5. Characteristics of the study area

The purpose of this section of the report is to provide an understanding of the traffic and transport conditions in the study area, and the biophysical, economic and social characteristics that have influenced the development of route options. The development of route options is described in **Section 6**, and the assessment of feasible route options is described in **Section 1**. Both the development and assessment of route options have been based on the information presented in this section.

5.1 Overview of the study area

5.1.1 Location

The study area for the proposed Wells Crossing to Iluka Road Upgrade is situated within the local government area of Clarence Valley, on the northern coastal plain of New South Wales. It is located approximately 640 kilometres north of Sydney and 350 kilometres south of Brisbane.

5.1.2 How the study area was defined

From Wells Crossing to Grafton, the existing highway alignment in this area is relatively flood free and has the potential to be upgraded to meet the program and project objectives. Whilst the Glenugie and Newfoundland State Forests, Grafton Airport and Yuraygir State Conservation Area are major constraints in this section, route options could involve a duplication of the existing highway or a deviation to the north and east. 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 is a major constraint, because of factors including visual impacts, impacts on aquatic and riparian habitats, and the cost of constructing a new crossing. The Clarence River defines the western boundary of the study area for much of the length from Grafton to Harwood Bridge. Woodford Island was considered unlikely to provide suitable conditions for the upgrade due to environmental constraints, nature reserves and state forests, and geological conditions. The town of Maclean is considered to be 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 primary constraints to the upgrade of the existing highway. A key consideration for definition of the study area in this section is that improvements along the existing Pacific Highway alignment are unlikely to meet the program and project objectives, and that a new route would be required. However, this strategic

assumption did not preclude the development of route options involving upgrading, in part or whole, of the existing highway.

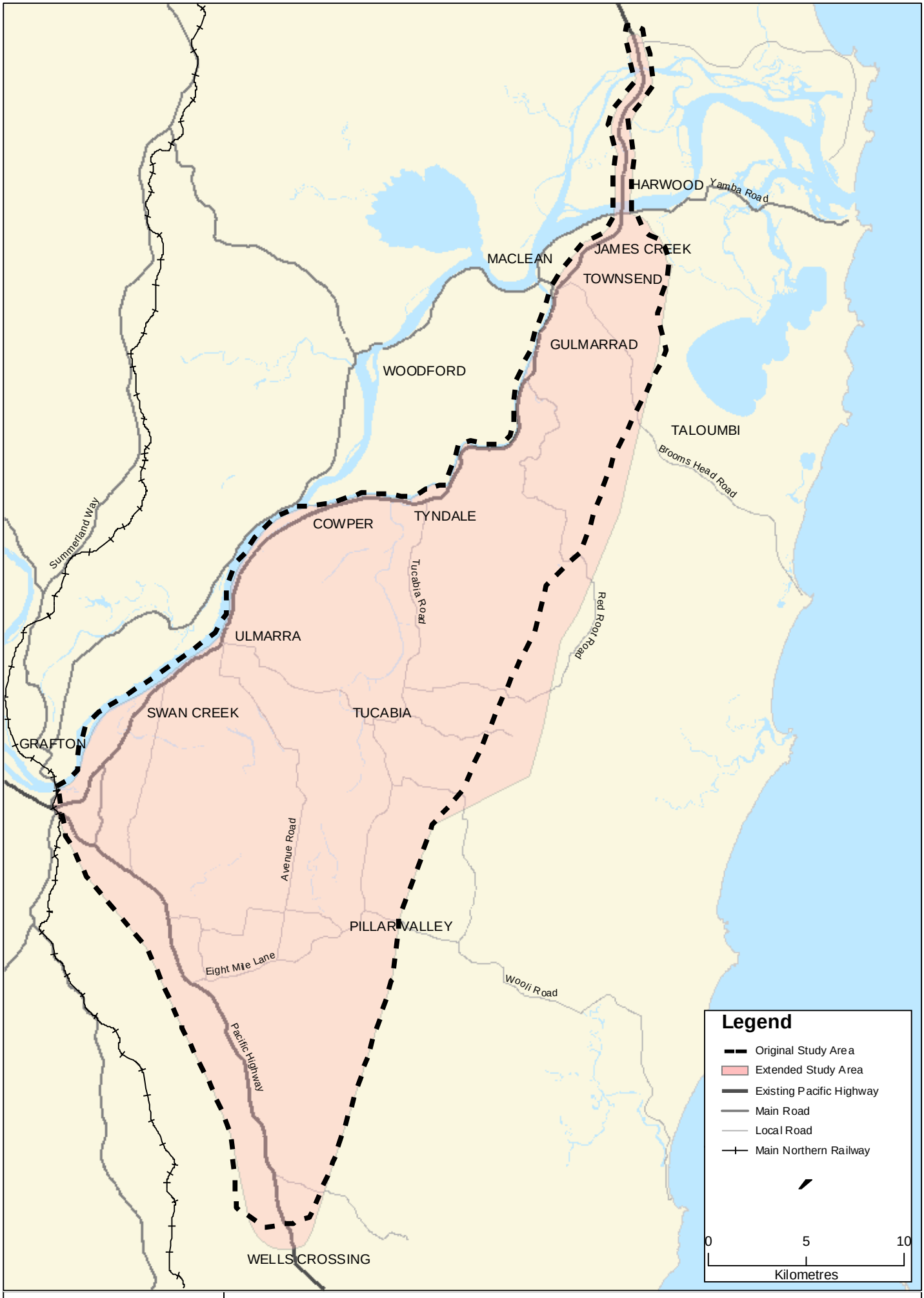
The eastern boundary of the study area from Wells Crossing to Harwood Bridge is largely defined by topographic and ecological constraints. Further north (east of Maclean) the eastern boundary of the study area has been located to minimise impacts on residential and rural residential areas around Maclean, Townsend, Gulmarrad and James Creek. The boundary has been defined to ensure route options that minimise impacts on urban and rural residential constraints could potentially be identified, while still ensuring appropriate connections to the existing highway south of the Harwood Bridge.

At least in the initial development of the project between Harwood and Iluka Road (to Class A standard) there is an opportunity to cross the Clarence River by duplicating the existing Harwood Bridge, rather than constructing two new bridges at another location on the Clarence River. This would minimise the cost to the Project. In addition, the strategy for upgrading the section from Harwood Bridge north to Iluka Road involves a new motorway that generally follows the alignment of the existing highway. Crossing locations are therefore limited to either upstream or downstream of the Harwood Bridge. Full upgrading of this section to Class M would require two new bridges, with the existing Harwood Bridge likely to be used for local access. Because of the advantages of aligning the upgraded road close to the existing highway, a narrow study area was defined either side of the existing highway.

