Proposed Realignment
of the Pacific Highway at

WARRELL CREEK
NEW SOUTH WALES

Review of Environmental Factors

R T A
Roads and Traffic Authority

Prepared by

SINCLAIR KNIGHT MERZ

April 1998

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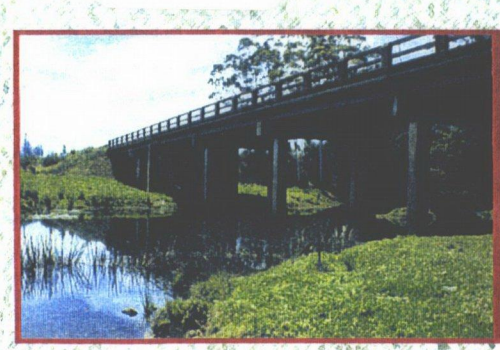

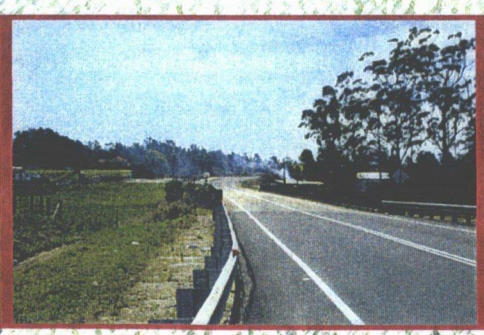

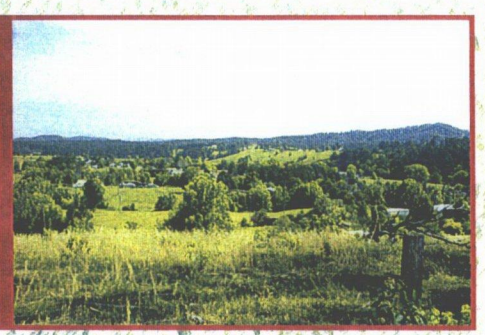

Roads and Traffic Authority
April 1998

Warrell Creek

Review of Environmental Factors

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Associated Documentation

Working Paper No. 1 - Water Quality
Working Paper No. 2 - Noise and Vibration Impact Assessment
Working Paper No. 3 - Social Impact Assessment

Glossary

Abbreviations

AADT	Average Annual Daily Traffic
AHD	Australian Height Datum
BCR	Benefit Cost Ratio
DLWC	Department of Land and Water Conservation
DUAP	Department of Urban Affairs and Planning
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
ENCM	Environmental Noise Control Manual
EPA	Environment Protection Authority
EP&A Act	Environmental Planning and Assessment Act 1979
ESD	Ecologically Sustainable Development
highway	Pacific Highway
km	kilometres
kmh	kilometres per hour
LALC	Local Aboriginal Land Council
LEP	Local Environmental Plan
LGA	Local Government Area
m	metres
NEPC	National Environment Protection Council
NHMRC	National Health and Medical Research Council
NPWS	National Parks and Wildlife Service
PAD	Potential Archaeological Deposit
RAC	Rail Access Corporation
REF	Review of Environmental Factors
REP	Regional Environmental Plan
ROTAP	Rare or Threatened Australian Plants
RTA	NSW Roads and Traffic Authority

SEPP	State Environmental Planning Policy
TSC	Threatened Species Conservation (Act)
TSP	Total Suspended Particulates
µg	micrograms
WHO	World Health Organisation
WQCP	Water Quality Control Pond

Terms

Council	Nambucca Shire Council
Proposal	The realignment of the Pacific Highway and the North Coast Railway within the study area.
railway	North Coast Railway
study area	The extent of the area examined - ie. between Upper Warrell Creek Bridge and the intersection of the Pacific Highway and Albert Drive (north).
village	the village of Warrell Creek

1. Introduction

1.1 Introduction

This Review of Environmental Factors (REF) has been prepared by Sinclair Knight Merz on behalf of RTA Technology, which is responsible to the NSW Roads and Traffic Authority (RTA). As a general overview, Sinclair Knight Merz, and its sub-consultants, has undertaken the assessment of the natural and social environments, while RTA Technology has provided input on the concept design, economics and construction components.

The REF details the potential environmental impacts of realigning the Pacific Highway at Warrell Creek (42.2 km to 47.0 km north of Kempsey). A number of separate, detailed, Working Papers accompany this document. They provide more detailed and technical information on:

- water quality
- noise impacts and
- social environment.

1.2 Purpose of the Review of Environmental Factors

This review of environmental factors (REF) has been prepared to assess the potential biophysical and socio-economic impacts of the proposal. The purpose of the REF is to identify potential impacts and assist the RTA to assess the significance of the impacts of the proposal and therefore any requirement for an environmental impact statement (EIS) under Section 112 of the Environmental Planning and Assessment (EP&A) Act 1979. The REF includes a consideration of Clause 82 of the Environmental Planning and Assessment Regulation, 1994.

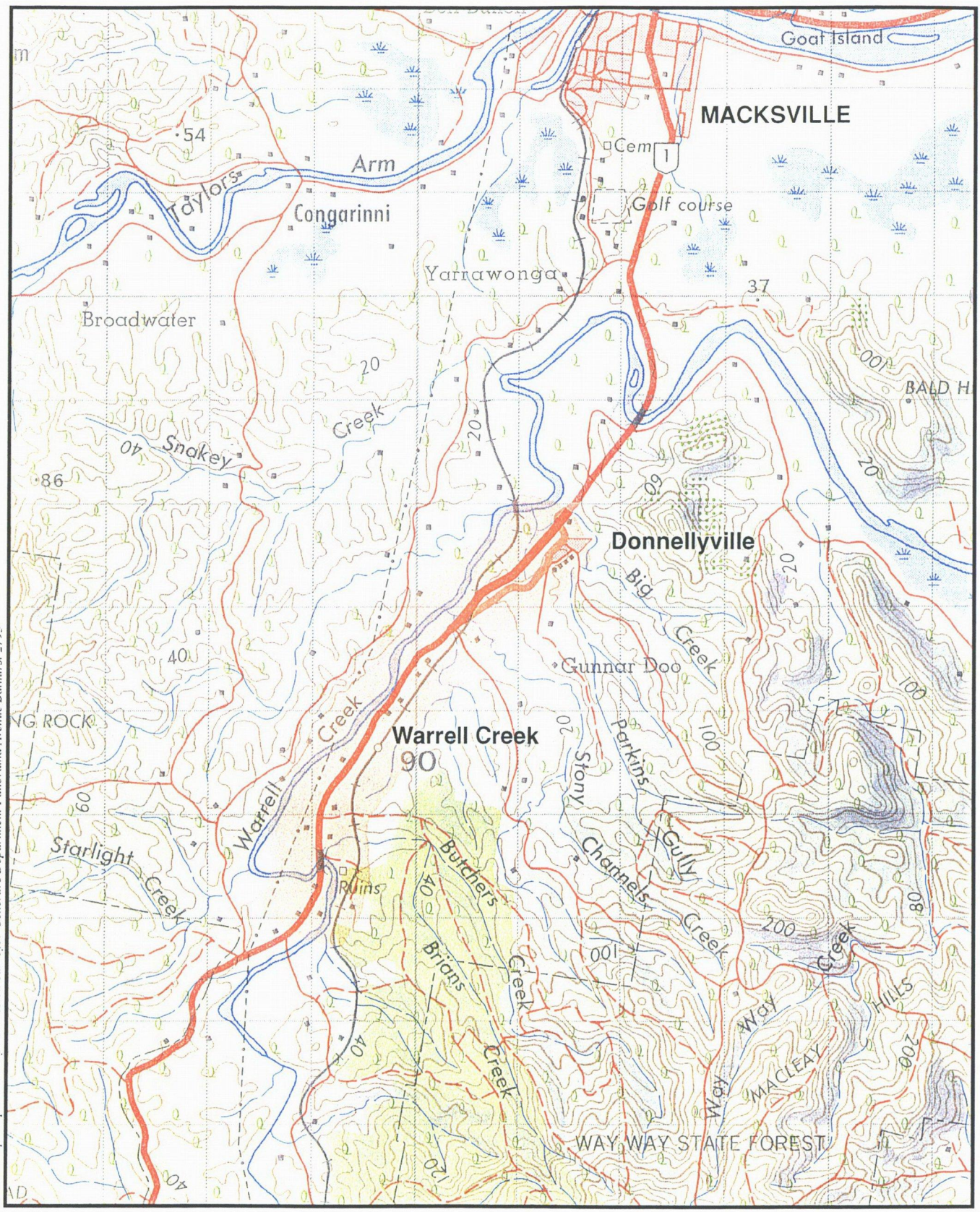
The findings of the REF will therefore be considered by the RTA when assessing:

- whether the proposal is likely to have any significant impact on the environment and therefore the necessity for an EIS under Section 112 of the EP&A Act; and

- the significance of any impact on threatened species as defined by the Threatened Species Conservation Act, in accordance with Section 5A of the EP&A Act and therefore the requirement for a Species Impact Statement (SIS).

1.3 The Proposal

The proposal is to upgrade a section of the Pacific Highway, from a two-lane road to a dual carriageway, between the northern end of Allgomera at Upper Warrell Creek and the intersection with Albert Drive (north), south of Macksville in the Shire of Nambucca (see **Figure 1.1**). The general alignment of the selected route links the dual carriageway south of Warrell Creek to the Rosewood deviation near Donnellyville, to the east of the highway.



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Legend

Study Area

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Figure 1.1
LOCALITY PLAN

Initial upgrading of the existing two lane road would take place between the Upper Warrell Creek Bridge and the intersection with Albert Drive (south), immediately north of the Warrell Creek village. The route would then follow the existing highway alignment north of the village. A section of the North Coast Railway Line would need to be realigned and reconstructed as part of the project. The features of the preferred route are as follows:

- approximately 5 km in length;
- located to the east of the existing highway and to the east of the existing Warrell Creek village area;
- utilises part of the existing highway alignment, ie. from the southern end of Albert Drive to the northern end of the highway's crossing with Albert Drive;
- requires a 1.2 km section of the North Coast Railway Line to be realigned to the east by approximately 60 m;
- would retain local road access and therefore separate through traffic from local traffic to eliminate existing traffic conflict problems; and
- would provide a high standard road, with 100 km/h speed limit through the area, which would increase traffic efficiency and improve traffic safety.

1.4 The Environmental Assessment and Determination Process

Within NSW, environmental impact assessment procedures are undertaken in accordance with the provisions of the Environmental Planing and Assessment Act (EP&A Act) 1979, as amended. The RTA, as the determining authority, must consider the potential impact of the proposal in accordance with Part 5 of the EP&A Act. The RTA has the responsibility under Section 111 of the EP&A Act to "examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reasons of the activity". To fulfil this obligation, this REF has been prepared in accordance with the provisions of the Act and of the EP&A Regulation,1994.

1.5 Guidelines for Making a Submission

This draft REF would be advertised and placed on public exhibition at the following locations:

- RTA - Pacific Highway Development Office, 21 Prince Street, Grafton
- Nambucca Shire Council, 44 Princess Street, Macksville.

During the exhibition period, members of the community, interest groups, and government authorities are invited to make a submission on any respects of the proposal. All submissions received on the draft REF would be taken into

consideration prior to finalisation of the REF and the RTA, as determining authority, would then make a decision whether the proposal can proceed, or whether an EIS is required or not.

If you wish to make a submission, it would be helpful if you would include:

- the nature of your interest in the proposal;
- your opinions on the proposal;
- any suggestions you wish to make about alternatives, or improvements to the proposal;
- any additional measures you consider necessary to adequately protect the environment;
- any errors or omissions in the information presented in the documents;
- any additional factual information you have (and its source); and
- any other aspects that you consider are relevant to this proposal and its determination.

In order to make it easier for the matters raised in your submission to be analysed and properly considered:

- list points wherever possible - this makes the issues clear;
- refer each point to the relevant section (or sub-section) of this document and/or the Working Paper;
- include your name, address and date if you want your submission acknowledged; and
- finally, please ensure that your submission is as legible as possible.

All submissions will be treated as public documents unless it is requested explicitly that they be regarded otherwise. Please indicate if you wish your submission to remain confidential. Form letters are accepted and considered.

Submissions should be forwarded to:

Mr Jim Campbell
Project Manager
RTA Northern Region
PO Box 576
Grafton NSW 2460

1.6 Approach to the Study

The approach to the study was divided into four separate, but inter-related, phases, as described below:

- Project Need - this phase reviewed the need for the Proposal, defined the objectives of the project, and considered alternatives. This is described in Sections 2 and 3 of the REF.

- Consultation - the community and relevant organisations and authorities were consulted at various stages of the study. A description of the consultation process is provided in Section 4.

- Concept Design and Refinement- identified the preferred alignment of the proposed realignments and why the alignment was refined. This is described in Section 3 of the REF.

- Environmental Impact Assessment - during which environmental specialist studies were undertaken and the REF prepared. This is described in Section 6 of the REF.

A series of environmental investigations were undertaken as part of the REF. The aspects investigated were:

- land use and planning
- air quality
- hydrology and water quality
- visual quality and landscape
- flora and fauna survey
- non-aboriginal heritage and aboriginal heritage investigations
- noise impact assessment
- transportation, traffic and access
- social impact
- economic impact
- value management study
- risk management study

Each of these is addressed in the REF to allow adequate assessment of the environmental impacts of the proposal. Consideration of Clause 82 of the EP&A Act 1979, has been undertaken in Section 7.

2. Need for the Proposal

2.1 Objectives of the Proposal

The objectives for the proposal were developed within the framework of ecologically sustainable development (ESD).

2.1.1 Principles of Ecological Sustainable Development

The National Strategy for Ecologically Sustainable Development (1992) defines ecologically sustainable development as:

> *"using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased."*

The NSW EP&A Act identifies four principles of ESD which must be considered in project planning and development. They are:

- the precautionary principle which states that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;
- intergenerational equity which requires that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;
- conservation of biological diversity and ecological integrity; and
- improved valuation and pricing of environmental resources.

2.1.2 Specific Project Objectives

The principal objective of the project is to complete the defined scope as part of the Pacific Highway Reconstruction Program. To achieve this, the following specific objectives have been identified for the project:

- Road Safety:
  - ensure compatibility with adjacent sections of the highway,
  - reduce the accident rate,
  - improve access,
  - reduce potential conflict points,
  - address the State and Federal Governments' commitment to providing a divided carriageway along the Pacific Highway, and
  - improve cyclist and pedestrian amenities.
- Environment - determine the potential impacts of the project on the social and natural environments in accordance with the relevant legislation and policies, and develop options for the mitigation of detrimental impacts and the cost-

effective exploitation of opportunities provided by the proposal in accordance with RTA policy.

- Efficiency - provide a transport efficient solution to the proposal, reducing vehicle operating costs and travel times while still providing for local traffic requirements.

- Customer Service - provide an acceptable level of service for both local users and through traffic.

- Economic Development - develop a proposal that contributes to economic development both locally and regionally, and reduce travel times and costs.

2.2 Need for the Proposal

The North Coast Region is the fastest growing non-metropolitan area in NSW with a population of approximately 500,000 which more than doubles during peak holiday seasons. Population growth modeling in the RTA North Coast Road Strategy predict population increases up to 450 000 by 2016 (Roads and Traffic Authority, 1993).

The Pacific Highway is the major road transportation link between this region and Sydney and Brisbane. In addition, it provides the major inter and intra-regional transport function. It services many rapidly growing tourist and commercial centres within the North Coast Region. Its capacity to provide a reasonable level of service to meet the road transportation requirements of this region are diminishing as the region continues to develop.

2.2.1 Strategic Justification

The Pacific Highway Reconstruction Program has as an ultimate aim to provide a dual carriageway along the length of the Highway so as to improve user safety by reducing degree of conflict, improving travel conditions and overtaking opportunity, and providing for future growth. The sections of highway south of the study area have dual carriageways, and this project provides the opportunity to extend the duals in an economic way.

The Proposal would provide a dual carriageway, but a single carriageway may be constructed in the interim, based on available funding and other factors such as traffic volumes. A single carriageway option would allow separation of local traffic, and would result in improved travel by way of safety, better alignment and improved pavement condition, which would reduce vehicle operating costs. The dual carriageway would further improve on the single carriageway scenario by reducing accident risk and improving overtaking opportunities. The community would prefer the construction of the dual carriageway to be undertaken as one project, to reduce the inconvenience of two, separate construction periods.

2.2.2 Specific Justification

The deficiencies of the existing Pacific Highway at Warrell Creek are as follows:

- sub standard road - formation, width, shoulders, horizontal alignment;
- poor level of service and continuing to deteriorate;
- residential property accesses directly onto the Pacific Highway in the Warrell Creek village and from adjoining rural properties with inadequate sight distance;
- commercial development access directly onto the Highway with no merge lanes;
- reduced safety due to the conflict between through and local traffic;
- no pull off area for buses;
- this relatively short section of substandard highway forms a link between two upgraded sections of highway, creating inconsistent road conditions, such as time delays for traffic.

2.3 The Role of the RTA

The RTA, which is the proponent for this project, is responsible for the management of a network of major roads and the traffic system in NSW. The RTA's aim is to manage the use, maintenance and enhancement of the State's road and traffic system, with emphasis on road safety and transport efficiency as part of an integrated and balanced transport system.

The RTA recognises that the environment is a key influence on its activities, and its Corporate Plan states that it is to care for the environment during the planning, construction, maintenance and use of the road system.

3. Analysis of Alternatives

3.1 Existing Highway

The highway is deteriorating in many sections. In the vicinity of study area, the highway safety and carriageway capacity are not considered to be of a suitable standard within the State Highway network (see Section 2.1).

The section of the highway to the south of the village has a generally fair horizontal alignment, although there is a short section with three substandard curves, with advisory speed signposting of 75 km/h. This section also has narrow shoulders. In the village area, the roadway is also fair, with narrow shoulders and numerous property accesses. The vertical alignment in this section is considered to be good in terms of standard guidelines for a rural highway. The posted speed limit through the area is 90 km/h. To the north of the village, the Highway standard improves, as it was constructed about ten years ago.

The section of highway through the study area carries a very high volume of through traffic, as well as local traffic. This compromises the efficiency of the Highway to operate as a major transport corridor between Sydney and Brisbane.

The Highway currently allows access to and from the local sawmill and to a roadside fruit stall. Cars and trucks enter the carriageway at low speed and immediately have to share the roadspace with through traffic travelling at higher speeds. Some 15 houses have direct access to the highway with poorly formed driveways and little or no shoulders, creating an undesirable situation. These shoulders are too narrow for the school buses servicing the area to safely pull off the roadway. Such access conflicts reduce the safety of all the existing Highway users and the efficiency of the highway.

At present, the highway through the study area is operating at a level of service C which is defined as "stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level." (AUSTROADS, 1988).

A number of alternative route alignments were examined for the proposed upgrade of the highway within the study area. The following sections outline the alternatives that were considered, and describe the process for selecting the preferred route. A detailed environmental impact assessment was then undertaken on the preferred route, which is described in Section 6.

3.2 Analysis of Alternatives

The Proposal is to realign the existing highway (42.2 km to 47.0 km north of Kempsey) in the vicinity of the study area. At the start of the investigations into the realignment five route alternatives were identified by the RTA, with a sixth alternative being to leave the Highway in its existing location (see Section 3.2.2). The route

alternatives were located within a corridor constrained by Way Way State Forest and a large hill to the east, and by Warrell Creek and a ridge to the west.

3.2.1 Alternatives Considered

The five route alternatives were:

- Route A - far east of the Highway at the edge of Way Way State Forest
- Route B - the shortest distance option between the start and finish points in the study area
- Route C - parallel and east of the railway line
- Route D - shifting the railway line so the road can run between the railway and the village and
- Route E - following the existing highway alignment through the village.

These routes are shown in **Figure 3-1**.

The options used varying lengths of the existing road infrastructure depending on their proximity to the existing Highway. As the existing Highway runs through the village, routes closest to the village made the most use of the existing road infrastructure.

Various alternatives within each route were then developed as part of the Value Management Study, which resulted in a total of eleven different options to the existing highway.

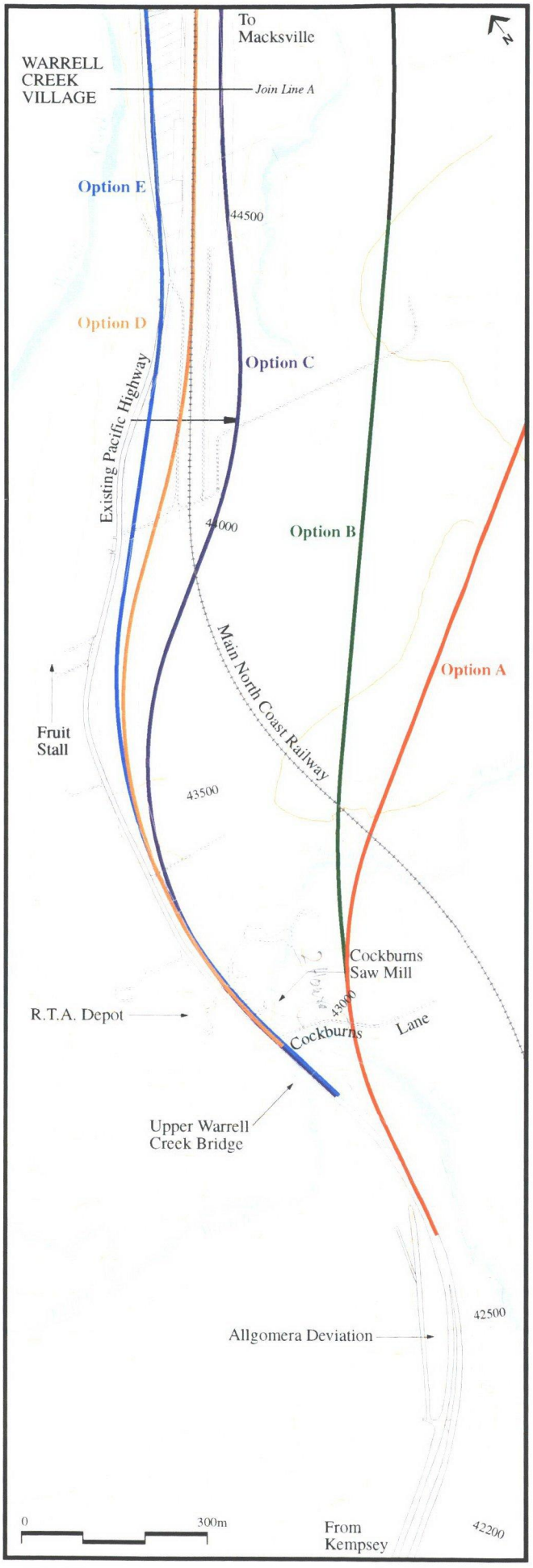
Route A - Far east of the village

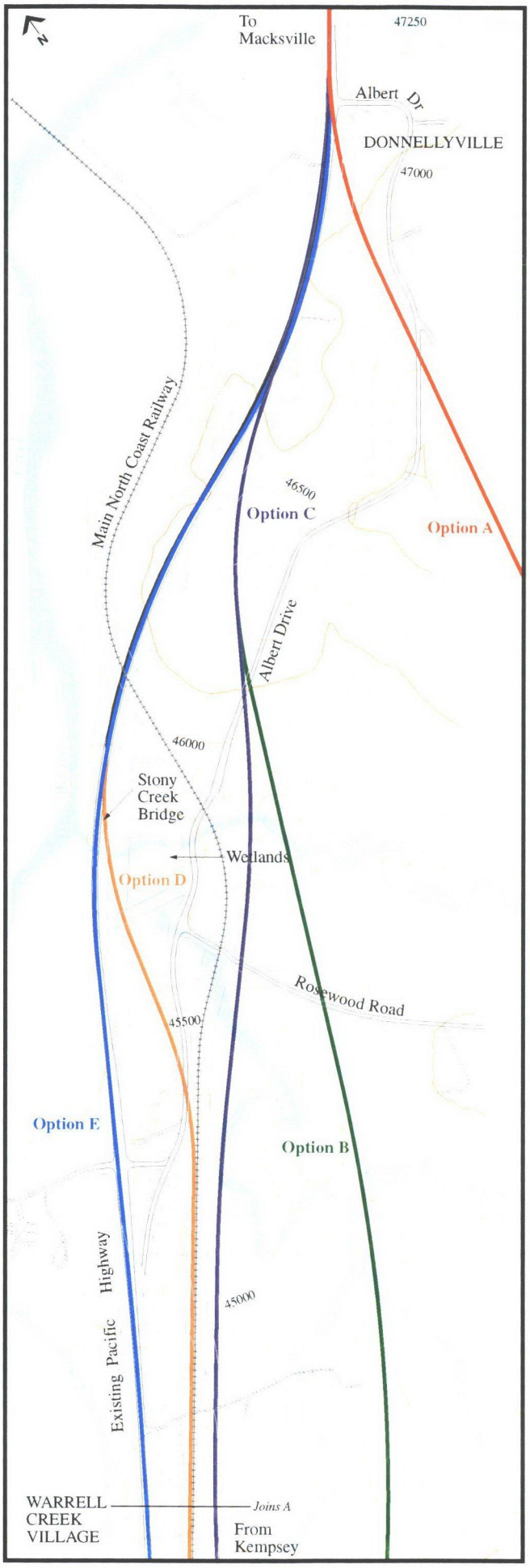
The basic road alignment is to the far east of the Highway at the edge of Way Way State Forest.

Option 1

This option started 250 m south of the existing Upper Warrell Creek Bridge at the end of the Allgomera Deviation. It required bridging Warrell Creek approximately 100 m east (upstream) of the existing bridge before crossing Cockburn's Lane and veering to the east, crossing the main northern railway where it is in cutting. The road then skirted the forest area to the east following a route behind the existing farms. It crossed Rosewood Road at grade approximately 900 m from the existing highway. From there it veered back to the west and cut Albert Drive passing to the west of Donnellyville and joining the Rosewood deviation 100 m north of the Donnellyville turnoff.

The redundant highway would become the village access road with connections to the new work at either end of the village. Albert Drive, connecting the village with Donnellyville, would be cut. Connection between the two villages would involve using the new highway.





ROAD DESIGN SERVICES SECTION
ROAD TECHNOLOGY BRANCH

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Figure 3.1
ROUTE OPTIONS

Route B - 300 m east of the railway

The basic road alignment lies 300 m east of the railway in a straight line between the start and finish points.

Option 2

This option started 250 m south of the existing Upper Warrell Creek Bridge at the end of the Allgomera Deviation. It required bridging Warrell Creek approximately 100 m east (upstream) of the existing bridge before crossing Cockburn's Lane and veering to the east, crossing over the main northern railway slightly west of Option 1. The new road would lie 500 m to the east of the existing sub-standard bends at the southern end of the village and parallel with the railway line approximately 300 m to the east following an almost straight line through the middle of farms and under Rosewood Road. This would require a grade separated intersection at Rosewood Road. It then crossed Stony Creek before cutting the Albert Drive and skirting Donnellyville slightly further west than Option 1 and joined the existing highway at the Donnellyville turn off.

The redundant highway would become the village access road with connections to the new work at either end of the village. Albert Drive, connecting the village with Donnellyville, would be cut. Connection between the two villages would involve using the new highway.

Option 3

This option is basically the same as option two, but crossed under the main northern railway instead of over the top.

Option 4

This option started 250 m south of the existing Upper Warrell Creek Bridge at the end of the Allgomera Deviation. It required bridging Warrell Creek approximately 100 m east (upstream) of the existing bridge before crossing Cockburn's Lane and veering to the east, crossing over the main northern railway slightly west of Option 1. The new road would lie 500 m to the east of the existing sub-standard bends at the southern end of the village and parallel with the railway line approximately 300 m to the east following an almost straight line through the middle of farms before deviating slightly to the west to cross Rosewood Road at grade. It then crossed Stony Creek before cutting the Albert Drive and passing Donnellyville well to the west and joins the existing highway 400 m south of the Donnellyville turn off.

The redundant highway would become the village access road with connections to the new work at either end of the village. Albert Drive, connecting the village with Donnellyville, would be cut. Connection between the two villages would involve using the new highway.

Option 5

This option is basically the same as option four, but crossed under the main northern railway instead of over the top.

Route C - Along eastern side of the railway
The basic road alignment is east of and adjacent to the railway with various connections to the existing highway.

Option 6
This option started 250 m south of the existing Upper Warrell Creek Bridge at the end of the Allgomera Deviation. It required bridging Warrell Creek approximately 100 m east (upstream) of the existing bridge before crossing Cockburn's Lane and veering to the west, crossing over the main northern railway slightly further to the west of previous options. The road would then run adjacent to the existing railway on the eastern side and followed the alignment of the railway line before crossing Rosewood Road at grade near the existing railway bridge, cutting Albert Drive and joining the existing highway 400 m south of the Donnellyville turnoff.

The redundant highway would become the village access road with connections to the new work at either end of the village. Albert Drive, connecting the village with Donnellyville, would be cut. Connection between the two villages would involve using the new highway.

Option 7
This option is basically the same as option six, but crossed under the main northern railway instead of over the top.

Option 8
This option started immediately south of the existing Upper Warrell Creek Bridge and utilised the existing structure for one carriageway. Duplication would be required when the second carriageway is constructed. The new carriageway would lie immediately adjacent to and east of the sub-standard bends in the existing highway before crossing over the railway line near the southern end of the village. The road would then run adjacent to the existing railway, on the eastern side, and follow the alignment of the railway line before crossing Rosewood Road at grade near the existing railway bridge, cutting Albert Drive and joining the existing highway 400 m south of the Donnellyville turnoff.

The redundant highway would become the village access road with connections to the new work at either end of the village. Albert Drive, connecting the village with Donnellyville, would be cut. Connection between the two villages would involve using the new highway.

Route D - Relocate railway with road adjacent
The railway is realigned approximately 100 m to the east and the new road alignment lies between the railway and the village.

Option 9
This option included relocating approximately 2 km of the existing railway line approximately 100 m to the east.

This option started immediately south of the existing Upper Warrell Creek Bridge and utilises the existing structure for one carriageway. Duplication would be required when the second carriageway is constructed. The new carriageway would lie immediately adjacent to, and east of, the sub-standard bends in the existing highway. The road would then run adjacent to the relocated railway, in the new corridor created between the existing village and the newly aligned railway, before cutting the Albert Drive and joining the Rosewood Deviation section of the existing highway at the recently constructed bridge over the railway. This bridge would require duplication when the second carriageway is constructed.

The redundant highway would become the village access road with connections to the new work at either end of the village. Albert Drive, connecting the village with Donnellyville, would be cut. Connection between the two villages would involve using the new highway.

Route E - Through Warrell Creek village
The new road alignment would follow the existing highway alignment.

Option 10
This option starts immediately south of the existing Upper Warrell Creek Bridge that would require duplication in stage two. The new road alignment would lie to the east of the existing sub-standard bends, following the existing alignment through the village and joining the recently constructed Rosewood Deviation. The second carriageway would pass through the existing village dwellings and would require duplication of the Rosewood Deviation.

Property access would remain as per the existing arrangement of local roads.

Option 11
This option starts immediately south of the existing Upper Warrell Creek Bridge that would require duplication in stage two. The new road alignment would lie to the west of the existing sub-standard bends, following the existing alignment through the village and join the recently constructed Rosewood Deviation. The second carriageway would pass through the existing village dwellings and would require duplication of the Rosewood Deviation.

Property access would remain as per the existing arrangement of local roads.

A comparison of the options is outlined in **Table 3.1.**

Table 3.1 - Comparison of Options

Route	Option No.	Carriageway Length (km)	Cut Volume 10^3m^3	Fill Volume 10^3m^3	Telstra Fibre Optic Cable Crossings	Houses Resumed	Individual Carriageway Bridged Required	Grade % min/max	Cost $M
A	1	9.0	800	800	1 of	5	2 over WC 2 over rail	1.0/4.5	30.1
B	2	8.6	600	670	1 of	4	2 over WC 2 over rail 1 @ Rosewood Rd over Hwy	0.3/4.1	25.9
B	3	8.6	600	450	1 of	4	2 over WC 1 rail over Hwy 1 @ Rosewood Rd over Hwy	0.1/3.8	25.6
B	4	8.2	540	500	1 of	2	2 over WC 2 over rail	0.1/4.1	23.4
B	5	8.2	480	520	1 of	2	2 over WC 1 rail over Hwy	0.1/2.1	24.9
C	6	8.2	240	730	1.5km	4	2 over WC 2 over rail	0.1/4.1	30.2
C	7	8.2	410	360	1.5km	4	2 over WC 1 rail over Hwy	0.1/2.4	23.5
C	8	8.0	280	590	1.7km	3	1 over WC 2 over rail	0.1/4.0	25.2
D	9	7.2	140	320	1.1km	3	1 over WC 1 over rail	0.1/exist	21.4
E	10	6.3	170	76	1 of	18	1 over WC 1 over rail	0.1/exist	17.5
E	11	6.3	230	150	1 of	19	1 over WC 1 over rail	0.3/exist	18.9

3.2.2 Consequences of No Action

The consequence of deferral or no action on this project will be the continuing deterioration in traffic safety and performance of the highway, with increased maintenance costs.

