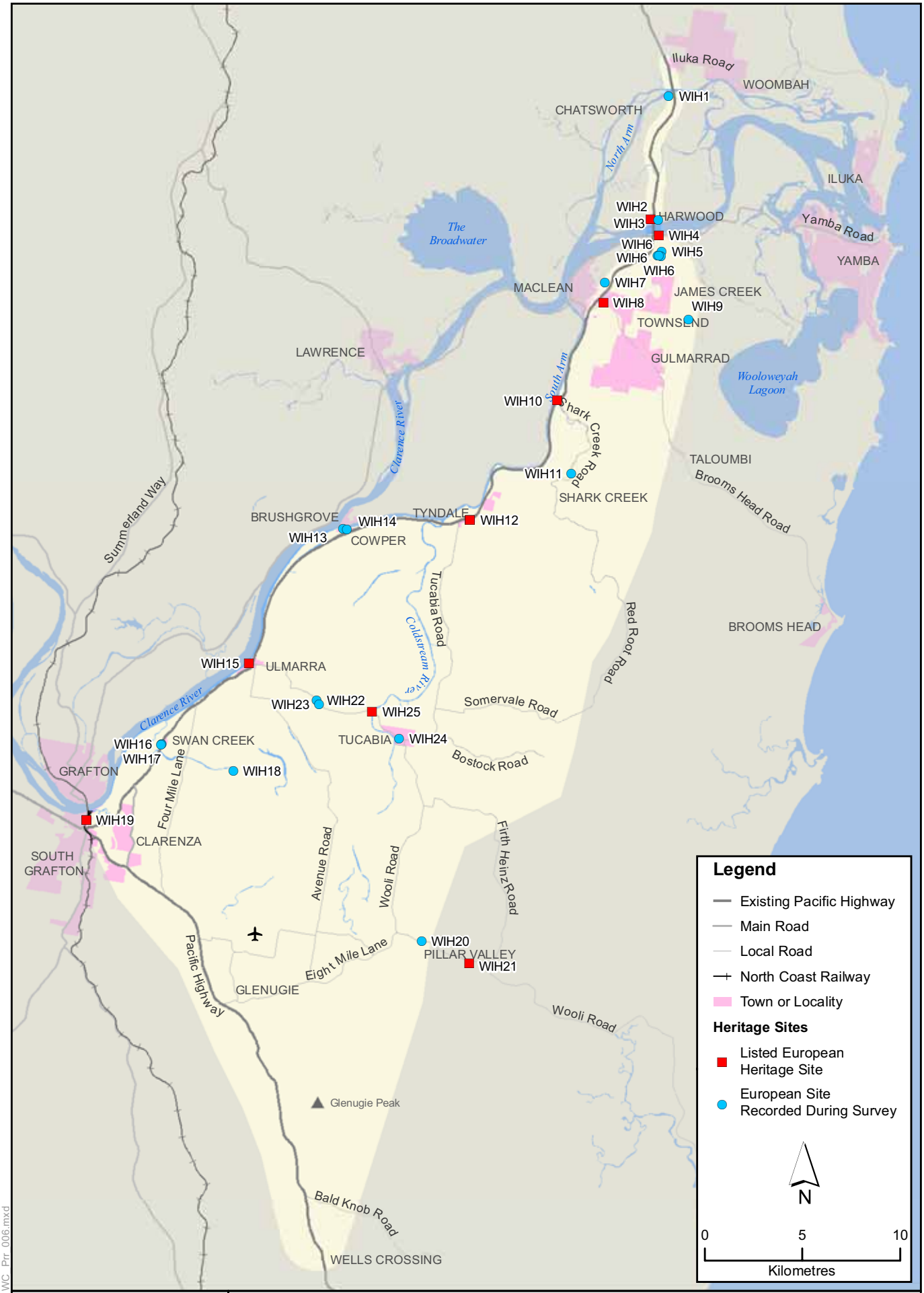

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Figure 3-7: European heritage items in the study area

- Residence, 3 Church Street.
- Convent, 12 River Street.
- Water Brigade Hall, River Street.
- Sports field and Grandstand, off Mill Street.
- Post Office, River Street.
- Police Station (former), River Street.
- War Memorial, River Street road reserve.
- Street Trees, River Street road reserve.
- Residence, 18 Morpeth Street.
- Tram Tracks, Old Pacific Highway.

The key issue for development of the project is the need to avoid or minimise impacts on heritage items and items of potential heritage significance. Due to the history of development in the Clarence Valley, the majority of non-indigenous heritage sites are located within or near the floodplain or other lowland areas. In particular, sites within the study area tend to be concentrated in and around towns and villages close to the Clarence River, or on properties within the floodplain.

3.5.3 Noise and vibration

The study area contains approximately 2800 residential dwellings, the majority of which are located in towns, villages and rural residential areas, while others are more widely dispersed across rural areas and smaller localities. These are shown on **Figure 3-5**. There is also a high concentration of dwellings along the existing Pacific Highway. Other sensitive receivers in the study area include schools, churches, and aged care facilities. A preliminary noise and vibration assessment has been undertaken to determine potential impacts of the various route options.

Buildings were identified from aerial photography dated November 2004. Field verification of structure types has also been undertaken in some parts of the study area. Actual numbers of affected residences, or other sensitive receivers such as schools and hospitals, may be subject to change as the assessment of noise develops through the project due to additional development in the study area and potential errors in the identification of structures. A conservative approach has been adopted in the identification of noise sensitive structures to address this issue. The noise assessment has been refined as the project has progressed, and detailed noise assessment would be undertaken for the preferred route. This would include verification of the location and type of all noise sensitive receivers.

There are a substantial number of properties near the existing highway that are subject to high levels of road traffic noise, both during the day and night. The majority of the study area is

currently not subject to significant road traffic noise, or to noise from other sources. Areas adjacent to the existing Pacific Highway are subject to the highest levels of road traffic noise.

Road noise goals

Road traffic noise goals are determined by the Department of Environment and Conservation's (NSW DEC) *Environmental Criteria for Road Traffic Noise* (ECRTN) (DEC, 1999) guideline. The appropriate noise goals for the proposed upgrade of the Pacific Highway are listed in **Table 3-4**. The assessment methodology and application of the noise criteria are taken from the RTA's Environmental Noise Management Manual (ENMM) (RTA, 2001).

- **Table 3-4: Base criteria for road traffic noise**

Road category	Daytime Levels	Night-time levels
New Freeway	$L_{Aeq\ (15hour)}$ 55 dB (A)	$L_{Aeq\ (9hour)}$ 50 dB (A)
Redevelopment of an existing freeway	$L_{Aeq\ (15hour)}$ 60 dB (A)	$L_{Aeq\ (9hour)}$ 55 dB (A)

The New Freeway criterion is used for residences that are currently unaffected by road noise, or where the direction of noise is to change as a result of new road development. This criterion is expected to be applicable for the majority of the study area. Options involving upgrading adjacent to the existing highway may be subject to the criteria for redevelopment of an existing freeway. The criterion for redevelopment of an existing freeway recognises the existing noise levels experienced at residences adjacent to existing roads. This criterion is expected to be applicable for routes that follow the existing Pacific Highway.

Other sensitive receivers not covered under the residential criteria include schools, hospitals and churches. These are subject to separate internal noise level criteria under the ECRTN.

Where the criteria are already exceeded, the ECRTN requires that new roads should be designed so as not to increase existing noise levels by more than 0.5 dB. For a road redevelopment, noise levels should not increase above the existing by more than 2 dB. In both cases the ECRTN states that consideration should be given to reducing noise levels to meet the base criteria. Mitigation measures can be applied to assist in meeting the criteria, where they cannot be met through alignment of the road to minimise noise exposure. Such measures may include:

- Installation of noise walls or mounds to limit noise emissions reaching dwellings.
- Maintenance of roads to identify and rectify potholes, to minimise vibration and airborne noise.
- Architectural acoustic treatment of existing buildings.
- Acoustic design in future developments, including imposition of conditions of consent by council on future development, and planning for future residential release areas.

- Road surface treatments, which can result in different noise emissions from roadways, particularly at higher traffic speeds.

Avoidance of noise impacts (above the NSW DEC criteria) reduces the potential need for implementation of costly mitigation measures and is most effective on addressing community concerns about road noise. In the initial constraints analysis for the project, dwellings were identified and buffers applied to indicate potential noise sensitivity. This constraint formed part of the development of route options. However, the spread of settlement across much of the study area means that avoidance of noise impacts is very difficult.

An important issue for this project is the distinct difference in existing noise conditions within the study area. Residences and other sensitive land uses along the existing highway are currently subject to high levels of road traffic noise. Many of these areas have been settled for a long period of time and traffic volumes and the size and number of heavy vehicles has grown incrementally over time. This has resulted in increasing levels of noise exposure for many residents. Conversely, areas away from the highway are typically less densely settled, and potential exists to develop new route options that result in noise affectation to less residents. However, these residents currently enjoy an environment that is relatively free of road traffic noise, and a new road would result in substantial changes to the existing noise environment. Even where dwellings are predicted to experience new noise levels below the NSW DEC criteria, the extent of change in noise levels has the potential to cause annoyance to residents.

The potential for traffic to be split between a new route and the existing Pacific Highway also has implications for the development of route options. While new route options (away from the existing highway) would divert through traffic and provide benefits to residents along the existing highway, a high proportion of local and regional traffic would continue to use the existing highway with residual noise effects. For this reason, since the display of the route options in late 2005, further assessment of noise impacts has been undertaken to model the cumulative noise impact of the existing highway and route options. This is further discussed in **Section 5.4.4** and in the *Noise and Vibration Working Paper* (RTA, 2006f).

3.5.4 The local economy

Grafton is located at the centre of the Clarence Valley and it provides retail outlets, services, entertainment and employment for many residents in the surrounding areas. While Grafton has only 35 per cent of the Clarence Valley population, it has 60 per cent of the retail establishments within the Clarence Valley and provides 75 per cent of the employment in the retail field (Grafton City Council website). Maclean and Yamba are also important retail and service centres.

The economic base of the study area is largely agriculture, tourism and transport services, with all sectors having good potential for future development. Clarence Valley Council has released the *Clarence Valley Economic Development Strategic Plan* (Clarence Valley Council, 2006a), and this identifies a range of measures to secure the economic future of the valley.