5.1.3 Review of the study area boundary

A strategic review of the boundaries of the study area was undertaken during the route options development phase of the project. The review assessed whether the potential exists to extend the study area to enable development of route options that meet the Pacific Highway Upgrade Program and project objectives more effectively than those options identified within the study area. The assessment considered opportunities to review the eastern and western boundaries of the study area. The review resulted in refinement of the study area boundaries, as shown in **Figure 5-1**, based on the following key issues:

- The northern and southern termination points of the project were not subject to review, as they are fixed connection points to other Pacific Highway Upgrade projects intended to generally follow the existing Pacific Highway alignment.
- From Wells Crossing to Grafton, route options west of the existing alignment were considered unlikely to meet the project objectives, particularly in relation to cost-effectiveness and reduction in travel times.



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Wells Crossing to Iluka Road
Upgrading the Pacific Highway

Figure 5-1 Original and extended study area

- From Grafton north, options to the west would not achieve the project objectives particularly in relation to transportation, as the strongest traffic demand is along the coast via the Pacific Highway rather than alternative inland routes.
- The section of the existing Pacific Highway from Harwood Bridge to Iluka Road is a relatively high standard alignment. Both the existing highway and Harwood Bridge provide opportunities for duplication to achieve a cost-effective upgrade in this area.
- Minor extension of the study area boundary to the east of Pine Brush State Forest and SEPP 14 wetland No. 232 would enable investigation of options that avoid areas of ecological significance, as well as avoiding impacts on the values of the Pine Brush State Forest.
- Extension of the study area boundary to the east of SEPP 14 wetland No. 220b provides an opportunity to investigate options that avoid this area of ecological significance, as well as avoiding direct impacts on the communities of Gulmarrad, Townsend and James Creek.

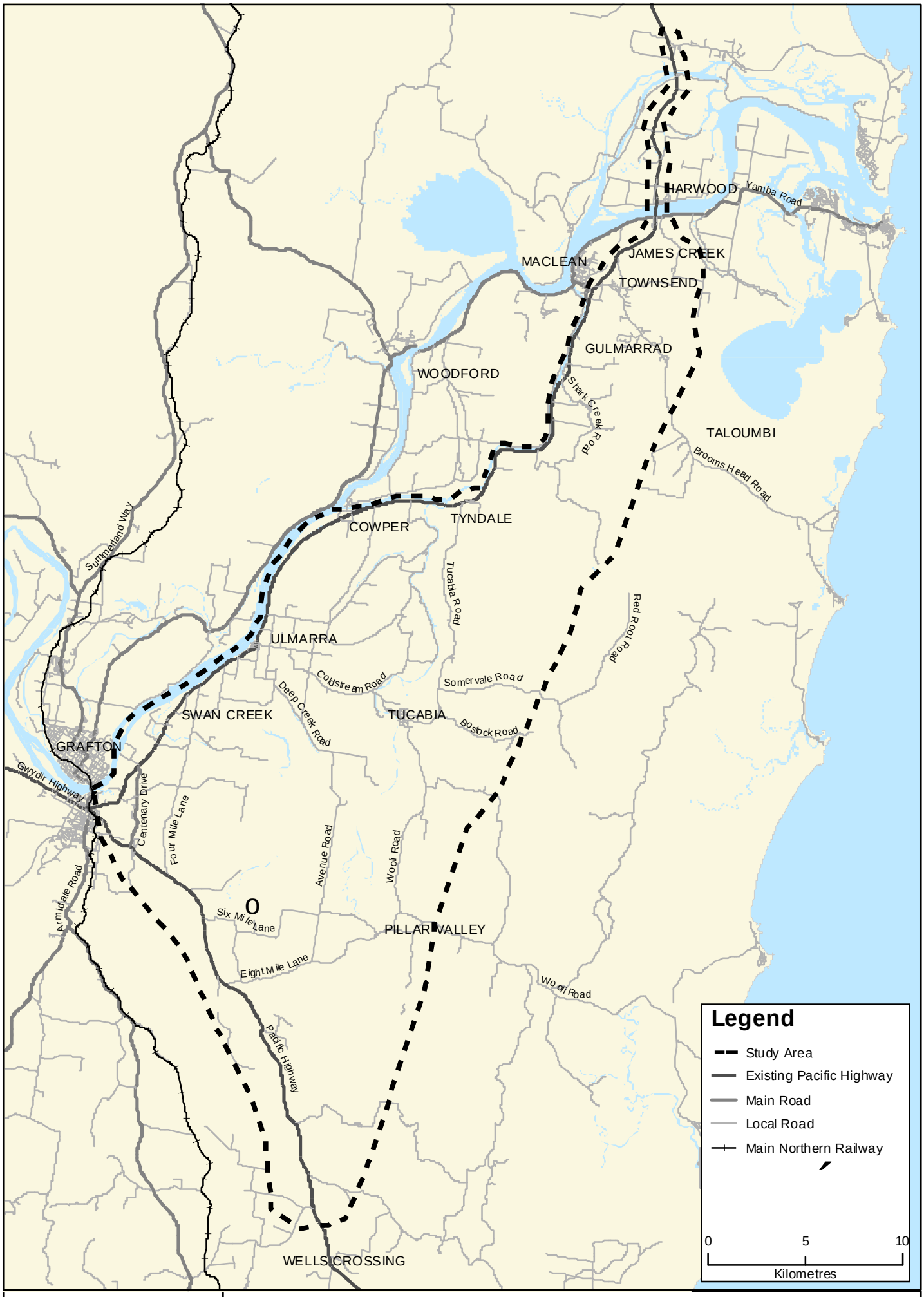
Several community submissions and feedback from community consultation activities (including several members of the CLGs) identified a desire to extend the study area boundary substantially further east. The conclusion of the assessment of options suggested by the community outside the original and revised study area, provided in **Section 6.5**, is that they do not provide any benefits beyond those achievable by options within the study area. Major extension of the study area boundary would therefore not achieve the objectives of the Pacific Highway Upgrade Program, and is not warranted.