If nothing is done to improve this section of the highway, existing problems will continue, and be exacerbated in some cases. Specifically:

- a sub-standard section of road will remain between two upgraded sections of road creating a bottleneck and increased chance of accidents;
- there would be increasing conflict with property access;
- the existing situation would not conform with the government's objectives;
- the road shoulders would be sub-standard;
- the horizontal alignment would be sub-standard;
- there would be further deterioration in the level of service and travel times;

- there would be an increase in conflict between through and local traffic; and

- there may be an increase in accident occurrence (a further two incidents of trucks losing their loads in the tight bends south of the village and a double fatality head-on collision north of the village were reported by residents at the start of 1997).

Future traffic growth and increased peak holiday flows would only further exacerbate the problems currently experienced. Historical evidence suggests that a steady increase will occur.

The option of deferral or no action is considered likely to generate a steady worsening of road and traffic conditions with consequent adverse community and environmental effects.

3.3 Value Management Study and Workshop

A Value Management Workshop for the project was held on 12 and 13 November 1996. The full details of the Value Management Workshop are documented in the Value Management Study (DPW&S, 1996) and the *Options Development and Selection Report* (RTA Technology, 1997d).

During the workshop the project was examined from a number of viewpoints including social impacts, the natural environment, impacts on property and construction and maintenance costs. Workshop participants included:

- community and local industry representatives;
- local government; and
- state government agencies.

A multi-criteria analysis was carried out during the Value Management Study. The criteria identified for qualitative assessment were identified by the participants at the workshop, and given a nominated weighting. The criteria were applied to the routes already identified as well as a further three options identified during the Value Management Study.

Two route options (D and E) (see Section 3.2.1) were identified as being superior to the others, but further technical investigation and refinement of costs were needed before a final decision on the route could be made. Additional investigations included an economic analysis of the options which found that both options were relatively similar in value.

However, the Department of Urban Affairs and Planning (DUAP) was concerned that Route E would result in the loss of a rural village in NSW (that is, the village of Warrell Creek). Therefore, Route D was accepted primarily on the basis that it was likely to have fewer social impacts than Route E.

3.4 Refinements to the Preferred Option

Following the Value Management Workshop the preferred option was further investigated and refined. The RTA undertook numerous meetings with potentially affected property owners and also with Nambucca Shire Council to discuss specific aspects about the preferred route option, resulting in a number of refinements being investigated.

As a result, one of the variations of Route D was selected as the preferred route. This route modified Route D by joining the existing highway before the Rosewood deviation through vacant land. The route also varied slightly between Upper Warrell Creek Bridge and the village, resulting in the preferred route being closer to the existing highway, with less effect on adjoining properties and a reduction of 400 m in the relocation of the railway line at the northern end.

The advantages of the northern variation are as follows:

- the land required for acquisition is mostly vacant and for sale;
- it shortens the amount of construction required and uses more of the existing road asset;
- there would be less overall social impact on individual residents, as some of the affected landowners are willing to move and/or have land for sale;
- it reduces the length of affected railway by 420 m and eliminates the possibility of the replacement of the new $0.5m railway bridge over Rosewood Road. (which was a requirement of RAC);
- eliminates the extent of the impact on the two existing large wetland areas, one between the railway and the Rosewood Deviation and one immediately to the east of the existing railway, near Rosewood Road;
- reduces the amount of fill to be imported by 200,000 m^3;
- reduces the overall cost of the project by $2 million; and
- allows the residue of the acquired property to be potentially "given back" to the community (possibly as a future community hall site)

The disadvantages of this variation are:

- involves a total acquisition of one additional property (this property is currently for sale) and two part acquisitions (including one rental property);

- divides the village, (although Council agree that the village is already divided in this area by the intersection with Albert Drive therefore does not appreciably change the current situation); and

- removes a portion of a parcel of land with development potential as part of the village.

Further, detailed studies have shown that this option does not significantly impact on the local environment. The social issues have been addressed in Section 6.13, not bold and the earthworks discussed in Section 5.6.

The benefit cost ratios (BCR) for the refined route, based on a dual carriageway scenario, are outlined below:

- dual carriageway operating in 1999 - 2.7
- dual carriageway operating in 2010 - 3.2
- dual carriageway operating in 2015 - 3.3

It is noted that the BCR is not less than two and on an economic basis the refined route is feasible for the dual carriageway option, regardless of when it is built.

3.5 Preferred Route

On 4 December 1997, the NSW Minister for Roads announced the approval of the following route as the preferred option for the Proposal (see **Figure 3-2**). It links the dual carriageway south of Warrell Creek to the Rosewood deviation near Donnellyville. Initial upgrading of the existing two lane road would take place between the Upper Warrell Creek bridge and the existing bridge over the railway north of the village. A section of the Main Northern Railway Line would need to be realigned and reconstructed as part of the project. The features of the preferred route are as follows:

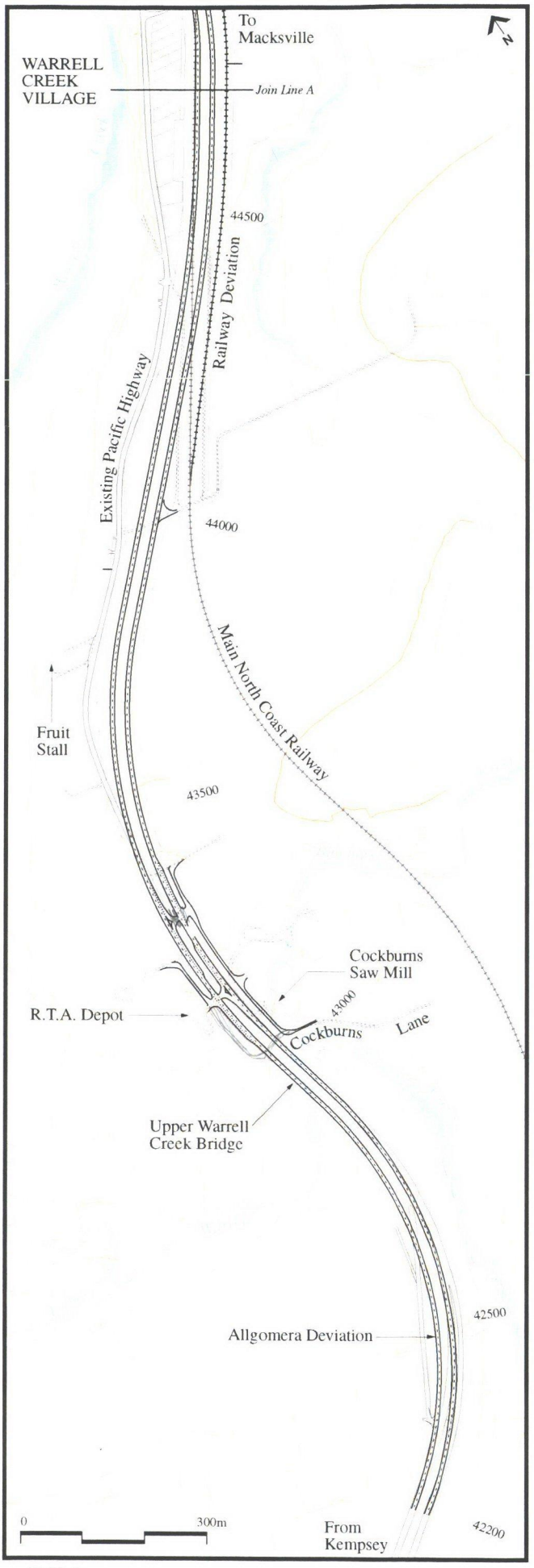
- approximately 5 km in length;

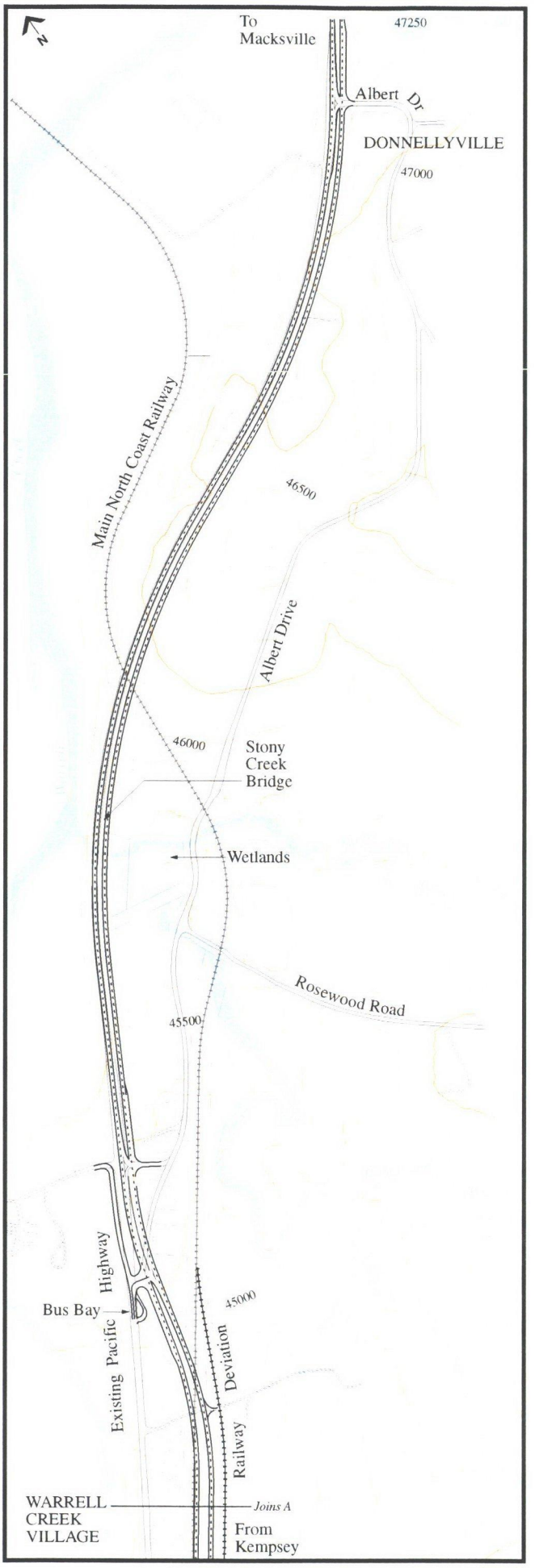
- four lane, two way road;

- located to the east of the existing highway and immediately to the east of the existing Warrell Creek Village area;

- utilises part of the existing highway alignment, ie. from the southern end of Albert Drive to the highway's crossing with the Main Northern Railway Line;

- requires a 1.2 km section of the Main Northern Railway Line to be realigned to the east by approximately 60 m;





RTA TECHNOLOGY
ROAD DESIGN SERVICES SECTION
ROAD TECHNOLOGY BRANCH

Figure 3.2
PROPOSED ALIGNMENT

- would separate through traffic from local traffic to eliminate existing traffic conflict problems; and

- would provide a high standard road, with 100 kph speed limit through the area which would increase traffic efficiency and improve traffic safety.

This REF assesses the environmental impact of a dual carriageway, which would operate as a four lane, two way highway with a median strip.

As a result of the construction and operation of this project, environmental impacts may be experienced. These have been identified by the study team as:

- noise impacts;
- flora and fauna impacts;
- impacts to indigenous and non-indigenous heritage items;
- air quality effects;
- changes to the visual environment and the landscape amenity of the area;
- potential water quality and hydrology impacts; and
- traffic impacts, mainly during the construction period.

Detailed studies assessing the potential environmental impacts of the Proposal are detailed in Section 6 and the Working Papers. Where potential adverse impacts have been identified, measures have been developed and implemented as part of the project to reduce these impacts.

4. Consultation

4.1 Approach to Consultation

The study team's intention for this project was to keep local and state government authorities and the local community informed at all times during the course of the study to enable them to make an input into the study process, to listen to views expressed and take those views, concerns and suggestions into consideration.

An important part of the process was the provision of information during the key stages of the project, ie. project initiation, route evaluation and selection, the design of the preferred route option and the detailed environmental studies and the preparation of the associated reports including the REF. A comprehensive Community Involvement Plan was prepared at the start of the project to ensure that the community of Warrell Creek and neighbouring areas were informed of all aspects of the impact assessment process and were involved in decision-making.

4.2 Consultation with Organisations and Authorities

All relevant government agencies and relevant stakeholders were invited to a Planning Focus Meeting, held on Thursday 12 September 1996 at the Macksville Ex-Servicemen's Club. The aim of the Meeting was to provide information about the project to all stakeholders and to provide a means for them to:

- state and define the issues which they believe should be considered in the project; and
- identify the detailed requirements of Government agencies for consideration throughout the study.

Prior to the meeting, participants were provided with a Background Information Paper. The meeting provided the participants with an introduction to the project team and a description of the project. Individuals were then given an opportunity to make their representations. The organisations which sent representatives to the meeting and their issues relating to the proposal are outlined below:

Bruce Jeffery MP, Member for Oxley

- cost involved
- increases in traffic using the Pacific Highway; eg heavy trucks
- water quality of Warrell Creek, need for monitoring and accountability
- access for school buses and consideration of passenger safety
- impact on prime agricultural land with very rich soil
- need longer access points and longer overtaking lanes
- concern of disruption during construction
- dangerous crossings need bigger and better lighting and sign posting
- impact of proposal on bottleneck that happens at Macksville Bridge.
- need to communicate appropriately with the local community regrading the proposed options

Nambucca Valley Catchment Management

- as per comments above
- main concerns are water quality, physical environment and social impact

Nambucca Shire Council

- water quality - the quality is poor and some landowners, including farmers, get water from the creeks for their gardens; water from creeks is not used for drinking (drinking mainly from tank or bore); septic sewerage system used
- local access arrangements should be considered
- during drought there would be competition for water, hence it would be very important to talk to residents on this matter
- consider the setting up of a service centre in the area (positive economic impact)
- Donnellyville would expand on the eastern side of the railway line, near the present orchard

Telstra

- Telstra has local cable on either side of the Pacific Highway. There is a fibre optic cable on the eastern side
- Policy is nil relocation of existing cable
- RTA should take care with cables during construction

Newman's Coach Service

- RTA should consult with Newman's prior to construction
- there are currently no bus bays

Optus

- Optus has one fibre optic cable which should be avoided if possible
- RTA to consult with Optus prior to construction

Warrell Creek community representatives

- some local suggestion that the preferred option should be west of Warrell Creek.
- request not to put road through the village; community (especially by the elderly) fears the village would disappear
- consider history of Warrell Creek village
- concern of relocation, compensation and the time taken to settle matters (social impact)
- other immediate issues of concerns are service delivery waste pick up

Nambucca Police Patrol

- accident history is not high; speeding is minimum
- fully support RTA proposal
- excessive speed tends to happen at the bridge site near the sawmill

Department of Agriculture

- pesticide survey needed; possible contaminant in the orchard
- agricultural mapping carried out 1:50,000 for detailed agricultural land

- consider what farming is undertaken and its infrastructure
- it would be important to consult with the local landowners
- the potential for acid sulphate soil should be considered
- fire weed, giant parramatta weed and camphor laurels are problem weeds in the area. These are easily spread by machinery

North Power

- powerlines can be relocated, if necessary
- North Power would need future access to all powerlines
- no underground cabling in the study area
- RTA should consult with North Power prior to construction

Department of Land and Water Conservation

- Department has environmental concerns on soil, water, and vegetation management; these issues should be integrated into the EMP
- concern over spills and how to contain the hazard
- detailed water quality management would be required
- water run-off treatment with vegetation and other means should be pursued
- water treatment areas/ponds/wetland should be considered in the design
- consider suitable location for storage of fuel etc during construction
- rehabilitation using local native species
- consider where the RTA going to get its water supply from during construction (30m buffer between the creek and the road is required as a minimum
- consider the fishery habitat and the resource for the area

Department Urban Affairs and Planning

- if an EIS is required then DUAP would be more involved in the project
- take note of the requirements of various Acts
- not aware of any heritage area in the study area
- check with NPWS re: threatened species.

Written representation was made by the National Parks and Wildlife Service (NPWS):

National Parks and Wildlife Service

- areas of native vegetation, with special reference to threatened or regionally significant flora species and communities
- areas of potential significance for native fauna with special reference to the value of habitat for threatened or regionally significant species
- areas of archaeological potential and Aboriginal heritage value as defined by the Aboriginal community
- areas of NPWS estate

4.3 Consultation with the Community

The community was consulted at various stages during the study, and any relevant comments and concerns were incorporated into the development of the proposal. Community consultation included:

- the identification of residents and the establishment of a mailing list/database;
- two community meetings;
- the preparation and distribution of three Information Sheets;
- interviews with potentially affected landowners (undertaken by RTA Technology);
- consultation with local and State government authorities;
- a Value Management Study
- advertising in the local newspaper
- public display of the REF.

4.3.1 Information Sheets

Four information sheets were prepared and distributed to the community by post, and additional copies left at Council. The contents of the information sheets are summarised below, and are included in **Appendix A.**

- Information Sheet No 1 - general introduction to the project;
- Information Sheet 2 - outline of issues associated with route selection as a result of the Value Management Study and a description of the selected route.
- Information Sheet 3 - description of the refined alignment, details about major access arrangements, key findings of the technical studies, and an update of the study's progress. The community was also invited to attend a second Community Meeting (see Section 4.3.2).

4.3.2 Community Meetings

During the development of the proposal, two meetings were held with interested members of the Warrell Creek community. The first community meeting was held on 28 October 1996 at the Warrell Creek Community Hall. Representatives from the RTA, RTA Technology and Sinclair Knight Merz presented the proposal to approximately 40 members of the community and outlined an number of alternatives for the realignment of the Pacific Highway at Warrell Creek (see Section 3.2). The participants were divided into groups with a facilitator to discuss the proposed options. The issues raised within the groups were then presented back to

the meeting. Key issues raised by the community during this meeting are outlined below:

- alignment location
- social impact
  - impact on village
  - impact on amenity (such as noise and air quality)
  - property settlement
- agriculture (cattle)
- timing of the project
- access impacts
- geology (hard rock and soils)
- flooding
- water quality
- climate (fog)

During the community meeting, a survey was handed out for residents to provide feedback on local issues such as travel movements, land use, occurrence of fog, water use, native flora and fauna as well as any other issue of importance.

A second community meeting was held on 10 December 1997 at the Warrell Creek Community Hall, and was attended by approximately 40 residents. The aim of this meeting was for the RTA and RTA Technology to detail progress in the development of the proposal, particularly in regard to the refined concept route (see Section 3.4), and to obtain community feedback. The meeting follows on from the Ministerial announcement on the Refined Concept Route, released on 2 December 1997. Details of this meeting are included in **Appendix A**.

The information received from the public meeting and the survey has been used in preparing this REF, and the community's concerns addressed.

5. Description of the Proposal

5.1 Road Alignment

The proposed road alignment starts at the southern end of the last bend of the Aligomera Deviation (as this bend is currently below 100 km/hr design speed standard) and uses the existing Upper Warrell Creek bridge. From the bridge, the route would be located immediately to the east of the existing Highway, veering slightly further to the east to run parallel to the rear boundary of the village of Warrell Creek (basically in the existing railway corridor) and crossing through the vacant property immediately north of the village to join with the existing highway near the southern intersection with Albert Drive.

5.2 Road Design

The road is to operate with a 100 km/h speed limit, and minimum geometric road design standards are in accordance with this limit as per the "Pacific Highway Guidelines, Schedule of Design Policies and Specifications for the Construction of New Sections of Dual Carriageway" (RTA, 1996). The design of the future dual carriageway would also be in accordance with the "Schedule of Design Policies and Specifications for the Construction of New Sections of Dual Carriageway for the Pacific Highway" and appropriate section of the RTA Road Design Guide.

It is noted that the proposed route actually meets the requirements for signposting at 110 km/h as per the RTA Road Design Guide having controlled access, having a minimum curve radii of 600m, and a maximum grade of 6%.

5.3 Overall Staging

It is expected that the project would be implemented in two stages. Stage One would be the construction of one new carriageway to replace/upgrade the existing Highway between Upper Warrell Creek Bridge and the intersection with Albert Drive (south), and the realignment of the railway line. Stage Two would be the duplication of the first carriageway, enabling Pacific Highway to operate as a dual carriageway highway.

The proposed realignment would require property acquisitions. Property settlements would be carried out for both stages during Stage One. Depending on the lag between stages, adjoining rural landowners could be granted use of the road reserve set aside for the second carriageway in the interim period based on a lease arrangement.

Detail staging would require consideration of factors such as the construction sequence, utility adjustments, work under traffic, local property access, RAC track possessions. Most of these decisions would be made in the detail design stage and controlled by planning tools such as an Environmental Management Plan (EMP). Some issues would be subject to the successful construction contractors scheduling.

5.3.1 Stage One

Stage One will be the construction of the southbound carriageway of the proposed dual carriageway and will cater for two lane, two way traffic.

The last bend of the Allgomera deviation would be upgraded as it is presently under 100 km/hr design speed standard.

The majority of construction activities would be conducted out of traffic until the final stage of tying in with the existing highway. This would necessitate some temporary staging works and traffic disruption at the end of Stage One.

Stage One also involves shifting 1.2 km of the North Coast Railway. This activity would need to be completed prior to road works being carried out.

5.3.2 Stage Two

Construction of the second carriageway, which would ultimately be the north bound lanes of the dual carriageway, would have little impact on the highway in use. The majority of road and bridge works would be constructed out of traffic. The only staging works required would be at either end switching traffic from the stage one carriageway and adjustments at Albert Drive (south).

Structures required would be duplication of the existing bridge over Warrell Creek on the western side, adjustments and duplication of the existing box culvert at Butchers Creek, and duplication of the existing bridge over the railway at the Rosewood Deviation, the bridge over Rosewood Creek and the Cattle Creep (livestock underpass) near the northern limit of the study area.

Staging of road and bridge works affecting the rail crossing would need to be performed in conjunction with the Rail Access Corporation.

5.4 Access Arrangement

The majority of traffic using the highway is through traffic. This leads to conflict and congestion of the highway when multiple individual local properties have direct access to the highway, as is the case at Warrell Creek. Furthermore, the school buses serving Warrell Creek create delays and safety concerns as there is little room to pull off the Highway. Highway efficiency and safety can be improved by reducing the number of direct access points onto the highway and hence reduce congestion and improve efficiency.

Currently, each property fronting the highway, has access directly onto the highway. This represents approximately 30 access points from residences and farms, the majority of which are of poor quality. The proposed route would maintain access to all properties, although some re-routing of property access routes would be required. This would be dependent on property settlements (see Section 6.1) and would be subject to further investigation in the detail design stage. During

construction, access requirements may change temporarily and the RTA, or its Contractor, would consult with residents regarding individual property movements.

Access to each of the sawmills would enable logging trucks to enter and exit in both directions. The access to the Cockburn Mill is proposed to be moved further towards the northern boundary of the property for safety reasons. Cockburn's Lane would be replaced with a service road joining with Cockburn's Mill access.

Access to the Warrell Creek Village would be via the existing Pacific Highway, with connection only at the northern end. This part of the highway would be maintained as a local road through the village. Provision would be made for the school buses to turn into the existing Highway.

Albert Drive between Warrell Creek village and Donnellyville would have access via a staggered "T" intersection (see **Figure 3-2**) with the highway. Access to Donnellyville from the Rosewood deviation to the north remains unchanged.

5.5 Earthworks

Please note: The following cut and fill volumes are given in the compacted embankment state and are approximate only. Assumptions on material insitu density and other geotechnical information have been made to enable the appropriate calculations to be made.

The total quantity of cut material available onsite from this project would be 75,000m^3. The majority of this material would come from the two cuttings adjacent the existing Rosewood Deviation. The excavation of these 2 cuttings, as part of Stage 1, would allow for the future second carriageway to be constructed in Stage 2.

The quantity of fill required for Stage 1 would be 55,000m^3 plus 10,000m^3 to allow for unsuitable material to be spoiled, giving a total of 65,000m^3.

Construction would be carried out as a cut to fill operation and the material would be hauled from the Rosewood Deviation cuttings to the fill areas in Stage 1 via the existing road. Smaller areas of cut on Stage 1 could be transported through the work site by machinery such as scrapers and dump trucks.

The following quantities of materials would need to be imported for Stage 1:

- Selected Fill Material 10,000m^3
- Verge Material 10,000m^3
- Rail Embankment Fill 5,000m^3

The quantity of topsoil required to be stripped and stock piled for Stage 1 would be 25,000m^3.

Of the 75,000m^3 total quantity of fill available 65,000m^3 would have been used in Stage 1, leaving 10,000m^3 available for Stage 2. All of this 10,000m^3 available would be reserved as an allowance for spoil material in Stage 2.

The following would need to be imported for Stage 2;

- Fill Material 120,000m^3
- Selected Fill Material 20,000m^3
- Verge Material 10,000m^3

The quantity of topsoil required to be stripped and stock piled for Stage 2 would be 30,000m^3

Material of suitable quality found in cut areas may be used for select or verge material and consideration may be given to adding a stabilising agent to improve the quality of materials used. Topsoil and unsuitable material would be used for landscaping.

Imported material would be sourced from commercial quarry operations or other areas requiring cutting in the road reserve. An environmental assessment would be undertaken prior to any source of material being used. This assessment would address all on-site impacts as well as impacts arising from transport of the material. This material would be required to be hauled to the worksite by road. The haulage, stockpiling (if required) and placement sequence will depend on the method of working determined by the road construction contractor. Haulage would be carried out by trucks meeting the registration requirements for NSW, including load limits and would be limited to the approved days and hours of work on this proposal.

Where feasible embankments would be constructed with batters of 4:1 or flatter, to provide a safe clear zone for errant vehicles. Where safety barriers are provided, such as adjacent to bridges, the embankments may be steepened to a maximum slope that would not affect stability. It is anticipated that cutting batter slopes required for stability in exposed insitu weathered material would be 1:1, and steepened in areas of solid rock. There may also be provision for a berm in higher cuttings.

5.6 Drainage and Erosion Control

Drainage design would be performed in accordance with RTA's standard policy to an AEP of 5%.

Drainage is proposed to be via grass lined drainage swales and piped into drainage treatment ponds prior to exiting into existing creek systems. Spillage control would play an important part in this scenario and detailed drainage investigation would be undertaken as part of the detailed design stage of the project.

Sediment control management measures would be advised in the EMP.

5.7 Amenities

At present there is no lighting of the highway and sign posting is minimal. There would be no further provision for lighting unless it is warranted at intersections. Signposting would be in accordance to RTA standards.

5.8 Construction

It is anticipated that the RTA would seek expressions of interest from the private sector for construction of this project. It would be the responsibility of the successful tenderer and its contractors to determine the specific means of construction, including the scheduling of works and the overall timing.

Telstra cable adjustments using backhoes or excavators would be undertaken prior to road and rail construction activities.

The description of works outlined below is typical for a project of this size. The successful tenderer would be required to comply with the concepts provided in the REF and with all the concepts provided in the REF and with all recommended environmental safeguards which would be incorporated into an EMP.

5.8.1 Construction Activities

Prior to construction, special arrangements would be required to made with the RAC and Telstra where their infrastructure is affected. Major penalties are likely in the case of disrupting Telstra's fibre optic cables and rail closures would be arranged with RSA in advance.

The main construction activities and major equipment expected to be used are as follows:

- site establishment including sheds and utilities;
- establishment of concrete and/or asphaltic concrete batching plants;
- property adjustments including fencing;
- rail adjustments requiring compaction of imported material using compacters. Actual track laying would require approval of the RAC;
- bulk earthworks involving scrapers, dozers, excavators, trucks, water carts and compactors;
- bridge works involving piling rigs and cranes;
- imported fill
  - selected material zone and pavement materials
  - truck movements
  - hours of work

- establishment of on-site concrete or asphalt batching plant (possibly subject to separate environmental assessment which would be determined during detailed design);
- drainage works involving culvert construction requiring excavators and backhoes;
- paving works involving trucks, profilers, pavers and compaction equipment; and
- landscaping involving establishment of wetlands and revegetation.

All the contractor's operations, equipment, work compounds and materials storage areas would be located within the road reserve or in adjacent areas. A RTA owned depot near the Upper Warrell Creek Bridge may be available for this use. All sites would be securely fenced. All construction equipment, facilities and temporary services would be removed on completion of the project, and the sites rehabilitated as part of the landscaping strategy.

5.8.2 Construction Timing

The actual construction schedule would depend on the workforce and equipment employed in delivering the works. The construction of the proposed realignments is expected to take one and a half years (although not continuously at any one point).

Construction activities would generally occur between 7 am to 6 pm Monday to Friday and 8 am to1 pm on Saturdays (see Section 6.10.3). Measures to minimise the effects of construction noise on the surrounding community would be addressed in the EMP.

5.8.3 Construction Traffic

Access to public roads and properties would be maintained throughout the full duration of the construction works. This would be achieved through the careful planning of construction phasing and in discussions with private landowners. Deliveries of material and equipment would be away from the existing Highway.

During the construction of works to connect the existing road to new work, some traffic delays would be experienced. Traffic Controllers would be employed to guide and manage traffic during these stages. Work at each tie-in would be for about one month. Temporary speed limits would be introduced at these times.

5.9 Waste Management

5.9.1 Clearing

The majority of the area is open grazing land with some isolated stands of vegetation. The proposed route would mainly impact open grazing land. The topsoil would be stripped and non-contaminated material would be stockpiled for late reuse in landscaping work. Cleared vegetation would be mulched or chipped on site for use in landscaping works. Local saw mills may be interested in some of the larger trees.

The proposed route would also involve disturbance to parts of the artificial wetlands created by the railway embankment in the vicinity of Rosewood Road. These areas would need to be mapped and samples taken for nurturing and reproduction at a nursery for future re-establishment. The topsoil would be stripped and non-contaminated material reused in later landscaping.

5.9.2 Waste Disposal

Waste disposal for general materials is available at the Nambucca Council Waste Disposal Depot located on Old Coast Road, Nambucca Heads. This facility can handle general waste and limited cleared vegetation.

A local contractor is responsible for waste pick up for the local community. As there would be a deficit in fill material, no disposal of earth is required.

Weed contaminated topsoil would be covered with weed free topsoils and revegetated.

Liquids such as paints, solvents and bituminous etc need to be contained and disposed of at an approved disposal point. The nearest location is in Newcastle. All waste would be transported in an acceptable manner and disposed of at an approved site.

There is no sewer in the area and human waste needs to be contained in portable pump out toilets for collection. General rubbish would be collected by the local waste contractors and taken to the local tip.

6. Environmental Impact Assessment and Proposed Safeguards

6.1 Land Use and Environmental Effects

6.1.1 Planning Controls

The study area is within the local government area (LGA) of Nambucca and land use within the area is regulated by the Nambucca Local Environmental Plan (LEP) 1995. One of the objectives of the LEP is:

"to ensure that an efficient and safe road network is maintained with minimum intrusion on business centres, public recreation and residential areas".

There are three land use zones within the study area, as shown on **Figure 6-1**. These zones and their objectives, as stated in the LEP (1995) are outlined below.

Zone 1(a1) Rural
The primary objectives of this zone are to:

- encourage the productive and efficient use of land for agriculture
- protect commercial agricultural enterprises
- permit appropriate agriculture-related land uses and certain non-agriculture-related land uses which would not adversely affect agricultural productivity
- protect, conserve and enhance natural and scenic resources, wildlife habitat refuges and corridors
- control development that could have:
  - an adverse impact on rural character
  - create unreasonable or uneconomic demands for the provision or extension of public amenities and services
  - cause adverse physical effects such as erosion hazard, bush fire risk, and flooding.