The Economic Development Strategic Plan acknowledges that there are both threats and opportunities associated with the proposed Wells Crossing to Iluka Road upgrade project and that accessibility of towns to and from the motorway, as well as the location of interchanges, will be of critical importance to the Clarence Valley. Threats include the loss of turnover of businesses providing goods and services to passing motorists, while opportunities include new types of business and visitor experiences from the enhanced amenity of town centres and the development of hubs or clusters of businesses offering transport and related services within close proximity of interchanges.

In the agricultural sector, the main crops grown are sugar cane, soy beans, sub-tropical fruit and vegetables and cereals, while beef cattle and dairying are also important activities. Much of the land in the study area is considered prime agricultural land, being associated with the floodplains and alluvial levees of the Clarence and Coldstream river systems. The emerging importance of other forms of agriculture, such as organic farming and small niche crops is also significant, particularly as some of these enterprises are located outside the traditional agriculture areas on the floodplain.

Grafton is a transport hub for the surrounding region, being served by three highways, the North Coast Railway and Grafton Airport. It is increasing in attractiveness as a location for the warehousing and distribution industry. This is partly because of improved road transport links and also factors such as proximity to the fast-growing south-east Queensland and mid-north coast of NSW and lower costs of land acquisition or building rental than Sydney or Brisbane locations.

Most manufacturing (other than sugar) is geared to production for local use, eg. food products, printing and local input requirements. This pattern is unlikely to change in the future, particularly as the general climate for business is possibly more favourable in south-east Queensland (through lower costs of doing business, other than land).

Economic growth opportunities in the study area are likely to be led more by tourism and in-migration of households (both retirees and working-age) rather than by production. Such growth, however, is not expected to be as strong as in the major centres of Coffs Harbour and Port Macquarie, with their better provision of health and education services, accommodation facilities and employment opportunities, or in coastal centres closer to Sydney or south-east Queensland (eg. Port Stephens, Great Lakes, Ballina, Tweed Heads). Grafton and surrounds

also lack comprehensive air travel services and this may be a limiting factor in the growth of tourism, relative to other areas with more regular and larger capacity flights.

Tourism is a major activity, with tourists attracted by the area's climate, beaches and waterways, heritage and cultural facilities, recreational and sporting activities, accommodation facilities and the village atmosphere of the town centres. There are large influxes of visitors to the coastal towns of Iluka, Yamba, Brooms Head, Minnie Water and Wooli during holiday periods and to Grafton during major events such as the Racing Carnival, the Bridge to Bridge Ski Race and the Jacaranda Festival. Visitors stop in and pass through the study area to reach these destinations.

Because the Pacific Highway is the main route to, from and within the Clarence Valley, its importance to the local economy is substantial. At a local level it provides access to employment, retail, commercial and entertainment opportunities and is used for local freight transport. At a regional level, it provides for the movement of freight associated with both local production (eg sugar and timber) and to service local retail (eg. deliveries to supermarkets and other stores). It is the primary means of access for tourists to the Clarence Valley. At an intra and inter-state level, it also creates income through highway related businesses such as service stations, motels and vehicle repairs.

Changes to the location of the highway have the potential to have flow on effects for the local economy. Re-assignment of traffic from the existing highway to an upgraded highway (regardless of its location) will reduce the amount of passing trade for many businesses along the existing highway. Notwithstanding, evidence from other highway redevelopment projects indicates that, while some businesses will be affected, overall the economic impact of removing through traffic from towns and villages is positive.

Grafton is an important sub-regional centre in its own right and has only limited reliance on the highway for its economic prosperity. It is therefore expected to be resilient to changes that may arise from the upgrading of the highway. However, the benefits of maintaining good access to Grafton for through or regional traffic, and maintaining the existing highway for local traffic, are important considerations in the development of the project.

3.6 Environmental issues

3.6.1 Topography, geology and soils

A geotechnical investigation was undertaken as part of the route selection process by Coffey Geosciences Pty Ltd. This study included a detailed terrain evaluation study followed by field investigations, which included a sampling program to determine geotechnical conditions across the study area. Further information is provided in the *Geotechnical Working Paper* (RTA, 2006c).

Topography and terrain units

The study area is located in the south-eastern corner of the Clarence-Moreton geological basin. It is underlain by a sequence of Jurassic age sedimentary rocks, mainly sandstones of varying hardness. Two key formations for this project are the Kangaroo Creek Sandstone, which forms a prominent chain of hills in the centre of the study area (Shark Creek Range, Pillar Range and Bondi Hill), and the Gatton Sandstone further east within the Coast Range. The topography of the study area is illustrated at **Figure 3-8**.

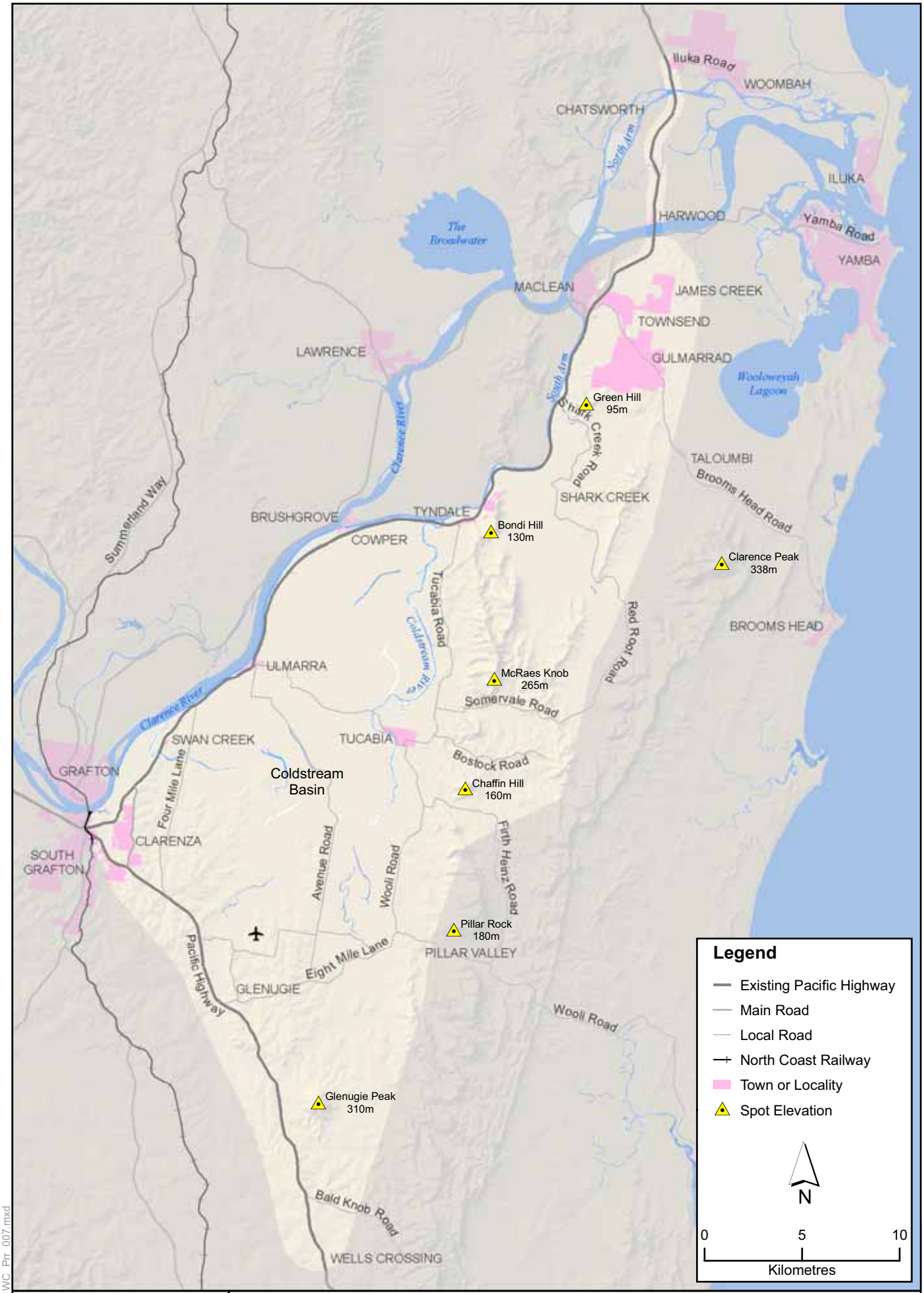
The western and northern sections of the study area are dominated by the flat floodplain, including Coldstream Basin and Shark Creek, and undulating low hills at the floodplain margins. The south and east of the study area are characterised by low but in some cases steep ranges, generally with ridges running in a north-south direction. Glenugie Peak, a volcanic plug, is a significant geological feature in the south of the study area.

To assist with selection of potential routes for further geotechnical investigation, the study area was divided into Terrain Units characterised by more or less uniform bedrock, topography and soils. Because the nature of these units is largely determined by the underlying geology, their boundaries are generally close to those of the principal outcropping geological formations. These are illustrated at **Figure 3-9**.

The most favourable geotechnical conditions for highway construction exist in the bedrock areas in the eastern parts of the study area. The least geotechnical constraints exist to the east of the Coldstream Basin along the hill slopes of the foothills and ranges between Pillar Valley and Tucabia and then along the Shark Creek Range to Harwood.

The main geotechnical constraints in the study area and issues for the project include:

- Construction materials (ie. sources and types of general and select fill, coarse aggregate, sand and road base) – suitable materials generally occur in the eastern part of the study area, which is also where less fill material would be needed for road construction.
- Soft soils – low strength, highly compressible and potentially acidic soils occur in low lying areas and present substantial constraints (mainly construction cost and time) because they may lead to foundation stability and embankment settlements. These soils are located predominantly within the floodplain that dominates the west and north of the study area, and in smaller alluvial flats such as along Shark Creek.
- Ease of rock excavation – where bedrock is encountered, sandstone is expected to be the main rock type. It could be removed mainly by ripping and or by bulk blasting in deeper cuts.
- Rock cutting stability – this constraint is considered to be relatively minor and applies to rock cuttings in the eastern part of the study area.