5.2 Transport and accessibility within the study area

5.2.1 Regional road network

The Pacific Highway is the main regional road connection passing through the study area. It connects towns and villages along the north coast of NSW, from Newcastle to the Queensland border. It is part of the highway network that extends further north into South-East Queensland, and south to Sydney and beyond. The current Pacific Highway is approximately 79 kilometres long from Wells Crossing to Iluka Road (70 kilometres from Wells Crossing to the southern end of the Harwood Bridge and nine kilometres from the southern end of the Harwood Bridge to the Iluka Road intersection). Other regional links in and around the study area (illustrated at **Figure 5-2**) provide access to major centres in north-eastern NSW. These include:

- The Gwydir Highway intersects with the Pacific Highway at South Grafton and extends west across the Great Dividing Range to Glen Innes, intersecting with the New England Highway.
- The Armidale Road, which travels south-west from South Grafton to Armidale, intersecting with the New England Highway.
- The Summerland Way, which starts in Grafton and heads north through Casino and Kyogle.



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Wells Crossing to Iluka Road
Upgrading the Pacific Highway

Figure 5-2 Road network and other transport infrastructure

5.2.2 Other transport infrastructure

The other main transport route in the study area is the Main Northern Railway. This line extends from Sydney through to Queensland, generally along the coastal strip east of the Great Dividing Range. The Main Northern Railway serves both passenger and freight travel and passes through Grafton. The Grafton Railway Station is located at south Grafton, just outside the study area.

Grafton Airport is located within the study area, south-east of Grafton. It is accessed from the Pacific Highway via either Six Mile Lane or Eight Mile Lane. Grafton Airport is used by private and charter aircraft. Regular services (currently at least daily) operate to Sydney via Taree.

Historically, water based transport was important in serving the Grafton area, including as the main connection to Sydney and Brisbane. Road and rail transport improvements led to the reduced importance of the river and ocean-going transport to provide regional connections. The Clarence River is now primarily used for tourist, recreational and commercial fishing related boating. Ferry services continue to provide crossings in some locations, such as at Ulmarra and Lawrence. The locations of rail and air transport infrastructure around the study area are illustrated at **Figure 5-2**.

5.2.3 Local road network

Within the study area, the Pacific Highway provides an important link between towns such as Maclean, Iluka, Yamba and Ulmarra and Grafton. As well as acting as a regional connection, the highway is used by many residents of the local area on a regular basis for local trips.

In addition to the highway, several other roads in the study area are important for local access. The main local connector roads in the study area are illustrated at **Figure 5-2** and include:

- Eight Mile Lane, which intersects with the Pacific Highway, and connects east to Wooli Road near Pillar Valley.
- Coldstream Road, which intersects with the Pacific Highway at Ulmarra, travelling east to Tucabia.
- Deep Creek Road and the Avenue, a north-south route through the floodplain in the west of the study area.
- Four Mile Lane, a north-south connection between the Pacific Highway to the south and north of Grafton.
- Centenary Drive, a north-south connection that is used as a high level bypass of Grafton, connecting the Pacific Highway north and south of South Grafton.
- Wooli Road, from Tucabia south to Pillar Valley and then south-east to Wooli and Minnie Water, on the coast.
- Tucabia Road/Coldstream Road, from Tucabia north to the Pacific Highway just west of Tyndale.

- Sommervale Road and Red Root Road, which provide access from Tucabia to the east of the study area.
- Shark Creek Road, which intersects with the highway just north of Shark Creek, and provides access to rural properties in this area, and connects to Red Root Road.
- Brooms Head Road, from Maclean to Brooms Head, passing through Townsend and Gulmarrad.
- James Creek Road and Gardiners Road, which connect Brooms Head Road to the rural and rural residential areas in the north of the study area.
- Yamba Road, which connects Maclean and the Pacific Highway to Yamba, along the south side of the Clarence River.
- Watts Lane and Chatsworth Road that provide access to cane farms and the village of Chatsworth, on Harwood and Chatsworth Islands.
- Iluka Road, at the northern limit of the study area, which provides access from the Pacific Highway east to the Iluka, on the north side of the Clarence River.

Numerous other local access roads provide access to properties within the study area. All the local roads in the study area carry generally very low volumes of traffic. However, some of these roads (particularly those accessing the coastal towns) experience substantially higher traffic volumes during peak holiday periods.

5.2.4 Existing and projected future Pacific Highway traffic

The RTA has a number of traffic count stations along the Pacific Highway, including three permanent counting stations in the study area or just beyond it. A non-permanent site south of the road to Maclean is also relevant to this study. The most recent count available from these stations is for 2001 with limited provisional information for 2004[8]. These data sources were supplemented with classified traffic counts on the Pacific Highway south of Grafton, south of the road to Maclean and 13 kilometres south of Woodburn, as well as seven other non-Pacific Highway locations in the study area. Monitoring was undertaken for seven days in October 2004. Utilising the relationship between the ADT in October 2004 and the AADT volume in 2001, the 2004 survey results were converted to an estimated AADT value. The AADT estimates for all the survey points are shown in **Table 5-1**.

[8] At the time of preparing the traffic analysis used in this report, the 2004 AADT data published by the RTA were not available. Provisional AADT counts were used, and these were compared against actual counts undertaken by SKM in 2004. The SKM data have been compared to the 2004 AADT, and are generally consistent. The RTA 2004 AADT data will be used for upcoming stages of the project.

Table 5-1 2004 annual average daily traffic estimates

Location	2004 AADT Based on SKM counts in October 2004[1]	2004 AADT Based on provisional counts provided by RTA[2]
Pacific Highway South of Grafton	8,305	9,980
Pacific Highway South of Maclean	7,490	8,540
Pacific Highway South of Woodburn	6,934	7,660
Armidale Road South of Grafton	3,640	—
Gwydir Highway West of Grafton	4,240	—
Summerland Way North of Grafton	3,140	—
Grafton-Maclean-Yamba Road North of Grafton	1,040	—
Yamba Road East of the Pacific Highway	5,630	—

(1) October 2004 ADT. No annual data are available for comparison at these sites.

(2) Provisional results based on axle pairs and adjusted to vehicles using the October 2004 vehicle axle pair data. An axle pair to vehicle ratio of 1:35 has been used to convert axle pairs to vehicles based on the October 2004 survey data.

Average travel times on the Pacific Highway have been calculated assuming vehicles travel at the speed limit (including reduced speed limits through built up areas and towns). Average travel time from Wells Crossing to Iluka Road is estimated to be approximately 51 minutes. Average travel time between Wells Crossing and Harwood Bridge is estimated at 45 minutes.

Traffic forecasts

Overall growth in through traffic in the period 1978-2004 has been around 2.4 per cent per annum. Prior to 1998, the growth rate was 2.2 per cent per annum, and since 1998 it has risen to 3.3 per cent. The effect of further upgrades of the highway will be felt right up until the end of the Pacific Highway Upgrade Program. For the purpose of forecasting, the 1998-2004 growth rate has been adopted for forecasting through-light vehicle traffic up to 2021. Beyond 2021, it is anticipated that traffic growth would revert to the previously observed rate of 2.2 per cent per annum.