Zone 1(a2) Rural (Prime/Flooding)
The objectives of this zone are the same as for Zone 1(a1) Rural with the addition of the following objectives:

- protect commercial agricultural enterprises and land of prime agricultural value
- prevent inappropriate development of prime crop and pasture land for purposes other than agriculture, and to discourage further subdivision
- ensure that development of land in that part of the zone which is liable to flooding is carried out in a manner appropriate to the flood hazard

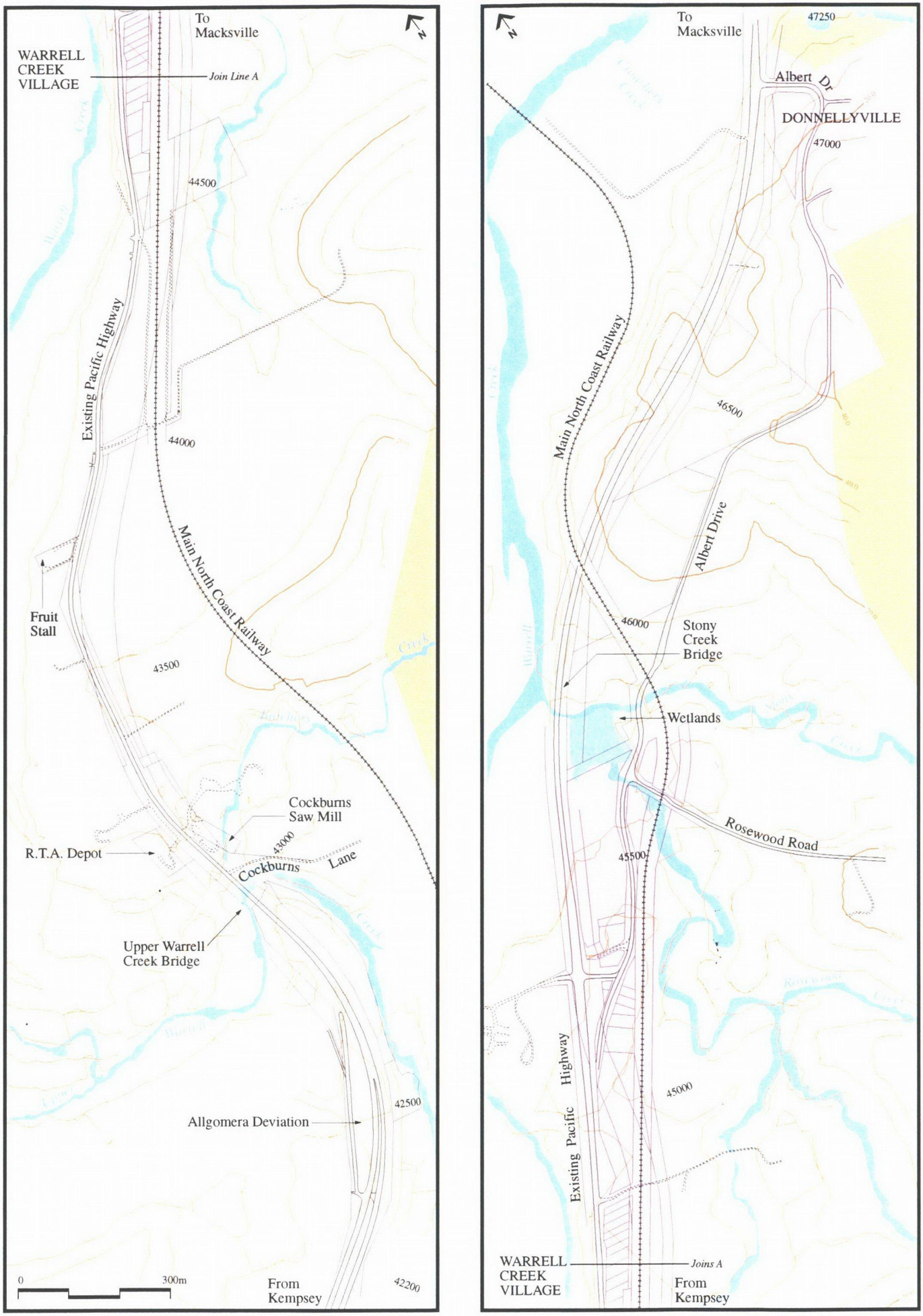


Figure 6.1
ZONING

Zone 2(v) Village
The objectives of this zone are to:

- permit the variety of urban land uses required within small urban communities
- ensure development does not take place unless adequate provision is made for water supply and sewage disposal
- particularise, by means of a development control plan, the location, form, character, height and density of permissible development
- ensure that new development retains and enhances the existing village character (including heritage values) or proposed residential neighbourhood character.

The development of a road within any of the above zones is not permissible without the prior consent from Nambucca Shire Council.

The only State Environmental Planning Policy (SEPP) which directly applies to the study area is SEPP No. 4 - Development Without Consent.

This instrument allows for relatively simple or minor changes of land or building use and certain types of development by public authorities without the need for formal development applications (DA), as long as that development is not prohibited under the Act. The types of development that are covered are described in the policy, however, Clause 11C - Classified Roads and Tollways, means that development for the purposes of a classified road or toll work can be undertaken without development consent.

This policy does not apply to land:

- where road development is permissible without consent in the local planning instrument (ie. LEP)
- to which SEPP No. 26 - Littoral Rainforest applies
- to which SEPP No. 14 - Coastal Wetlands applies (by agreement between the RTA and the Department of Urban Affairs and Planning)
- which is reserved under an environmental planning instrument for acquisition for a public purpose such as open space.

The project therefore does not require Council consent.

North Coast Regional Environmental Plan (REP) 1988
The relevant regional environmental planning instrument is the North Coast Regional Environmental Plan (REP) 1988. This REP covers the north coast region, being that area along the coast between the Tweed Shire in the north to Hastings

Shire in the south and including the shires of Kyogle, Copmanhurst and Nymboida to the west.

The main aims of the REP which are relevant to this project are to:

- develop regional policies that protect the natural environment, encourage an efficient and attractive built environment and guide development to a productive, yet environmentally sound future

- provide a basis for the coordination of activities related to growth in the region and encourage optimum economic and social benefit to the local community and to visitors in the region.

Part 5 of the REP outlines the objectives of the plan in relation to regional infrastructure, and the objectives of Division 1 (Transport) are to:

- safeguard the role and efficiency of the main road system of the region, particularly by recognising the importance of primary arterial roads

- facilitate maintenance and improvement of transport within the region.

An improvement of the highway, providing a safe and efficient highway in the study area, is paramount to achieving these aims and objectives. Therefore the Proposal is consistent with the objectives of the REP.

Environmental Planning and Assessment (EP&A) Act 1979

The Pacific Highway, State Highway No. 10, is a classified road. Accordingly the proposal is an "activity" and is subject to the provisions of Part 5 of the Environmental Planning and Assessment Act, 1979.

Under Section 111 of the EP&A Act, the determining authority is obliged to "examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reasons of that activity". Section 112 of the EP&A Act requires the determining authority to consider whether the proposed activity is "likely to significantly affect the environment". If so, the determining authority is required to prepare and consider an Environmental Impact Statement. The RTA has resolved to prepare and consider a Review of Environmental Factors (REF) report at this stage. If this report finds the proposal to result in significant impact, then an EIS would be prepared for the project.

6.1.2 Land Use

The village has an area of approximately 13 ha. The surrounding area is dominated by rural landuse, notably grazing and limited cultivation. The region to the east of the village is classified by the NSW Department of Agriculture as Class 3, being suitable for grazing and pasture improvement for occasional cash or forage crops, in conjunction with pasture management (see Section 6.5).

The North Coast Railway line runs parallel to the existing Pacific Highway until just north of the Warrell Creek village and then it deviates in a north westerly direction running almost parallel to Upper Warrell Creek Road to Macksville.

The majority of residences within the study area are located on large properties which are adjacent to the Pacific Highway. There are a number of orchard plantations in the area, located to the north of where the Pacific Highway and the North Coast Railway line intersect and also to the south of Scotts Head Road.

There are two sawmills within the study area, one located near Upper Warrell Creek Bridge, next to Cockburn's Lane, and the other to the west of the village on Mill Road.

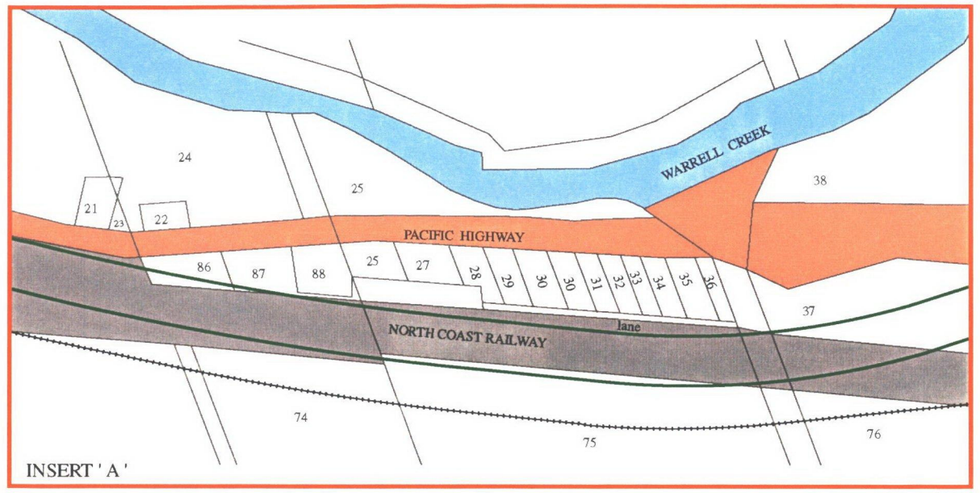
The surrounding land use comprises the urban area of Macksville and state forests such as Way Way State Forest and Eungai National Forest.

6.1.3 Land Tenure and Acquisition

Most of the land in the study area is privately owned. The Proposal would require the full acquisition of one residential property and the partial acquisition of 18 properties, including four residences.

The properties that would be directly affected by the proposal, based on the concept design indicated in **Figure 6-2**, are shown in **Table 6.1.**

Land acquisition would follow the provisions of the Land Acquisition (Just Terms Compensation) Act, 1991. Compensation is assessed as having regard to market value of the property, as if it was unaffected by the proposal. The purchase price would be negotiated with the landowner to establish an agreement satisfactory to both parties, and the RTA would allow for compensation as a result of the impact of the road on the property.



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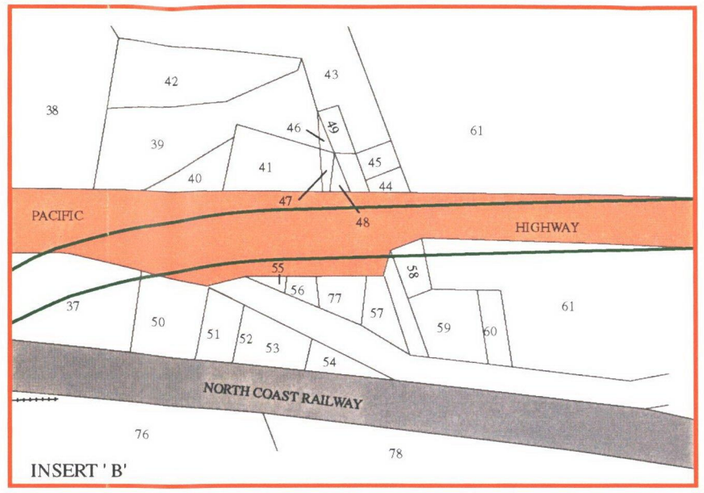

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Plan No.	Lot and Number
1	24 DP809352
2	39 DP809352
3	1 DP628692
4	66 DP755562
5	1 DP246173
6	2 DP246173
7	3 DP246173
8	4 DP246173
9	5 DP246173
10	6 DP246173
11	7 DP246173
12	1 DP388406
13	3 DP226146
14	221 DP593216
15	222 DP593216
16	1 DP545190
17	1 DP337750
18	21 DP565094
19	1 DP 565035
20	231 DP589180
21	1 DP323170
22	1 DP373780
23	89 DP661795
24	10 DP710005
25	12 DP9737
27	11 DP9737
28	10 DP9737
29	9 DP9737
30	7&8 DP9737
31	6 DP9737
32	5 DP9737
33	18 DP710005
34	19 DP710005
35	20 DP710005
36	21 DP710005
37	22 DP710005
38	22 DP710005
39	11 DP710005
40	12 DP710005
41	13 DP710005
42	14 DP710005
43	15 DP710005
44	16 DP710005
45	4 DP240067
46	42 DP710005
47	43 DP710005
48	44 DP710005
49	45 DP710005
50	3 DP25634
51	4 DP25634
52	1 DP389280
53	1 DP389281
54	5 DP25634
55	23 DP710005
56	24 DP710005
57	25 DP710005
58	25 DP710005
59	6 DP748478
60	1 DP374127
61	5 DP748478
62	6 DP 25634
63	22 DP722702
64	10 DP710006
65	11 DP710006
66	12 DP710006
67	13 DP710006
68	14 DP710006
69	21 DP716217
70	22 DP716217
71	83 DP75562
72	232 DP589180
73	562 DP702336
74	20 DP755562
75	22 DP755562
76	1 DP755562
77	46 DP710005
78	62 DP740091
79	411 DP707817
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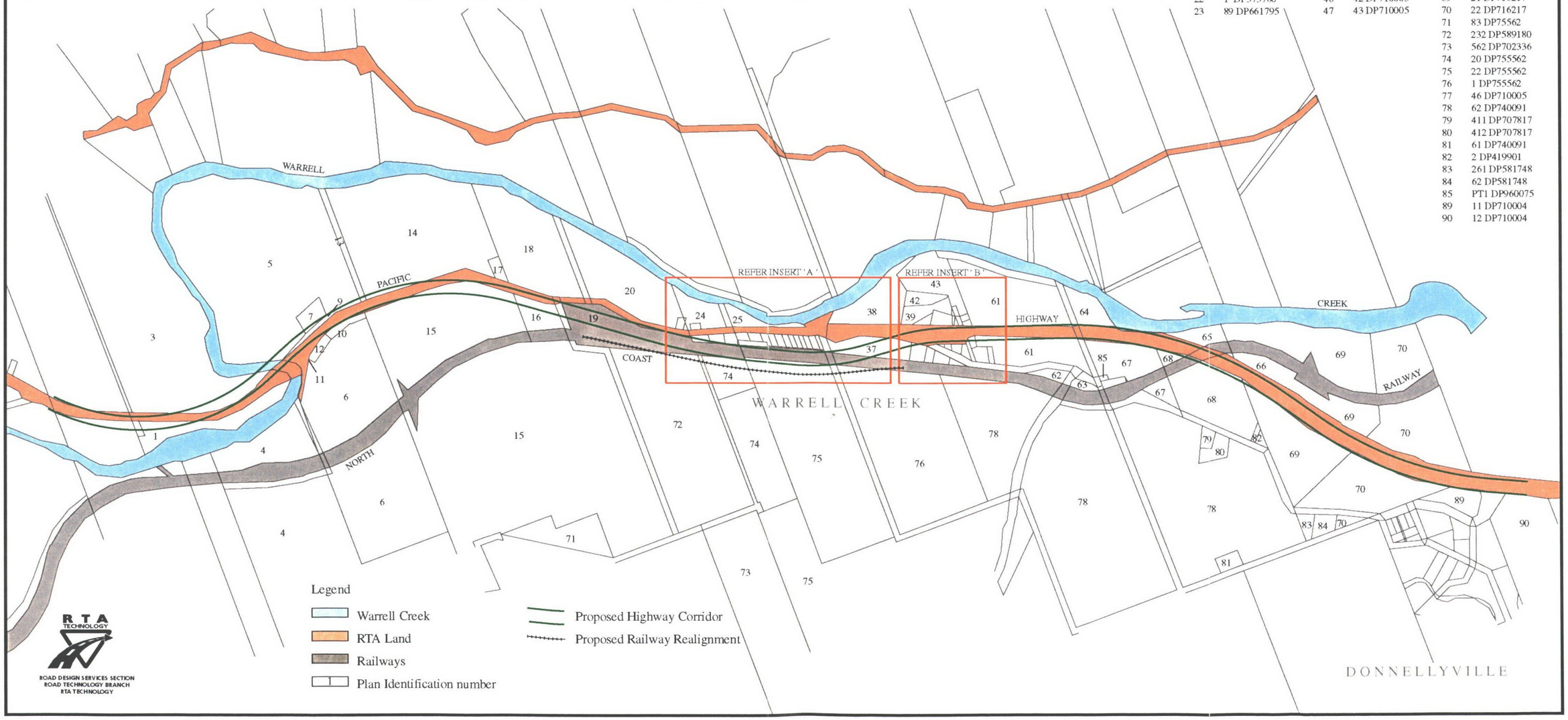


Figure 6.2
LAND TENURE

Table 6.1 - Description of Affected Properties

Property (Deposited Plan No.)	Area of Acquisition	Type of Acquisition	Land Use
DP628692 (Thursfield)	4,660 m^2	Partial	Rural
Lot 2, DP246173 Lot 1, DP388406 (Cockburn)	2,080 m^2	Partial	Industrial (secondary)
Lot 3, DP246173 RTA sub-depot	1,400 m^2	Partial	Special Use
Lot 222, DP593216 Lot 1, DP545190 McDonnell	27,500m^2	Partial	Rural
Lot 1, DP246173 (Sutton)	3,800m^2	Partial	Rural
McInnes	900 m^2	Partial	Rural
State Rail Authority (including Waters)	31,600 m^2	Partial	Special Use/ Residential
Dawes	2,420 m^2	Partial	Rural
Apps (Dairy house)	16,400 m^2	Partial	Rural
Whalen	2,380 m^2	Partial	Rural
Lot 22, DP710005 (Williams/Fawcett)	14,400 m^2	Full	Residential
Lot 3 DP25634 (L. Donnelly)	130 m^2	Partial	Residential
Lot 25, DP710005 (Neaves)	1,720 m^2	Partial	Residential
O'Connor and Kingston	8,850 m^2	Partial	Rural
K. Donnelly	5,800 m^2	Partial	Rural
Cutler	5,200 m^2	Partial	Rural
Sanger	1,950 m^2	Partial	Rural
I. Donnelly	3,100 m^2	Partial	Rural

Where partial acquisition of a property is necessary, the RTA would purchase the affected portion of the property. In these cases the RTA would be responsible for establishing the fences, access routes and landscaping to a standard similar to existing conditions.

The RTA seeks only to acquire land that is needed for the proposal.

6.1.4 Utility Installations and Services

The main utilities in the vicinity of Warrell Creek include high voltage electricity, Optus and Telstra fibre optic cable and the RAC rail line. Their impact on the routes is as described below.

The main electricity transmission line easements lie to the west of Warrell Creek and therefore are not affected by the proposed Highway and Railway alignments.

The Telstra fibre optic cable would be affected by the proposal. Advice from Telstra's representative (see Section 4.2) was that adjustments to the 12 and 100

fibre cables are feasible but Telstra does not have the resources to perform any adjustments. A detailed survey would be undertaken prior to construction to determine the extent of adjustments required. The proposed route would require the additional protection Telstra fibre optic cable at two locations along the railway and in one location next to the proposed highway alignment.

Telstra has also indicated that the following conditions on adjustments would apply:

- excavation to within one metre of the 100 fibre optic cable is permissible with power equipment. Within this one metre limit all excavation would be required to be performed by hand;
- at the cable location closest to the village a cable junction exists. This junction would need to be adjusted so access is available at all times; and
- cables are not permitted to be laid longitudinally in the rail reserve.

Optus cables would not be affected.

The RAC has been approached regarding the realignment of the affected portion of the railway. The proposed route involves relocating approximately 1.2 km of rail track. It has indicated that adjusting the track is technically feasible and has provided initial design constraints to the RTA.

6.1.5 Mitigation of Impacts

The RTA would provide access across the road where property access has been severed both during and after construction. Construction access arrangements to individual properties would be negotiated during the detailed design stage of the project.

Following determination of the proposal, adjacent property owners would be contacted by letter, outlining the likely timing of the project. Where land is to be acquired, advice would be given regarding the land acquisition process.

All utility and service authorities would be consulted by the RTA or its Contractor during the detailed design phase of the project. Adjustments and track possessions would be coordinated twelve to eighteen months in advance with the RAC. All rail construction activities would be undertaken prior to the construction of the roadworks.

6.2 Traffic and Transportation

The Pacific Highway is classified as a State Highway and forms the main coastal road link between Sydney and Brisbane. It carries local, regional, inter-city and inter-state traffic. Intersecting roads in the study area are local roads, some sealed and some unsealed, providing access to properties, residences and local sawmills.

6.2.1 Existing Traffic Conditions

The Average Annual Daily Traffic (AADT) on the highway in the vicinity of Warrell Creek is approximately 7,200 for 1997. This figure is based on a one week count undertaken by the RTA in June/July 1997 with verification using background AADT data from permanent count stations within the vicinity of Warrell Creek. The heavy vehicle percentage on the highway is 16.5% northbound and 15.5% southbound and the growth rate for traffic on the highway is generally 3.5% per annum (RTA, 1996).

Based on the above AADT, the Highway is operating at a level of service B to C using the "Guide to Traffic Engineering Practice, Part 2 - Roadway Capacity" (AUSTROADS 1988). This is indicative only based on the route traversing rolling terrain and a proportion of the length having insufficient sight distance. The level of service is a qualitative measure describing operational conditions within a traffic stream, and their perception by motorists and/or passengers. It provides a ranking from A to F of roads with A being free flow conditions and F being oversaturated conditions. Based on historic traffic growth, it is expected that the level of service would deteriorate in future.

The section of the highway in the vicinity of Warrell Creek is expected to be carrying a relatively large proportion of through traffic. This traffic, mixed with local turning traffic compromises the efficiency of the highway in its role as a major transport corridor between Sydney and Brisbane. This section of the highway is signposted at 90kph, however 75kph speed advisory signs have been installed in some places.

The highway currently allows access to and from the local sawmills. Vehicles from the mills enter the carriageway at low speed and would immediately have to share the roadspace with higher speed through traffic. The potential access conflicts between this essentially local traffic and the longer distance through traffic effectively reduce safe operating conditions of the highway. In addition, access from the highway is allowed to various private properties within the Warrell Creek vicinity.

Accident data for the years 1988 to 1993 indicate that 9 accidents were reported including one fatal accident (Source: "Warrell Creek - Background Paper". Roads and Traffic Authority, 1996).

Accident types included several out of control off carriageway accidents, however, two head on collisions were also recorded. A combination of the alignment, pavement condition, travel speed and access for local traffic onto the highway mixing with through traffic, and fatigue are possible causes of accidents.

6.2.2 Traffic Impact Assessment

The Proposal would remove through traffic from much of the developed area within the study area. However, due to the relatively minor volume of local traffic along this section of the highway and its origins and destinations, it is not expected that the AADT along the Highway would be greatly altered.

Using the 3.5% per annum traffic growth rate as outlined in Section 6.2.1, indicative 2000, 2010 and 2016 traffic volumes have been calculated and are shown in **Table 6.2** below.

Table 6.2 - Existing and Projected Traffic Volumes

Year	AADT (indicative)
1997	7,200
2000 (first full year of operation)	8,000
2010	11,300
2016	14,300

Again, the traffic volumes shown in **Table 6.2** above provide an indication only of travel conditions, but are reasonably consistent with those documented in the "North Coast Road Strategy" (RTA 1993). That document indicates that the future traffic volumes within the Pacific Highway segment between Port Macquarie and Coffs Harbour would be 14,000 to 16,000 in 2016. This is based on the Pacific Highway Upgrade option noted in the report which has been subsequently adopted by the RTA. The above figures should therefore be adopted as a broad indication of potential future traffic volumes on the Highway in the vicinity of Warrell Creek.

The Proposal would provide improved sight distances, travel times and potentially improve safety and upgrade this section of the highway to a standard expected of a National Highway route. The cross section would provide two lanes in each direction with sealed shoulders, a central median and localised widening at intersections and other access points.

Travel times along the route would be decreased due to the removal of sub-standard curves and undulation of the carriageway. The proposed alignment is expected to be of a high standard including a signposted speed of 100 km/hr. Sight distances would be designed to the standard consistent with the Pacific Highway Upgrade Program.

The travel time for the upgraded road is expected to be lowered from approximately 3 minutes 30 seconds for the existing highway alignment to approximately 3 minutes for the proposed alignment. This is based on both the existing and proposed alignments having an approximate length of 5kms, a speed increase from 85 km/hr (indicative average for the existing highway) to 100 km/hr for the proposed alignment and free flow conditions. The lowered travel time would provide savings to motorists travelling along the proposed alignment.

The pavement quality would be greatly enhanced compared to the existing situation. The section of upgrade proposed would not have rutting and cracking as is prevalent on the existing surface. The cross section and riding quality would be consistent with upgraded highway sections both north and south of Warrell Creek.

The safety of the route would be enhanced due to improved horizontal and vertical alignment, separation of opposing traffic streams, improved riding quality and reduced conflict caused by through and local traffic sharing the same road space. Whilst several access points would be maintained, these locations would have provision for turning traffic in the form of turn bays, merge and diverge tapers. Also, some traffic would continue to use the existing highway alignment as an access route.

Access to the upgraded alignment is to be rationalised. Some existing access points would be consolidated into several common access points. The proposed access arrangements are based on an upgraded four lane divided road and are as follows:

- the McDonnell and Cockburn/sawmill property access would be combined with the entry/exit to the RTA Depot opposite, with both accesses configured as a split T-intersection;
- a split T-intersection at the northern end of the village including a median with painted right turn bays to the village and Neaves' saw mill on the western side and Albert Drive (south) on the eastern side;
- four rural properties (two on the eastern side and two on the western side of the existing Highway) would share their access with one neighbouring property; and
- at-grade crossings over the railway line to the highway would be maintained for properties on the eastern side of the railway line. Access onto the Highway from these properties would be licensed access points to a controlled access road.

There would be no change in access arrangements onto the highway for properties between the intersection with Albert Drive (south) and the Bridge over the railway line.

The above arrangements, while maintaining local access, would assist in separating through and local traffic as turning traffic would utilise the proposed turn bays and tapers at intersections. This would assist in maintaining consistent travel speeds for through traffic. In addition, the provision of staggered T-intersections would improve safety as cross movements at the existing four way intersections would not be possible under the Proposal.

6.3 Public Transport

6.3.1 Existing Environment

Two bus companies operate services that service the study area. Newman's Coach services operate from Macksville and Cavanaghs from Kempsey. Newman's

operate five school buses a day servicing schools in the local area. They link the centres of Macksville, Browns Crossing, Donnellyville, Warrell Creek and Eungai. Cavanaghs operates three school buses a day between Stuarts Point and Macksville during the school term and one service a day during school holidays. These services are primarily for school children but are available for general public use as well.

Pick up and set down points occur along the highway in the study area. Currently there are no designated pull off areas for the buses and buses are forced to use the limited shoulder area available. This leads to conflict with through traffic as buses decelerate to pull off the road and accelerate to join the traffic flow. This situation is magnified through the study area where there are narrow shoulders and reduced opportunity for passing vehicles. Buses currently use the short slip lane at the intersection of the access road to Neaves Mill as a bus stop. This creates two unsatisfactory situations as there is potential for conflict with mill traffic and there is no pedestrian access at this point.

No local train services exist as the Warrell Creek Railway Station has been closed for some time. Both inter-city bus and rail services pass through Warrell Creek as they provide services along the main corridor between Sydney and Brisbane. The bus services would only pick up or set down passengers at Warrell Creek on request. The majority of rail traffic carries freight.

6.3.2 Impact Assessment

The proposed alignment would provide bus access to the Warrell Creek village via the split T-intersection described previously. Buses would diverge from the through carriageway when approaching from the south to turn left into the village and utilise the painted right turn bay when entering the village from the north. Once buses enter the village, an exclusive setdown/pickup area would be provided which would also act as a U-turn facility. This would mean that school children would not have to cross the proposed alignment to board or alight a bus.

Access to areas such Rosewood Road would remain similar to the existing situation. However, a right turn bay from the south and left turn taper from the north would be provided to assist with safe exit from the proposed alignment to the east.

Both bus operators have been consulted and consider the above arrangement satisfactory. There is agreement that the operators would utilise the proposed facility to setdown/pickup passengers and therefore allow continued operation of existing bus services. This would provide a safer access configuration as compared to the existing arrangements, as there is limited potential for congestion and conflict as buses would not setdown/pickup on the proposed alignment.

6.4 Flora and Fauna

The Flora and Fauna assessment has been undertaken by Gunninah Consultants. The key findings of this report are summarised below, and the full report is included in ***Appendix B.***

6.4.1 Flora

The study area largely comprises cleared pasture, with isolated trees and occasional patches of disturbed regrowth vegetation (see **Figure 6.3**). Regrowth generally occurs in gullies, along creeklines and in areas which are little used (such as between the existing road and railway easements). The range of hills located approximately 3 to 6 km to the south and south east of the study area support a significant area of forest vegetation, much of which is included in Way Way State Forest.

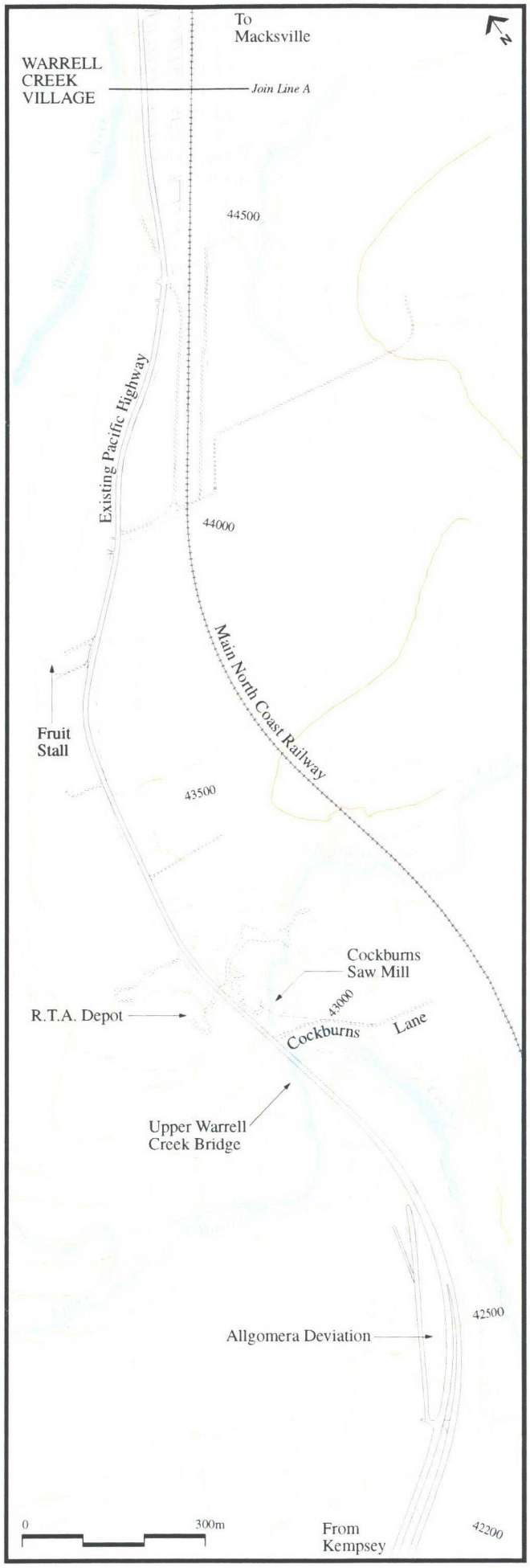
Four broad vegetation communities were identified within the study area. These communities are described below. A species composition list of flora in the study area is included in **Appendix B**.