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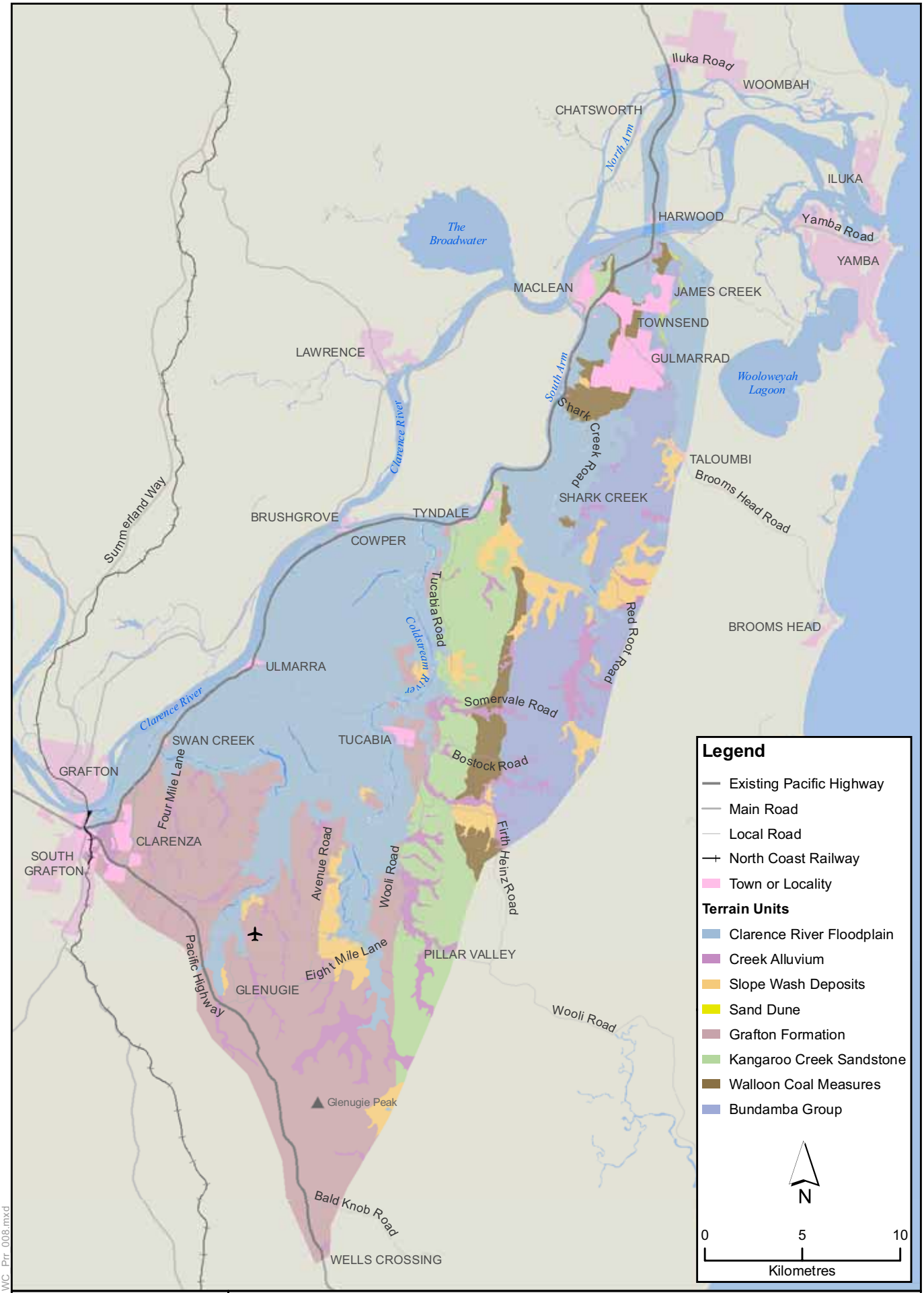
Wells Crossing to Iluka Road
Upgrading the Pacific Highway

Figure 3-8: Topography



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Wells Crossing to Iluka Road
Upgrading the Pacific Highway

Figure 3-9: Geology and soils

Other potential geotechnical constraints include expansive and dispersive soils, stability of natural slopes, acid and combustible rocks, and foundation conditions at bridges and structures.

Land contamination

Recorded potential contaminated sites within the study area include 67 former cattle dips, sawmills, fuel storages, several small industrial undertakings and at least one landfill. Based on the information presently available, none of these sites are sufficiently large to present a major constraint to the project. Further information would be obtained on any contaminated sites likely to be impacted by the preferred route.

Acid sulphate soils

The acid sulphate soil map for the study area (**Figure 3-10**) indicates that areas with a high probability of acid sulphate soils coincide with the occurrence of alluvial and estuarine soils in the Clarence River floodplain at elevations up to five metres above sea level. The greatest risks for the project therefore exist in the western, central and northern parts of the study area in areas of Class 2 or Class 3 acid sulphate soils. These classes indicate soils where acid generating material is likely to be present and the potential depth at which potential acid sulphate material is likely to be encountered. The presence of potential acid sulphate soils may have both construction and environmental implications. Construction methods, such as driven piles, may be required to limit excavation or further de-watering of these soils. Construction materials may also need to be resistant to acid. Environmental implications of inappropriate management of acid sulphate soils may include fish kills and changes to in-stream or wetland habitats.

3.6.2 Flooding and drainage

An assessment of hydrology and hydraulics was undertaken for the study area as part of the route selection process by WBM Oceanics Pty Ltd. This study was based on modelling undertaken for the Lower Clarence River Flood Study, and included further modelling specific to the Wells Crossing to Iluka Road study area, and modelling of the route options under consideration. Further information is provided in the *Hydrology and Hydraulics Working Paper* (RTA, 2006d).

The Clarence is the largest river system on the east coast of NSW, and the size of the catchment and floodplain present significant risks for the development of an upgraded highway. The Clarence River floodplain areas are subject to frequent and extensive flood inundation. The catchment of the Clarence River covers more than 20,000 square kilometres upstream of Grafton and at times of major flooding some 500 square kilometres downstream of Grafton become inundated. The project study area encompasses much of the extensive floodplains of the Clarence River and its tributaries including Swan Creek, Glenugie Creek and Shark Creek and the Coldstream River to the east of Grafton and **Figure 3-11** shows main drainage features.