Within the study area, local traffic growth will primarily be driven by population growth. The Clarence Valley Settlement Strategy indicates that between 1996 and 2016, there is the potential for the population of the Clarence Valley to increase from 46,555 to 60,290 people. Interpolating a 2004 base year, this represents a 1.3 per cent increase in population per annum. This is considered to represent the maximum likely population growth rate. The recent trend rate of 0.9 per cent is considered likely to be the minimum population growth rate.

The relationship between population growth and traffic growth would therefore indicate that local traffic could be expected to grow at 1.4-2.1 per cent per annum**.** The midpoint of this range (1.7 per cent per annum) is an appropriate rate to adopt for the purpose of forecasting growth in local traffic.

These growth rates were applied to 2004 trips between zone pairs. **Table 5-2** details the forecast volumes at three Pacific Highway locations, up to 2041. Generally, overall traffic volumes are predicted to roughly double by 2041. Heavy vehicle volumes are predicted to more than double, with the proportion of heavy vehicles to total vehicle volumes expected to increase.

Travel times through the study area vary by trip type, purpose and vehicle class. Average times recorded in October 2004 from Wells Crossing to Iluka Road were in the range 45-50 minutes. Average travel times between Maclean and Grafton range from 30-35 minutes.

Table 5-2 Current and forecast AADT volumes on the Pacific Highway

Location	2004[1]	2011	2021	2031	2041
Pacific Highway, South of Grafton					
Light	6,600	7,810	9,560	10,740	11,940
Heavy	1,630	2,090	2,740	3,320	3,800
Total	**8,230**	**9,900**	**12,300**	**14,060**	**15,740**
% Heavy	*20%*	*21%*	*22%*	*24%*	*24%*
Pacific Highway, South of Maclean					
Light	6,050	7,080	8,550	9,640	10,730
Heavy	1,530	1,970	2,580	3,130	3,580
Total	**7,580**	**9,050**	**11,130**	**12,770**	**14,310**
% Heavy	*20%*	*22%*	*23%*	*25%*	*25%*
Pacific Highway, South of Woodburn					
Light	5,340	6,330	7,750	8,710	9,680
Heavy	1,620	2,080	2,720	3,300	3,780
Total	**6,960**	**8,410**	**10,470**	**12,010**	**13,460**
% Heavy	*23%*	*25%*	*26%*	*27%*	*28%*

[1]Based on traffic counts from survey undertaken by SKM in 2004, adjusted to RTA provisional AADT counts for 2004.

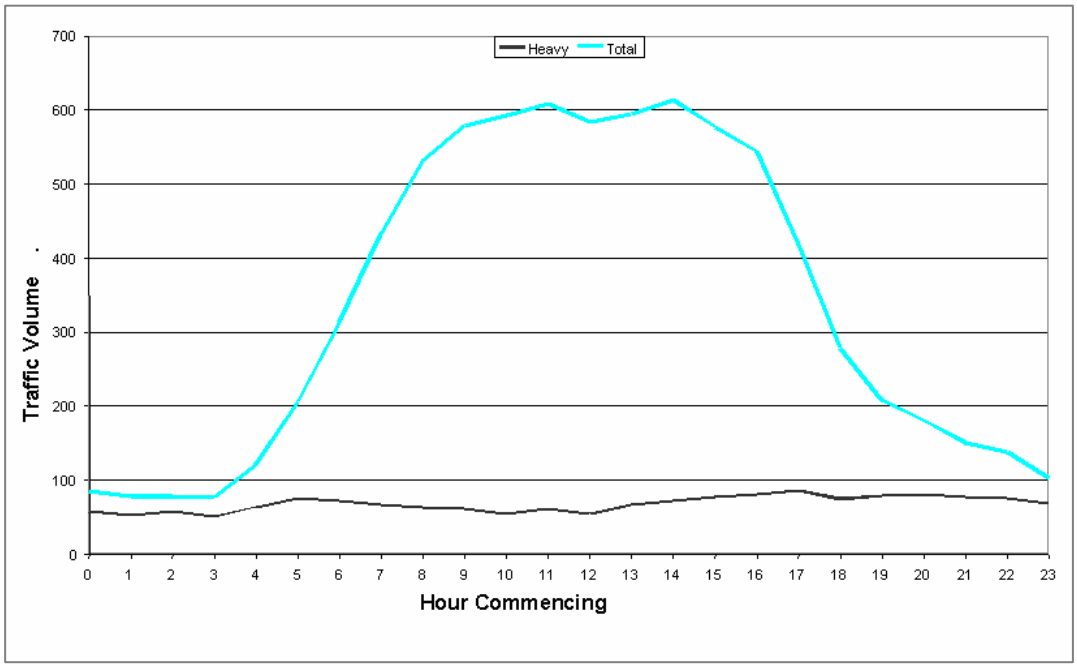
Heavy vehicles

Just over 20 per cent of all Pacific Highway traffic is heavy vehicles of over 4.5 tonnes in gross weight. By 2021 this is projected to increase to up to 26 per cent, and by 2041 to up to 28 per cent. This is indicative of the projected increase in freight volumes and increased mode share transported by truck. Of the heavy vehicles approximately 25 per cent are rigid trucks and 75 percent are articulated (6, 8 and 9 axle semi-trailer and B-Double) vehicles.

Figure 5-3 shows the profile of light and heavy vehicles for the location south of Grafton. A similar pattern was observed at the other Pacific Highway survey sites. 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. However, the actual volume of heavy vehicles is lowest during the night, and highest in the

late afternoon. Further discussion of the origin and destination of heavy vehicles is provided in **Section 5.2.5**.

Figure 5-3 Hourly traffic profile on the Pacific Highway south of Grafton, October 2004



Estimates of growth in heavy vehicles were prepared for the purposes of forecasting growth in heavy vehicle volumes in the study area. Forecasts for trips that service the study area were calculated based on factors such as population growth, which will influence demand for consumables, and projections of growth in industries on the north coast. Interstate freight movements were forecast based on estimated growth in gross State product, forecast to decline from 4.0 per cent per annum up to 2020 to 3.5 per cent per annum between 2020 and 2030 and 3.0 per cent per annum from 2030. The results are presented in **Table 5-3**.