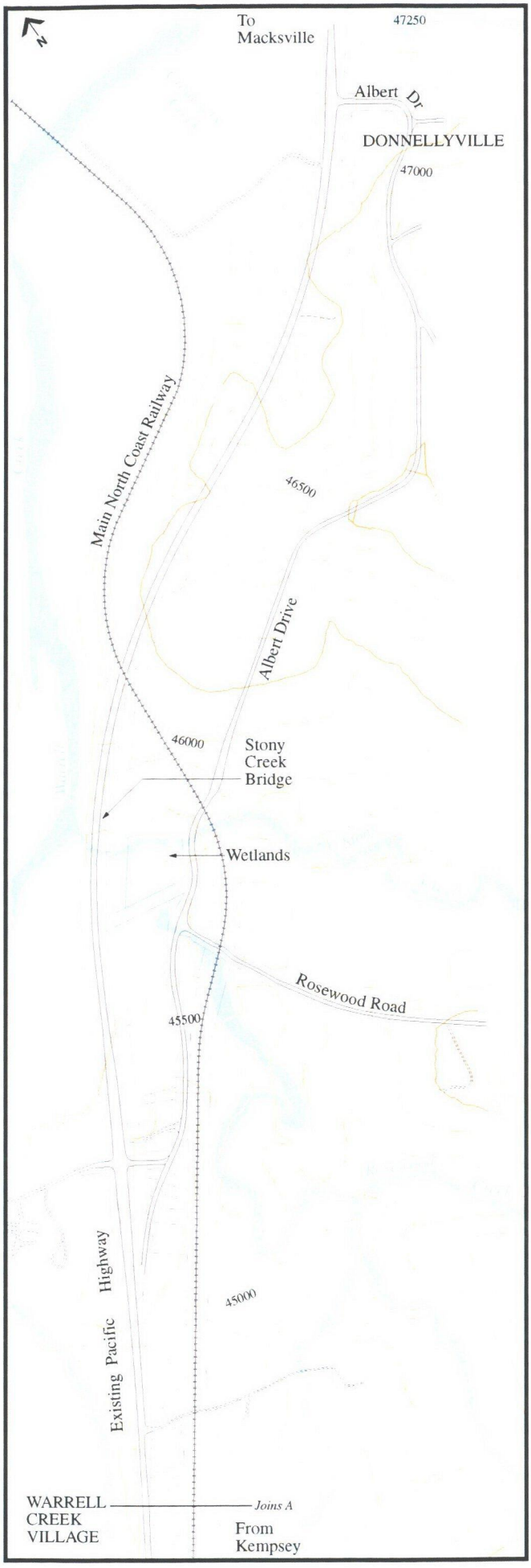
Riparian Forest/Open Forest

This community consists of narrow strips of vegetation which run along the watercourses throughout the study area. The north-eastern bank of Warrell Creek, near the Pacific Highway bridge in the south of the study area, supports a modest stand of riparian forest. The upper-canopy trees are generally mature, single-trunked specimens of Sydney Blue Gum, with broad canopies. This stand is largely regrowth, and is too young to provide tree-hollows for use by native fauna.

A variety of native and introduced rainforest species form a relatively continuous mid-storey within the stand on Warrell Creek (see **Table 6.3**). There is limited species diversity in the understorey, however, and a large number of exotic species occur throughout. Additionally, this riparian forest has been disturbed by previous timber-getting and agriculture, and is not a significant stand of vegetation.

This area of vegetation is continuous to the east with Way Way State Forest, whereas to the west the land has been cleared for agriculture. While a section of the riparian vegetation on the western edge of this community is likely to be removed for the proposed road construction, this is only a small area of already disturbed forest, and is unlikely to involve significant adverse effects on native plant species. Clearing of this vegetation would not contribute significantly to further habitat fragmentation, and should not present any further barrier to fauna movements, beyond those which already exist.





R T A TECHNOLOGY
ROAD DESIGN SERVICES SECTION
ROAD TECHNOLOGY BRANCH

Legend

- Woodland/Forest
- Riparian vegetation
- Cleared pasture

Figure 6.3
VEGETATION TYPES

Table 6.3 - Characteristic Flora Species

Community	Characteristic Species
Riparian Forest/Open Forest	
Upper Canopy	Sydney Blue Gum, Brush Box, Turpentine
Mid-Canopy	Brush Kurrajong, Jackwood, Sweet Pittosporum, Wattle, Camphor Laurel, Privet.
Understorey	White Dogwood, Rasp Fern, Spiny-headed Mat-rush, Red Kennedy Pea, Lily, Rhodes Grass, Cobbler's Pegs, Veined Verbena, Lantana.
Disturbed Open Woodland	
Upper Canopy	Forest Red Gum.
Mid-Canopy	Cheese Tree, Camphor Laurel, White Cedar, Lilly Pilly, Forest Oak, Brush Kurrajong.
Shrub layer	Sandfly Zieria, Wattle, White Sally, Elderberry Panax, *Lespedeza juncea*, White Dogwood, Wild Tobacco, Lantana.
Groundcover/Trailers	Whiteroot, Basket Grass, Red Kennedy Pea, Native Passionfruit.
Wetland Vegetation	
Shrubs	*Lespedeza juncea*, Spiny-headed Mat-rush, Montbretia, Japanese Honeysuckle, Lantana, Privet, Climbing Asparagus Fern.
Aquatic/Semi-aquatic species	Broad-leaved Cumbungi, *Juncus planifolius*, Tall Spike-rush, Spike-rush, Dirty Dora, *Cyperus sanguinolentus*, *Juncus usitatus*, *Juncus polyanthemus*, *Bolboschoenus caldwelli*, Umbrella Sedge, Cape Waterlily.
Cleared Pasture	
Upper Canopy	Tallowwood, Small-leaved Fig, Hoop Pine, Forest Red Gum, Turpentine.
Shrub Layer	Lantana
Groundcover	Hedgehog Grass, Bordered Panic, Couch Grass, Brown's Lovegrass, Bracken Fern, Pale Pigeon Grass, Veined Verbena, *Stenotaphrum secundatum*, Cobbler's Pegs, Flaxleaf Fleabane, Vasey Grass, Kikuyu Grass.

Disturbed Open Woodland

This community occurs along the perimeter of wetlands in the vicinity of Rosewood Creek, and is highly disturbed with a large number of introduced Camphor Laurels in the canopy. Trees are generally up to 14m in height, although emergent specimens of Forest Red Gum occur at heights of up to 18m.

The shrub-layer in the disturbed open woodland is variable, although is generally dominated by a number of exotic species (see **Table 6.3**), with native groundcovers limited to hardier species (such as Whiteroot).

Wetlands

Wetlands in the vicinity of the proposal are associated primarily with some of the small creeklines and drainage lines in the vicinity. In particular, several small wetlands are located on Rosewood and Stony Creeks, in the vicinity both of the North Coast Railway line and the existing Pacific Highway.

The wetlands in this locality have been modified to varying extents by grazing, agricultural activities and infrastructure construction (roads and the railway line). Most of the wetlands support only small areas of open water, with moderate to high densities of Bullrushes, areas of inundated grass, adjacent pasture, and disturbed weed-infested riparian vegetation. Other wetland areas support stands of Swamp Oak, or sedgelands, which are often disturbed by cattle.

Less disturbed portions of the wetlands in this locality support a moderately diverse native flora assemblage, and are considered likely to provide suitable habitat for a range of amphibians and wetland birds. Aquatic vegetation is present in some areas of open water.

Most of the wetland areas would be avoided by the proposed roadworks. However, there would be a minor impact on the wetlands associated with Rosewood Creek to accommodate the duplication of the Rosewood Creek Bridge. The wetland areas, in general, are already modified by existing agricultural and infrastructure activities, and additional wetland areas would be created for water quality and stormwater control, providing supplementary wetland habitat in the locality. Specific safeguards for the Rosewood Creek wetlands have been included in Section 6.4.5.

Cleared Pasture with Isolated Trees

The majority of the study area consists of cleared pasture, with infrequent isolated trees. The trees are generally mature or semi-mature, and are restricted to a small number of native and exotic species (see **Table 6.3**). Scattered exotic shrubs occur in some areas and the majority of grasses are introduced, although some native grasses do occur amongst the pasture species.

Conservation Significance

No Rare Or Threatened Australian Plants (ROTAP), as listed by Briggs & Leigh (1996), nor any endangered or vulnerable species, as listed on Schedules 1 or 2 of the Threatened Species Conservation (TSC) Act, were located in the study area during the current survey.

One threatened plant species, the Rusty Plum (*Amorphospermum whitei*), has been recorded previously in the region, as listed on the NP&WS Wildlife Atlas. This species was not recorded during the flora survey conducted for this report, nor has it been located during previous surveys conducted in the vicinity (Leonard 1997; G Leonard *pers comm*). It is extremely unlikely that either this species will be present or would be affected.

6.4.2 Fauna

A total of 50 native vertebrate species were recorded during the fauna surveys conducted for the Proposal. Fauna species located include 31 birds, 9 mammals, 6 reptiles and 4 amphibians. A list of fauna found in the study area is included in **Appendix B**

The majority of species recorded are typical of disturbed grassland and agricultural habitats and/or disturbed woodland and forest communities, and are common to abundant across substantial distributions. Most are generally tolerant of some level of habitat disturbance or modification.

Birds

A total of 31 native bird species were recorded during the investigations along the proposed Highway upgrade route at Warrell Creek, most of which are common to abundant, and widespread in distribution. No threatened bird species were recorded during the field investigations, and none are expected to occur other than occasionally, if at all.

The majority of avifauna species recorded are typical of open disturbed habitats, and are commonly recorded during surveys conducted in rural areas. Species recorded include the Welcome Swallow, Kookaburra, Australian Raven, Pied Currawong, Australian Magpie, Willie Wagtail, Magpie-lark, Black-faced Cuckoo-shrike and Eastern Rosella. A number of other birds recorded, including the Pacific Black Duck, Great Cormorant, Great Egret, Australian White Ibis, Straw-necked Ibis, Royal Spoonbill and Dusky Moorhen, are typical of wetland habitats in agricultural areas. These species are all tolerant of some disturbance (as indicated by their presence in the study area), and are considered highly unlikely to be adversely affected by the proposed construction works.

As noted above, no threatened birds were recorded during either the fauna survey conducted for this report or during the previous survey in the vicinity (G Leonard pers comm). However, a number of threatened species (listed as Vulnerable in the TSC Act) have been recorded in the region (NP&WS Wildlife Atlas), and are discussed in further detail in Section 6.4.4 of this report. Threatened birds recorded within 10 km of the subject site include:

- Glossy Black Cockatoo
- Osprey
- Barred Cuckoo Shrike
- Wompoo Fruit-dove
- Brolga
- Masked Owl
- Black Bittern
- Sooty Owl
- Square-tailed Kite

Mammals

Nine native mammal species were recorded in the study area during the fauna surveys conducted for this report, including the Northern Brown Bandicoot, Red-necked Wallaby, Common and Mountain Brushtail Possums, Common Ringtail Possum and four microchiropteran bat species (**Appendix B**).

The only threatened fauna species recorded during the survey was the Little Bent-wing Bat (*Miniopterus australis*) (see Section 6.4.4). No other threatened mammal species were observed or recorded during the fauna surveys conducted along the proposed Highway upgrade route, although the Koala (*Phascolarctos cinereus*) is included on the NP&WS Wildlife Atlas within 10 km of the study area.

Forests and woodland along the proposed alignment may provide some foraging resources for microchiropteran bats, but these species are highly mobile and wide-ranging, and it is unlikely that the degraded resources present in the study area are of any significance for microchiropteran bats.

Given the nature and condition of the vegetation in the vicinity, it is considered that Koalas are extremely unlikely to occur along the proposed alignment. Only two Koala records are included on the NP&WS Wildlife Atlas, both of which are relatively old (greater than 20 years), and prior to much habitat clearing along the Highway and railway easements. While it is possible for Koalas to occur in some of the regrowth in the study area, no evidence for this species was obtained, and the degraded and fragmented resources present would not provide satisfactory or substantial habitats for Koalas.

Reptiles

Six native reptile species were recorded in the study area during the field investigations, including the Eastern Water Dragon, Bearded Dragon, Red-bellied Black Snake, Striped Skink, Garden Sunskink and the Eastern Blue-tongued Lizard. The Upper Warrell Creek contains a variety of submerged and exposed tree debris, providing potential habitat for a number of other reptile species, including freshwater tortoises. All of the species recorded are common to abundant and widespread, and are generally tolerant of some disturbance or of modified environments.

No threatened reptile species were recorded during surveys conducted for this investigation, and none are included on the NP&WS Wildlife Atlas within 10 km of the study area. Considering the small area of vegetation to be disturbed and the extensive grassland, woodland and forest habitat available in the region, it is highly unlikely that any threatened reptile species would be adversely affected by the proposed roadworks.

Amphibians

Four amphibian species were recorded during the fauna surveys conducted for this report, including the Common Eastern Froglet, Green Tree Frog, Peron's Tree Frog and the Eastern Dwarf Tree Frog.

No evidence for the presence of any threatened amphibian species was obtained within the study area, and no threatened amphibian species are included on the NSW NP&WS Wildlife Atlas within 10 km. However, it is possible that the Rosewood Creek wetlands provide habitat or resources for the Green & Golden Bell Frog, or possibly for the Green-thighed Frog. The latter species, however, has not been recorded in the locality, and is not regarded as likely to be present given the nature and condition of the resources and habitats present.

The Green & Golden Bell Frog has previously been recorded in the Warrell Creek area (Ehmann 1997), in (disturbed) wetlands along Rosewood Creek. However, recent surveys of the Warrell Creek site failed to reveal the presence of this species (Ehmann 1997; A White pers comm; this study). The Proposal intends to retain most of the wetlands along Rosewood Creek, and consequently habitat for the Green & Golden Bell Frog, and other amphibian species, would be maintained in this locality. Furthermore, stormwater basins associated with the project could be designed to provide suitable habitat for this species.

Threatened Fauna

While a number of threatened species have been recorded in the general vicinity of the Proposal, the habitats and resources which are present are highly degraded and the alignment supports few resources of relevance for threatened species. It is of particular note that the Proposal is immediately adjacent to the existing highway and railway, and consequently involve affecting a portion of land which is already highly disturbed and degraded. Threatened species known from the general locality are discussed in detail in **Appendix B**, although none are considered of concern with regard to the proposed upgrade.

6.4.3 Additional Flora and Fauna Investigations

As a result of a discussions between the NPWS and the RTA, supplementary flora and fauna field surveys were carried out to clarify and enhance the information already collected. Activities covered by this additional survey included:

- a walked survey to search for specimens of the threatened plant species *Parsonsia dorrigoensis*;
- trapping for small terrestrial fauna over three nights, particularly targeting *Planigale maculata* (the Common planigale); and
- supplementary spotlighting and additional opportunistic observations, including call playback for amphibians.

No specimens of *Parsonsia dorrigoensis* were located along the proposed route during the walked survey. In addition random observations recorded no other threatened plant species in the study area or along the route.

No evidence for any threatened fauna species along the proposed route was recorded during these supplementary investigations. Two observations of the Squirrel Glider, *Petaurus norfolcensis*, (listed in Schedule 2 of the Threatened Species Conservation Act) were recorded in Way Way State Forest, 3-4km from the proposed route.

Squirrel Gliders generally inhabit dry sclerophyll forest and woodlands and require medium sized tree-hollows for nesting and shelter. The presence of Squirrel Gliders in Way Way State Forest is not unexpected given that the Forest fulfils their vegetation and habitat requirements.

The small, isolated and degraded areas of woodland and forest habitat found along the proposed route are not considered of relevance to the Squirrel Glider, particularly given the distance and disconnection from Way Way State Forest.

The information collected during this additional survey is reported and discussed in detail in **Appendix B**, as an addendum to the flora and fauna assessment.

6.4.4 Impact Assessment

The Proposal would directly affect a small amount of vegetation in the study area. However, the majority of land that would be affected is already cleared or has been significantly affected by previous agricultural or urban activities. Where vegetation does occur along the proposed route, it generally comprises a limited mixture of native and introduced species, with acute weed-infestation in some localities.

There is a also a potential for indirect affects on the native flora and fauna in the study area. This can include the imposition of barriers to fauna movements, alterations to hydrologic regimes, the discharge of contaminants or pollutants into watercourses and natural habitats, the creation or exacerbation of 'edge-effects', and the potential for increases in road mortality of native fauna.

It is unlikely that the Proposal would involve any significant increase in constraints on fauna movement or fauna mortalities While the proposed roadworks (involving relocating and widening the Highway and the relocation of the railway) will increase the existing barrier to fauna movements, this barrier is already considered a significant constraint for most terrestrial fauna. It is unlikely that the increase in the barrier will significantly increase its effect on native fauna, or on fauna mortalities.

During construction, there is a potential for adverse impacts on flora and fauna arising from the discharge of sediment and contaminants. Whilst the areas of cut and fill along the proposed alignment are relatively small, inadequate management of erosion and sediment discharge, and of contaminant and waste during the construction process, has the potential to adversely impact on swamps and watercourses in the study area. However, appropriate controls, such as bunding and water quality control measures (see Section 5.7), would be provided to avoid the discharge of excess sediment into adjacent watercourses, and appropriate

management protocols would be implemented to prevent the discharge of contaminants from work sites and from the roadworks.

Similarly, appropriate design measures would be implemented in the roadworks and final road design. The use of constructed wetlands and drainage swales would minimise the discharge of sediments and contaminants from the roadway and railway. Following the completion of construction, the comprehensive landscaping and rehabilitation program (see Section 6.6) would ensure that subsequent discharges to the natural environment are not significant.

Discharges and contaminants from the roadway would be reduced through the appropriate location of stormwater discharge points, the use of flow control structures, and the use of wetlands constructed initially for sediment control purposes and subsequently re-engineered to treat water quality (by alterations in structure, de-silting and planting with appropriate macrophyte plant species).

Overall, it is considered unlikely that the roadworks and associated activities would adversely affect natural environments or native vegetation communities to any significant extent. Specific measures to minimise the potential for adverse impacts on the natural environment are outlined below.

6.4.5 Safeguards

Management protocols to protect native flora and fauna would be addressed in an EMP, prepared prior to construction. The EMP would include safeguards, such as those outlined below:

- minimisation of the removal of native vegetation and trees along areas affected by the proposed re-alignments wherever possible, particularly where large trees are involved or where riparian vegetation and wetlands are located;

- location of the project works site(s) away from native vegetation patches and away from watercourses or wetlands;

- protection of trees which are to be retained along the proposed re-alignments from damage by the use of protective fencing. Soil levels should not be altered within the drip zones of trees wherever possible, and the parking of vehicles and stockpiling of materials under trees to be retained should be avoided;

- imposition of strict sediment control measures during construction activities (as is normal RTA practice), involving sediment traps, hay bale filters, and sediment control ponds. These measures are intended to limit the quantity of sediment discharged from works and construction sites, particularly in the vicinity of watercourses and wetlands and where Warrell Creek is located in close proximity to the proposed roadworks;

- careful design of, and subsequent management of, the roadworks, railway re-alignment and sediment control works in the vicinity of the Rosewood Creek

wetlands, to minimise adverse impacts on these habitats, either by direct or indirect activities. Engineering and landscape design should, in this locality, focus on minimising adverse impacts upon the wetland;

- reconstruction of sediment control ponds following the completion of earthworks and roadworks construction, to function as macrophyte wetlands, fauna habitat and water quality control ponds;

- discharge of stormwater from the finished roadway through grassed floodways or swales and shallow wetlands to remove contaminants prior to discharge into existing watercourses, particularly into Warrell Creek;

- management of general construction activities along the re-alignment routes and rehabilitation areas to manage rubbish and waste materials, to collect and remove excess contaminants and liquids, and to prevent the discharge of contaminants from ablution and work shed facilities;

- implementation of a weed management program to reduce the levels of weed-infestation in native vegetation to be retained adjacent to the proposed re-alignments and in areas which are to be rehabilitated;

- the use of shredded native plant material which is removed from the re-alignments as a mulch and groundcover in areas which are to be rehabilitated and on relevant batters along the road alignment. This approach would utilise local plant material, reduce weed infestation opportunities, and retain native plant propagules for recolonisation;

- where appropriate, significant native plant species known from the region should be used in replanting and landscaping programs. In particular, the Rusty Plum (*Amorphospermum whitei*) would be appropriate, as it is included on the NPWS Wildlife Atlas, and known within 10 km of the study area. An agenda for replanting and landscaping, involving a range of relevant plant species, should be produced for the project, as part of the overall management plan;

- construction of the approaches to Warrell Creek at the southern end of the Pacific Highway re-alignment to maintain a potential fauna movement corridor along the northern bank of Warrell Creek. Landscaping in this area should particularly address the requirements of water birds and other fauna species which could potentially utilise Warrell Creek as a movement corridor.

6.5 Agriculture

6.5.1 Existing Environment

The study area is dominated by rural landuse, notably grazing and limited cultivation. The immediate area surrounding the Warrell Creek village, including the floodplain region, is classified by the NSW Department of Agriculture as Class 3,

being suitable for grazing and pasture improvement. This land may also be cultivated for occasional cash or forage crops, in conjunction with pasture management. Land of this class has a moderate capability for agriculture, with production levels being moderate due to high environmental costs (such as erosion and low soil nutrients) which limit the frequency of ground disturbance. Pasture lands of this class are capable of sustained high levels of production, although conservation measures may be required.

Lands associated with the surrounding hills and spurs to the east and west of the Warrell Creek village are classified as Class 4 by the NSW Department of Agriculture. These lands are suitable for grazing, but not suitable for cultivation. Agriculture on these lands is based on native pastures or improved pastures relying on minimum tillage techniques. Overall level of production for these lands is low.

Cattle are the main livestock grazing in the study area. There used to be a Travelling Stock Route through Warrell Creek, however, it is not used any more. There is an ostrich farm on the eastern side of the existing Highway.

Historically, orchards and vegetable crops have been a source of income for Warrell Creek residents.

6.5.2 Impact Assessment

Discussions with the Department of Agriculture and the community have highlighted that the proposal has the potential to impact on the agricultural activities in the study area in a number of ways:

- loss of fertile agricultural land;
- constraining livestock, such as cattle and ostriches;
- restriction/loss of movement of farm machinery within and between properties;
- spread of noxious weeds;
- generation of acid sulfate soils.

Approximately 1.34 ha of land from 18 properties would be resumed as a result of the Proposal (see Section 6.1.3). All of the agricultural land resumed would be from narrow strips along the boundary of the individual properties. There would be no fragmentation of individual properties, although the Proposal would require the resumption of the more fertile land within the study area.

Highway access would be limited for safety reasons and to meet the RTA's design standards, and therefore access arrangements to some rural properties would be altered (see Sections 5.4 and 6.1.3). Four rural property owners would share access onto the proposed highway alignment with neighbouring properties (see **Figure 3-2**).

The use of farm machinery in the study area would not be constrained by the proposal.

6.5.3 Safeguards

As cattle and ostriches are grazed in the area, there would be a need to ensure that there is adequate fencing during the construction and operation of the Highway, so that the animals are secure and do not move onto the Highway where they are in danger and can endanger traffic. Discussions between graziers and the RTA would be undertaken during prior to construction on the best means to achieve this.

Specific details to reduce the impacts on agricultural activities would also be detailed in an EMP, prior to construction of the proposed alignment. The type of management practices that would be recommended include:

- discussions should be held with property owners and Council's Noxious Weeds Officer about the likelihood of W1 category weeds occurring;
- ensure that the fill imported to the study area does not include seed stock from W1 weed species;
- ensure that the Contractor's machinery is not likely to import material with affected seed stock on the properties;
- the location of wash-down points for trucks and machinery to reduce the potential for the spread of weeds between properties;
- ensure that the Contractor meets RTA and EPA guidelines on acid sulfate soils management (see Section 6.9.4).

6.6 Visual Quality and Landscape Character

This section summarises the findings of the Visual Impact Assessment undertaken to assess the effects of the Proposal on the community. An unabridged version of the Visual Assessment is included in ***Appendix C****.*

6.6.1 Existing Visual Character

The study area is located within a well-defined valley, featuring dense vegetation on steep hills in the background and rural patterning of open farmland on undulating terrain in the immediate foreground. The Upper Warrell Creek provides good local identity and feature to the village. The creek is in most sections visually defined by dry rainforest trees and tall eucalypts that have survived past land clearing for farm establishment. Excellent glimpses of the creek can be obtained from the Pacific Highway and existing bridge crossing over the Upper Warrell Creek.

A significant scenic element from the area is the strong distance hill system that extends in a north-south direction to the east, and the undulating hills to the west of the proposed corridor. The landform provides strong visual containment as well as significant background views from the highway and the village.

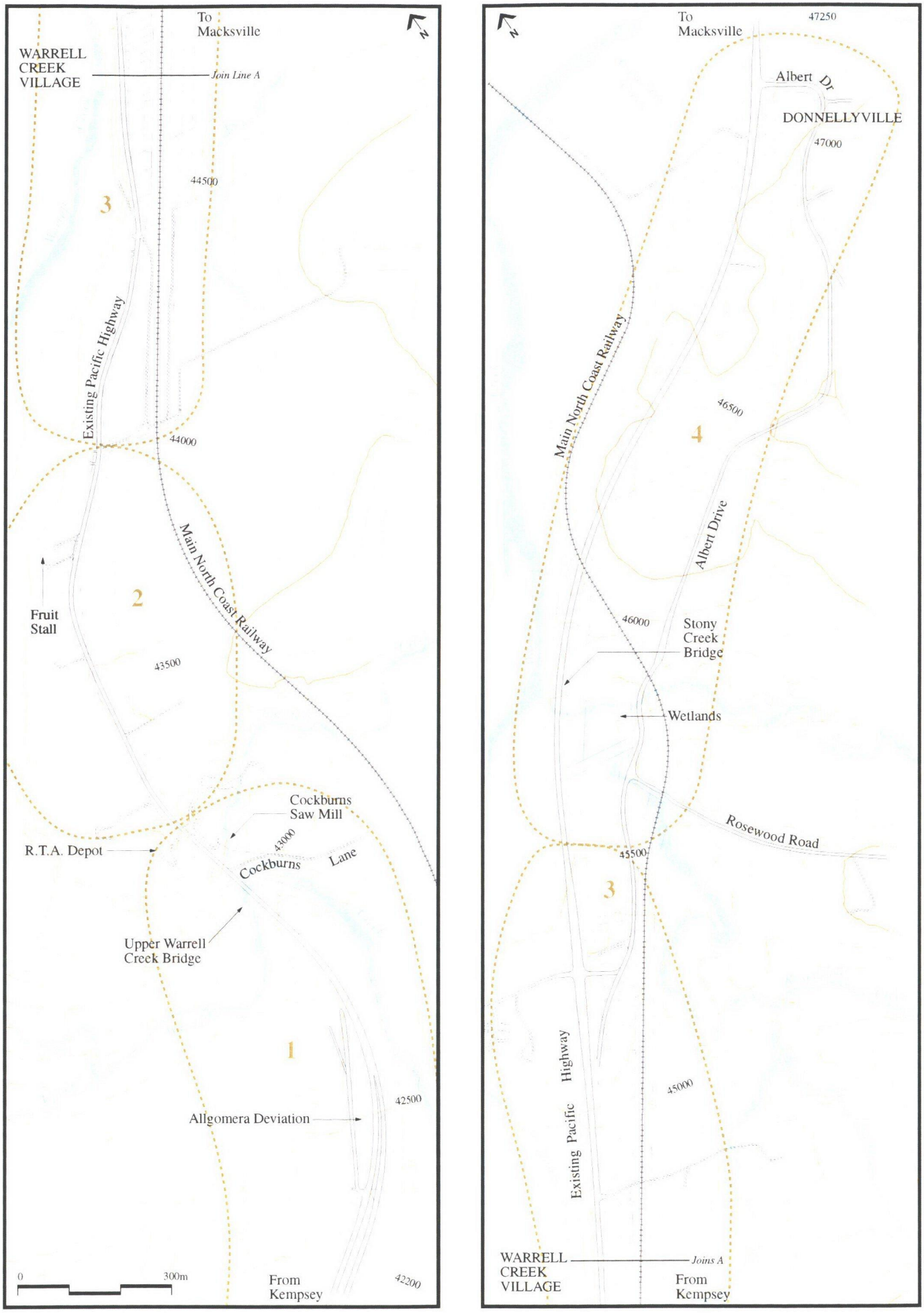
The dominance of the adjoining forested hills, creeks, strong rural patterns of cleared farmland on undulating landform, the village, and presence of culturally significant trees in private properties have all contributed to the unique landscape of the area.

6.6.2 Landscape Sub-Units

The study area can be divided into four landscape sub units. Each landscape sub unit depicts a homogenous landscape identity unique to the area. Each sub unit is described in terms of the landform and the land cover that reflects a combination of land use and vegetation. The landscape sub units as shown in **Figure 6-4** are:

- Upper Warrell Creek / Bridge Precinct
- Farmland On Alluvial Flat
- Warrell Creek Village / Railway Precinct
- Stony Creek/Pacific Highway Precinct

The descriptions of these sub units and the extent of the visual impact of the Proposal are described in the following section.



Legend

1 Upper Warrell Creek/Bridge Precinct
2 Farmland on Alluvial Flat
3 Warrell Creek village/Railway Precinct
4 Stony Creek/Pacific Highway Precinct

ROAD DESIGN SERVICES SECTION
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Figure 6.4
LANDSCAPE SUB-UNITS

6.6.3 Visual Impact

The visual impact of the proposed alignment is determined by the degree of contrast between the existing landscape and the form of the proposed road alignment and the proximity of potential viewers. Visual impact is measured by the combined effect of visual effect of the Proposal and visual sensitivity of the surrounding land uses, and is expressed in terms of very high, high, moderate and low visual impact (see **Appendix C**).

Upper Warrell Creek / Bridge Precinct

Located on the existing highway and on the alluvial flats adjacent to the Upper Warrell Creek, this section of the proposed road would closely follow the existing grade and alignment. The road would generally incur minor cut and fill embankments over the flat landform. Overall, the relatively flat landform and the gentle curve of the road alignment would enable this section of the proposed route to be readily integrated with the surrounding landscape.

Residences on the surrounding hills would have elevated views of the Proposal from the middleground and background distances. Two dwellings and the existing sawmill north of the Upper Warrell Creek Bridge would have clear foreground views of the highway.

The visual sensitivity of this area is considered moderate due to the fact that a few houses would have middleground and background views of the road widening. The visual impact of this section of the proposed road is moderate due to the combination of moderate visual effect and moderate visual sensitivity.

Farmland On Alluvial Flat

The proposed route would move away from the existing highway and traverse across farm paddocks and the railway reserve on the alluvial flat. The proposed road would be constructed on fill embankment of up to 1.5 m in height. These low fills associated with the roadworks would contrast in only a minor way with the adjoining flat landscape.

The minor extent and scale of some of the earthworks would be easily integrated into the landscape setting. The visual effect of this section of the proposed road would be moderate. There is potential for landscape treatments to ameliorate visual effect in this section of the proposed road.

The proposed road is readily visible to five nearby farm properties that are at similar grade with the carriageways on open flat terrain. The road would also be readily visible to a range of viewpoints at middleground and background distances by the surrounding residential houses situated on elevated hillside. The visual sensitivity of this area is moderate.

The combination of moderate visual effects and moderate visual sensitivity would produce a moderate visual impact for this section of the proposed road.

Warrell Creek Village / Railway Precinct

The proposed road alignment is located immediately at the rear of residential houses of Warrell Creek village. Four houses would be removed under the proposal to make way for the Proposal. The road would incur minor fill embankments over the flat landform. Nevertheless, the combined scale of the Proposal would generate a significant visual contrast with the adjoining flat landscape. The visual effect of this section of the proposed road would be high.

This section of the proposed road on flat terrain is clearly visible to all residents living next to the proposed alignment. Approximately 20 residents would have foreground views of the Proposal, either in the front and at the rear of their properties. As well, residents living on the surrounding hills would have views of the proposed road from the middleground and background distances. The visual sensitivity of this area is considered high.

The combination of high visual effect and very high visual sensitivity would produce a high visual impact for this section of the proposed road.

6.6.4 Visual Impacts during Construction

During construction, the short term visual impact would include the loss of approximately 18 mature trees scattered along the road corridor in farm paddock and existing highway reserve as well as exposed cut and fill embankments. However, the immediate implementation of landscape revegetation and planting works as outlined in the landscape strategies and concept plan (see Section 6.6.6) would assist to minimise these short term visual impacts.

The noise impact assessment (see Section 6.10) determined that some form of noise treatment measures would be required for residents within Warrell Creek village and Sonnys Lane, to reduce the impact of noise from the Proposal. Options that may be considered to reduce noise impacts include landscaped bunding, noise walls or noise insulation measures. The RTA would consult with individual land owners during the detailed design stage of the project to find the most satisfactory visual solution for the community.