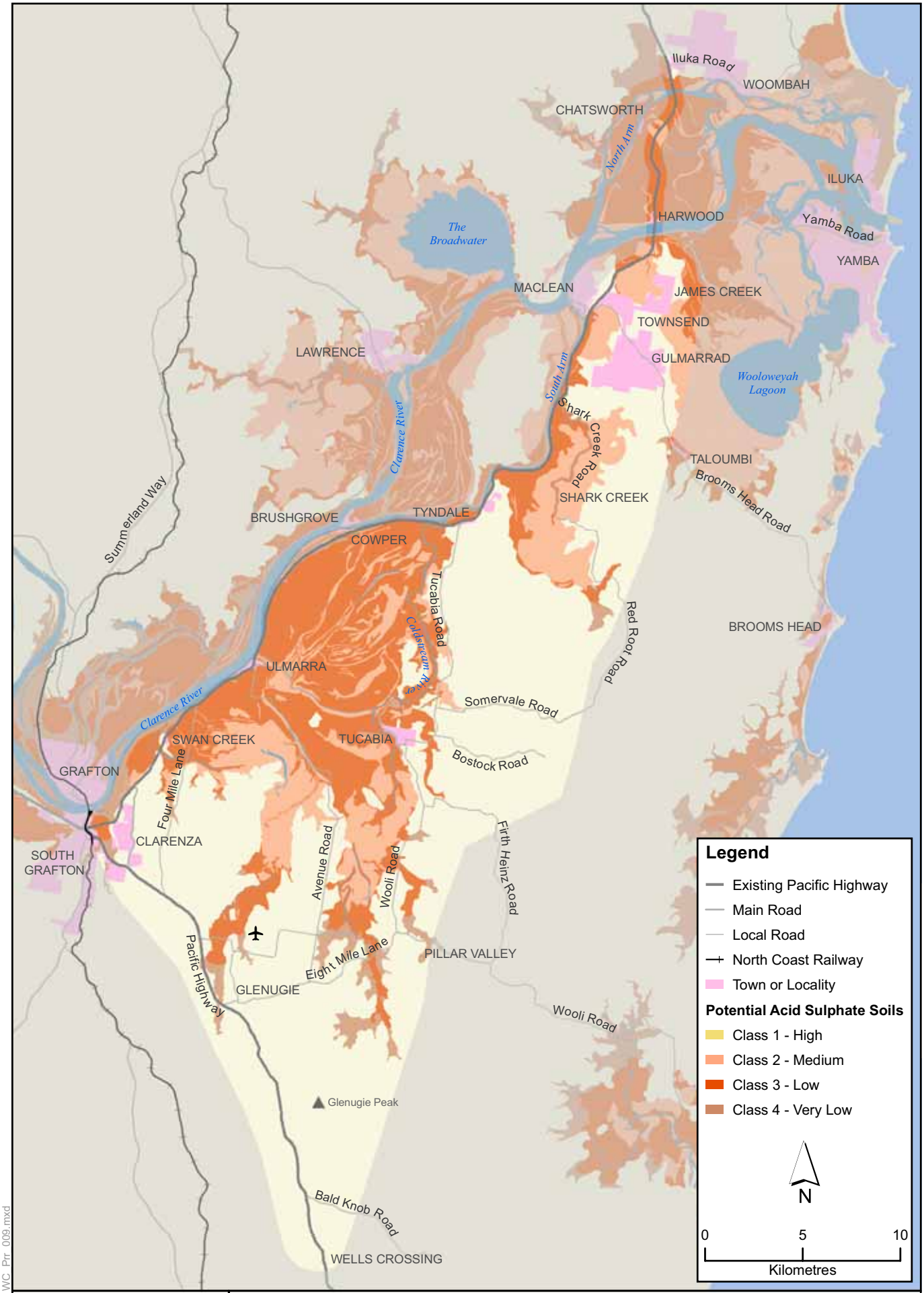

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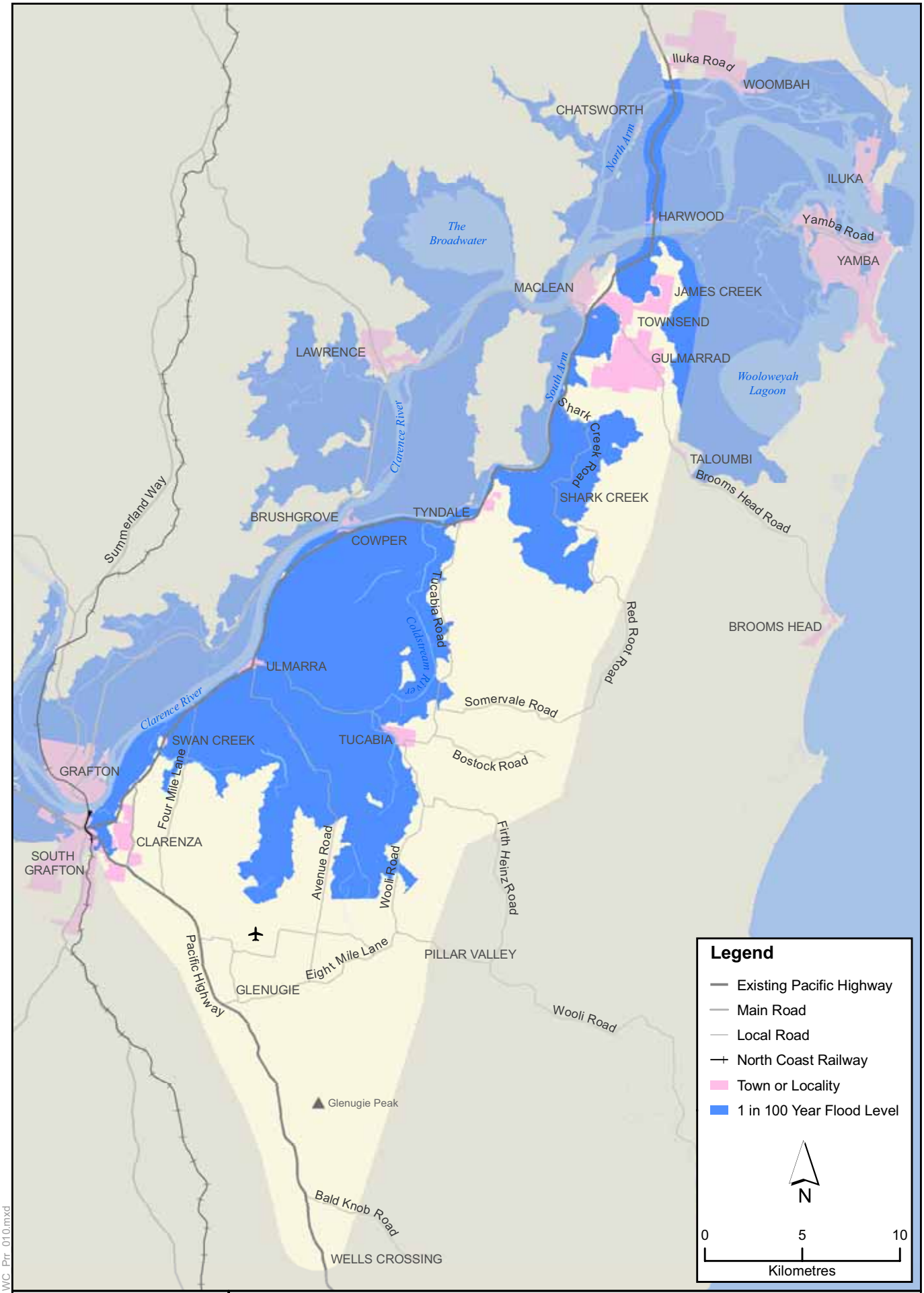
Figure 3-10: Potential acid sulphate soils



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Wells Crossing to Iluka Road
Upgrading the Pacific Highway

Figure 3-11: Drainage and flood levels

The numerous sub-catchments within the Clarence River system vary in size and flooding characteristics. This variability, along with the influence of the ocean (through storm surges) means that the study area experiences different types of flooding, and combinations of flooding types in some circumstances. Inundation as a result of flows from upstream in the catchment can combine with storm surges to create major floods. In addition, the contribution of smaller catchments to local flooding is important, particularly for smaller floods. Flow velocities and depths can be high in some of the tributaries of the Clarence River such as the Coldstream River and Shark Creek.

There are two very important issues in relation to flooding for the project. The first is the potential for the project to result in changes to flooding behaviour within the catchment and floodplain. A new road across the floodplain has the potential to result in upstream (and downstream) changes including reduced floodplain storage capacity, changed flood heights, flow velocities and inundation times. The impacts of the project can to an extent be predicted through modelling of changes to flood behaviour. However the complexity and scale of flood behaviour introduces a high level of risk to the assessment of flooding impacts. The position of the study area in the floodplain heightens the potential risks of the project impacting on farms, towns and residences. The potential for economic and social consequences from changes to flooding are substantial for this project.

The second issue relates to flood risks associated with the functionality of the upgraded highway. Flood flows create risks for the structural stability of the road, including the potential for scouring of embankments and stresses on bridges and other structures. Inundation may cause traffic delays and damage to the road pavement. These risks are greatest within the floodplain, although high velocity flows in upper sections of some smaller catchments also present risks such as damage from debris carried by flood flows.

More detailed discussion of flooding risks associated with the preferred route option is provided in **Section 7**.

3.6.3 Ecology

Ecological studies undertaken to date have focused on understanding ecological conditions in the study area and surrounds for the purposes of comparing route options and determining a preferred route. Investigations have included desktop assessment of mapping and literature reviews, consultation with the community and government agencies, aerial inspection of the study area to provide an overview of conditions and to assist in planning field work, and targeted field investigations on three occasions, in April and November 2005 and May 2006. More detailed information is provided in the *Biological Assessment Working Paper* (RTA, 2006a).

Given the size of the study area, investigations were initially focused on providing a general understanding of ecological conditions, as a basis for assessment of the route options. The assessment has been refined as the project has progressed, and field work at each stage of the project has been targeted to develop a more detailed understanding of the potential impacts of the options. Both terrestrial and aquatic investigations have been undertaken.

Vegetation types and endangered ecological communities of the study area

Within the study area at least six broad vegetation types were identified from field surveys, with a minimum of 10 vegetation associations recorded. Several of the communities recorded are considered as representative of vegetation types classified as Endangered Ecological Communities listed under the *Threatened Species Conservation Act, 1995* and additionally as vegetation of local and regional significance. The communities are summarised in **Table 3-5**.

Table 3-5: Broad vegetation types of the study area

Vegetation Type	Dominant Species
Woodland / Open Forest	*Corymbia henryi, Eucalyptus fibrosa, Eucalyptus moluccana, Eucalyptus siderophloia.* *Eucalyptus pilularis, Eucalyptus microcorys, Angophora subvelutina, Eucalyptus planchoniana, Banksia* spp. *Eucalyptus signata, Corymbia gummifera, Eucalyptus microcorys, Angophora subvelutina.*
Moist Open Forest*	*Eucalyptus resinifera* subsp. *hemilampra, Corymbia intermedia, Eucalyptus acmeniodes, Lophostemon suaveolens, Callistemon salignus.*
Swamp Forest*	*Eucalyptus robusta, Melaleuca quinquenervia, Lophostemon suaveolens, Casuarina glauca.* *Casuarina glauca, Melaleuca quinquenervia.*
Freshwater Wetlands*	*Eleocharis* spp., *Baumea* spp. *Juncus* spp.
Lowland Rainforest*	*Aphananthe philippinensis, Ficus* sp., *Grevillea robusta.*
Disturbed / Grazing Land	Primarily comprised of introduced grasses and herbaceous species.

* Denotes communities that are classified as Endangered Ecological Communities under the *Threatened Species Conservation Act*.

Much of the lowland floodplain area of the Clarence River would have comprised lowland rainforest, swamp forests, wetlands and wet floodplain eucalypt forests prior to European settlement. The vast majority of the vegetation was cleared from the area and throughout the North Coast bioregion due to pressures from forestry, the presence of fertile soil types suitable for agriculture, and proximity to the river and coast for transport and settlement. As a result of past clearing and modification, several vegetation communities of the NSW north coast bioregion have been scheduled as endangered ecological communities under the *Threatened*

Species Conservation Act, 1995. The endangered ecological communities recorded within the study area during the preliminary surveys are shown on **Figure 3-12** and include:

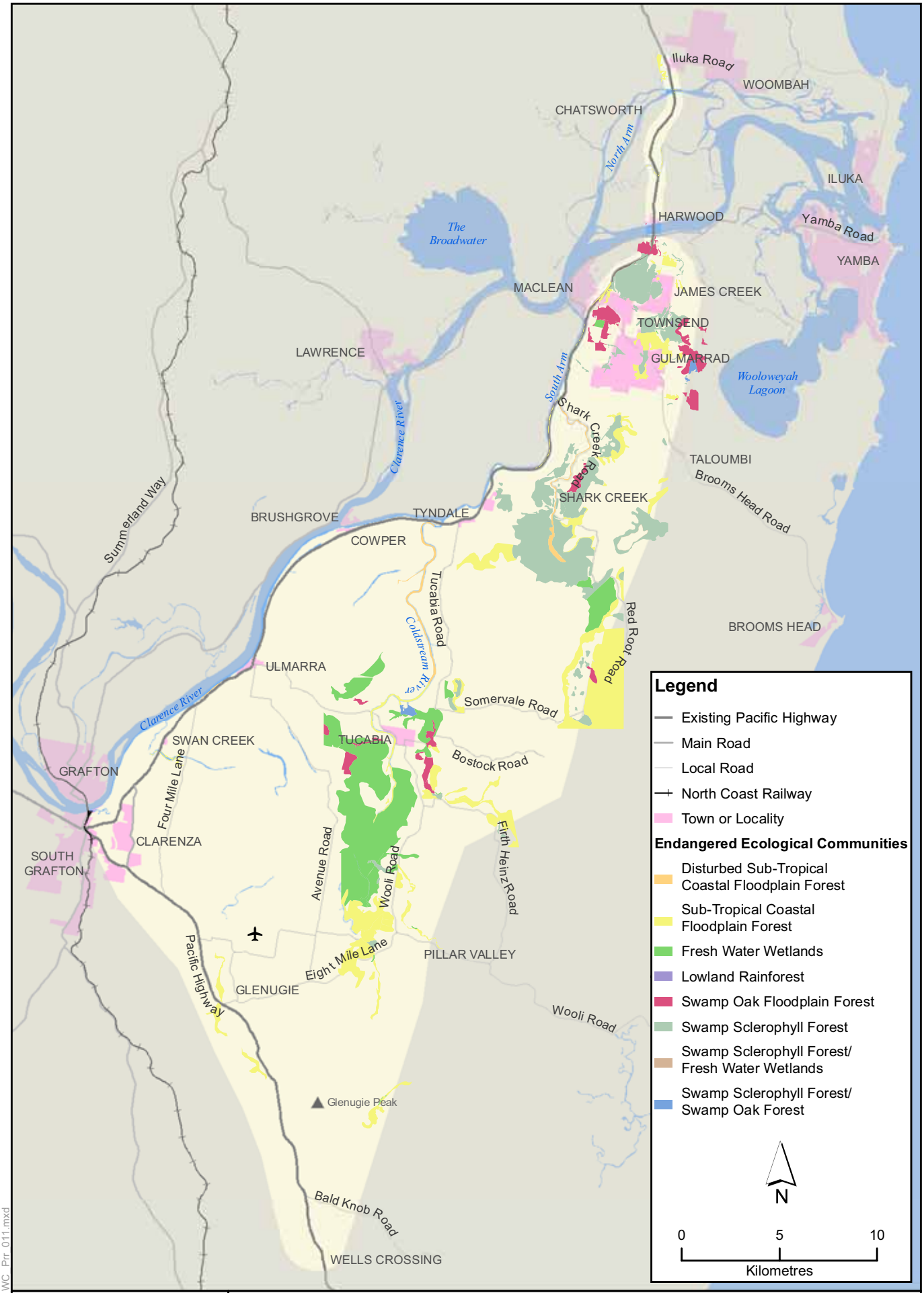
- Subtropical Coastal Floodplain Forest of the NSW North Coast bioregion.
- Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions.
- Lowland Rainforest on floodplains in the NSW North Coast Bioregion.
- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions.
- Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions.