Road freight, both interstate and inter-regional (either to or from the mid-North Coast) is projected to double in tonnage by the year 2020. Over 90 per cent of interstate freight in the corridor is projected to be transported by road. Of inter-regional freight, approximately 80 per cent is projected to be moved by road in 2020. These figures indicate projections for strong growth in heavy vehicles using the Pacific Highway for both interstate and inter-regional trips into the future. The number of heavy vehicles using the Pacific Highway, and the size of vehicles, is likely to increase in proportion with the overall growth in freight volumes. In the period to 2020, growth in heavy vehicle volumes is expected to be around 4.0 per cent per annum. Beyond 2020, growth is expected to slow (reflecting completion of the Pacific Highway Upgrade Program) to between 3.5-3.0 per cent per annum.

Table 5-3 Freight movement forecasts by road and rail

(a) Inter State Freight – million tonnes per year (NSW/QLD)						
	2001		2010		2020	
Road	12.0 (90%)		16.4 (90%)		24.3 (92%)	
Rail	1.4 (10%)		1.8 (10%)		2.2 (8%)	
(b) Inter-regional Freight, To/From Mid North Coast – million tonnes per year						
	2001		2010		2020	
Road	6.5 (75%)		9.2 (77%)		13.6 (80%)	
Rail	2.2 (25%)		2.7 (23%)		3.5 (20%)	
(c) Commodities Moved in Mid North Coast – thousand tonnes per year						
	2001		2010		2020	
	Origin	Destination	Origin	Destination	Origin	Destination
Grain	8	67	12	102	17	120
Minerals	9,700	9,500	16,400	15,900	25,100	24,400
General	5,900	6,130	8,800	9,200	11,600	12,000

Source: Based on ABS Freight Movement for Year Ended 31 March 2001 and forecasts prepared by SKM

5.2.5 Origins and destinations of traffic using the Pacific Highway

An origin-destination survey was undertaken for this project in October 2004. The purpose of this survey was to gain an understanding of the locations that traffic travels to and from on the highway in the study area. In particular, it is important in understanding the proportion of through traffic (with an origin and destination outside the study area) and local traffic (either traffic travelling to or from a destination within the study area, or with both origins and destinations within the study area). Key findings (discussed further below) are:

- The largest volume of light vehicles was surveyed travelling to and from Grafton with a similar volume travelling to and from the Maclean and Yamba zones.
- A similar pattern was observed for heavy vehicles although a higher through traffic component was recorded.
- About 70 per cent of all trips recorded can be classified as internal or local trips with both trip ends (origin and destination) within the study area.

Through traffic

Through traffic is traffic that was recorded at either end of the study area on the Pacific Highway. The survey results indicated that 20 per cent of northbound and 26 per cent of southbound light vehicles are through traffic. Fifty-eight percent of northbound and 45 per cent of southbound heavy vehicles on the Pacific Highway were through traffic. The relatively low proportion of through traffic on the highway in the study area demonstrates the contribution of local destinations such as Grafton to overall traffic volumes using the highway.

Further analysis of the data for through trips indicates that almost 500 vehicles per day make a stop of up to three hours within the study area, before continuing their trip through the study area. This

equates to about 14 per cent of all through vehicles. This might include people making a stop for a meal or refreshments, or to visit Grafton, Maclean or one of the other towns in the study area. There may also be some heavy vehicles that make a delivery or pick up within the study area before continuing on a through journey. Some vehicles may make a stop in Grafton (or elsewhere in the study area) because of the convenience of services. However, these vehicles may in fact be through vehicles that would choose to make a stop elsewhere along an upgraded Pacific Highway route, providing appropriate services are available. As the proportion of through vehicles that make a stop is relatively small, this issue was assessed to have limited potential to significantly distort the traffic data, for the purposes of comparing route options in **Section 1**.

Regional traffic

Regional traffic travels to or from the areas to the west, north-west or south of Grafton via Armidale Road, the Gwydir Highway, or the Summerland Way. The major destination for traffic from these areas was Grafton, which attracted 78 per cent of traffic that entered the survey area. A total of 10 per cent of inbound traffic to the survey area left via the Pacific Highway (north or south). This indicates that the strongest movement for traffic is along the coast, via the Pacific Highway, rather than using alternative inland routes or travelling to inland destinations.

Local traffic

Local traffic has its origin or destination in the Grafton, Maclean or Yamba areas. Almost 70 per cent of northbound and southbound traffic on the Pacific Highway had its destination within the Grafton, Maclean or Yamba areas. The survey did not record trips within these zones, however, there was significant movement between zones, particularly between Grafton and Maclean, and Maclean and Yamba.

Heavy vehicles

For the most part, the origin and destination pattern of heavy vehicles during the survey was similar to light vehicles. For heavy vehicles, however, through trips made up a greater proportion of all trips than for light vehicles. Trips to and from Grafton and Maclean made up a similar proportion of all trips. Yamba, Armidale Road, Gwydir Highway and the Summerland Way were less prominent in the profile. This demonstrates that a high proportion of heavy vehicle movements in the study area are to destinations within the study area, particularly Grafton.

The two-way truck volume passing through the study area on the Pacific Highway was 790 trucks over the 24 hour day. This represents 11 per cent of the AADT on the highway north of the Harwood Bridge and 10 per cent south of Grafton. Given that heavy vehicles account for around 20 per cent of total vehicle volumes on the Highway, approximately half the heavy vehicles using the highway have a destination within the study area.

Sixty trucks, or about 8 per cent of truck AADT, south of Grafton travel through Grafton to the Gwydir Highway or the Summerland Way. Only 20 trucks out of the 340 truck AADT (6 per cent) on the highway in the north, travel through Grafton from the Gwydir Highway and Summerland Way. These results indicate that the Pacific Highway is the dominant route for long distance heavy vehicles, and that the Summerland Way is not a viable alternative route for the majority of heavy vehicles.

5.2.6 Property access

The existing highway provides direct access to many properties along the Pacific Highway and indirect access to properties in the study area via local and regional roads. The upgraded highway would have limited access points to service major population areas rather than individual properties. A strategy is required to ensure that access to properties along the routes is maintained. This would include retention of the local road network in its current form wherever possible. Where changes to local roads are required, service roads would be provided to ensure that adequate property access is maintained. An alternative route (to the new road) for through traffic would also be maintained as part of the project.

Because much of the study area is rural, vehicle access and stock movement around and between properties is an important consideration. The project has the potential to sever properties and to limit connections between rural properties, including travelling stock routes. Movement of cattle between paddocks, or from one property to the next, is an important consideration. Consultation with some property owners has indicated that stock is moved on a regular basis both within properties, and between different properties within and outside the study area. The design of the options needs to consider the retention of suitable access both within and between properties.