6.6.5 Visual Impacts during Operation

Noise barriers have been recommended along the rear of the properties facing the new highway realignment in order to mitigate the anticipated noise impacts to the adjoining residents (see Section 6.10.4). However, the barriers would generate adverse visual impacts to the surrounding environment and would be visible to both the local residents and motorists. The proposed barriers would be visible as an intrusion to the village because of is imposing scale and incongruous form in the rural landscape. The barriers would effectively block the existing excellent mountain views available to the local residents affected by the noise. It is possible, however, to minimise the adverse visual impact by appropriate landscape treatment with dense shrubs and tall trees along both sides of the noise barriers.

In order to retain the existing excellent views to the mountain, an alternative solution such as noise insulation may be more desirable. From the landscape view point, it is preferable that solid noise wall be avoided so that the unique visual environment and character of Warrell Creek village is not adversely affected. However, the decision to install any noise attenuation measure is best met through consultation with the community, so that the most suitable decision can be made to satisfy local resident's requirements.

Growth of native vegetation and planting would gradually modify and enhance the roadscape environment.

6.6.6 Landscape Mitigation Strategy

The visual impacts of the Proposal can be minimised by sympathetic landscape treatment carried out in conjunction with the road construction works. The landscape strategies seek to maintain and reinforce the character of the existing environment of Warrell Creek village and its surround along the proposed route, rather than develop a uniform vegetation treatment along the whole corridor.

To mitigate the disturbance created by construction of the Proposal, visual guidelines and treatments have been developed. These guidelines and treatments address visual impacts identified, and are intended to improve the visual amenity of the Proposal for motorists, the adjacent land users, and local residents. As part of the mitigation measures, a landscape concept plan has also been developed for the Proposal (see **Figure 6-5**). This concept plan, together with the visual guidelines described below would be part of a Detailed Landscape Plan prepared during the detailed design phase of the Proposal. This would ensure that the visual impact generated by the project can be minimised and that the landscape environment is protected and enhanced.

The visual guidelines which would be incorporated in to a Detailed Landscape Plan are outlined below:

- provide a thematic landscape design approach to the planting layout and species selection in order to visually reinforce the unique character of the village;

- enhance the visual environment of the road corridor by creating a visually bold and attractive landscape character along the highway for the enjoyment of motorists using it;

- retain existing excellent views for motorists and the community to the surrounding hills, open farm properties and creeks wherever possible;

Legend

- Native revegetation along median to 1.5m high for headlight glare
- Native revegatation along median to 1m high to retain view for the neighbourhood
- Native revegatation on batter to minimise visual impact of cut embankment, soil erosion and future maintenence
- Existing vegetation

Landscape treatment with tall *Eucalyptus saligna* planting at bridge crossing to visually signal entry to Warrell Creek village

Informal tree grouping with eucalypts to enframe existing views to the broad rural farmland

Formal planting with clear trunk trees with *Eucalypts microcorys* or lilly pillies and low shrub understorey to visually to

- register arrival at Warrell Creek village precinct
- maintain/frame existing excellent mountain view from the residential properties
- provide visual separation to the properties from the highway and railway corridor

43500

Existing Pacific Highway

44400

Warrell Creek Village

45000

To Macksville

A

A

Main North Coast Railway

Informal tree grouping with eucalypts

Informal tree grouping with eucalypts to enframe existing views to the broad rural farmland

Excellent views to mountain to be retained

42200

From Kempsey

Formal tree planting 11m from Highway

1m wide mowing edge

Low shrub planting to 1.2m high

Railway

View to mountain

Native revegetation to provide visual linkage to existing revegetation bushland along the Highway

Section A-A

Informal Eucalypts planting/ revegetation to all exposed batters

Informal Eucalypts planting/ revegetation to all exposed batters

Screen planting/ revegetation

Cultural tree planting with *Araucaria cunninghamii* and colourful ground cover at this significant visual node to visually register entry to the village

45000

Section B-B

46500

Informal tree grouping with eucalypts

47250

B

B

Wetland tree planting with *Casuarina glauca* to visually relate to the immediate foreground of Warrell Creek

Native revegetation on batters with tall shrubs

To Macksville

To Donnellyville

RTA TECHNOLOGY

ROAD DESIGN SERVICES SECTION
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Figure 6.5
LANDSCAPE CONCEPT

- provide visual definition and formality to the village at important road intersections and entry from either end of the study area;
- provide visual separation with appropriate landscape treatment between the Proposal and the affected properties;
- retain existing culturally significant trees such as *Araucaria cunninghamii*, Ficus spp, Pinus spp, *Jacaranda mimosifolia* as far as possible;
- initiate a minor contract for on site seed collection of local tree species for future landscape planting works. Minimise ongoing landscape maintenance requirements by selecting plant material that is adapted to the prevailing growing conditions;
- initiate top soil management to minimise spread of noxious weeds found at the site;
- revegetation and stabilisation of all cut batters and fill embankments with locally collected seed to ensure similar species composition; to reduce the visual impact of the cut and fill slopes associated with the Proposal and to enhance native fauna corridor;
- maximise the wildlife habitat value of the landscape treatment where possible by selecting indigenous plant species of known habitat value especially along Warrell Creek and beneath the Rosewood Creek Bridge;
- install screen planting/revegetation for headlight glare reduction along the median and where possible between the proposed railway and highway.

Permanent landscape work would be implemented for all road reserves and the median in accordance with the detailed landscape plan immediately followed completion of all roadworks for the southbound carriageway. It is also intended that temporary landscape revegetation works would be implemented for all disturbed areas in order to minimise visual impact generated by the earthwork, the spread of weeds and areas subject to erosion for all disturbed areas.

6.7 Topography and Drainage

6.7.1 Topography and Landform

The Warrell Creek area can be characterised as a gently undulating rural landscape, with floodplains existing adjacent to banks of Warrell Creek. In detail, the area consists of a low v-shaped valley, which rises from the floodplain at an elevation of approximately 5 to 10 m to surrounding hills up to 3 km away approximately 80 m in height. This valley has been incised by Warrell Creek, creating a moderately sinuous water body, which flows into Nambucca River approximately 17 km north east of the Warrell Creek village.

The hills surrounding Warrell Creek have ridgelines and low rounded spurs, separated by drainage channels and creeks. Several of these creeks and watercourses flow into Warrell Creek in the vicinity of the village, notably Butchers Creek, Stony Creek and Crouches Creek on the eastern bank, and Starlight Creek and Snakey Creek on the western bank. The reach of Warrell Creek in the area of the village is approximately 25 m wide, growing wider to the north near the Lower Warrell Creek bridge where it is approximately 50 m wide.

6.7.2 Drainage

Information in this section has been summarised from reports undertaken by Webb McKeown and Associates (1996), Willing and Partners (1997) and WBM Oceanics Australia (1997) for the RTA.

The main watercourse in the study area is Warrell Creek, which has a number of smaller tributaries, namely Butchers Creek, Stony Creek, and Rosewood Creek. The Pacific Highway crosses Warrell Creek at the Upper Warrell Creek Bridge at the southern extent of the study area, and Rosewood Creek to the north of Warrell Creek village (see **Figure 6-6**).

Warrell Creek

Warrell Creek drains the largest catchment in the study area, being the receiving waterway for Eungai, Allgomera and a number of other creek in the area. From the Upper Warrell Creek Bridge, Warrell Creek meanders parallel to the Highway for a number of kilometres along a heavily vegetated path.

Butchers Creek

Butchers Creek flows under the Pacific Highway via four large culverts to join Warrell Creek just downstream of the Upper Warrell Creek Bridge. This creek drains a catchment of 5.97 km^2, mostly on the eastern side of the highway and railway. The creek is generally only flows under wet conditions.

Rosewood Creek

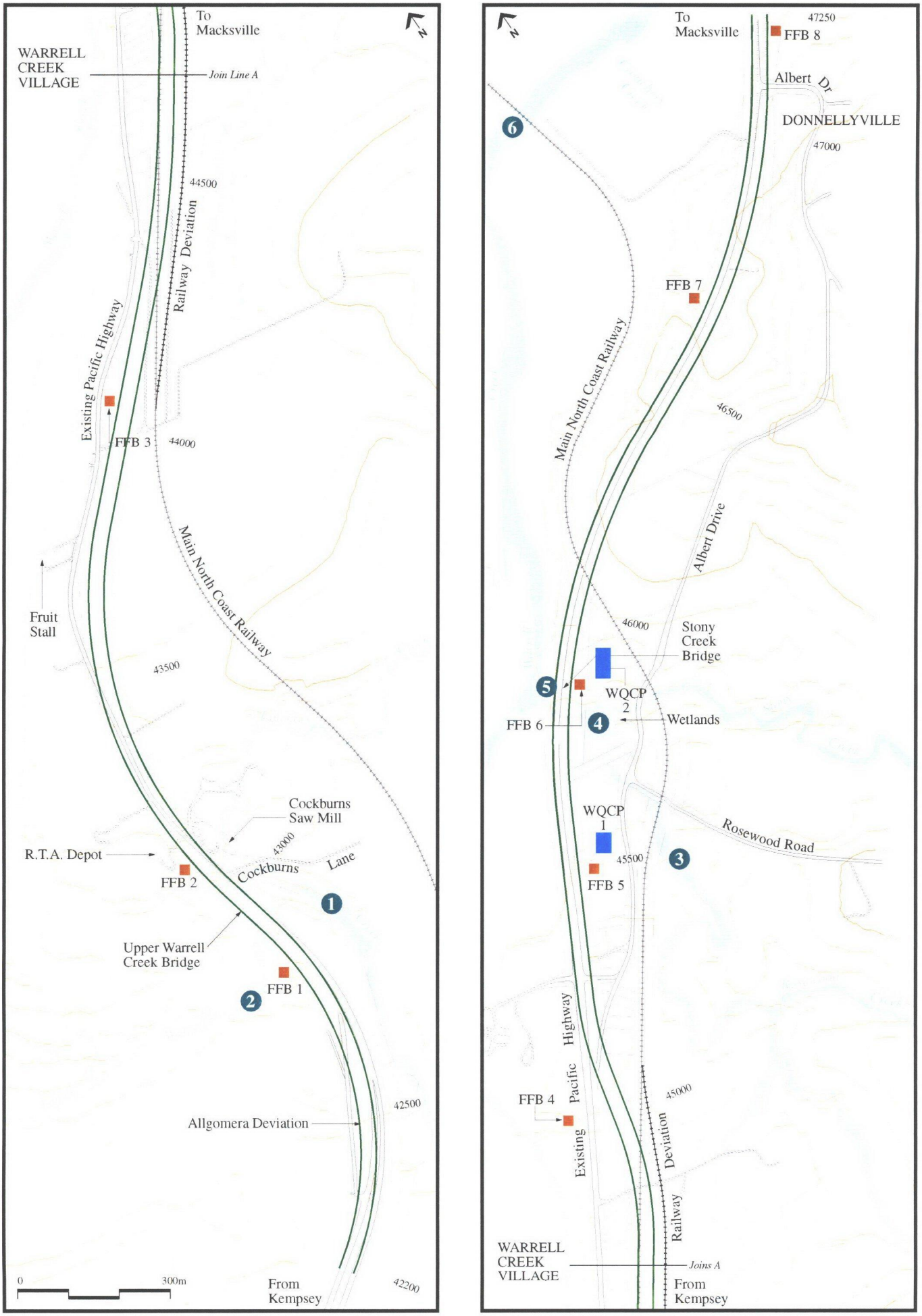
Rosewood Creek drains a 1.9 km^2 catchment on the eastern side of the Highway and passes through culverts under Albert Drive and joins with Stony Creek to discharge into Warrell Creek. The drainage lines in the upper part of the catchment are small and flow only under wet conditions. Once the flow joins Stony Creek it becomes a much larger drainage path which flows permanently.

Stony Creek

Stony Creek drains a catchment of approximately 5.63 km^2 . The creek runs parallel, to the east, of the railway and highway, passing through culverts under Albert Drive into Warrell Creek. It is a large drainage path that flows permanently.

6.7.3 Flooding

Webb McKeown and Associates (1996) has undertaken a preliminary route feasibility assessment between Kempsey and Nambucca Heads to determine the whether the Pacific Highway can operate under flooding conditions.



RTA TECHNOLOGY
ROAD DESIGN SERVICES SECTION
ROAD TECHNOLOGY BRANCH

SINCLAIR KNIGHT MERZ

Figure 6.6
WATER QUALITY MONITORING SITES AND CONTROL STRUCTURES

The design flow in Warrell Creek was calculated using the Probabilistic Rational Method (PRM). The preliminary estimate of the 1 in 100 flood level ranges from 6 m AHD at the downstream end of Warrell Creek (in the vicinity of the railway bridge) to 7.5 m AHD at the upstream end (Upper Warrell Creek Bridge). This is about 3 m below the present Highway level. An approximation to the Probable Maximum Flood (PMF) was obtained by running three times the 1 in 100 flow through a HEC2 model. The resultant levels were 3 m to 3.5 m higher than the 1 in 100 values.

Anecdotal evidence of the extent of past flooding was provided by Warrell Creek residents at the first Community Meeting held on the 28th of October 1996 (see Section 4). This evidence correlates strongly with the calculated flood regime from the Webb McKeown report, particularly with respect to the calculated extreme flood levels.

It should be noted that the methodology used is a recognised method, but is rather simplistic, and would be updated to a more sophisticated runoff routing type method and calibrated against observed flood data during the detailed design phase of the project.

6.8 Water Quality

*Information in this section has been summarised from the **Working Paper No 1 - Water Quality**, the hydrological & water quality study by WP Consulting Engineers (1997) , and the pre-construction water quality monitoring reports undertaken by WBM Oceanics Australia (1997) for the RTA.*

6.8.1 Introduction

Discussions with the Warrell Creek community (see Section 4) revealed that water quality is an important local issue as water is drawn from Warrell Creek and its tributaries for many purposes, including washing, irrigation and stock watering. Furthermore, Warrell Creek flows into the Nambucca River. Both waterways have important recreational and conservation values along their extent, with the lower reaches particularly popular for swimming and fishing.

There is concern within the community that past road construction activities, as part of the upgrade of the Allgomera Bends, to the south of the study area, may have adversely impacted on the water quality of Warrell Creek.

The following sections of the REF outline the existing water quality conditions of Warrell Creek and its tributaries, and steps that would undertaken to reduce any effects of construction and operational activities of the road.

6.8.2 Pollution Sources

Point Source Pollution

Two point pollution sources were identified during field investigations and based on discussions with the RTA. These are the two timber mills. Pollution problems are

likely to be limited to suspended solids, turbidity and litter, as it is believed that no preservation of the timber is undertaken at the timber mills.

Non-Point Source Pollution

The catchments within the study area have been cleared for agricultural or urban uses. As a result, there has been a degradation of downstream water quality, from waste by-products entering the water cycle through either stormwater runoff or groundwater infiltration. For example, roads and urban areas accumulate solids, nutrients, oils and greases; farms and plantation areas utilise high levels of fertilisers (nutrients) and pesticides. Septic tanks also contribute to nutrient contamination of surface and groundwater.

6.8.3 Existing Water Quality Monitoring

Surface water quality monitoring was undertaken on one occasion in 1996, in dry weather and wet weather, at three locations on Warrell Creek, and two on major tributaries (see Figure 3 and Table 3.1 of **Working Paper No. 1 - Water Quality**). The results of this limited monitoring indicated that the recorded concentrations were within acceptable ANZECC (1992) water quality levels for freshwater and estuarine waters at all five sampling locations.

More comprehensive sampling was undertaken by WBM Oceanics over a six months period in 1997 at six locations. the purpose of this monitoring was to establish baseline water quality data for the proposal and assess the pre-construction conditions.). The locations of the sampling sites (see **Figure 6.5**) were chosen based on the proposed road and rail alignments and the zone of potential disturbance. A description of the location of the sampling sites is given on **Table 6.4.**

Table 6.4 - Water Quality Sampling Locations

Site/Station No	Location *
1	Warrell Creek, upstream of Upper Warrell Creek Bridge
2	Warrell Creek, downstream of Upper Warrell Creek Bridge
3	Stony Creek, east of railway
4	Rosewood Creek upstream of Pacific Highway
5	Rosewood Creek downstream of Pacific Highway
6	Warrell Creek upstream of Railway Bridge over Warrell Creek

* all sampling locations are in freshwater sections, except for site 6 which is in the estuarine section

6.8.4 Results

The summary results of the detailed water quality sampling program over six months (WBM, 1997) are given in **Table 6-5**. **Appendix D** contains the complete sampling results.

- Site 1 - Warrell Creek, upstream of Upper Warrell Creek Bridge

The median concentration results in **Table 6-5** indicate that for Site 1, nutrient levels and measured heavy metals are within acceptable levels with the exception of aluminium in dry weather and wet weather and Iron in wet weather.

- Site 2 - Warrell Creek, downstream of Upper Warrell Creek Bridge

The median concentration results in **Table 6.5** indicate that for Site 2, nutrient levels and measured heavy metals are within acceptable levels with the exception of aluminium in dry weather & wet weather.

- Site 3 - Stony Creek, east of railway

The median concentration results in **Table 6.5** indicate that for Site 3 nutrient levels and measured heavy metals are within acceptable levels with the exception of aluminium and cadmium in wet weather. Dry weather sampling in dry weather was not conducted at this site.

- Site 4 - Rosewood Creek upstream of Highway

The median concentration results in **Table 6-5** indicate that for Site 4, nutrient levels and measured heavy metals are within acceptable levels with the exception of aluminium and iron in dry weather and wet weather and Lead in wet weather.

- Site 5 - Rosewood Creek downstream of Pacific Highway.

The median concentration results in **Table 6.5** indicate that for Site 5, nutrient levels and measured heavy metals are within acceptable levels with the exception of Aluminium and Iron in dry weather and wet weather.

- Site 6 - Warrell Creek upstream of Railway Bridge over Warrell Creek

The median concentration results in **Table 6-5** indicate that for Site 6, nutrient levels and measured heavy metals are within acceptable levels with the exception of Aluminium in dry weather and wet weather.

The source of the consistently elevated aluminium concentrations at all sites is not known, but it could be related to the general type of soils in the upstream areas or to disturbed acid sulfate soils (see Section 6.9.2).

Table 6.5 - Dry and Wet Weather Median Concentrations for Sites 1 to 6 (all units in mg/L)

	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6			
	Median Dry	Median Wet	Median Dry	Median Wet	Median Dry	Median Wet	Median Dry	Median Wet	Median Dry	Median Wet	Median Dry	Median Wet	ANZECC Criteria (freshwater)	ANZECC Criteria (estuarine)
Turbidity (NTU)	4.7	6.5	4.4	5.9		5.0	3.7	5.3	6.6	6.5	5.3	2.6	<10 % change in seasonal mean	<10 % change in seasonal mean
Total nitrogen	0.42	0.46	0.39	0.51		0.31	0.35	0.54	0.17	0.47	0.38	0.47	0.1 - 0.75	
Total phosphorus	0.02	0.02	0.06	0.02		0.03	0.02	0.03	0.02	0.02	0.02	0.03	001 - 0.1	
Total hydrocarbons	0.55	0.4	0.25	1.6		1.5	0.2	3.4	0.3	1.5	0.3	4.05		
Copper	<0.005	0.005	<0.005	0.004		0.003	<0.005	0.005	0.003	0.004	<0.005	0.004	0.002 - 0.005	0.005
Zinc	<0.1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.005 - 0.05	0.05
Lead	<0.005	<0.005	<0.005	0.004		0.003	<0.005	0.007	<0.005	0.003	<0.005	0.003	0.001 - 0.005	0.005
Cadmium	0.0014	<0.001	0.00055	0.0009		0.0045	0.0020	0.0015	0.0015	0.0009	0.0014	0.0008	0.0002 - 0.002	0.002
Aluminium	0.120	0.147	0.125	0.112		0.113	0.125	0.092	0.100	0.113	0.080	0.090	<0.005 (if pH = <6.5) 0.1 (if pH >6.5)*	
Iron	1.15	0.9	0.9	0.8		0.7	1.3	1.1	1.2	1.3	0.3	0.40	1.0	

Numbers in shaded boxes represent exceedance of acceptable ANZECC criteria.

* pH > 6.5 for all sites.

SEPP 14 Wetlands

There are no SEPP 14 wetlands in the vicinity of the site, the closest SEPP 14 coastal wetland is located approximately 5 km downstream of the site and is unlikely to be impacted from any activities on site.

A small wetland has developed on the lower reaches of Rosewood Creek is a result of impeded drainage which was most probably created as a result of railway related earthworks. This wetland has an area of approximately 2.6 ha.

Other wetlands in the vicinity of the Proposal are associated primarily with some of the small creek lines and drainage lines in the vicinity. In particular, several smaller wetlands are located on Rosewood and Stony Creeks, in the vicinity both of the railway and the highway.

6.8.5 Water Quality Mitigation Works and Environmental Safeguards

The following two sections summarise the water quality controls needed during the construction phase and during the operational phase of the road.

Construction Phase Water Quality Safeguards

Detailed safeguards to minimise the impacts of construction works of the Proposal on the water quality of Warrell Creek and its tributaries are discussed in **Working Paper No. 1 - Water Quality**, and summarised below. Specific procedures would be addressed in an EMP which would be prepared prior to the construction of the Proposal.

As with all road construction projects, the construction phase of the proposal presents a potential risk to water quality. The primary risk occurs while soils are exposed during earthworks. During this time suspended sediment and associated pollutants can be washed into downstream watercourses, which causes a decline in water quality, damage to the ecosystems, and silting up of waterways. To prevent this degradation, road construction works are subject to controls which are documented prior to commencement of the works in a soil and water management plan.

It is recommended that contractors engaged in the construction of the proposed road be responsible for preparing a soil and water management plan in consultation with the Department of Land and Water Conservation (DLWC) and the EPA.

The plan would need to be prepared in accordance with the principles and practices in:

- Department of Conservation and Land Management (now DLWC) "Urban Erosion and Sediment Control" (1992);
- Roads and Traffic Authority's "Guidelines for the Control of Erosion and Sedimentation in Roadworks" (1992); and

- Environment Protection Authority Guidelines. Managing urban stormwater, treatment techniques (November 1997). Draft, construction activities (Sept 1996).

Activities and measures to achieve the desired minimisation of off-site sediment transport include:

- diversion of overland clean runoff away from the construction site;
- strip and stockpile topsoil for later re-spreading;
- fill material should be sufficiently compacted;
- progressively revegetate as works are completed;
- use defined haul roads and access tracks with a shaker pad equipped entrances;
- use bitumen/straw mulch to protect exposed soil faces and to facilitate grass growth;
- construct a sediment trap across stormwater channels;
- locate soil stockpiles on flat areas, away from areas subjected to runoff, and away from flowpaths. Limit the height and batter of soil stockpiles;
- undertake hydroseeding on exposed ground rather than relying on filter fences;
- construct sedimentation ponds to improve the stormwater runoff quality prior to discharge into downstream waterways

Operational Phase Water Quality Safeguards

Detailed safeguards to minimise the impacts of the Highway on the water quality of Warrell Creek and its tributaries are discussed in the Warrell Creek Hydrological and Water Quality Study (Willing and Partners, 1997) and summarised below.

On completion of the proposed realignments, contaminants generated by traffic on the Highway would continue to constitute the major source of pollutants, washed from the pavement surface by stormwater runoff. Road pavement surface pollutants would mainly be contained in particulates but also would include some solubles.

The proposed strategy to mitigate the impacts of increased pollutants washed from the highway is to provide a suite of controls comprising:

- grassed swale/highway shoulder drains with a buried low flow/seepage pipe;
- water quality control ponds at or near the outlet to drains discharging to the existing wetlands in the vicinity of Rosewood/Stony Creeks with separate diversions/structures for accidental spills; and
- "First flush" basins for all runoff not directed towards the existing wetlands.

A summary of the size of each pond is given in **Table 6.6**.

Table 6.6 - Proposed Location and Sizes of Stormwater Constructed Wetlands and Stormwater Interceptors

Approximate Road Chainage (km)	Wetland or First Flush Basin No.	Wetland Storage Capacity (ML)	Wetland Surface Area (m^2)
42.78	FFB 1	n/a	n/a
43.12	FFB 2	n/a	n/a
44.08	FFB 3	n/a	n/a
44.99	FFB 4	n/a	n/a
45.50	FFB 5	n/a	n/a
45.84	FFB 6	n/a	n/a
46.68	FFB 7	n/a	n/a
47.25	FFB 8	n/a	n/a
45.55	WPQP 1	1.96	2000
45.85	WPQP 2	1.96	2000

n/a = not available

The water quality control ponds (WQCP) have been sized to achieve a decrease in the estimated current pollutant export loads under both the Stage 1 upgrading where the highway will be maintained as a two lane road and under Stage 2 when the highway will be duplicated (see Section 5.3).

Provision has been made for the trapping a minimum of 20 KL of fuel or chemical to remain in the "first flush" tank irrespective of whether the basin is full.

Maintenance of constructed wetlands

Regular cleaning of the first flush tanks and WQCPs would be necessary to maintain the water quality measures operating as they are intended. Cleaning of these devices would be carried out on a regular basis depending on the amount of sediments and debris captured.

6.8.6 Water Quality Monitoring

Baseline Data

Baseline water quality data has already been collected by WBM Oceanics (**Table 6-5**). However, it is recommended that additional water quality data be collected at the same six locations immediately prior to the commencement of the construction works. The additional water quality data should include suspended solids. This should then provide a database enabling water quality changes during the construction process or the operation of the motorway to be traced to the recent existing conditions.

Construction Phase

Water quality testing should be carried downstream of sediment control device prior to releasing any runoff into creeks.

Testing for suspended solids, nutrients, hydrocarbons and heavy metals should also be carried out on downstream creeks where baseline data has been collected

prior to the construction operations to check whether the overall construction process is affecting the streams.

If the runoff within the sediment basins does not meet a predetermined level set by the EPA (usually in the order of 50 mg/L) and if the reason for non-compliance is due to the dispersible nature of the soils in the water column, then treatment of the water within the sediment basins would be necessary. For this purpose there should be stockpiled on site sufficient quantities of an appropriate flocculant such as Gypsum. Flocculant may then be added to the sediment basins at appropriate rates as the need arises.

The responsibility for water quality testing during construction should be vested upon a dedicated and trained person to thoroughly and constantly check water quality levels, inspect water quality structures for integrity and flocculate runoff as necessary.

Operational Phase

Once the construction process has ceased and stabilisation of all exposed soil surfaces through the planting of landscaping vegetation has been achieved, operational phase water quality testing of the highway should begin. The extent of testing should include further testing at the baseline points, and at the downstream end of the WPCPs. This testing will check pond performance as well as overall water quality along the streams.

6.9 Geology and Soils

6.9.1 Geology

The underlying geology for the Warrell Creek area consists of lower Permian metamorphics, including slate, phyllite, and schistose sandstones, shown on the Dorrigo - Coffs Harbour 1:250,000 Geological Series Sheet SH 56 -10 & 11. Minor recent Quaternary alluvial deposits of sand, silt and gravel, exist in the floodplain on the banks of Warrell Creek. In particular, the alluvial sediments are found in the vicinity of the Warrell Creek village near the confluence of Butchers Creek and Warrell Creek, and to the north of the confluence of Crouches Creek and Warrell Creek, extending to the lower Warrell Creek Bridge.

6.9.2 Soils

Soil Landscapes and Limitations

Soils on the tidal plain adjacent to Warrell Creek comprise moderately well-drained alluvial soils (>150 cm). These soils are strongly acidic with high aluminium toxicity potential, have low to very low wet bearing strength, high erodibility and low soil fertility.

Gentle to undulating residual alluvial terraces rise above the tidal plain, from the Upper Warrell Creek Bridge to the northern end of the village. Soils in this area comprise well drained krazonzems with imperfectly drained red podzolic soils (200-300 cm). There are no significant limitations to construction in these areas as the

soils are highly fertile and have good water holding capacity, although there is a moderate rill erosion hazard.

The undulating to rolling low hills on lower slopes either side of Rosewood Road comprise well-drained red podzolic soils and kraznozems (160 to 200 cm). These soils are erodible, Stony and acid, of moderate to high fertility, and susceptible to gully and rill erosion.

The drainage lines of Stony and Rosewood Creeks are typical of the narrow, gravelly meander plains and valley flats of the upper reaches of the Nambucca River. These soils comprise well-drained brown earths and prairie soils (>300 cm) and 50-20 cm of well drained gravelly alluvial soils. Limitations to construction include stream bank erosion, high run-on and low available water holding capacity.

Acid Sulphate Soils

Potential acid sulfate soils are naturally occurring acid clays from water-logged swamps and estuaries which often contain large amounts of sulphur and are usually high in organic matter. If these soils are drained, the sulphur compounds are oxidised and converted to sulphuric acid (Chapman and Murphy, 1989). This reaction can lead to adverse impacts on aquatic flora and fauna and corrosion of iron, steel and concrete.

The Proposal lies to the east of the floodplain between Warrell Creek and the highway. This floodplain has been identified as a potential source of acid sulfate soil. DLWC acid sulfate mapping (1:100,000) indicates that there is a low probability of encountering acid sulfate soils over a length of approximately 250 m (Ch 44,300 to 44,550 m) along the proposed alignment. However, further sampling undertaken by the RTA has identified the presence of acid sulfate soils in the wetland areas adjacent to Rosewood Creek.

6.9.3 Impact Assessment

The disturbance of soils in the study area would be most likely during the construction phase of the project. Soils which have high erodibility characteristics, such as those adjacent to the drainage lines, would be more susceptible to disturbance from construction activities. Soils with low soil fertility or high aluminium toxicity, such as those adjacent to Warrell Creek, would be more difficult to revegetate after construction.

The proposed alignment has been set to avoid, as far as possible, the acid sulfate soils identified in the wetland areas adjacent to Rosewood Creek. Potential contact with acid sulfate soils could occur during the construction of the duplicated bridges over at Upper Warrell Creek and over Stony Creek, but the remaining road works are unlikely to be affected.

6.9.4 Safeguards

Appropriate erosion and sediment control measures would be implemented to reduce potential erosion impacts during construction of the project. To aid regeneration along the alignment after construction, lime would need to be applied to acid soils in exposed areas prior to landscaping. Top soil would be stockpiled in suitable locations and stabilised with hydromulch and sterile varieties of exotic grass species. If stockpiles are moved within one month, then they would be located on sites away from drainage lines and maintained in a moist condition. They would be bunded to ensure that they did not represent a sediment source.

During the detailed design phase of the project, more detailed sampling and testing would be undertaken of the soils in the study area to determine the likelihood of encountering further acid sulfate soils. Additional safeguards would be implemented during construction to minimise the effects of acid sulfate soils on the environment. The Contractor would be required to meet the RTA's "Acid Sulphate Soils Guidelines" (1995) and the EPA's "The Environmental Guidelines - Acid Sulfate Soils Assessment and Management Guidelines" (1998). The safeguards would be part of an EMP.

Specific safeguards to minimise the effects of the construction phase on water quality are outlined in Section 6.8.5 and **Working Paper No. 1 - Water Quality**.

6.10 Noise and Vibration Impact Assessment

A Noise and Vibration Impact Assessment has been undertaken for this project by Wilkinson Murray Pty Ltd. The findings of this assessment are summarised below and detailed in ***Working Paper No. 2.***

6.10.1 Introduction

The impact of noise and vibration associated with construction and operation of the Proposal has been assessed in accordance with the Environment Protection Authority (EPA) and RTA agreed position for the assessment of road traffic noise and the guidelines contained in the EPA's Environmental Noise Control Manual (ENCM). As the proposed road is not classified as a freeway, the requirements of Chapter 157 of the ENCM manual would apply. The noise impact assessment considers the dual carriageway proposal.

Since the Proposal involves moving the existing railway, an assessment of rail noise and vibration from the realigned tracks has also been made in terms of the EPA's noise criteria.

6.10.2 Existing Noise Environment

The existing noise environment along the proposed road and rail corridors is typical of a rural environment that is exposed to isolated roads.

In order to characterise the existing noise environment along the proposed road and rail corridors, ambient noise monitoring was undertaken at seven residential

locations likely to be affected by the Proposal. The ambient sound pressure level measurements were conducted continuously over 15 minute sampling periods at six sites between 29 June to 6 July 1997, and 3 December to 18 December 1997 at one additional site. Noise levels were measured at a height of 1.2 m and generally, 1 m from the side of the ground floor facades.

The residential monitoring locations are shown on **Figure 6-7**.