Other endangered ecological communities potentially present in the study area, but not identified during field investigations to date, include:

- River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions.
- Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner bioregions.
- Littoral Rainforest in the NSW North Coast, Sydney Basin and South East Corner bioregions.

Within the study area there are numerous small and isolated remnant fragments of these community types scattered throughout the floodplain. Additionally, there are some large intact and undisturbed remnant stands of high ecological importance. The large stands are often associated with wet depressions containing wetland and swamp forest communities, several of which are located within the boundaries of SEPP 14 wetlands. The small stands of vegetation more commonly exist as scattered and occasional remnant stands or small regrowth patches.

The condition of endangered ecological communities has been assessed in the vicinity of the route options as shown on **Figure 3-13**. Generally, the condition of endangered ecological communities in the study area is moderate to poor due to influences of other land use such as grazing and land clearing, or changes to hydrological regimes. Some areas of relatively intact, high quality vegetation communities have been identified, particularly in the eastern parts of the study area.



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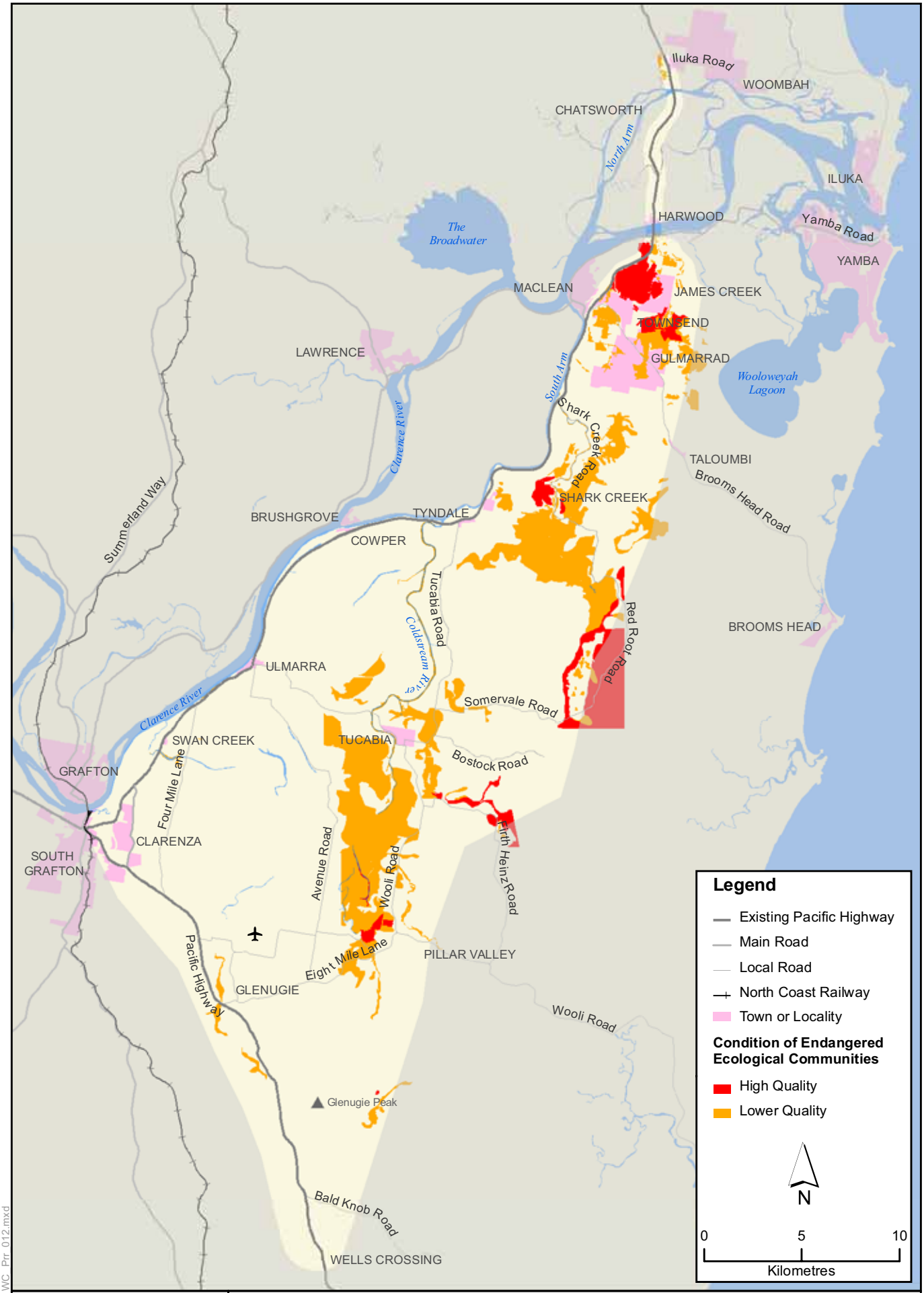
Wells Crossing to Iluka Road
Upgrading the Pacific Highway

Figure 3-12: Endangered Ecological Communities



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Wells Crossing to Iluka Road
Upgrading the Pacific Highway

Figure 3-13: Condition assessment of Endangered Ecological Communities

Conservation reserves

There are several state forests and ecologically significant areas within the study area. National parks, nature reserves, state conservation areas, conservation zones within state forests and SEPP 14 wetlands are shown on **Figure 3-14**. The existing highway from Wells Crossing to Grafton passes through the Glenugie State Forest and Bom Bom State Forest and the Pine Brush State Forest is located near the centre of the study area. The Wells Crossing Flora Reserve is located within the eastern corner of the Newfoundland State Forest, and is partly within the study area. Numerous other parts of the state forests within the study area are zoned under the *Forestry Act, 1916* for conservation purposes.

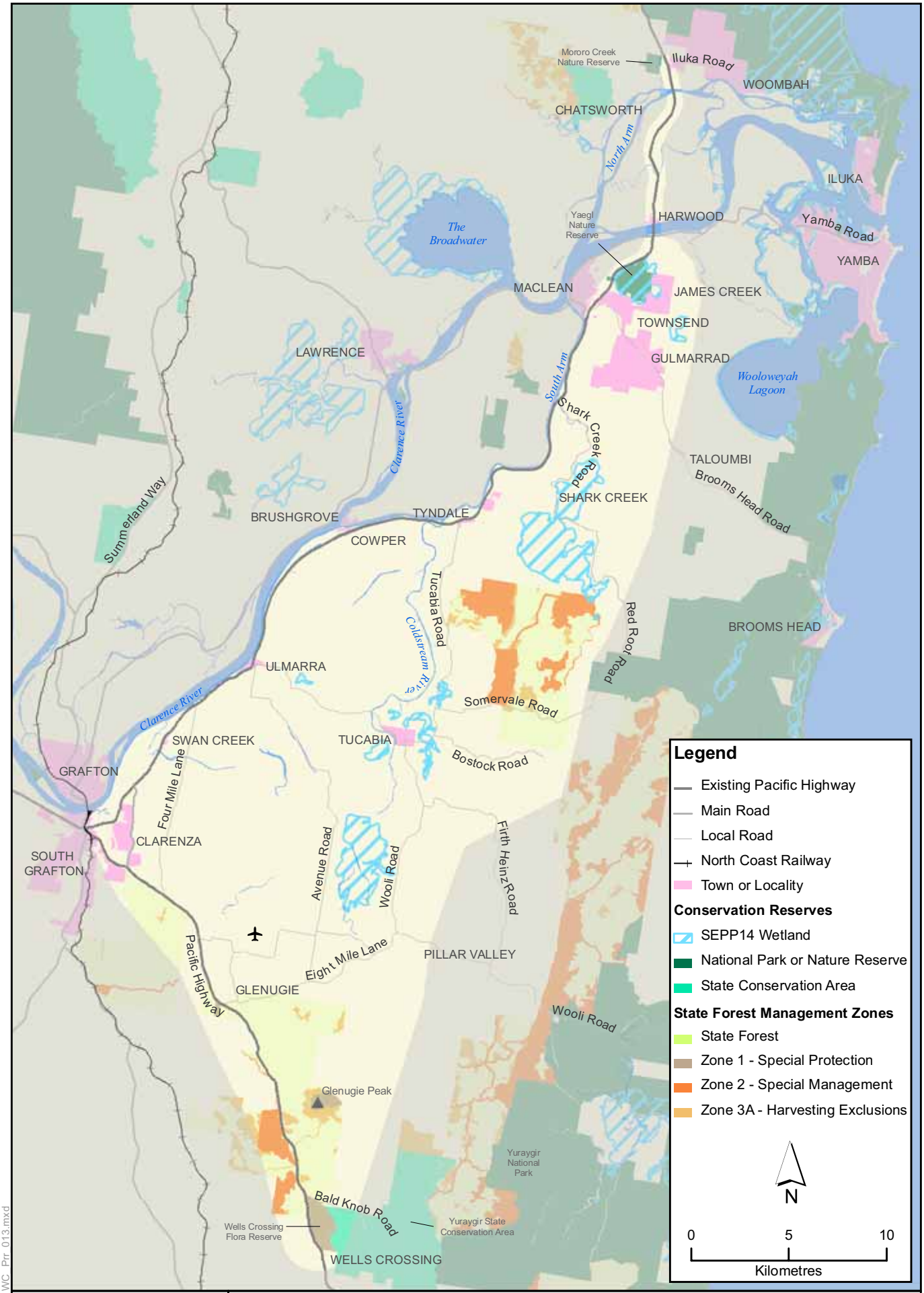
The Yuraygir State Conservation Area is located at the southern tip of the study area, and adjoins land within Newfoundland State Forest that is identified as the Wells Crossing Flora Reserve. The Yaegl Nature Reserve is located entirely within the study area to the east of Maclean and the existing Pacific Highway. The Yuraygir National Park is located beyond the eastern boundary of the study area. A small part of the Mororo Creek Nature Reserve is located within the study area to the west of the Iluka Road intersection.