Another important consideration is access within cane farms for vehicles and equipment, especially in the north of the study area. Cane planting and harvesting equipment has particular spatial requirements that may also be impacted by route options passing through cane farms. Direct access for cane trucks between farms and the Harwood mill is also critical. Consultation with the cane industry is ongoing to determine specific vehicle and equipment movement requirements so that these can be accommodated in the design.

5.3 Biophysical characteristics

The dominant physical feature in the Clarence Valley is the Clarence River, which flows from the McPherson Ranges in Queensland to the Pacific Ocean in New South Wales. The Clarence River is the largest coastal river in NSW and it has a catchment area of approximately 22,700 square kilometres. The biophysical characteristics of the study area are highly influenced by the close proximity of the Clarence River to the study area. The main biophysical characteristics of the study area include:

- The Clarence River floodplain which is predominantly used for agricultural purposes.
- SEPP 14 wetlands and other threatened vegetation communities and threatened species habitats on the flood plain.
- State Forests including Glenugie State Forest, Bom Bom State Forest and Pine Brush State Forest.
- Tributaries of the Clarence River including the South and North Arms of the Clarence River, Shark Creek, Coldstream River, Swan Creek and other minor creeks.

5.3.1 Topography, geology and soils

A detailed geotechnical investigation was undertaken by Coffey Geosciences as part of the route selection process. This study included detailed terrain evaluation study followed by field investigations, which included a sampling program to determine geotechnical conditions across the study area.

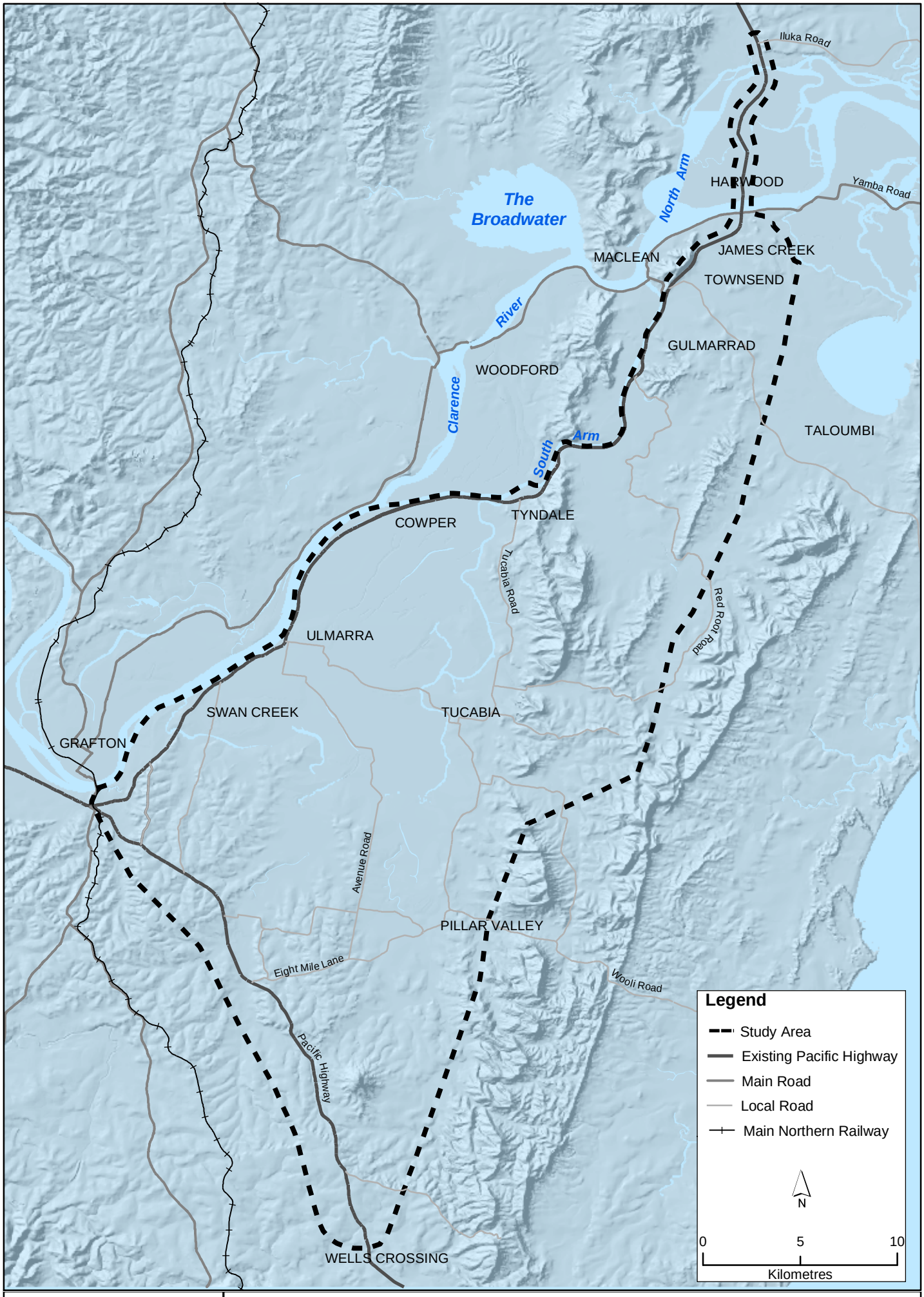
Terrain units

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, and the Gatton Sandstone further east. The topography of the study area is illustrated at **Figure 5-4**.

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 5-5**.

The assessment undertaken to date indicates that 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 along a corridor passing through shale lowlands north of Wells Crossing, along the lower western dip slopes of the Kangaroo Creek Sandstone (between Pillar Valley and Tucabia), and skirting low bedrock hills from there to Harwood. The main geotechnical constraints in the study area 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.