The noise loggers were set to record LA_1, LA_{10}, LA_{90}, and LA_{eq} levels of the existing noise environment. The LA_1, LA_{10} and LA_{90} levels are the levels exceeded for 1%, 10% and 90% of the sample time respectively. The LA_1 is indicative of maximum noise levels due to individual noise events such as the occasional passby of a heavy vehicle. The LA_{90} level is normally taken as the background noise level. The LA_{eq} level is the Equivalent Continuous Sound Level and has the same sound energy over the sampling period as the actual noise environment with its fluctuating sound levels.

Both the LA_{10} and the LA_{eq} are standard descriptors for traffic noise. The noise criterion (discussed in section 6.10.3) is based on the following descriptors:

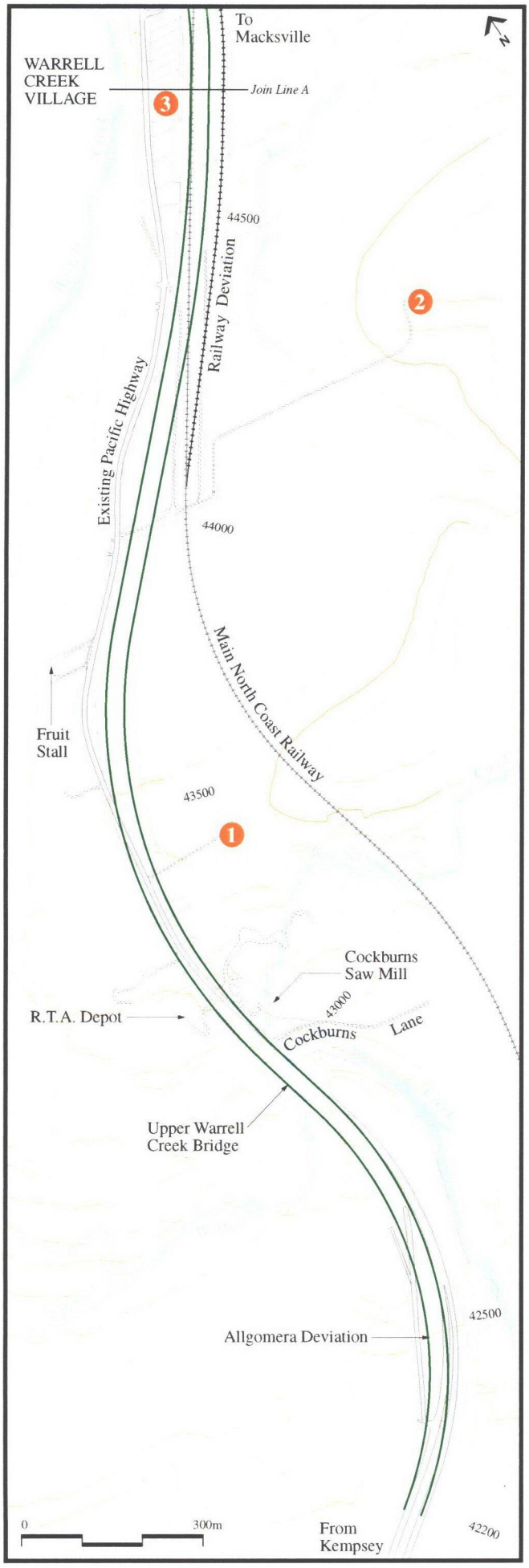
- $LA_{eq,15hr}$, based on daytime noise levels between 0700-2200 hours
- $LA_{eq,9hr}$, based on night time noise levels between 2200-0700 hours

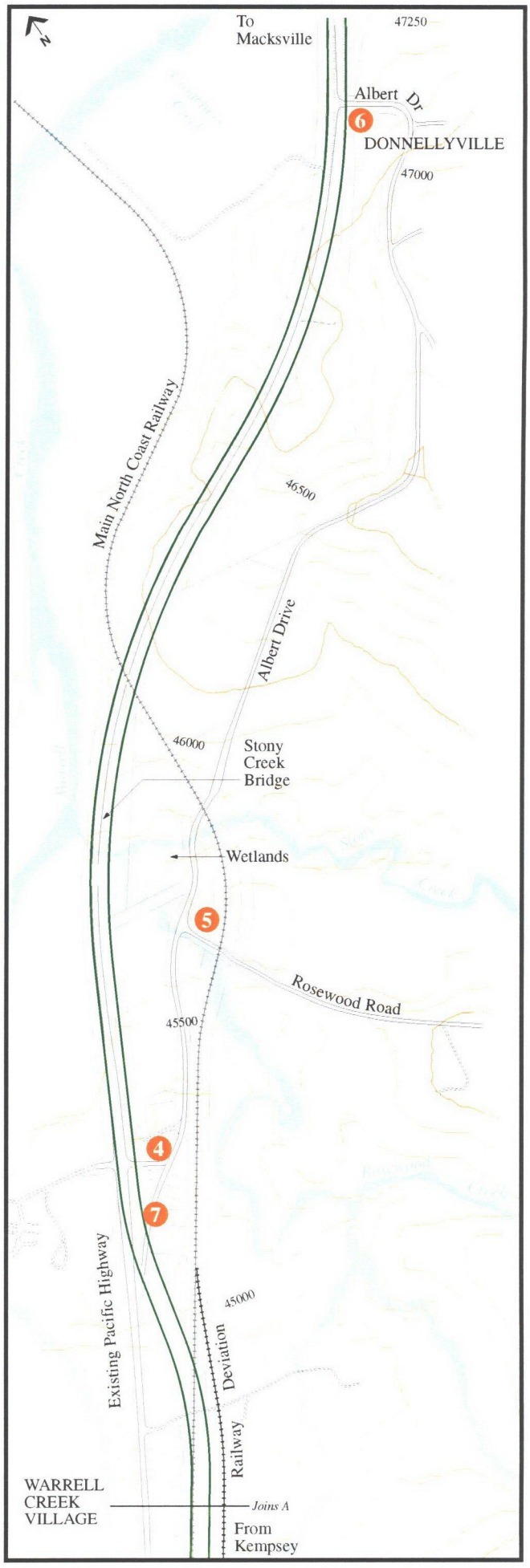
These LA_{eq} levels can either be measured over the time period indicated or calculated from the logarithmic average of the individual 15 minute LA_{eq} levels, as adopted during this project.

Construction noise is assessed with reference to the LA_{90} background noise level, which is determined using the repeated minimum background (LA_{90}) levels for the period 0700 - 1800 hours, Monday to Friday, and 0800 - 1300 hours on Saturday.

The ambient noise measurement results are set out in **Table 6.7**. It should be noted that if facade reflection is taken into account, noise levels approximately 2 dB(A) higher would have been recorded.

The detailed noise monitoring results using 15 minute periods are shown graphically in **Working Paper No 2**.





ROAD DESIGN SERVICES SECTION
ROAD TECHNOLOGY BRANCH

Figure 6.7
NOISE MONITORING LOCATIONS

Table 6.7 - Summary of Ambient Noise Measurements

Location	Address	$LA_{eq,\ 24hr}$ (dB(A))	$LA_{eq,\ 15hr}$ (dB(A))	$LA_{eq,\ 9hr}$ (dB(A))	LA_{90} Day	LA_{90} Night
1	McDonnell's residence	51-58	50-59	49-56	31-38	26-35
	- Typical Level	54	54	54	34	32
2	Bilgola Ostrich Farm	51-55	50-56	48-53	33-40	27-35
	- Typical Level	52	53	52	35	33
3	Richards residence	62-64	62-64	57-64	32-34	28-32
	- Typical Level	64	64	63	33	32
4	Neaves residence	54-55	54-55	52-56	32-37	28-33
	- Typical Level	54	54	55	35	30
5	Browns residence	54-57	54-57	53-59	30-35	27-33
	- Typical Level	56	55	56	33	30
6	Cnr Albert Drv & Pacific Hwy	54-58	54-58	50-58	32-36	27-33
	- Typical Level	57	57	56	34	30
7	McDonald Residence, Sonnys Lane	45-51	45-53	44-53	27-37	25-30
	- Typical Level	48	49	48	28	28

Note: This table includes noise levels corrected to include facade reflection, where no measured

The measurement results shown in **Table 6.7** indicate that the residences likely to be affected by the Proposal presently experience moderately low ambient noise levels.

6.10.3 Noise Assessment Criteria

Road Traffic Noise Criteria

Traffic noise levels are determined in accordance with the road traffic noise policy developed by the EPA and the RTA, as summarised in **Table 6.8**. The noise level goals apply to new road developments operating at full capacity.

Table 6.8 - Traffic Noise Level Criteria for New Roads

Land Use	EPA Criteria
Residential	$LA_{eq,15hr}$ 55 dB(A) (Day) $LA_{eq,9hr}$ 50 dB(A) (Night) Assess night time maximum noise levels.
Schools	$LA_{eq,1hr}$ 55 dB(A) $LA_{eq,1hr}$ 45 dB(A) internal
Places of Worship	$LA_{eq,1hr}$ 40 dB(A) internal
Parks	Active recreation: $LA_{eq,1hr}$ 60 dB(A) Passive recreation: $LA_{eq,1hr}$ 55 dB(A)

The noise criteria relating to road upgrades or redevelopment are $LA_{eq,15hr}$ (daytime) 60 dB(A) and $LA_{eq,9hr}$ (night time) 55 dB(A). If these criteria cannot be achieved practically, then the increase for a road upgrade (involving no capacity change) should be limited to 0.5 dB(A) and for a road redevelopment (capacity change) 2 dB(A). The allowable increases are those which would result from the change of the road construction and from the increased capacity (redeveloped capacity minus existing capacity).

For this assessment, the road deviation is being regarded as a new road in terms of the traffic noise criterion, (ie daytime and night time noise level of $L_{Aeq,15hr}$ 55 dBA and $L_{Aeq,9hr}$ 50 dBA respectively). Where these goals can not be met, the road should be designed so as to not increase existing noise levels by more than 0.5 dBA. The EPA acknowledges that in some instances this may only be achievable though long term strategies.

Heavy Vehicle Noise Criterion

Whilst not a part of the RTA policy, the potential for sleep disturbance from short term maximum noise levels generated by heavy vehicles at night time has been assessed. The ENCM specifies that an applicable guideline for protection from sleep disturbance is background (LA_{90}) +15 dBA at the facade of the most potentially affected residences.

Another LA_{max} criterion which is considered more appropriate has been adopted for this assessment. It is based on recent research in which a correlation has been found between the maximum noise level of a variety of transportation noise sources, the number of such noise events during the night and awakening reactions of subjects. The results indicate that for an internal LA_{max} level at or below 53 dBA, no more than 10% of exposed people are likely to experience awakening reactions for a large number of such events. Assuming a minimum sound level reduction from outside to inside through an open window of 10 dBA, an internal guideline of 53 dBA is equivalent to an external facade LA_{max} level of 63 dBA.

Therefore, the external facade guideline which has been adopted for maximum noise events in this assessment is a maximum noise level of 63 dBA.

Construction Noise Guidelines

The noise level guidelines for assessment of construction noise relating to this proposal have been adapted from the ENCM and are presented in **Table 6.9**. The noise levels listed in **Table 6.9** are applicable to residential dwellings along the route for the various construction durations and have been based on the results of ambient noise monitoring.

Table 6.9 - Construction Noise Criteria

Location	Site Address	LA_{10} (dB(A)) < 4 Weeks (LA90 +20)	LA_{10} (dB(A)) < 26 Weeks (LA90 +10)
1	McDonnell's residence, Pacific Highway	54	44
2	Bilgola Ostrich Farm	55	45
3	Richard's residence, Lot 9, Pacific Highway, Warrell Creek Village	53	43
4	Neave's residence, "Little House on the Prairie", Albert Drive, Warrell Creek Village	55	45
5	Brown's residence, Cnr. Rosewood Road & Albert Dr	53	43
6	Cnr. Albert Dr and Pacific Highway	54	44
7	McDonald Residence, Sonnys Lane	47	37

No construction work would take place on Sundays or Public Holidays.

Construction Vibration Criteria

The EPA give guidelines on vibration in buildings. Where vibration affects a residential area the criteria listed in **Table 6.10**.

Table 6.10 - Residential Vibration Criteria

Time	Frequency Weighted rms Acceleration (m/s^2)	
	Continuous Vibration	Intermittent or Impulsive Vibration
Daytime (7 am-10 pm)	0.01	0.30
Night-time (10 pm-7 am)	0.007	0.10

Where vibration magnitudes are less than those given in the continuous limits, no time restriction is recommended. However, where measured acceleration magnitudes exceed those for continuous vibration, then the following time restrictions apply:

- 7.00 am - 6.00 pm Monday to Friday
- 7.00 am - 1.00 pm Saturday
- None on Sunday or Public Holidays.

Vibration generated within the ground can be transmitted into building structures whence it can be radiated as structureborne noise into occupied spaces. This effect of groundborne vibration is likely to have a greater impact than the vibration itself within the building.

In the case of structureborne noise, it is appropriate to set the noise criterion within the building according to the Australian Standard 2107 - 1987. This Standard recommends the following internal maximum noise levels for private houses in rural areas and the outer suburbs:

- Residence daytime (recreation areas) 40 dB(A)
- Residence night-time (sleeping areas) 30 dB(A)

Rail Noise Criteria

Chapter 163 of the EPA's ENCM sets criteria for residential receivers of rail traffic noise in terms of both a maximum passby level and as an equivalent continuous 24 hour noise level ($LA_{eq,\ 24\ hr}$). These planning levels and maximum levels are given in **Table 6.11**.

Table 6.11 - Rail Noise Level Goals

Location	Planning Levels (dB(A))	Maximum Levels (dB(A))
Residential Receivers	$LA_{eq,\ 24\ hr}$ = 55	$LA_{eq,\ 24\ hr}$ = 60
	LA_{max} = 80	LA_{max} = 85

In this report the new rail noise levels would be assessed with reference to the EPA's planning level of $LA_{eq,24hr}$ of 55 dB(A) and LA_{max} of 80 dB(A).

6.10.4 Impact of Road Traffic Noise

The noise impact assessment has been undertaken using the CORTN Model (Calculation of Road Traffic Noise) developed by the UK department of Transport, 1988. This method takes account of vehicle movements and speed, the percentage of heavy vehicles, character of the ground and topography of the surrounding area, and the effect of reflections and shielding from barriers. The model has been used to calculate LA_{eq} levels for the year, ten years after opening (2010) and assumes a compounding annual 3.5 % growth in traffic volumes. It has been assumed that the average speeds along the road would be 100 km/hr.

The predicted levels of road traffic noise ($LA_{eq,15hr}$) calculated at the facade of each of the residential reference locations are shown in **Working Paper No. 2**. The noise contours are for the year 2010, assuming that no noise barriers are used along the Proposal, and include a 2 dB(A) facade reflection correction. The contours are therefore only representative of the noise level directly in front of a residence facing the road. Noise levels in open space between dwellings would be approximately 2 dB lower than indicated by these contours.

In general, the growth in traffic volume to the year 2010 would result in an increase in day-time noise level of approximately 2 dB(A) at those houses located adjacent to sections of the proposed highway alignment which essentially follows the

existing Pacific Highway alignment. These locations are limited to the McDonnell and Sutton residences at the southern end of the road upgrade and those residences located north of Albert Drive.

The majority of the road upgrade however experiences a 50 m relocation to the east of the present road alignment. This relocation extends to a maximum of approximately 100 m through the village of Warrell Creek. For the majority of houses therefore located along this section of road upgrade, the new distance between residences and the Pacific Highway would be approximately twice that that presently exists. This increase in distance would result in a drop in day-time noise level of approximately 3 dB(A), assuming constant traffic volumes. Taking into account the increase in road traffic volume to the year 2010, a net degrease in day-time noise level of approximately 1 dB(A) is expected for the majority of houses along the Proposal.

In order to achieve a daytime $LA_{eq,15hr}$ of noise level of 55 dB(A) and a night time $LA_{eq,9hr}$ noise level of 50 dB(A), roadside noise barriers would be required along the southern half of the road upgrade to a position 150 m north of Albert Drive. This barrier is required to be 4 m high through most of the village of Warrell Creek where houses are approximately 50 m from the edge of the proposed highway alignment. This drops to 3.5 m where houses are located approximately 90 m from the edge of the roadway and increases to 5 m adjacent to those houses as close as 40 m to the proposed highway alignment.

Additionally, at least 200 m of 4 m barrier is required along the eastern edge of the road alignment to shield the McDonnell residence to the south of the road upgrade and a 5 m barrier is required along the eastern edge of the roadway from the location where the highway leaves the old rail alignment into a position 100 m north of Albert Drive where the barrier can be reduced in height to 3 m where it continues until the highway crosses the rail line. Other strategies for noise mitigation may also be considered.

Heavy Vehicle Noise

To achieve a residential night time LA_{max} noise level criterion of 63 dBA, a noise reduction of approximately 49 dBA is required based on a maximum truck sound power level of 112 dBA.

Assuming that roadside noise barriers are not used and that no shielding is provided by the local topography, a set back from the highway of approximately 90-100 m is required to achieve the LA_{max} noise level criterion.

6.10.5 Impact of Construction Noise

This assessment is based on the general type of construction likely to occur during the Proposal. These activities include earth and drainage works, surface preparation, pavement laying and pavement furniture. Detailed information regarding the construction programme for the proposed works would be

determined prior to construction, and mitigation measures (see Section 6.10.8) would be designed to minimise the impact on the community.

The earthworks and drainage phase is expected to have the longest duration and to generate the highest construction noise levels. The noise generated by construction equipment would rise and fall as construction progresses along the route. The equipment may therefore be assumed to have a moving acoustic centre, which, for most of the construction period, would not be immediately adjacent to a single residence.

Due to the lack of specific information relating to construction methods, a generalised approach has been adopted to provide typical overall noise levels that can be expected during construction. The prediction method takes into account progressive movement of construction machinery, number and type of construction plant, the relative phasing of various construction operations and the time periods for which differing guidelines are set.

Noise levels have been predicted by grouping together typical types of noise sources for a particular phase of the works and by taking into account relevant acoustic factors such as distance attenuation, shielding effects and ground effects. Noise levels have been predicted for a number of indicative distances between the centre of earthworks operations and the typical residential receiver locations.

The closest residences are located approximately 30 m away from the noise sources, but more typical distances are between 60 and 120 m from the centre of operations.

The noise levels expected at various distances from the earthworks and the paving and asphalt phases of the works are given in **Table 6.12**. Given that not all items of plant would be operating near each other simultaneously all the time, a 10 dBA range has been assumed in our expected noise levels.

Table 6.12 - Predicted Noise Levels due to Construction

Phase of Construction	Distance from Centre of Operations	LA_{10} (dB(A))
Earthworks	30	70 - 80
	60	64 - 74
	120	58 - 68
	200	54 - 64
Paving And Asphalt	30	65 - 75
	60	59 - 69
	120	53 - 63

At distances up to 120 m, the construction noise criteria are likely to be exceeded most of the time. It is therefore expected that noise levels from the earthworks may cause annoyance to a varying degree at residences within 200 m of the Proposal for a temporary period only when earthworks are being performed on the closest section of road.

The paving operations would on the whole be significantly quieter than the earthworks and would in general affect each particular residence for a period of 1-2 weeks only. As with the earthworks phase, these levels would exceed the construction noise criteria for some of the time and may cause annoyance, even if for a temporary period.

6.10.6 Impact of Construction - Vibration

Groundborne vibration may occur during the paving phase of the construction works.

Groundborne vibration magnitudes resulting from Vibrating Rollers have previously been measured by Wilkinson Murray Pty Limited and are shown in **Table 6.13**.

Table 6.13 - Residential Vibration Criteria

Distance from Centre of Operations	LA_{10} (dB(A) Paving works
15	0.2
20	0.09
30	0.04

It is accepted that the vibration from vibratory rollers can present annoyance when operated close to dwellings. The measured results produce predicted vibration magnitudes which are well below the criterion for intermittent vibration and below the continuous criterion at a distance of 60 m during daytime. Where the vibratory roller is to be used within 60 m of dwellings, time restriction should apply to prevent continuous exposure to particular residences for the whole day.

6.10.7 Impact of Rail Noise

In assessing the impact of rail noise, the results of noise monitoring conducted at Browns residence (Location 5), approximately 25 m from the rail line, have been used. The $LA_{eq,24hr}$ noise level at this location is typically 56 dB(A), and given its close proximity to the rail line, the majority of this level would be due to rail traffic with a small contribution from road traffic. We would assume that rail noise in the absence of road traffic noise would have resulted in a typical $LA_{eq,24hr}$ noise level of 55 dB(A).

Typical LA_1 noise levels during train passbys is 75 dB(A) (± 5 dB(A)). For the purpose of rail noise, the LA_1 noise level measured over a 15 minute period can be

considered to approximate the LA_{max} noise level. The results indicate that at this distance from the rail line, the rail noise level criteria are satisfied.

The only position where the rail line has been deviated closer to residences is for the cottage located close to the access road to the Apps' residence. It would appear that this cottage is located so close to the rail deviation that it would need to be purchased and demolished.

Virtually all other residences would experience a 3 dB(A) decrease in rail noise due to the deviation of approximately 50 m to the east of the present alignment. The two residences located east of the rail deviation are presently at such a distance that the increase in rail noise experienced would be less than 1 dB(A) which would not be noticeable.

6.10.8 Mitigation of Impacts

Road Traffic Noise Mitigation

Most residences located along the Pacific Highway upgrade would experience a reduction in road traffic noise level of approximately 1 dB(A). Despite this general increase in acoustic amenity, if the noise criterion of $LA_{eq,15hr}$ 55 dBA and $LA_{eq,9hr}$ 50 dBA is to be met, noise barriers (as identified in Section 6.10.4) would need to be erected. However, the Warrell Creek community has expressed concerns over the visual impact of noise barriers (see Section 4). As a result, noise reduction measures would be negotiated with individual property owners during the land acquisition process, prior to construction. This would include agreements with landowners on the types of noise reduction measures.

Heavy Vehicle Noise

If the scheme of roadside noise barriers proposed in Section 6.10.4 is implemented, then the residential night time LA_{max} noise level criterion would automatically be met.

Construction Noise and Vibration

The assessment in above indicates a noise impact from construction activities, and therefore, consideration would need to be given to noise controls where these are practicable. However, it is difficult to consider such control measures in detail in view of the lack of details regarding construction methods and timing. Prior to construction, a more detailed construction noise assessment would be addressed in the EMP. The controls that would be considered include:

- formulation of a Noise Management Control Plan;
- care in restricting construction hours to normal daytime hours, where noise impacts are likely;
- the replacement of very noisy equipment with quieter equipment and/or the treatment of some very noisy equipment, where feasible;
- time restrictions on operation of vibratory rollers;

- consultation with the community to keep landowners informed about the timing of the various construction activities, such as the earthworks, asphalting and paving, and landscape works.
- EPA license for concrete/asphalt batch plants

Rail Noise

No mitigation measures would be required for rail traffic noise since the noise monitoring which has been conducted shows that the rail noise criteria can be satisfied at distances exceeding 25 m. One cottage which appears to be almost directly in line with the proposed rail deviation would, however, need to be demolished.

6.11 Climate

The Climate of the Warrell Creek area is primarily influenced by latitude, proximity to the ocean, elevation and topography of the surrounding area. Warrell Creek is located approximately 31°S of the equator, and approximately 12 km inland from the coast. This sub tropical location and proximity to the coast has a significant influence, producing warm summers and mild winters. Rainfall at Warrell Creek is relatively reliable all year round and exhibits a marked seasonal variation with most rain falling during the summer and early autumn months.

The NSW Bureau of Meteorology operates a meteorological station at Kempsey, approximately 40 km south of Warrell Creek. The data recorded at this station have been used as the nearest available meteorological information for evaluating the climatic environment of Warrell Creek area.

Data for the following parameters are collected at the Kempsey station and are summarised below:

- mean temperature
- mean monthly rainfall
- mean number of rain days per month
- incidence of fogs

6.11.1 Temperature

The mean daily maximum temperatures experienced at Kempsey range between 29.3 °C in January to 19.6 °C in July. The mean daily minimum temperature range is between 17.5 °C in January and 5.6 °C in July. During the 21 years of record, temperatures at Kempsey have not risen above 43.0 °C. The lowest recorded temperature is -1.8 °C, occurring during the month of June. The temperatures experienced at Warrell Creek are expected to be slightly less extreme than temperatures experienced at Kempsey due to the lower elevation of Warrell Creek and its closer proximity to the ocean.

6.11.2 Humidity

The relative humidity experienced at a particular location varies with the season and the time of day. Relative humidity data obtained from the Kempsey station are indicative of the relatively humid environment experienced at Warrell Creek. The higher incidence of fogs at Warrell Creek would however increase the 9 am relative humidity readings above those experienced at Kempsey.

The 9 am relative humidity readings remain above 70 % throughout most of the year, falling to 65 % during September and October and rising to around 80 % during the months from January to July. The 3 pm relative humidity readings vary between 46 % in August to 61 % in February and March.

6.11.3 Rainfall

The mean monthly rainfall pattern exhibits a distinct seasonal variation with most rain occurring during the summer and autumn months. Based on 113 years of record, Kempsey receives an average annual rainfall of approximately 1216 mm.

The highest mean monthly rainfall of approximately 153 mm occurs during February, while the lowest mean monthly rainfall of 56 mm occurs during September. The highest monthly rainfall recorded during the 113 years of monitoring at Kempsey is approximately 883 mm occurring during February . A minimum monthly rainfall of 0 mm has been recorded during February and the 5 months from May to September.

The annual average rainfall of 1216 mm received at Kempsey occurs over approximately 108 rain days. The winter months of July and August receive the lowest mean number of rain days throughout the year, while February and March have the highest number of rain days, experiencing an average total of approximately 12 rain days. The highest number of rain days on record occurred during March where rain was received on 26 days.

6.11.4 Fogs

Kempsey experiences an average of approximately 18 fog days each year with most fogs occurring during late summer and early autumn. Fogs occur most frequently in February which experiences fog on approximately 2-3 days. December experiences the least number of fogs throughout the year with approximately 1 fog day.

The occurrence of fogs at Warrell Creek is likely to be greater than that at Kempsey due to the differing topographical influences surrounding each location. Downslope drainage of cold air is expected to be significant in the formation and frequency of fogs experienced at Warrell Creek with fog formation being most frequent during the late evening and early morning hours of the cooler months.

Within the study area the Pacific Highway runs along the base of a relatively steep valley adjacent to Warrell Creek. The ground elevation of Warrell Creek and the Highway remain below approximately 10 m, while the surrounding land rises to

elevations of up to 250 m. As a result of this relatively steep terrain surrounding Warrell Creek, topographically induced local air flows can produce drainage of cold air to the low ground along the creek line where it settles, cooling further and forming fogs.

Kempsey is located in a broad flat area along the Macleay River Valley. Downslope drainage flows and the stagnation of cold air at Kempsey is consequently much less common than at Warrell Creek and the formation of fogs at Kempsey are therefore expected to be much less frequent than at Warrell Creek.

Anecdotal reporting by the Warrell Creek residents indicates that fog occurs throughout the length of the valley on nearly every day during the winter time, and intermittently throughout the remainder of the year. Thick fog may form as early as 9 pm in the evening and usually disperses by around 9 am the following day. It has been estimated that fogs occur on at least 120 days throughout the year.

6.11.5 Wind

Wind directional data for the Warrell Creek area were not available and as such, the general wind pattern described is for a coastal location along the east coast of Australia.

The broadscale synoptic wind pattern experienced at Warrell Creek is easterly in summer and westerly in winter. The surface winds are modified by localised circulation effects such as downslope drainage flows occurring during the cooler months, and land and sea breezes occurring throughout the warmer months.

On an annual basis at 9 am winds are predominantly from the south west, a pattern which prevails throughout the year. In spring and summer, winds from the north and south are also common. In the afternoon, the winds tend to blow from the north east in all seasons. In summer, autumn and winter winds from the southern quadrant are also common.

On an annual basis both south westerlies and north easterlies predominate in both the morning and afternoon hours, with winds from the south also contributing. Winds from due west and north west are the least common.

This general pattern of morning south westerlies (off-shore) and afternoon seabreezes (on-shore) is expected for an east coast location such as Warrell Creek.

6.12 Air Quality

The air quality impact assessment was undertaken for this project by Holmes Air Sciences Pty Ltd. The following sections provide a summary of this air quality report, which is presented in detail in ***Appendix E****.*

6.12.1 Introduction

The assessment of impacts of motor vehicle emissions along the proposed deviation of the Pacific Highway at Warrell Creek has been undertaken using a computer model to determine the dispersion of emissions and to predict ground level concentrations of the various exhaust components in the area close to the road.

In the first year of operation (2000), the primary pollutants of concern are carbon monoxide, hydrocarbons, nitrogen oxides, particulate matter and lead. It has been assumed that by the tenth year of operation (2010) lead emissions would no longer be significant due to the continued reduction in lead content of fuels.

6.12.2 Dispersion Meteorology

The dispersion meteorology and general climate of the local environment has been discussed in Section 6.11.

6.12.3 Existing Air Quality

Site-specific air quality monitoring has not been carried out for this study. However, similar rural roadway studies for Pacific Highway upgrades have been carried out by Holmes Air Sciences near Billinudgel on the far north coast, and at Bulahdelah to the north of Newcastle. Some monitoring of carbon monoxide has been undertaken for these projects. The results indicate that in general, hourly concentrations of carbon monoxide in this type of environment are quite low, averaging between 2-5 ppm. However on occasions, readings up to 17 ppm were obtained in these studies, but these did not appear to be associated with roadway emissions. Other local factors such as saw mill activities or bushfires may contribute more significantly to air pollution in rural areas than motor vehicle emissions.

Air Quality Issues

Photochemical Smog

Apart from local air quality impacts, motor vehicle emissions have the potential to contribute significantly to photochemical smog in an urban environment. Photochemical smog is formed by the reaction between nitrogen oxides and reactive hydrocarbons in the presence of sunlight.

Photochemical smog is often a concern on the fringes of large cities as parcels of smog-laden air can travel to areas remote from the source. However in the Warrell Creek area there are unlikely to be any regional air quality problems associated with vehicle emissions. The most important air quality issue associated with the

proposed road development would be the local impacts at kerbside and nearby residences from specific emissions from vehicles.

Conversion of nitric oxide to nitrogen dioxide
Nitric oxide is converted to nitrogen dioxide and its rate of conversion is dependent on the presence of oxidising agents. The issue here is the rate at which NO converts to NO2. Monitoring data collected by the RTA in Sydney indicate that close to the roadways, NO2 would make up from 5 to 20% by weight of the total NOx. A conservative value of 15% by weight at 0-10 m from the roadway and 20% by weight at 30 - 50 m from the roadway has been used in the impact assessment presented in Section 6.12.5.

6.12.4 Air Quality Criteria

The New South Wales Environment Protection Authority (EPA) notes air quality goals for nitrogen dioxide, carbon monoxide, and particulate matter determined by the World Health Organisation (WHO), the United States Environment Protection Agency (US EPA) and the National Health and Medical Research Council of Australia (NHMRC). Air quality goals for hydrocarbons have been used previously, but these have been discarded because they are not specific for reactive species which are the important elements in the formation of photochemical smog.

Table 6.14 lists the EPA's air quality goals for New South Wales. Not all of these are major emissions from motor vehicles. The basis of these air quality goals and the safety margins which they provide are outlined below.

It should be noted that the National Environment Protection Council (NEPC) is currently determining a new set of air quality goals for adoption at a national level. These are likely to be more stringent than the current goals.