Nine ecologically significant wetlands listed under SEPP 14 occur within the study area. These wetlands are primarily located in the central and eastern parts of the study area near Pillar Valley, Tucabia and Shark Creek.

Terrestrial fauna habitats

The diversity of threatened fauna species in the study area and surrounds is very high relative to other areas on the NSW north coast, and this is an indication of both the diversity and quality of fauna habitats within the study area, and the importance of links to other areas of high value habitat such as the Yuraygir National Park. All parts of the study area provide some habitat value, however, the forested eastern parts of the study area and the large freshwater wetlands are of greatest importance. The presence of large areas of contiguous and high quality remnant bushland, and linkages from bushland to wetland and floodplain habitats, are very important to the native fauna of the area.

Fauna habitat information was obtained for the project from the NSW DEC regional key habitats mapping. Field assessment provided more detailed assessment of locally significant fauna habitats. Following the display of the route options in late 2005, more detailed assessment of habitat values within the study area was undertaken to gain a better understanding of the importance of habitats within and around the study area in a local and regional context. The assessment included additional field work, review of the results of habitat assessments undertaken previously, and consideration of habitat values in a broader regional context through review of other studies.



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Wells Crossing to Iluka Road
Upgrading the Pacific Highway

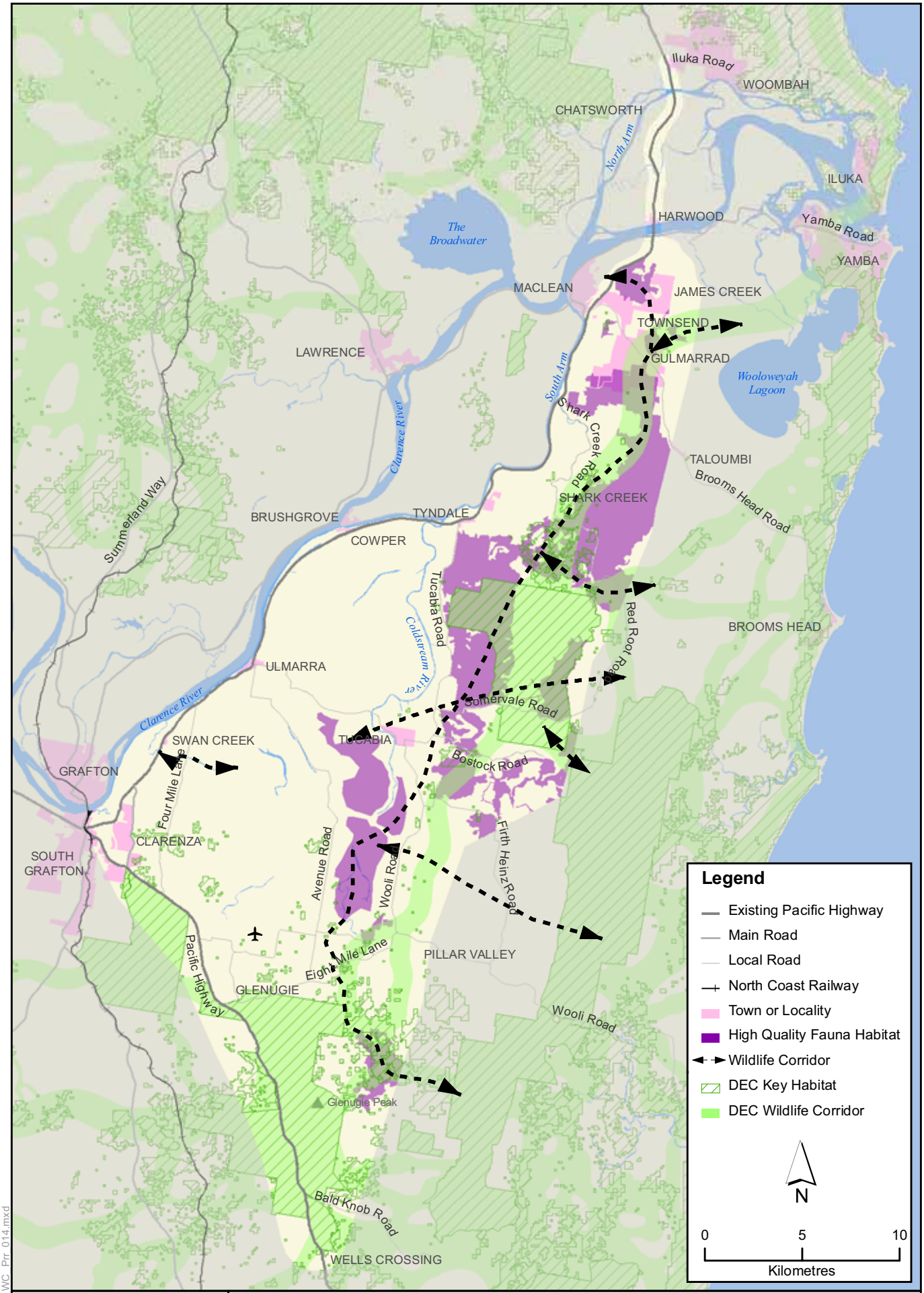
Figure 3-14: Conservation reserves and SEPP 14 wetlands

The main habitat types within the study area include forests and woodlands, riparian areas and wetlands, however, cleared pasture and croplands also have habitat values for some species. Key features of these habitat types are summarised in **Table 3-6**. Remnant native vegetation, areas of high quality habitat, and wildlife corridors are shown on **Figure 3-15**.

The large area of contiguous high quality habitat is a key ecological feature of the study area and for this reason it is important to consider both the area of habitat to be directly impacted by the road corridor, and the potential for fragmentation of habitat as a result of linear clearing and road construction. Fragmentation has the potential to substantially impact on habitat values due to the importance of linkages between the forests and woodlands in the east of the study area and the Yuraygir National Park, and the floodplain habitats in the centre and west of the study area. The wetland / swamp habitats on the floodplain are significant to the regional fauna, and these are not well represented in Yuraygir National Park. Retention of access to these is therefore important particularly during drought or to maintain breeding cycles.

The area is rich in ecological resources, with approximately 100 threatened fauna species known from the study area and immediate surrounds. This diversity and quality of fauna habitats within the study area is a key consideration for the project as is the importance of links to other areas of high value habitat such as the Yuraygir National Park. In a broader regional perspective, the containment of the study area by the Clarence River and the presence of Yuraygir National Park contribute to making the Clarence Valley and adjacent coastal areas a sink for high biodiversity, particularly fauna.

The identification of significant fauna habitat in the study area was based on mapping habitats in a natural or near natural state, and is likely to be an underestimate of the extent of important habitat present, particularly given the number of species and therefore the range of habitats required. Information on habitat values in the study area remains limited. It is, however, generally accepted that native vegetation clearing is the single biggest threat to biodiversity and the cumulative impacts of development in the Clarence Valley beyond the construction of the new highway are an important factor to consider.



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Wells Crossing to Iluka Road
Upgrading the Pacific Highway

Figure 3-15: Fauna habitats and movement corridors

The assessment of nearly all the habitats potentially affected by the route options revealed that forests dominated by Scribbly Gum and Bloodwood on sandy soils have been the least impacted historically due to poorer quality soils for farming and the lack of suitable timber species. As a result, these habitats are in a near natural state and present the highest quality habitat for the largest diversity of local threatened fauna in general. The best examples within the study area include:

- The area to the west of Brooms Head Road and Wallaby Lane.
- Several patches of forest between Firth Heinz Road north to Somervale Road and Red Root Road.
- To the east of Tucabia Road on the lower slopes of McRaes Knob north to Round Mountain.

When considered from a regional perspective there are very few areas of such high significance as these areas represented outside conservation reserves in coastal NSW. In a regional context, the high value habitats of the study area must therefore be considered as significant. In particular, the retention of large areas of contiguous remnant vegetation is important in retaining these habitat values.

Table 3-6: Habitat conditions in the study area

Habitat type	Characteristics
Forest and woodland habitats	■ Well represented in the study area, comprising all remnant vegetation areas. ■ Largely contained in the south and east in Glenugie and Pine Brush State Forest and connecting forests east of Tucabia. Continues to the north east of the study area along the steeper slopes and gullies of the Shark Creek Range and contiguous with Yuraygir National Park further east to the coast. ■ Capacity to support a wide range of species (including threatened species) and support breeding, sheltering, feeding and freshwater habitat values. ■ High quality forest habitats exist to the east of Tucabia in the Bostock gully and Chaffin Creek area north to Champions Creek, along the foothills and escarpments of Shark Creek Range and along Brooms Head Road and connecting to the east into Yuraygir National Park.
Riparian areas	■ Includes moist forest, rainforest and mangrove elements along the Clarence River and larger tributaries, in agricultural areas that have been heavily depleted due to past clearing of the floodplain. ■ Important for fauna movement and refuge. ■ Weed invasion is a problem, but habitats are generally diverse. ■ Examples occur along the Clarence River and Coldstream River, Shark Creek, and Glenugie Creek.