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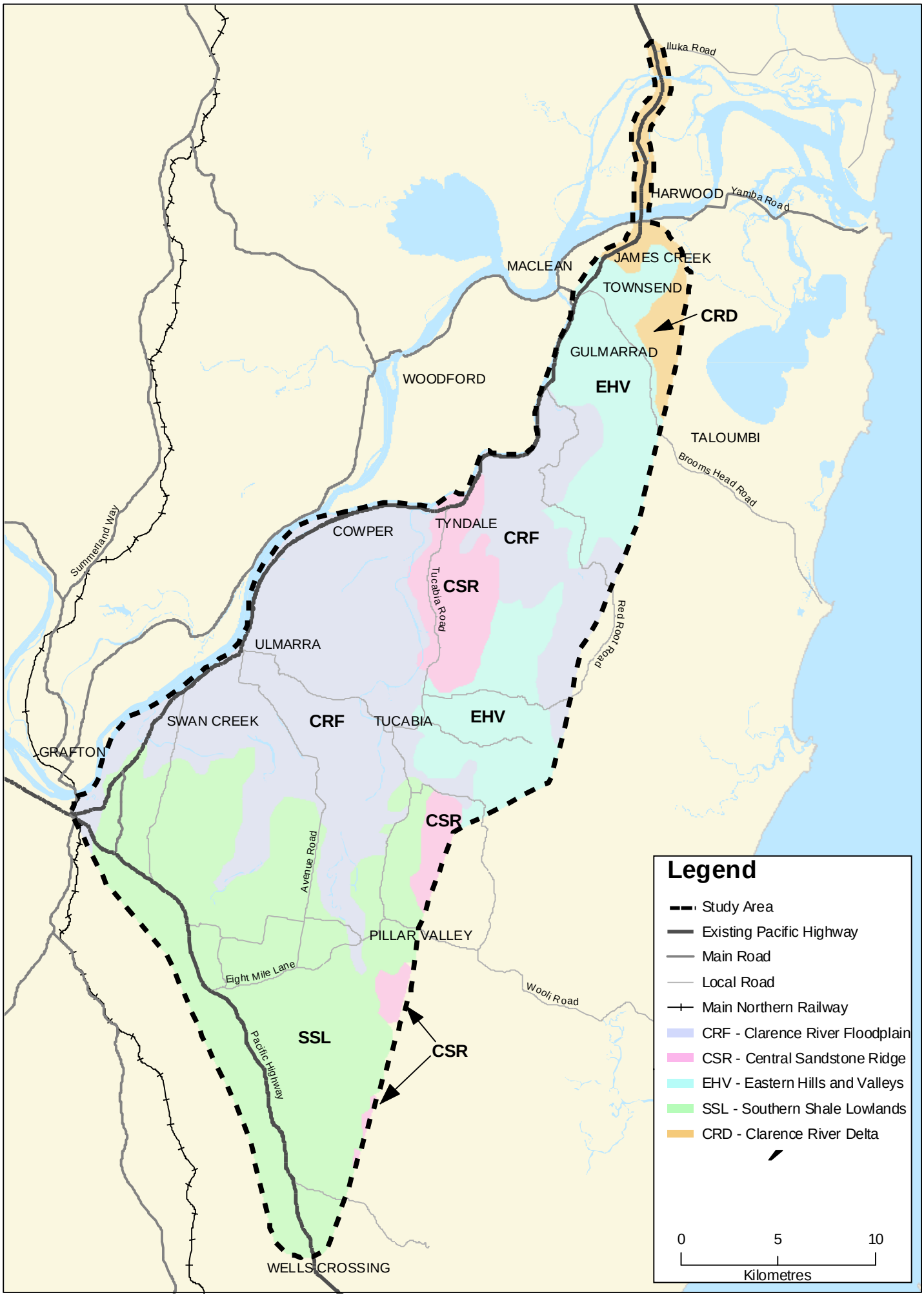
Wells Crossing to Iluka Road, Upgrading the Pacific Highway

Figure 5-4 Topography



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Wells Crossing to Iluka Road Upgrading the Pacific Highway	**Figure 5-5 Geology and soils**

- Soft soils and acid sulphate soils – low strength, highly compressible and potentially acidic soils occur in low lying areas and present severe geotechnical constraints (mainly construction cost and time) due to impact on excavation, foundation stability and embankment settlements.
- Rock cutting stability – this constraint is considered to be relatively minor and applies to rock cuttings in the eastern part of the study area.
- Ease of rock excavation – where bedrock is encountered, sandstone is expected to be the main lithology. It could be removed mainly by ripping and or by bulk blasting in deeper cuts.
- 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 is sufficiently large in scale to require more than minor re-alignment of route options. Further information would be obtained on any contaminated sites likely to be impacted by the preferred route.

Acid sulphate soils

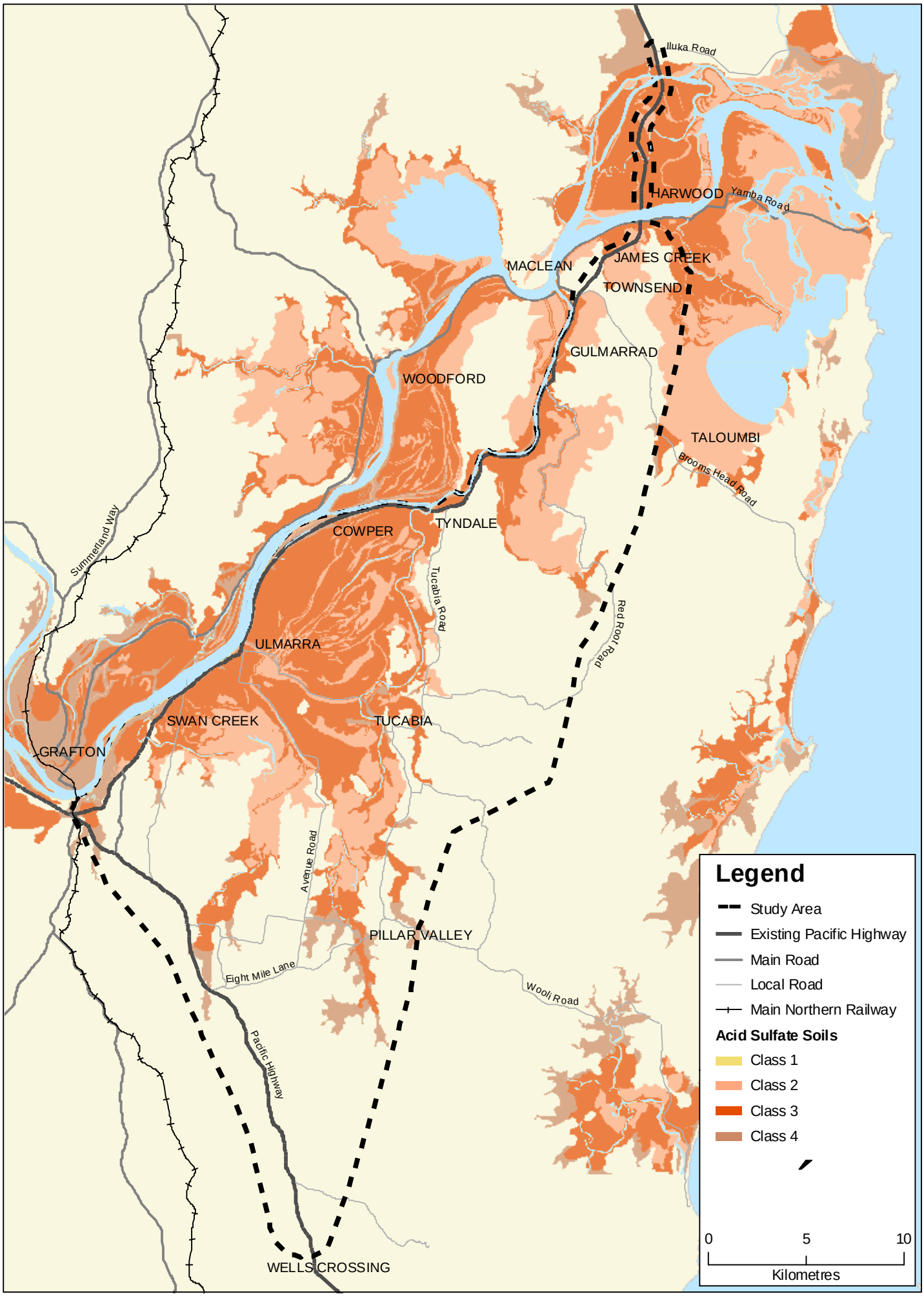
The acid sulphate soil map for the study area (**Figure 5-6**) indicates that areas with a high probability of acid sulphate soils coincide with the occurrence of alluvial and estuarine soils in the Clarence River floodplain below about RL 5 metres AHD. The presence of potential acid sulphate soils would have both environmental and geotechnical impacts. Construction methods may be preferred that limit excavation or further de-watering of these soils, such as driven piles.