Table 6.14 - NSW Air Quality Goals

Pollutant	Standard *		Agency
Total suspended particulate matter (TSP)	90 mg/m^3	(annual mean)	NHMRC
Particulate matter < 10 μm	50 mg/m^3	(annual mean)	US EPA
	150 mg/m^3	(24-hour maximum)	US EPA
Lead	1.5 mg/m^3	(90-day average)	NHMRC
Carbon monoxide	87 ppm or 108 mg/^{3}	(15-minute maximum)	WHO
	25 ppm or 31 mg/m^3	(1-hour maximum)	WHO
	9 ppm or 11 mg/m^3	(8-hour maximum)	NHMRC
Nitrogen dioxide	0.16 ppm or 328 mg/m^3	(1-hour maximum)	NHMRC
	0.05 ppm or 103 mg/m^3	(annual mean)	US EPA
Ozone	0.12 ppm or 258 mg/m^3	(1-hour maximum)	NHMRC
Sulphur dioxide	50 pphm or 1400 mg/m^3	(10-minute maximum)	NHMRC
	25 pphm or 700 mg/m^3	(1-hour maximum)	NHMRC
	2 pphm or 60 mg/m^3	(annual mean)	NHMRC
	17.5 pphm or 500 mg/m^3	(10-minute maximum)	WHO
	12 pphm or 350 mg/m^3	(1-hour maximum)	WHO
Suspended matter	40 mg/m^3	(annual mean)	WHO

Source: EPA

* All concentration units have been converted at °C

Carbon Monoxide

Carbon monoxide can be harmful to humans because when it is inhaled it is taken up by the blood and reduces the capacity of the blood to transport oxygen. This process generally causes temporary lassitude and headaches, and has been shown to increase health risks for individuals with cardiovascular disease. The symptoms of carbon monoxide intoxication are generally not reported until the concentrations of carboxyhaemoglobin in the blood are in excess of 10% of saturation. This is approximately the equilibrium value achieved with an ambient atmospheric concentration of 70 mg/m^3 for a person engaged in light activity. The WHO recommends that ambient concentrations be kept to values which would protect individuals from exceeding the 4% level.

The 15-minute, 1-hour and 8-hour goals noted by the EPA provide a significant margin for safety, however this is appropriate for this type of guideline, which is designed to protect a wide range of people in the community including the very young, the elderly and the infirm.

Oxides of Nitrogen

Nitrogen oxides (NO_x) emitted by motor vehicles are comprised mainly of nitric oxide (NO, approximately 95% at the point of emission) and nitrogen dioxide (NO_2, approximately 5% at the point of emission). Nitric oxide is much less harmful to humans than is nitrogen dioxide and is not generally considered a pollutant with health impacts at the concentrations normally found in urban environments. Concern with nitric oxide relates to its transformation to nitrogen dioxide and its role in the formation of photochemical smog. Nitrogen dioxide has been reported to

have an effect on respiratory function although the evidence concerning effects has been mixed and conflicting. The EPA has not set any air quality goals for nitric oxide however it has set 1-hour and annual average goals for nitrogen dioxide.

Hydrocarbons

Hydrocarbons alone do not generally pose a problem in the urban environment at the concentrations commonly experienced. However, some hydrocarbons such as benzene are known to have an adverse effect on human health (see later), but the effects are thought to occur at concentrations higher than the levels of exposure that are found at roadsides from traffic emissions.

There is growing concern about the amount of benzene released in motor vehicle emissions, especially in Europe where fuel has a higher benzene and aromatic content than in Australia. At present NSW has no ambient air quality goals for benzene. The Victorian EPA currently has a limit of 0.10 mg/m_3 (0.033 ppm) (3-minute average). Many in the scientific community hold the view that there is no safe limit for benzene. The United Kingdom has an annual average ambient benzene goal of 5 parts per billion (ppb) or 16 $\mu g/m^3$ to be achieved by 2005. The 5 ppb goal is based on the "No Observable Adverse Effect Level" from the findings of the UK Expert Panel on Air quality Standards that the risk of leukaemia in workers would not be detectable when the average working lifetime exposure to benzene was less than 500 ppb. Two safety factors of 10 were then applied to derive the goal of 5 ppb. The Australian draft air quality goal for benzene is 5 ppb.

Particulate Matter

The presence of particulate matter in the atmosphere can have an adverse effect on health and amenity. The health effects of particles are largely related to the extent to which they can penetrate the respiratory tract. Larger particles, that is those greater than 10 μm, generally adhere to the mucus in the nose, mouth, pharynx and larger bronchi and from there are removed by either swallowing or expectorating. Finer particles can enter bronchial and pulmonary regions of the respiratory tract, with increased deposition during mouth breathing which increases during exercise. The very fine particles can be deposited in the pulmonary region and it is these which are of particular concern.

The health effects of particulate matter are further complicated by the chemical nature of the particles and by the possibility of synergistic effects with other air pollutants such as sulphur dioxide.

The NSW EPA notes the US EPA 24-hour air quality standard of 150 mg/m^3 and annual average standard of 50 mg/m^3 for PM_{10}. The NSW EPA also notes the NHMRC's 90 mg/m^3 annual average goal for total suspended particulate matter (TSP). This level is recommended as the maximum permissible level in urban environments.

Lead

Lead is a cumulative poison which exerts its toxic effects on the kidneys, blood and central nervous system. It is now generally agreed, that while the effects are not readily discernible on an individual basis, on a population basis, lead exposure in young children can lead to an IQ deficit of between 2 to 3 points for each 10 mg/dL increment in blood lead. As environmental lead has emerged as a public health issue, governments in Australia have developed strategies to reduce the levels of lead exposure.

It has been estimated that about 90% of the lead in air arises from motor vehicle emissions, apart from areas where there are significant local lead industries. Since the introduction of unleaded petrol there has been a steady and unambiguous decline in lead emissions and in the low concentration of lead in the air in urban environment, clearly demonstrating the effectiveness of this strategy.

The NHMRC goal for lead is 1.5 $\mu g/m^3$ (90-day average) and is currently under consideration for revision downwards.

In 2000, the first year of opening about 15% of the fleet would still be using leaded petrol. By 2010 lead would no longer be a significant emission from motor vehicles.

Ozone

Ozone is a powerful oxidant, formed in the atmosphere in the presence of sunlight, nitrogen oxides and reactive hydrocarbons. It is not a primary emission from motor vehicles, but a regional pollutant, being a major component of photochemical smog. Because of its highly reactive nature, ozone can combine with virtually all classes of biologically active molecules including enzymes, proteins and lipids. Cellular membranes are a target for ozone which has also been reported to have an irritant effect on the respiratory system.

The air quality goal has been revised downwards from 257 $\mu g/m^3$ (0.12 ppm) to 210 $\mu g/m^3$ (0.10 ppm) for a 1-hour maximum. In addition the EPA now notes a four hour ozone goal of 0.08 ppm or 170 $\mu g/m^3$.

Sulphur Dioxide

Sulphur dioxide is an acid gas which can have harmful effects on the respiratory system as well as on vegetation and building materials. It is however a minor component of motor vehicle emissions, due to the low sulphur content of Australian petrol, and has not been assessed quantitatively in this study. For example the Metropolitan Air Quality Study estimates that for the 1992 fleet, average SO_2 emissions under arterial travel conditions are 0.065 g/km compared to emissions of nitrogen oxides of 2.33 g/km for the same conditions. In addition transient emissions of above average levels of odorous sulphur compounds such as hydrogen sulphide and carbonyl sulphide (which may be smelled at concentrations as low as 5 ppb) have been noted from vehicles fitted with catalytic converters.

While these compounds may produce a local short term nuisance, they do not represent significant emissions under normal running conditions.

Acid Gases and Suspended Matter

The term 'acid gases' refers to gases in the atmosphere which can form acids in solution. These include sulphur dioxide which can be oxidised to form sulphuric acid, nitrogen oxide which can be oxidised to form nitric acid and hydrogen chloride which forms hydrochloric acid. Acids in the air can adhere to particulate matter and as well as acting individually, these pollutants can act synergistically and cause severe air pollution problems.

Suspended matter refers to the very fine fraction of total suspended particulate matter in the 0.1 to 2 μm diameter range. These small particles can deposit in the lungs and if they are acidic in nature they can be more damaging. The acid component of particulate matter is generally contained in this fine fraction.

Goals have been set by the WHO for the combined exposure to these pollutants. However, they are most relevant to an industrial environment where there are substantial sulphur dioxide emissions and fewer controls on particulate matter emissions, than the Warrell Creek area.

Until 1994, the EPA noted the WHO acid gas goal of 60 $\mu g/m^3$. This goal has now been abandoned, and as such, the impacts of acid gases and suspended matter have not been considered in relation to emissions from this project. The impacts of nitrogen dioxide and particulate matter are considered individually.

6.12.5 Air Quality Impact Assessment

Methodology

The Caline4 dispersion model has been used to estimate the concentration of oxides of nitrogen, carbon monoxide, hydrocarbons and particulate matter, that are likely to be produced in the vicinity of the highway. The approach in this report has been to identify worst case conditions which comprise 1-hour peak hour traffic flow, combined with the poorest dispersion conditions, equivalent to atmospheric inversions with very light winds. The traffic flow has been assumed to be constant (at peak levels) along sections of the route, and although this is clearly a simplification, it is a reasonable approximation to what could happen in practice.

The receptor positions were chosen as 0 m, 10 m, 30 m and 50 m. Traffic numbers in each direction were obtained from measurements carried out over a week in June/July 1997.

Emissions from vehicles were calculated using data presented in the Metropolitan Air Quality Study (MAQS, 1995). This data have been combined with traffic flow data, and used as input to the dispersion model to determine air quality impacts for peak traffic flow.

Emission Estimates

Emission estimates have been summarised in **Table 6.15** and are presented in detail in **Appendix E**.

Table 6.15 - Estimated Peak Hour Traffic Emissions (kg/km/hr)

Roadway Section		Carbon monoxide	Nitrogen oxides	Hydrocarbons	Particulate matter	Lead
2000	- Northbound	3.91	1.40	0.40	0.07	0.0010
	- Southbound	3.32	1.19	0.34	0.06	0.0008
2010	- Northbound	4.51	1.88	0.48	0.10	--
	- Southbound	3.84	1.60	0.41	0.09	--

Operational Impacts

Air quality impacts associated with the proposal were assessed by comparing the predicted ground-level concentrations of roadway emissions with air quality goals or other air quality criteria where specified goals are not available.

Table 6.16 presents the maximum predicted 1-hour average increase in ground-level concentrations of carbon monoxide, hydrocarbons, nitrogen oxides, nitrogen dioxide, particulate matter and lead, at distances of 0 m, 10 m, 30 m and 50 m from the proposed roadway edge. Predictions at 30 m and 50 m have been made to assess impacts at any nearby residences.

Table 6.16 - Predicted Increase in 1-hr Average Ground Level Concentrations

Year	Distance from Kerb (m)	Carbon monoxide (mg/m^3)	Nitrogen oxides ($\mu g/m^3$)	Nitrogen Dioxide * ($\mu g/m^3$)	Hydrocarbons (mg/m^3)	Particulate matter ($\mu g/m^3$)	Lead ($\mu g/m^3$)
2000	0	2.3	833	83	0.24	44	0.6
	10	1.3	476	71	0.14	25	0.3
	20	1.1	378	76	0.11	20	0.3
	30	0.9	324	65	0.09	17	0.2
	50	0.7	255	51	0.07	13	0.2
2010	0	2.6	924	92	0.27	48	
	10	1.5	521	78	0.15	27	
	20	1.2	415	83	0.12	22	
	30	1.0	353	71	0.10	19	
	50	0.8	279	56	0.08	15	

* *Assumed to be 10% by weight of total nitrogen oxides at the kerbside, 15% at 10 m and 20% at 20 m, 30m and 50 m from the roadway edge*

Carbon Monoxide

It can be seen from **Table 6.16** that the highest predicted 1-hour carbon monoxide concentration 10 m from the proposed road is 1.3 mg/m^3 in 2000, and 1.5 mg/m^3 in 2010. This is well below the EPA's 1-hour goal of 31 mg/m^3 and levels at 30 m and 50 m are even lower. Levels at kerbside are also below the 1-hour EPA goal.

The average "background" level of carbon monoxide, that is carbon monoxide which is due to all other sources apart from the road, is likely to be of the order of 2 to 5 mg/m^3. Monitoring data from a similar study near Billinudgel (Nigel Holmes and Associates, 1994) average background concentration could be around 17 mg/m^3 although not from roadway sources. Adding this to the maximum predicted increase of 1.3 mg/m^3 and 1.55 mg/m^3 at 10 m from the kerb, gives maximum concentrations of 18.3 mg/m^3 and 18.5 mg/m^3 in 2000 and 2010 respectively These values are still less than the goal of 31 mg/m^3.

Nitrogen Dioxide

As discussed previously, nitrogen oxides are initially emitted as a mixture of nitric oxide and other oxides of nitrogen, which are oxidised to nitrogen dioxide. Data from an extensive monitoring program undertaken by the RTA indicates that at 10 m from the roadway a conversion rate of 15% by weight is conservative. At distances of 30-60 m from the kerbside the 20% conversion rate appears to be appropriate. There are no monitoring data for the kerbside location in the present study for Warrell Creek, but it is considered that a 10% conversion rate is likely to still be conservative.

Taking this into consideration, the highest predicted 1-hour nitrogen dioxide concentration 10 m from the road in 2000 is 71 μg/m^3, and 787 μg/m^3 in 2010, both of which are below the 1-hour goal of 320 μg/m^3. Concentrations at 50 m from the roadway are expected to be as low as 51 μg/m^3 and 56 μg/m^3 in 2000 and 2010 respectively. These predictions do not take into account background concentrations which are likely to be in the range of 30-50 μg/m^3.

It should be noted that predictions do not take into account fully the benefits of three-way catalytic converters which are fitted to all new (fuel-injected) petrol-fuelled passenger vehicles in Australia and which substantially reduce NOx emissions. Nor (more significantly) do they take account of controls on diesel vehicles which are being implemented through new design rule ADR 70.

Particulate Matter

The highest predicted increase in PM_{10} at 10 m from the proposed roadway in 2000 is 25 μg/m^3. This is expected to increase to 27 μg/m^3 by 2010. These values are for 1 -hour averaging periods, and are well below the EPA 24-hour goal of 150 μg/m^3. Comparing the 1-hour prediction with the 24-hour goal is a conservative approach (an over-prediction) as the maximum predicted 1 hour average would always be higher than the predicted 24-hour average. There are no

data available on background PM_{10} levels but EPA monitoring data from Sydney indicate that average background levels are not likely to exceed 30 $\mu g/m^3$.

All predicted increases in PM_{10} more than 20 m away from the road are less than 50 $\mu g/m^3$ (the annual goal), even under the worst-case dispersion conditions combined with peak traffic flow. Concentrations over a year would be substantially less and concentrations at sites further removed from the road would again be reduced. Similarly the NHMRC 90 $\mu g/m^3$ (annual average) TSP goal is unlikely to be exceeded.

Hydrocarbons

Hydrocarbon concentrations are no longer specified in the EPA's air quality goals. A simple hydrocarbon concentration goal is now recognised as not being useful for the purposes of assessing health impacts or identifying the need for air quality management requirements. One of the hydrocarbon components contained in petrol which is of concern to the community is benzene, a known carcinogen.

From **Table 6.16** the predicted maximum 1-hour increase in total hydrocarbons is of the order of 0.14 mg/m^3 in 2000 and 0.15 mg/m^3 in 2010 at 10 m from the roadway. Assuming a 5% benzene composition in the exhaust the benzene concentration at 10 m from the roadway edge would be approximately 0.007 mg/m^3 or 7 $\mu g/m^3$ (1-hour average), under unfavourable dispersion and with peak traffic flows in 2000, and 0.008 mg/m^3 or 8 $\mu g/m^3$ in 2010. Both these values are below the proposed UK goal of 16 mg/m^3 (the UK goal however is an annual average). Concentrations of total hydrocarbons are of course substantially lower at the locations of residences 30 m from the road, 0.10 mg/m^3 (5 mg/m^3 benzene) being the maximum predicted in both 2000 and 2010.

Levels of benzene can range from 3 mg/m^3 in a rural environment to up to 160 mg/m^3 in an urban environment (higher close to service stations and storage tanks) with typical levels of about 20 mg/m^3 in residential areas. It is recognised that there may be no safe limit for benzene, but the risks to a particular individual over a lifetime is small, and on a population and individual basis could be offset by lower risks through safer roads, although to an undetermined extent.

Construction Impacts

Dust would be generated from earthworks associated with the construction of the Proposal. The total amount of dust generated would depend on the silt and moisture content of the soil and the types of operations being carried out.

Estimates of dust emissions from construction operations can be made using emission factors developed by the State Pollution Control Centre which relate the amount of dust generated by different types of equipment and operations associated with construction work. The major sources of dust associated with the project would be dozers, excavators, scrapers and wind erosion during construction. An estimate of the amount of dust generated by each operation per day is summarised below:

- Dust from loading of material by excavator to trucks would generate 11.25 kg/day.
- Dust from trucks travelling on the unsealed road surface (taking account of dust suppression by watering of the trafficked areas) would generate 40 kg during a ten-hour working shift.
- Dust from wind erosion from an exposed area could generate 2.4 kg in a ten-hour working shift.

Thus the total dust generated in a ten-hour working day could be as high as approximately 50-60 kg. On a hot, dry, windy day (worst case emission conditions with respect to dust) the amount of dust from wind erosion could be much higher, and should be controlled using water sprays. It is possible that under some extreme wind conditions, construction activities would be stopped.

Previous dispersion modelling studies indicate that high levels of dust generation associated with road construction work, can result in short-term dust impacts. That is exceedances of the EPA 24-hour air quality goal for TSP, out to 600 m or more under "worst-case" dispersion conditions and out to 300 m for typical conditions.

As construction is likely to continue for at least one year, it is important that exposed areas be stabilised as quickly as possible and that appropriate dust suppression methods be used to keep dust impacts to a minimum.

Greenhouse Issues

An important factor in determining the amount of radiant energy absorbed in the atmosphere, and hence global surface temperatures, is the concentration of carbon dioxide within the atmosphere. Increases in carbon dioxide concentration are expected to cause increases in the temperature of the earth's atmosphere.

Approximately 21% of NSW's total carbon dioxide emissions are estimated to come from the transport sector. The RTA is committed to ensuring that its environmental goals and policies are consistent with those outlined in the 1992 Intergovernmental Agreement on the Environment. It contributed to the development of the National Greenhouse Response Strategy (1992) which included the following initiatives:

- reducing fuel consumption in motorised transport;
- improving the technical and economic efficiency of operation of the road network and traffic management; and
- and to encourage the use of bicycles.

This proposal contributes to the initiatives listed above.

The RTA has also prepared a Greenhouse Reduction Plan at a strategic level which addresses and provides policy in relation to greenhouse gas emissions resulting

from its activities. A greenhouse emissions inventory of RTA activities has been carried out and the findings incorporated into the RTA Greenhouse Inventory.

Emissions of carbon dioxide from motor vehicles are directly proportional to fuel consumption. They cannot be reduced by emission control technologies except where they result in an improvement in fuel consumption. RTA programs which encourage better vehicle maintenance and hence better fuel economy would be beneficial.

The RTA also continues to engage in other strategies to encourage the tightening of vehicle emissions standards. These include;

- working with the EPA to implement the State's Motor Vehicle Maintenance Program for lowering emissions, and on the introduction of vehicle emissions testing;
- enhancing the State's vehicle emissions enforcement resources; and,
- continuing its role on ACVEN (Advisory Committee on Vehicle Emissions and Noise) to encourage the early implementation of more stringent Australian Design Rules, including the revision of ADR-37/0X to tighten current light vehicle emission standards. A revision of ADR-70, is also in progress. This would also contribute to controlling emissions from diesel vehicles, which would be particularly important for NO_x and particulate matter emissions .

In terms of greenhouse emissions associated with the Proposal, operation of the Proposal is likely to result in better traffic flow and hence better fuel economy and a reduction in overall travelling times, and therefore reduced greenhouse emissions.

6.12.6 Conclusions and Recommendations

A summary of the air quality impact assessment for the Proposal is presented below:

- The present emission controls on motor vehicles and the projected traffic conditions for 2000 and 2010 are not expected to cause the EPA's carbon monoxide 1-hour or 8-hour goals to be exceeded during the operation of the bypass;
- The PM_{10} annual and 24-hour maximum air quality goals, are not likely to be exceeded at any nearby residences;
- The predicted increases in concentration of nitrogen dioxide indicate that the EPA's goals would not be exceeded at any distance from the roadway;
- Predicted concentrations of benzene (and other pollutants) are not at levels which should pose health effects. However it is recognised that there may be no safe level for exposure to benzene.

The introduction of catalytic converters has resulted in a substantial reduction in carbon monoxide and hydrocarbon emissions from motor vehicles. This is also true for nitrogen oxides, as all new fuel-injected passenger vehicles are fitted with

three-way catalytic converters which reduce nitrogen oxide emissions. However the increased speed on upgraded roads results in increased nitrogen oxide emissions and this has offset to some extent the gains from the improved technology. Nevertheless the proposed roadway is predicted to result in nitrogen dioxide levels which are substantially below the air quality goal.

6.13 Social Impact Considerations

*A separate study (**Working Paper No 3 - Social Impact Assessment**) was undertaken for this project. A summary of this Paper is provided below.*

6.13.1 Existing Environment

The study area is a diverse social environment, comprising a mixture of rural residential home and farms. The Warrell Creek village has been subject to significant change over time, from an independent village earlier this century to the current residential community which is reliant on road travel to other centres such Macksville, Kempsey and Coffs Harbour for all services, facilities education needs.

The most useful demographic data for the study area are the 1991 census statistics for the Donnellyville/ Warrell Creek Collector District. These show that there was a higher proportion of young children and lower proportion of elderly residents when compared to both the North Coast and NSW. Anecdotal evidence, such as observations on the number of school-aged children using the local bus service, supports this.

Employment is currently generated in the study area through two sawmills, a fruit stall and agricultural activities. Agricultural activities include grazing and limited cultivation. Unemployment rates were low (3%) in 1991.

6.13.2 Impact Assessment

Many of the impacts considered in the REF may be considered "social" impacts, but are assessed on their independent, technical merits. These include the economic effects, the noise effects, the likely impact on accessibility and the visual impacts both during the construction and operational phases of the project which have been addressed in separate sections of the REF. The social impact is assessment of cumulative impacts on people, their amenity, health and the way they use their community.

The Proposal would require the resumption of approximately 1.34 ha of land from 18 properties and directly affect four houses (see Section 6.1.3). Of the dwellings that would be acquired, two currently provide rental accommodation and one is unoccupied. There may also be some impacts on property access, on properties where land would not be resumed. The RTA would negotiate with individual property owners regarding access requirements. Local traffic movements and access would also be temporarily adversely affected (see Section 5.8.3).

The Proposal would provide a safer environment for the pick-up and drop-off of students (see Section 6.3). Safety would also be improved for pedestrians within the Warrell Creek village. However, cross-highway pedestrian movements would become more difficult as a result of the dual carriageway and fencing.

The acoustic (noise) environment for the majority of residences located along the proposed alignment would improve, even allowing for a project growth in traffic of 3.5% per year (see Section 6.10). However, there a small number of residences that would receive an increase in noise and there may be some potential for annoyance during construction, particularly during the earthworks phase.

There would also be an adverse visual impact along the route as a result of the proposal (see Section 6.6). To minimise this, a landscaping plan has been designed to reduce the visual impact on the Warrell Creek village and surrounds.

There are not expected to be any adverse impacts contributing to the change in amenity of the air quality in the region, and therefore the health of the Warrell Creek community (see Section 6.12).

Overall, the Proposal has general community acceptance. Notwithstanding this, there are some individuals who do not agree with the refined alignment. As with any proposal of this nature, some residents would benefits and others would be adversely affected. Safeguards have been suggested below to minimise the impact on those adversely affected. For the wider community, the proposal would provide positive social impacts, including safer driving conditions and a reduction in accident rates (see Section 6.2.2).

6.13.3 Safeguards

Various safeguards and mitigation measures have been developed to reduce the potential environmental impacts from the construction and operation of the Proposal. Of these measures, those safeguards that would reduce potential social effects include the following:

- The RTA's standard acquisition and compensation arrangements would apply to properties directly affected by the Proposal in accordance with the Just Terms Compensation Act, 1991.

- The RTA would negotiate with individual landowners regarding access across the proposal required to ensure the continued viability of properties which are severed by the Proposal.

- The RTA would implement noise control measures such as roadside barriers, noise mounding or individual acoustic treatment to reduce potential adverse noise impacts to local residents.

- The RTA would implement landscape treatment to screen the Proposal from view and therefore improve the visual amenity of the area surrounding the proposal.

- The RTA would endeavour to keep the community informed about the project. If it is decided to construct the proposal, the RTA would notify property owners of the likely timeframe for construction activities and commence negotiations early within the project schedule including property acquisitions.

- The RTA would provide a continuous contact telephone number (and contact person, where feasible) during the life of the project. This would enable any member of the community to have his/her concerns about the project addressed, reduce any anxiety or uncertainty about the project, and reduce the likelihood of the spread of misinformation.

Discussions between the RTA and Council during the detailed design phase would include the review of schemes which would maintain or improve the character of the village and surrounds.

6.14 Aboriginal and Non-Aboriginal Heritage

The Aboriginal and Non-Aboriginal Heritage assessment has been undertaken by heritage specialist, Robynne Mills. The assessment was designed to identify potential impacts of the proposed development on Aboriginal relics ('relics' as defined by the New South Wales National Parks and Wildlife Act 1974) and non-indigenous heritage items as defined by the NSW Heritage Act and the Environmental Planning and Assessment Acts of 1975 and 1979 respectively. A copy of the report is included in ***Appendix F.***

6.14.1 Aboriginal Heritage

Archaeological evidence shows that Aboriginal people have been present in the north coast region for at least 22,000 years (Neal and Stock 1986). However most sites postdate the Pleistocene sea level stabilisation which occurred about 6000 years ago. Evidence suggests that an increase in population occurred in the region after 4000 years ago. This increase is represented in the archaeological record by a dramatic increase in the numbers of sites, the intensity of use of sites and more extensive resource exploitation characterised by use of new habitats, resource types, extractive technologies and management strategies (Collins 1993). By approximately 2500 years ago the north coast region was populated by numerous language groups, linked through extensive systems of marital exchange and ceremonial obligation.

The study area is located within an area administered by the Unkya Local Aboriginal Land Council (LALC). The LALC was consulted during the preliminary assessment of route options for the proposed bypass. The Aboriginal Community did not identify any issues of concern.

A search of the National Parks and Wildlife Service (NPWS) register of known sites showed that there are 12 sites recorded within a 6 km radius of the proposed development. No sites were within the proposed development area.

Based on an assessment of site types and distribution patterns in the immediate area and the identification of landscape units present within the development area, it was predicted that the most archaeologically sensitive micro-landform units in the study area would be associated with raised spurs and low ridge lines adjacent to permanent water sources. The low lying flood plain area was considered as having low archaeological sensitivity.

6.14.2 Non-Aboriginal Heritage

Permanent white settlement of the Nambucca Valley substantially commenced around 1865 when changes to land title first allowed leasehold and freehold tenure. Prior to this period, most occupancy was on conditional purchases, many of which did not lead to permanent ownership. This transience was associated with the uncertain economic returns from timber and the unsustainable early pastoral ventures which brought the first settlers to the area.

In 1841 the first cedar getters moved into the area after cedar along the Macleay River was worked out. These early ventures did not last long as the cost of transporting timber from the Warrell Creek area to Grassy Head ended operations, leaving good stands of cedar remaining.

The mid 1850's saw a resurgence in cedar getting, largely in response to higher market prices resulting from increased development following the gold rush boom of the 1850's. This provided the impetus for the start of permanent settlement in the Nambucca area. Initially cedar getting involved using bullock teams to haul logs to the cedar dealers hut at Warrell Creek from where they were punted to Scott's Head, then taken by dray to Grassy Head for shipping to Sydney and Newcastle. It was not until 1871 that the first mill appeared on the Nambucca. By 1900, there are records of a mill at Warrell Creek which was run by the Eichmann family. Dunne (1990) notes that the mill was producing hardwood girders 20'x8'x6' for boat building and bridge construction. Eichmann's mill provided timber for the Eungai Progress hall in 1907 and was still operating in 1922 when it supplied timber for the Eungai Soldiers' Memorial Hall.

From all accounts, cedar getting was a difficult occupation. Most cedar cutters were ticket of leave convicts who lived for long periods in the forest, protected only by rough huts made of bark. Surprisingly, they were mostly married or with female companions. It was common for them to spend up to 2 months at a time in the bush, only coming to town for their pay and provisions.

It is thought that the name "Warrell Creek" dates from around 1842 and that it may be a corruption of the aboriginal word "warral." This coincided with the period when the area was first subject to pastoral selection. These pastoral runs proved to be difficult to maintain and many were abandoned within a few years of their

commencement. Early records indicate that the runs supported few stock, perhaps an indication that the major interest was cedar felling, and that there was a shortage of fresh water, most of the creeks being brackish. A William Scott leased the "Werral Creek Run" in the early 1840's. It was noted in the Government Gazette of the day as having 5000 acres, but only 4 horses and 10 cattle. Robert Massie, a Crown Lands Commissioner, writing in the Macleay Letter-Books 1842-46 (NSW Archives) refers to the "bad nature of the country" as a serious problem. As a result of these conditions, most of the runs which were established in the early 1840's had been abandoned by 1850.

The Warrell Creek area was subject to increased selection during the period 1870-1884. (Maps 1 and 2 (Townsend 1993 p 62 & 65)). It was always destined to be a small settlement, given the dominance of Macksville and Nambucca, together with the added constraint that the site of the village was marshy, low lying and flood prone. An elementary school was opened in 1889, but appeared to experience difficulties as there was a subsequent petition for its reopening in 1899. This was most likely as result of low attendance resulting from children being involved in seasonal farming activities.

It appears that the conditions facing school teachers at this time were also rather difficult. At Warrell Creek Lower, where a school was built in 1910, the first teacher, Grace Nolan described her working conditions. "The roofs and rafters are filthy with soot and cobwebs and the flooring boards are rough sticks .....under it is used as a shelter by a large number of ducks and fowls as well as two dogs.....the ground for some distance being covered to a depth of several inches with decomposed manure. There is no WC, only a kerosene tin." (Townsend 1993 p. 104)

Around the turn of the century, there was a rapid growth in dairying. This was associated with the clearing of the tropical rainforest and the successful introduction of paspalum which provided nutrients which were lacking in the local native grasses. The extension of the northern rail line from Hexham in 1906 caused a demand for hardwood sleepers which led to a resurgence in timber felling in the area. This was welcome as cedar supplies were all but exhausted by 1900. In 1913, the Macleay Chronicle recorded that there were 60 bullock teams working in the local forests, 30 in the Warrell Creek area. The First World War further increased demand for local hardwood timber.

The railway line finally reached Kempsey in 1917. The station at Warrell Creek, noted as being 544.46km from Sydney, was opened in 1919. It featured a platform on the up (toward Sydney) side and a goods siding on the down side. Its construction involved a timber frame with fibro-cement sheet cladding. The station was never manned and with rationalisation of country rail services, it was closed on 30th June 1974.

6.14.3 Field Survey

The field component of the study was conducted by Robynne Mills and Jim Kelton, archaeological consultants on 8 July, 1997. The Unkya Local Aboriginal Land Council was represented during the survey by Reginald Donovan and Neville Buchanan (Elder). The survey for indigenous and non-indigenous sites was carried out concurrently.

A 'total coverage' survey strategy was adopted for the entire route. This involved four on-foot transects approximately 15m wide along the entire route. Surface visibility varied. The high level of previous disturbance to the area increased surface visibility, but visibility on the hill slopes was low which allowed only a limited level of archaeological assessment of this unit.

6.14.4 Impact Assessment

No Aboriginal sites or significant places were identified by the survey. However, one area of potential archaeological deposit (PAD) was identified in the survey area. This PAD area is located on a small raised spur on the southern side of the present railway line to the west of Rosewood Road. This spur area has been previously impacted by a Telstra cable, the installation of a sewer line and the construction of a railway cutting. However, there is still a section of the spur which appears to be relatively undisturbed. The proposed alignment would not impact the PAD.

The archaeological significance of this area has been assessed as low to moderate. Although the integrity of the area has been compromised to some degree by previous disturbance, the consultant concludes that there remains, within the impact zone, an area of the spur which appears relatively undisturbed. The potential educational and scientific value of the PAD is unknown at this point in time.

No items of non-indigenous heritage were identified during the survey.

6.14.5 Safeguards

Because of the high degree of disturbance which has occurred in this area, no sub-surface investigation is recommended. However, it is recommended that the areas be monitored for the presence of Aboriginal cultural heritage items during the removal of top soil and sub-soil to a depth of approximately 1m.

Additional safeguards and recommendations outlined in **Appendix F** would be considered as part of an Environmental Management Plan (EMP), should the project proceed.

7. Consideration of Clause 82 Factors

Clause 82 of the Environmental Planning and Assessment Regulation1994 details those factors which must be taken into account when consideration is being given to the likely impact of an activity on the environment.