Habitat type	Characteristics
Swamp forest	■ Vegetation retained or established in low-lying areas adjoining creeks, wetlands and rivers. ■ Generally isolated fragments, with the best-preserved areas of swamp forest occur around low-lying wetlands (including SEPP 14 wetlands) and as small remnant patches on the Clarence River floodplain. ■ Well represented throughout the Tyndale and Tucabia areas and include Crows Nest Swamp, and Morans Swamp. ■ Swamp forests provide habitat for common and threatened amphibians and waterfowl and waders as well as aerial nectivores during the peak flowering period. They also provide breeding habitat for insects and therefore are an important resource in terms of the provision of food for insectivorous fauna. Mammal fauna are generally restricted to bats and macropods that are capable of moving across cleared lands to access the isolated remnants of this habitat.
Freshwater wetlands, lagoons and estuarine areas	■ Represented by a variety of different habitats from relatively natural freshwater creeks to open lagoons in cleared agricultural lands to grazed ephemeral reed and sedge areas. ■ Common on the floodplain south of Brushgrove and around Ulmarra, such as Harrington Lagoon and Swan Creek. Frequented by waterfowl and other wetland birds capable of moving distances in search of food. ■ Impacts from cattle grazing and agricultural chemicals are evident and some habitats are completely devoid of natural vegetation. ■ Provide habitat for threatened fauna including the Black-necked Stork, Brolga, Magpie Goose and Comb-crested Jacana. Black-necked Stock nest sites in the study area include Crows nest Swamp, Chaffin Creek, the lower Coldstream area and Swan Creek. ■ Fresh and estuarine waterways are well represented in the region, ranging from major permanent streams such as Coldstream River and Shark Creek. ■ Provide a diversity of fish habitats as well as habitat for fauna dependent on aquatic and semi aquatic habitats, eg. frogs, some reptiles, mammals and several common wader and waterbird species. ■ Estuarine fauna habitats in the study area include open water, intertidal sand flats, sandy shores, mangrove forests and *Phragmites* (reed) vegetation. Such habitats are important nursery, refuge and feeding grounds for a range of commercial and recreational fish and crustacean species and provide important habitat for bird groups such as waders, waterfowl, cormorants, pelicans, herons, oystercatchers and their allies. The threatened Osprey is known from the study area.
Modified grasslands and pastures	■ These habitats provide fewer important features for fauna and comprise lower fauna diversity as a result of the degree of clearing and modification. ■ Generally devoid of significant vegetation or habitat for threatened species, except for small remnants and some isolated trees. ■ Dominated by common agricultural and disturbance tolerant fauna species and introduced fauna. ■ Large dead trees are often selected as preferred nest sites for raptors including the threatened Osprey.

Wildlife corridors

Several important wildlife corridor linkages are located within the study area and are relevant to the assessment of the route options. As discussed in relation to habitat values, corridors are important in providing access to the diverse habitats of the floodplain and ranges, and assist in supporting a high diversity of fauna species.

A review and assessment of local fauna movement corridors was undertaken to determine areas of greatest fauna movement activity within the study area and adjacent areas. The information and data used in the assessment included:

- Location of state forests, conservation reserves and SEPP 14 wetlands.
- Fauna records from the NSW DEC wildlife observations database, WIRES and local naturalists, and observed during surveys undertaken for this Project.
- Key fauna habitats identified by NSW DEC.
- High quality fauna habitats identified during field investigations for this project.
- Concentrations of Emu activity based on data supplied by NSW DEC (Matt Clarke, *pers. comm.*) along with clusters of Emu records located in the atlas.

The data showed trends in fauna activity and movements associated with the two main large SEPP 14 wetlands, Coldstream wetlands in the south and the Shark Creek wetlands (Tyndale) in the north. Movements to and from the wetlands are in both north-south and east-west directions. Based on these investigations, the mapping of wildlife corridors has been updated from those provided by the NSW DEC, and those identified in the Route Options Development Report. The updated corridors are shown on **Figure 3-15**, along with corridors identified by the NSW DEC. This information has been used in the assessment process to determine fauna crossing types and locations, and is discussed further in **Section 5.4.2**.

The most important corridors identified in the study area and surrounds include:

- Habitat linking the Coast Range to Shark Creek Range. This corridor provides an east-west link between Yaegl Nature Reserve and the habitats around Gulmarrad across to Yuraygir National Park to the east of the study area.
- From the Coast Range over the Pillar Ridge and across to Crows Nest Swamp.

Many smaller local wildlife corridors and links also occur throughout the study area. Those close to roads are often identified by wildlife road kill black spots. One of these black spots has been identified on the existing Pacific Highway between Yaegl Nature Reserve on the east side and habitat to the north of Maclean on the west side of the highway.

Evidence from a number of community surveys undertaken by NSW DEC on the local Emu population suggests that ecotonal areas of forest adjoining open sugar cane farms are particularly important post-breeding. Access to open cleared land and the forest edge, along with the local wetlands associated with Shark Creek, Tyndale Swamp and the Coldstream River, account for the majority of movements from Yuraygir National Park into the study area.

Aquatic habitats

Assessment of the condition of aquatic habitats was also undertaken within the study area. NSW Fisheries (1999) provides guidance on classification of freshwater habitats. The guidelines define habitat based on four categories, from Class 1 (major fish habitat) to Class 4 (unlikely fish habitat).

Waterways were assessed at 35 separate locations across the study area. These waterway locations were classified as either Class 1 or Class 2. Class 1 locations, providing high quality estuarine or freshwater aquatic habitats within the study area, include:

- Chaffin Creek.
- The Clarence River.
- Coldstream River (at the confluence with Clarence River, near Tucabia and at Reserve Road).
- Serpentine Channel.
- Shark Creek (at Stokes Road).
- Swan Creek at Four Mile Lane and downstream of Wilcox Bridge.

The waterways of the lower Clarence region are diverse in terms of environmental condition and form. A characteristic of most waterways is a continuum of decreasing in-stream and riparian condition with distance downstream as streams that originate within forested headwaters enter freehold agricultural land where land clearance, grazing and intensive farming is prevalent. While waterways in the study area exhibit relatively good aquatic habitat values, key issues include predation or competition by exotic species such as *Gambusia* (Mosquito Fish), poor quality riparian zones impacted by grazing and clearing, and degradation of freshwater and estuarine wetland habitats. Key features of importance in terms of aquatic habitat values include:

- The interface between freshwater and saline sections of waterways, important in terms of breeding and nursery habitats, particularly for species that transition between fresh and saline water as part of their breeding cycle.
- Permanent pools in intermittent waterways such as Chaffin Creek, the Coldstream River and Pillar Valley Creek.
- Potential habitat for threatened aquatic species including widespread wetland habitat for the Giant Dragonfly, and potential habitat in permanent pools for the Eastern Freshwater Cod.

Species of conservation significance

Records have been obtained for threatened aquatic and terrestrial species and populations previously recorded from a 10 kilometre radius of the study area and details are provided in the *Biological Working Paper* (RTA, 2006a). Documented locations of threatened flora and fauna species within the study locality were reviewed and compiled. The data sources used in this review included but were not limited to the following:

- NSW DEC Atlas of NSW Wildlife Database.
- Records from the State Forests in the study area, supplied by the Department of Primary Industries (NSW Forests).
- Results of previous surveys within the study area (Clancy 2003).
- Listings maintained by the Department of Environment and Heritage of species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999*.
- NPWS (1999) Threatened Species Management Guidelines.
- Community Access to Natural Resources Information (CANRI) and Fish files database.
- Records published in scientific journals, reports and general flora and fauna distribution text.
- Results from the field surveys in April and November 2005 and May 2006.
- Results of local environmental studies, including studies prepared by consultants, local government authorities, biological organisations, universities, local naturalists and ecologists.
- Discussions with personnel from the NSW DEC (incorporating the former NPWS) and Department of Primary Industries (NSW Forests and NSW Fisheries).
- Anecdotal reports from government agency officers, WIRES, local naturalists and the local community.

Coastal Emu endangered population

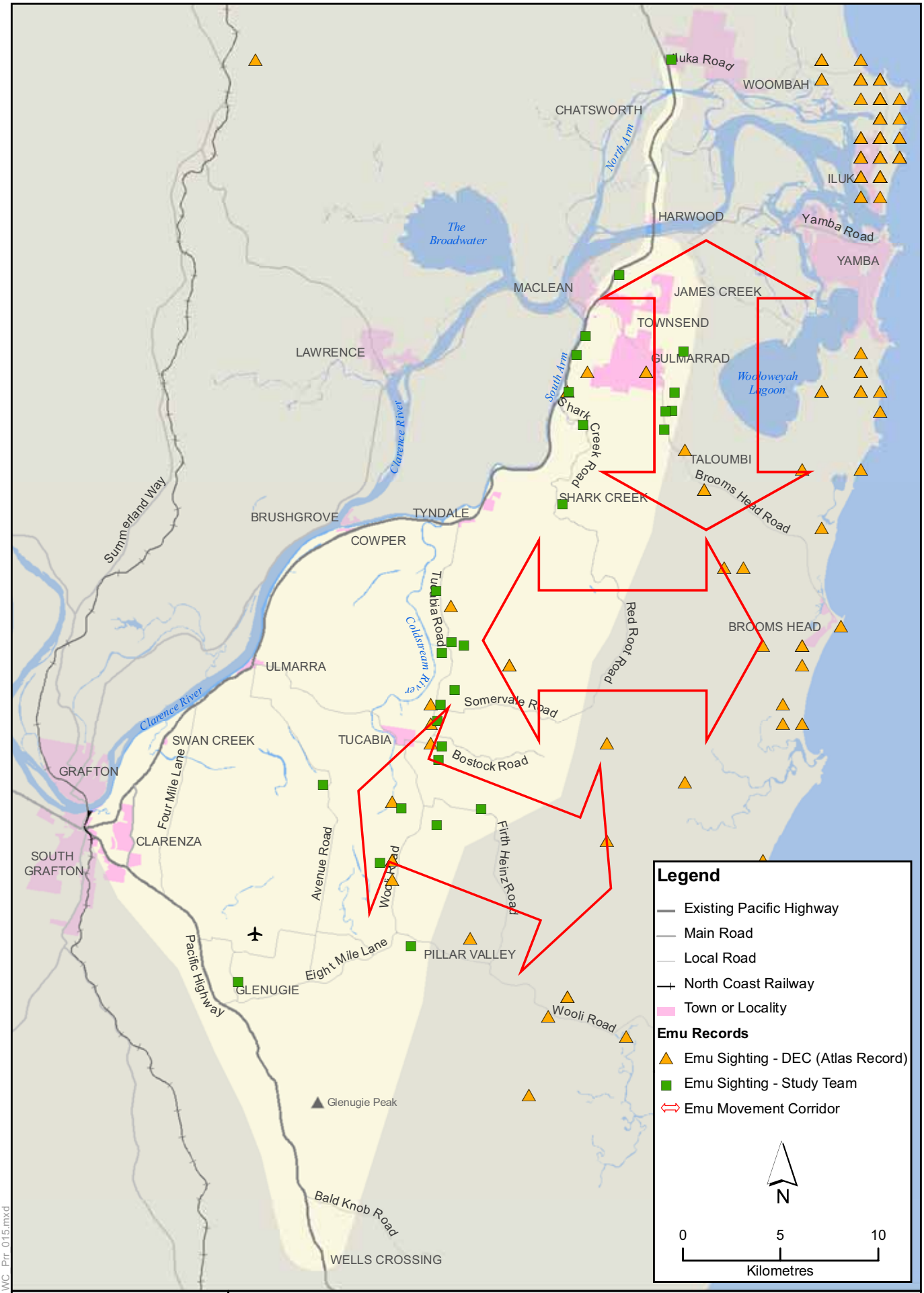
The Emu *Dromaius novaehollandiae* population in the NSW North Coast Bioregion and Port Stephens Local Government Area has been listed as an endangered population on Part 2 of Schedule 1 of the NSW *Threatened Species Conservation Act, 1995*. An isolated population of the coastal Emu population, estimated to be less than 100 individuals, is found east of Bungawalbin and Tucabia, between Red Rock and Evans Head. Yuraygir National Park and surrounding areas (including parts of the study area) are the main habitat zones for this population and the Sandon / Brooms Head area is particularly important as one of two main breeding areas. Concentrations of the Emu are also recorded in the Pillar Valley and lower Coldstream River areas.