5.3.2 Drainage and flooding

An assessment of the hydrology and hydraulics for the study area has been undertaken by WBM Oceanics.

The project study area encompasses the extensive floodplains of the Clarence River and its tributaries including the Swan, Glenugie and Shark Creeks and Coldstream River to the east of Grafton. The Clarence River is a major coastal river with lower floodplain areas subject to frequent and extensive flood inundation. The catchment of the Clarence River covers more than 20,000 km^2 upstream of Grafton and at times of major flooding some 500 km^2 downstream of Grafton become inundated. The major tributaries of the Clarence River located in the study area to the east of Grafton Glenugie Creek, Coldstream River and Shark Creek.

Due to the large difference in the size of the catchment areas and the close proximity to the ocean, the study area experiences different types of flooding, and combinations of flooding types in some circumstances. Main drainage lines and the extent of flooding are illustrated at **Figure 5-7**.



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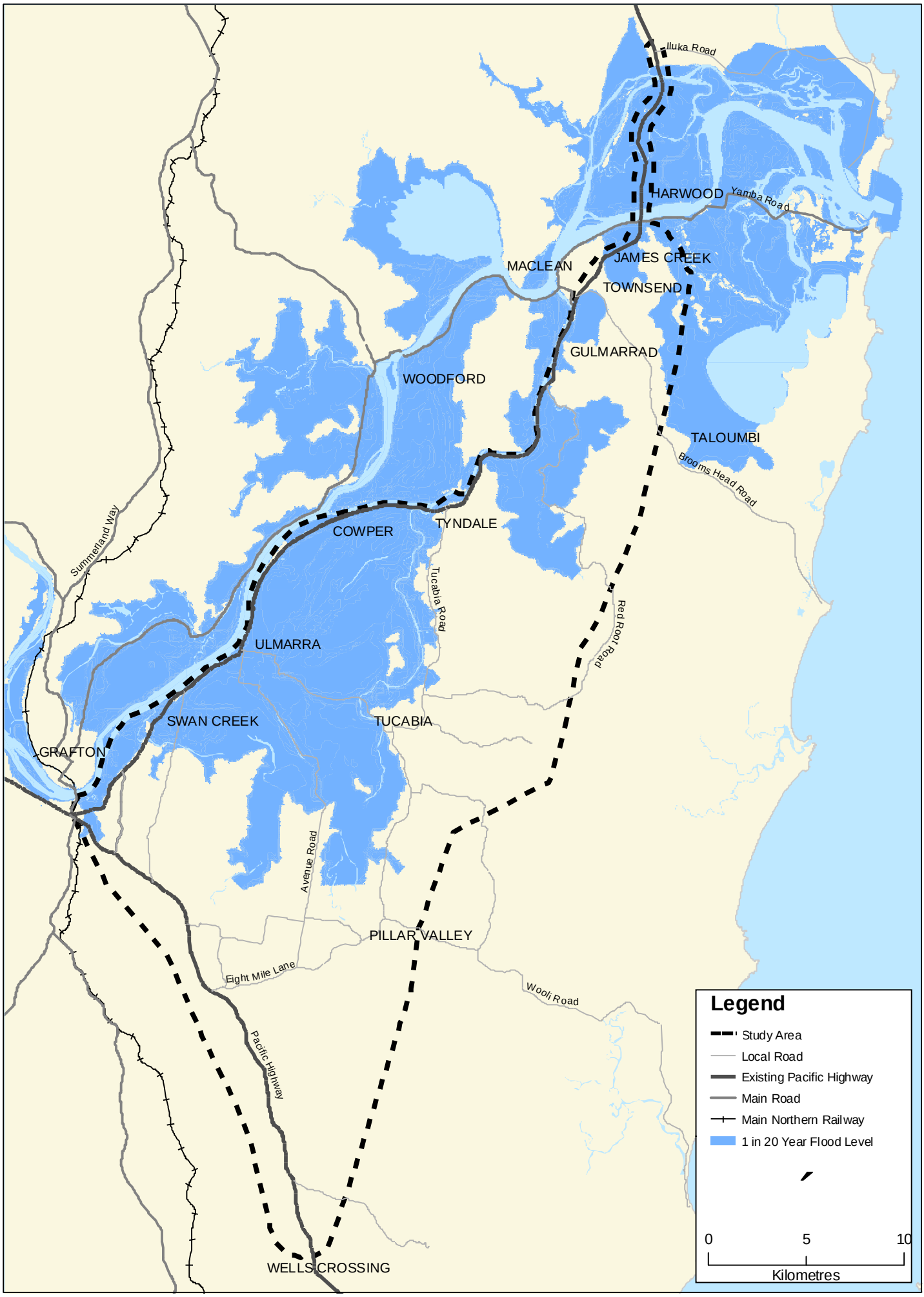
Wells Crossing to Iluka Road Upgrading the Pacific Highway	**Figure 5-6 Potential acid sulfate soils**



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Wells Crossing to Iluka Road Upgrading the Pacific Highway	**Figure 5-7 Drainage and flood levels**