Figure 3-16 shows recorded sightings of the Emu within and near the study area, as an indication of its known range. It should be noted that these records are not based on comprehensive surveys for the species, but are mostly compiled from opportunistic sightings. The high incidence of records from near public roads and towards the western extent of the known range of the Emu is explained by this.

The presence of the largest sub-population of coastal Emu remaining today in the Clarence Valley is probably due to the historic conservation of Yuraygir National Park, the largest extent of undeveloped coastline in NSW, adjacent to large expanses of agricultural land. The relative dispersed pattern of development on the valley floodplain is also likely to be a factor. The Emu population has access to a relatively wide variety and large area of habitats that provide requirements for foraging and breeding. The Clarence River is a barrier to the north and west and has effectively isolated the population making it vulnerable to decline without recruitment from outside populations. Further research is required to gain a better understanding of the characteristics of the Emu population in and around the study area. Current knowledge indicates that the size of the Emu population appears to be sufficient for maintaining viability in the long-term future, and this is evidenced by the presence of breeding pairs and chicks, indicating that the population size is stable. The long-term survival of the population is dependent on a wide range of factors including controlling habitat loss or degradation and other threats such as road kill and predation.

Of the three remaining sub-populations of coastal Emu in northern NSW, the Clarence Valley population is the largest and most viable in the long-term. When viewed in this perspective, the potential consequences of impacts for road development on this population are very high. Significant reductions in the availability or quality of habitat, or fragmentation of the population from a range of different developments and land uses, may place further pressure on the viability of the population.

There are insufficient data available to identify all the habitats in the study area used by the Emus and hence the significance of any particular areas cannot be accurately mapped. At present, based on several years collecting observations by NSW DEC and anecdotal evidence, it is reasonable to conclude that the floodplain wetlands are significant areas for the population particularly during drought and in the pre and post-breeding life-cycle stages. Movements between Yuraygir National Park and the floodplain wetlands are an important component of the life-cycle events of these birds.



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Wells Crossing to Iluka Road
Upgrading the Pacific Highway

Figure 3-16: Emu records from in and around the study area

The NSW DEC has reported Emu road mortalities on Sandon Road in Yuraygir National Park and Brooms Head Road. A number of submissions from the community have emphasised the importance of the coastal Emu population in the study area and provided additional information. Access to a diversity of habitats is considered critical to the survival of this population, which is known to travel between the forested areas of the coast range and the open grassland and wetlands of the floodplain. Further consideration of the coastal Emu is provided in **Section 6** and in the *Biological Working Paper* (RTA, 2006a).

3.6.4 Water quality

Water quality has been assessed for the project by review of previous water quality investigations and implementation of a water quality sampling program that is to be continued through the development of the project. Further information is available in the *Water Quality Working Paper* (RTA, 2006l).

The Clarence River is a major features of the study area. There are several main tributaries of the Clarence River and other minor water courses that traverse the study area including:

- Coldstream River, Glenugie Creek, Pillar Creek, and Chaffin Creek in the south of the study area.
- Shark Creek in the centre of the study area.
- South Arm of the Clarence River, which forms the western boundary of part of the study area, from Cowper to Maclean.
- Serpentine Channel, which separates Harwood and Chatsworth Islands.
- North Arm of the Clarence River.

Existing water quality data on the Clarence River and its tributaries are limited and available sources of information have been reviewed. The Northern Rivers Water Quality Assessment (EPA, 1996) and State of the Rivers and Estuaries Report (DLWC, 2001) both concluded that the water quality of the Clarence River varied between upstream sites (near Grafton) and downstream sites (near Iluka). Water quality generally improves further downstream, varying from ‘poor’ at Grafton to ‘good’ at Iluka. This shows the influence of tidal flushing on maintaining good water quality within the lower reaches of the system.

Based on the findings of previous studies, the water quality of tributaries of the Clarence River can be considered to be generally poor and this is predominantly due to consistently low dissolved oxygen saturation levels. Turbidity and pH were also rated poorly for some tributaries. Typically, upstream sections of tributaries in forested areas have better water quality conditions but highly variable flows. Mid-sections of major tributaries such as Shark Creek and the Coldstream River generally have poor water quality due to pollution from surrounding land

uses and poor quality riparian zones, which provide little opportunity for buffering from activities within the catchment.

Two dry sets of weather water samples have been undertaken to date for the project, in April and June 2005. Water quality was assessed at a total of 33 monitoring locations in the vicinity of the route options. Water quality results were then compared to the ANZECC/ARMCANZ (2000) guidelines for protection of aquatic ecosystems.

Key water quality issues appear to relate to dissolved oxygen, turbidity and pH levels. Overall, water quality appears to improve in the lower reaches of the river systems. This may be associated with tidal flushing in estuarine reaches of the Clarence River and major tributaries, which assists in removing or diluting pollutants. Pressures from rural and urban land use are contributing to high levels of bacterial contamination (presumably from sewage and stock faeces). High levels of nutrients and turbidity are likely to be related to rural land practices that are expected to be common across much of the study area, such as clearing, tillage and fertiliser application.

3.6.5 Climate and air quality

Existing conditions

Climatic data were obtained from the NSW Bureau of Meteorology weather stations at Grafton, Yamba and Glenugie. In general, the recorded temperatures are similar at all stations, however, the inland stations of Grafton and Glenugie show greater daily temperature variation than Yamba, which is subject to the moderating effect of the coast. Rainfall fluctuates seasonally, with greater rainfall in the summer and autumn months and less rainfall during late winter and early spring. Generally, Yamba experiences greater total rainfall per annum and more rainy days than Grafton and Glenugie. Mean annual rainfall ranges from 1051 mm in Grafton to 1459 mm in Yamba.

There is limited information regarding existing air quality within the study area. Long-term monitoring is not usually undertaken outside metropolitan and/or industrial areas, because pollutants typically do not exist in concentrations that would cause adverse environmental or health impacts. The study area contains a large proportion of rural areas and air quality is generally good.

Air quality considerations

Construction activities have the potential to result in dust emissions which may impact on nearby sensitive receivers, in particular residences. Wherever ground is disturbed, or spoil is handled, there is the potential for the generation of dust.

Once operational, emissions from the upgraded highway would comprise mainly hydrocarbons, carbon monoxide, NO_x and particulate matter. The level of concentration of vehicle emissions and their subsequent impacts in the immediate vicinity of the proposal depends on the traffic volume, vehicle speed and make-up (eg percentage of heavy vehicles) as well as the ability of the local environment to disperse emissions.

A number of environmental impact assessments undertaken on other sections of the Pacific Highway included short-term air quality monitoring of carbon monoxide (CO) adjacent to the highway. These studies have shown that CO concentrations measured close to the Pacific Highway are well below the relevant NSW DEC eight hour criteria of nine parts per million. It is considered that, given the relatively low volume of traffic on this section of the highway, air quality could also be expected to meet the guidelines for this project.

Individual assessment of the air quality impacts of each the route options has been undertaken. Air quality impacts of the route options would all be well below criteria established by the NSW DEC. Concentrations would diminish with distance from the road, resulting in negligible impacts. As such, none of the route options is assessed as likely to result in air quality impacts that would even approach the standards set by the NSW DEC.

Climate considerations

Fog is an important issue in the design of the road because it can present a significant safety hazard for road traffic. A desktop level assessment of existing fog conditions has been undertaken as part of the climate and air quality assessment.

Specific fog data are not available across the study area from Bureau of Meteorology sources. The Bureau of Meteorology records the occurrence of fog at 9am and 3pm daily at Grafton Olympic Pool. A local resident in the Pillar Valley area has been collecting records of fog and mist occurrences in the local area for the period from January 2003 to April 2005 (Griffin and Dunlop, *pers comm* to RTA).

In Grafton, more fog days are recorded during the cooler months with the highest number of fog days recorded during the month of June. This contrasts with data for Pillar Valley provided in a submission to the project team (Griffin) which indicates more days of fog or mist during the months of February and March.

There are no historic data for determining differences in fog patterns across the study area. However, most parts of the study area are prone to fog, with the most affected areas likely to be the valley regions in the east and south of the study area. These areas are likely to experience radiative or ground fog. The low lying plains in the centre of the study area are also likely to be prone to radiative or ground fog.