Table 7.1 is a summary of the environmental assessment related to the factors to be considered under Clause 82:

Table 7.1 - Summary of Clause 82 Factors

Clause 82 Factor	Consideration/Comment
a) any environmental impact on a community	Discussed in Working Paper No. 3 - Social Impact Assessment and Section 6. The proposal would create an overall noise reduction and greater safety for people within the Warrell Creek village, and safer access provisions for the Cockburn Mill and other rural properties. However, there would be a loss of four dwellings and it would become more difficult for local pedestrians to cross the Highway.
b) a transformation of a locality	Discussed in Working Paper No. 3 and Section 6. The Warrell Creek village would be transformed as a result of the realignment of the Highway from the front to the rear of the properties. The properties along Sonnys Road and Albert Drive would be further fragmented from the Warrell Creek community.
c) any environmental impact on the ecosystems of the locality	Discussed in Section 6. The proposal would involve some clearing of some roadside vegetation. Mitigation would include minimising clearing, replanting with native species, and weed control.
d) any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality	Discussed in Section 6.7. There would be a medium to high impact on the aesthetic environment of Warrell Creek and surrounds. However, appropriate landscaping measures would be provided, including the retention of views and provision of screenings. The visual outlook may be reduced considerably if noise barriers are constructed.
e) any effect upon a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations	Discussed in Section 6.5. There would be no impact on any of these environs.
f) any impact on the habitat of protected or endangered fauna (within the meaning of the National Parks and Wildlife Act 1974)	Discussed in Section 6.5 There would be no impact on threatened fauna.
g) any endangering of any species of animal, plant or other form of life whether living on land, in water or in the air	Discussed in Section 6.5. There would be no endangering of any species of animal, plant or other form of life whether living on land, in water or in the air.
h) any long-term effects on the environment	Discussed in Section 6. Long-term effects on the community would include a reduction in noise levels for residents in the Warrell Creek village, but an increase in noise for some residents on the eastern side of the existing Pacific Highway. The proposal would provide increase safety for drivers using the Highway, but make cross-Highway movements more difficult for pedestrians. The visual outlook may be reduced considerably if noise barriers are constructed.
i) any degradation of the quality of the environment	Discussed in Section 6. There would be some loss of roadside vegetation.. However, locally sourced

Clause 82 Factor	Consideration/Comment
	native species would be widely used in landscaping and site rehabilitation
j) risk to the safety of the environment	Discussed in Sections 2 and 6. The safety of road users would enhanced by the proposal. The risk to the safety of the environment would be reduced by the provision of: □ permanent spill retention ponds adjacent to major watercourses; and □ temporary erosion and sediment control structures during construction.
k) any reduction in the range of beneficial uses of the environment	Discussed in Section 6 and Working Paper No. 3. The proposal would result in the loss of a small portion of quality agricultural land, although there may be some opportunity for some excess parcels of land to be sold back to rural landowners.
l) any pollution of the environment	Discussed in Section 6. Pollution of the environment would be restricted to short term construction noise impacts. Acoustic mitigation measures would be applied to reduce noise impacts from machinery and equipment during construction. Sediment and erosion controls and permanent spill control ponds would minimise the potential for pollution of Warrell Creek or its catchment.
m) any environmental problems associated with the disposal of waste	Discussed in Section 5.9. There would not be any environmental problems associated with the disposal of waste. The environmental management plan (EMP) would address the question of waste disposal and the contractor would be required to comply with EPA guidelines.
n) any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply	Discussed in Section 5.5. The proposal is likely to increase the demands on materials reqired for road-base and fill.
(o) any cumulative environmental effect with other existing or likely future activities	Discussed in Chapter 2. The proposal would form part of the Pacific Highway Reconstruction Program. Cumulative effects would include positive outcomes such as improved safety, reduced travel costs and increased fuel efficiency.

8. Declaration

This Review of Environmental Factors provides a true and fair review of the proposal in relation to its potential effects on the environment. It addresses to the fullest possible extent all matters affecting or likely to affect the environment as a result of the proposal.

Fiona Richmond
Project Manager
Sinclair Knight Merz

Date:

Jim Campbell
Project Manager
NSW Roads and Traffic Authority

Date:

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Appendix A - Community Consultation

IMPROVING THE PACIFIC HIGHWAY AT WARRELL CREEK

No.1 September 1996 (Ver 3)

COMMUNITY INFORMATION SHEET

This is the first of a series of information sheets to keep the community fully informed as to the status and progress of the proposed improvements for the Pacific Highway at Warrell Creek. Your comments and input into the project are important in helping the RTA to arrive at the best solution for this work.

The RTA invites and welcomes comments and feedback about the project. There are details overleaf to assist you to receive regular information.

BACKGROUND

The RTA is proposing to upgrade the Pacific Highway between Rosewood and Allgomera deviation at Upper Warrell Creek. Presently the Pacific Highway through Upper Warrell Creek is a two lane rural highway with a speed limit of 90 km/hr.

To the south of Upper Warrell Creek at the Allgomera deviation the highway has been upgraded and north of the township, a new highway rail bridge has been constructed. It is intended to build a road consistent with these adjoining sections.

DEVELOPING THE BEST OPTION

No preferred route for the new work has been selected, although due to the constraints imposed by the Warrell Creek flood plain, no route options will be investigated west of the existing highway.

A number of potential routes either using sections of the existing highway or through new areas to the east of the railway line are possible in engineering terms and will be carefully assessed for their environmental and social impacts.

Particular attention will be paid to any impacts on the existing settled areas, including economics, noise and vibration, existing and future road access and water quality in Warrell Creek.

This initial study into the various route options will provide a basis for this decision and will involve extensive community consultation.

FURTHER INVESTIGATION

Once the preferred route has been identified, there will be a need to undertake detailed environmental studies which will be presented in the form of a Review of Environmental Factors (REF) report.

The RTA has commissioned environmental and engineering consultants, Sinclair Knight Merz, to provide the environmental overview for route selection and the environmental assessment of the preferred route.

The current program for the project is as follows:

- *September - November 1996*
  Initial environmental and technical studies to assist in route selection.
- *November 1996*
  Route selection.
- *November - January 1997*
  Concept design and detailed investigation of the preferred route, and preparation of documentation.
- *February 1997*
  REF completion and exhibition.

How to get more information?

Community information will be distributed describing the route selection process in more detail. Further community information sheets will outline issues being considered and assist the RTA in receiving community feedback.

If you would like to receive future copies of the Information Sheet please fill out the coupon and either mail or fax it to:

Neil Urwin
Sinclair Knight Merz
PO Box 164, St Leonards NSW 2065
fax (02) 9928 2502

If you would like further information about the project, or would like to discuss particular issues, please contact the RTA's Project Manager:

Peter Borrelli
PO Box 576, Grafton, NSW 2460
Tel: (066) 401300; Fax: (066) 402 304

IMPROVING THE PACIFIC HIGHWAY AT WARRELL CREEK

I/We would like to receive future Information Sheets.

Name:.....
Address:.....
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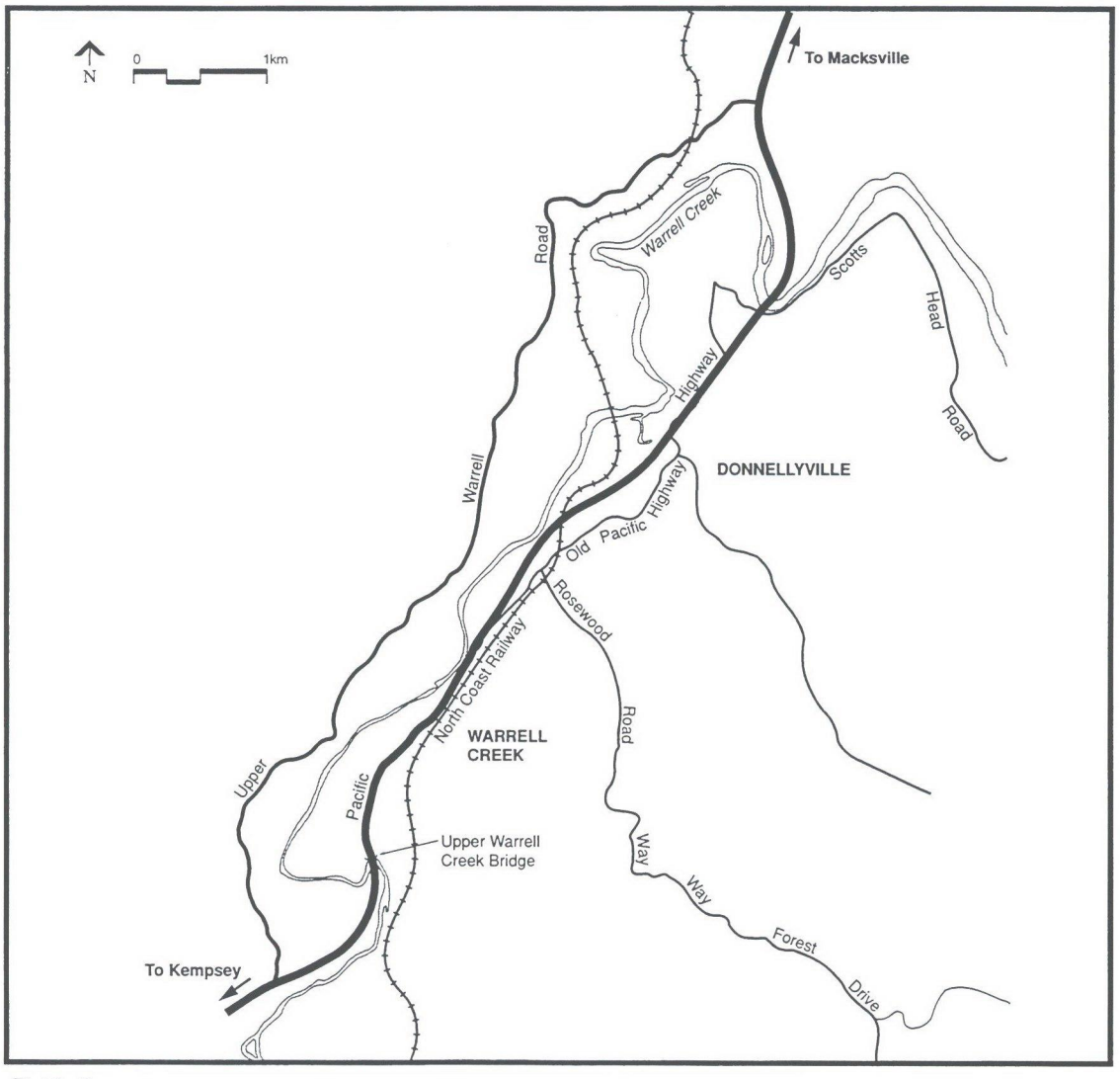
Telephone:.....



RTA

SINCLAIR KNIGHT MERZ

IMPROVING THE PACIFIC HIGHWAY AT WARRELL CREEK

June 1997

COMMUNITY INFORMATION SHEET No 2

Welcome to the second issue of the Community Information Sheet for the proposed improvements to the Pacific Highway at Warrell Creek. This issue reviews the project activities to date and, in particular, describes the route selection process which has just been completed.

Background

An upgrade of the Pacific highway is proposed between Rosewood and Allgomera deviation at Upper Warrell Creek. As a result, the standard of the Pacific Highway along this section would be consistent with adjoining sections of the highway to the north and south.

In September 1996 Information Sheet No.1 was distributed to the community. It introduced the project and included a timetable for the major steps involved in route selection, detailed investigation and environmental impact assessment.

The purpose of Information Sheet No. 2 is to update the community on progress to date and to describe the recently completed process which lead to the selection of a preferred route.

Project Activities to Date

An environmental overview has been completed of the area between the Upper Warrell Creek highway bridge and the Scotts Head turnoff and the foothills east and west of the current Pacific Highway. The environmental overview described the area in terms of its soils, geology, climate, wildlife, vegetation, land use, hydrology, water quality, air quality, existing noise sources, heritage and traffic activity. A social profile of the area was included and took into consideration current concerns of local residents about the proposal.

An initial overview of community concerns was gained from submissions by community representatives at a "Community Focus Group". Further issues were gathered through direct contact with local residents at a community workshop attended by 50 people on 28 October 1996 in Warrell Creek. This was followed up with a questionnaire which was distributed to residents and landowners in the study area.

At the community workshop, 11 different route options, which satisfied the traffic needs and safety and engineering requirements for the upgrade were exhibited. After comments were received from the public, the 11 identified options were extensively assessed in a "Value Management Workshop".

The Value Management Workshop

A Value Management Workshop for the Pacific Highway Upgrade at Warrell Creek was held on 12 and 13 November 1996. Workshop participants included:

- community and local industry representatives;
- local government; and
- state government agencies.

A Value Management Workshop is a special assessment exercise for large public infrastructure project proposals, such as major highways, to ensure that the wider community will receive value for money. During the workshop the project is looked at from a number of viewpoints including social impacts, the natural environment, impacts on property and construction and maintenance costs.

Four route options were identified as being superior to the others, but further technical investigation and refinement of costs was needed before a final decision on the route could be determined.

The Selected Route

The general alignment of the selected route is shown on the map overleaf. It links the dual carriageway south of Warrell Creek to the Rosewood deviation near Donnellyville. Initial upgrading of the existing two lane road will take place between the Upper

Warrell Creek bridge and the existing bridge over the railway immediately north of the Warrell Creek village. The route then follows the existing highway north of the railway crossing. A section of the Main Northern Railway Line will need to be realigned and reconstructed as part of the project. The features of the preferred route are as follows:

- approximately 4.5 km in length;
- located to the east of the existing highway and to the east of the existing Warrell Creek Village area;
- utilises part of the existing highway alignment, i.e. north of the highway's crossing with the Main Northern Railway Line;
- requires a 2 km section of the Main Northern Railway Line to be realigned to the east by approximately 60 metres;
- will separate through traffic from local traffic to eliminate existing traffic conflict problems; and
- will provide a high standard road, with 100 kph speed limit through the area which will increase traffic efficiency and improve traffic safety.

As a result of the construction and operation of the project, environmental impacts may be experienced. These have been identified by the study team as:

- noise impacts;
- flora and fauna impacts;
- impacts to indigenous and non-indigenous heritage items;
- air quality effects;
- changes to the visual environment and the landscape amenity of the area;
- potential water quality and hydrology impacts; and
- traffic impacts, mainly during the construction period.

Detailed studies assessing the potential environmental impacts of the proposal will now be undertaken. The results from these studies will be documented within the Review of Environmental Factors (REF) report. Where potential adverse impacts are identified, measures will be developed and implemented as part of the project to reduce these impacts. Measures might include earth mounding or roadside barriers for noise control, stormwater detention facilities and landscaping treatments.

What Happens Next

Detailed engineering design for the selected route will now begin, as well as the preparation of a Review of Environmental Factors (REF). The project team can then take into account any measures needed to avoid or reduce the effects of environmental impacts and incorporate them directly into the road design. These measures may include minor adjustments to the alignment to avoid important features, and any environmental mitigation measures identified.

The following timing of activities is planned:

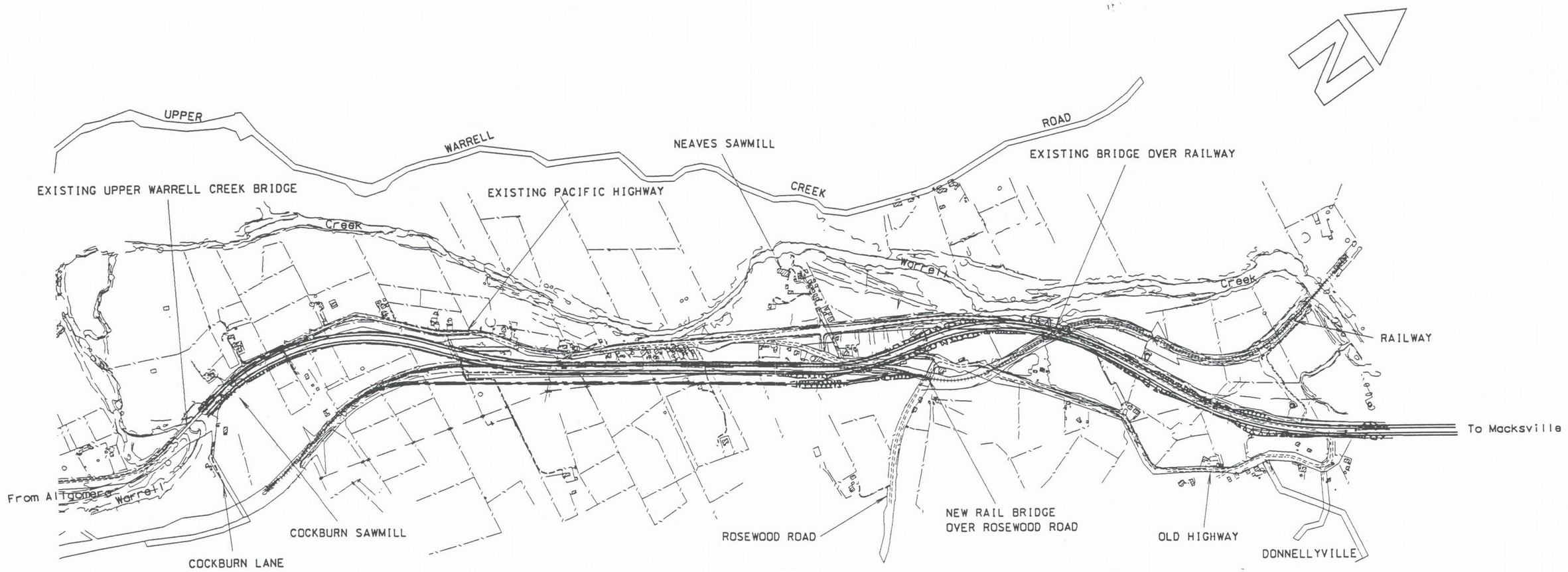
- Ground Survey - *May and June*
- Concept Design - *July, August, September and October*
- Detail Design - *November, December and January*
- REF - *July and August*
- Next Information Sheet - *September*
- Community Reference Group meeting - *August*

As these processes take place, properties affected by the proposal will be identified, and the RTA will contact the owners of properties where land acquisitions are involved. The RTA will endeavour to purchase the land by negotiation in much the same way as a private property transaction. The offer of compensation will be assessed in accordance with the Land Acquisition (Just Terms Compensation) Act 1991.

How do I get more information?

If you would like further information about the project, or would like to discuss particular issues, please contact the RTA's Project Manager:

Peter Borrelli
Roads and Traffic Authority
PO Box 576, Grafton, NSW 2460
Tel: (066) 401 300;
Fax: (066) 401 304
Email:peter_borrelli@rta.nsw.gov.au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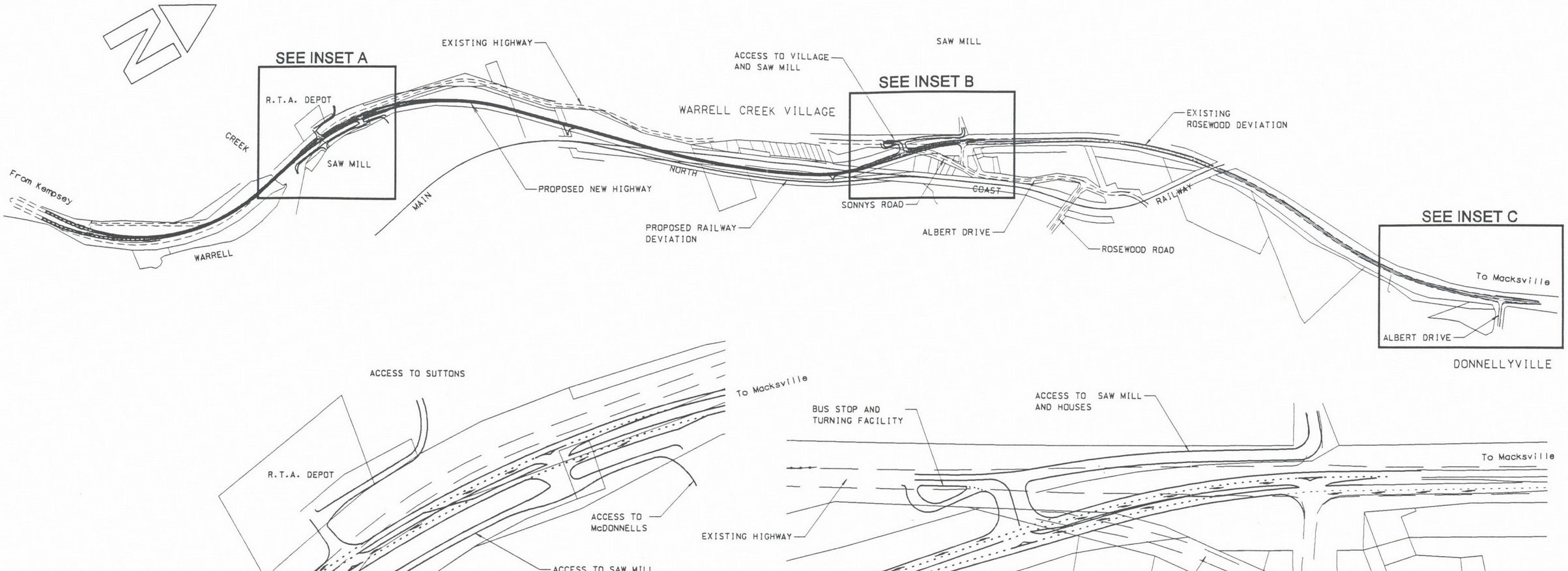
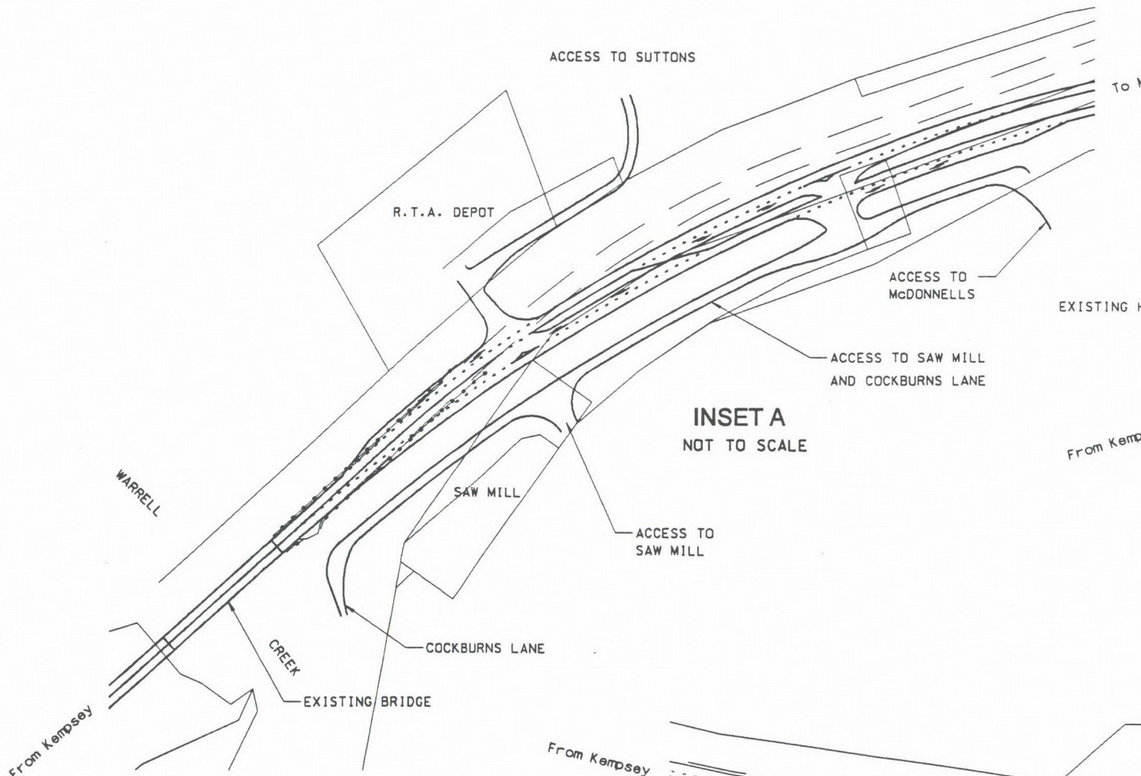
EXISTING PACIFIC HIGHWAY
Creek
Warrell
Creek
RAILWAY
To Macksville
From Altgomera
Warrell
COCKBURN SAWMILL
COCKBURN LANE
ROSEWOOD ROAD
NEW RAIL BRIDGE
OVER ROSEWOOD ROAD
OLD HIGHWAY
DONNELLYVILLE





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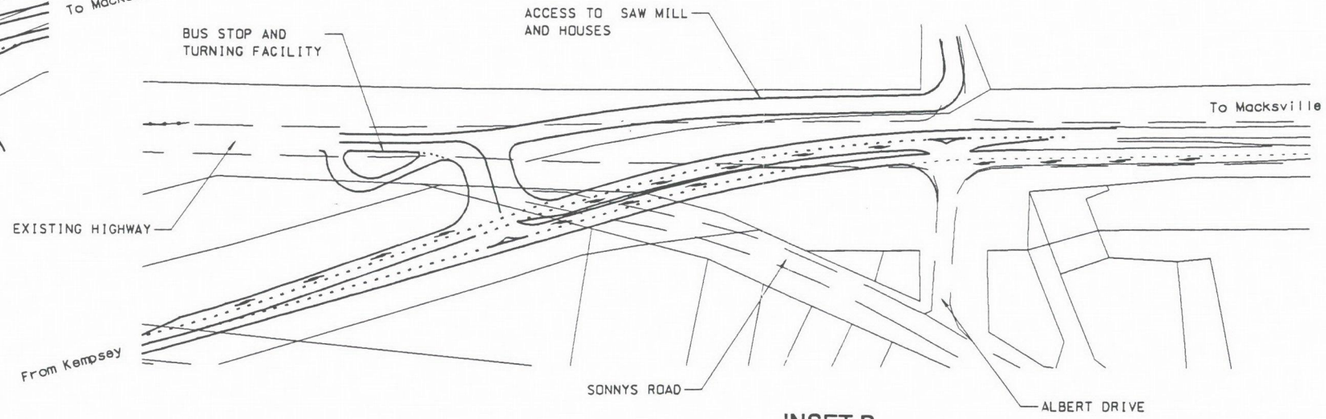

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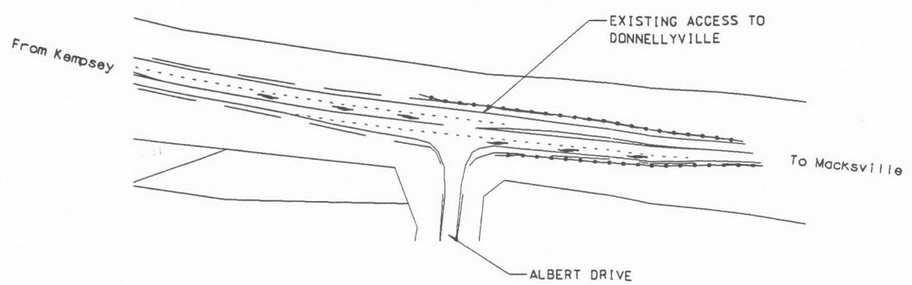

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RTA

S.H. 10 - SHIRE OF NAMBUCCA
PROPOSED DESIGN FOR WARRELL CREEK DEVIATION
STAGE 1 - SINGLE CARRIAGEWAY
42.2 KM TO 47.2 KM NORTH OF KEMPSEY

UPGRADING THE PACIFIC HIGHWAY AT WARRELL CREEK

COMMUNITY INFORMATION SHEET No 3

December 1997

This Community Information Sheet provides an update on minor changes that have been made to the preferred route for the Pacific Highway at Warrell Creek. These changes were recently announced by the Minister for Roads, Carl Scully, after completion of preliminary studies and consultation with affected community members. This information sheet also describes the preferred route, outlines why it was chosen and asks for further community feedback. Details about a second community meeting are also included.

Background

The Roads and Traffic Authority (RTA) proposes to upgrade the Pacific Highway between Upper Warrell Creek and Donnellyville, 43 to 47 kilometres north of Kempsey. Construction of this new single carriageway will remove sections of poor alignment on the highway and improve travel and safety conditions for local traffic and through traffic.

In September 1996 Information Sheet No. 1 was distributed to the community. It introduced the project and included a timetable for the major steps involved in route selection, detailed investigation and environmental impact assessment.

Information Sheet No. 2, distributed in June 1997, identified the process which led to the selection of a preferred route, and described that route.

The preferred route outlined in Information Sheet No. 2, has been refined as a result of further discussion with members of the Warrell Creek community and Nambucca Shire Council officers and in light of the results of preliminary investigations into potential environmental impacts of the preferred route.

The purpose of this information sheet is to provide the community with details of the proposed changes to the preferred route.

The Refined Route

The refined route will link the new alignment with the existing highway closer to the northern side of the Warrell Creek village. In addition, the project is extended to the south to improve the curve between the Allgomera dual carriageway and Upper Warrell Creek bridge. The general alignment of the refined route is shown on the map overleaf.

This new alignment of the Pacific Highway will retain more of the existing Pacific Highway from the intersection with Albert Drive (south), and all of the Rosewood deviation. There would be no impact on Rosewood Road or the adjacent wetlands.

The refined route will provide the following benefits:

- ⇨ use of land which is currently unused, vacant and for sale;
- ⇨ reduce the impact on flora and fauna and two wetland areas;
- ⇨ provide better value for money;
- ⇨ reduce the length of the Railway affected, and reduce the amount of fill material required, which will result in a reduction in project costs.

The refined route will impact on a number of properties. The RTA will be contacting those affected owners and residents in the immediate future.

Staging of the Project

To improve the current alignment and village amenity, construction of a single carriageway will commence in 1999, with completion expected in 2000. A second two lane carriageway will be constructed at a later date, to provide two lanes of traffic for both north and southbound traffic.

Sufficient land to accommodate the construction of a second carriageway in the future will be acquired in the first stage, to minimise further disturbance to the community at a later time. Construction of a second carriageway is not likely for several years.

Access Arrangements

There would be a number of changes to property access arrangements. Overall, the number of access points to the Highway will be reduced for safety reasons. The major changes are outlined as follows:

- ⇨ access to Cockburns Lane and Sawmill will be common and moved north of its existing location. The junction will allow for the turning movements of heavy vehicles;
- ⇨ residents of the Warrell Creek village would use the existing Highway as a local road to reach a formal intersection access point onto the new Highway route;
- ⇨ Highway access at Neaves' Sawmill will be at the same location as that for the Warrell Creek residents.

Opportunities to combine one or more rural property accesses onto the proposed Highway realignment will also be examined. These access points will allow for truck movements to and from rural properties.

Detailed Environmental Studies

A detailed environmental assessment is being undertaken which will be presented in the form of a Review of Environmental Factors (REF). Key findings to date include:

- ⇨ there would be no significant impact on native flora or fauna in the study area;
- ⇨ there is a potential for noise to impact on residents within 200 m of the realignment during the construction phase of the project;
- ⇨ after construction, the noise impacts from the Highway and railway would be lower than at present for most residents. Further noise investigations have been undertaken to examine the effects of noise from the refined route;
- ⇨ there would be no significant impact on the agricultural environment of Warrell Creek. However, recommendations will be made for the control of weeds and movement of livestock during construction;

The impact on properties during construction, in regard to access and the environment, is currently under investigation and will be addressed in the environmental assessment. The impact, however, is expected to be minimal.

Specialist studies on the noise, geotechnical conditions and drainage are being completed.

What Happens Next?

The concept design and the environmental assessment are nearing completion and a community meeting is to be held to gain further community input. The results of the environmental assessment and the issues raised at the community meeting will be incorporated into the final design and environmental assessment where appropriate.

The following timing of activities is planned:

- ✦ Concept Design - *December 1997*
- ✦ Community meeting - *December 1997*
- ✦ REF completion - *January 1998*

Negotiations with affected property owners will take place once the concept design is completed. Any property acquisitions necessary for the project will be under the provisions of the NSW Land Acquisition (Just Terms Compensation) Act, 1991.

Have Your Say!

The RTA would like to hear any comments or concerns you may have with this project. If you wish to offer comments or need more information, please see the contact details below.

To plan for the future, the RTA is particularly seeking the community's views on noise reduction measures.

All interested residents are invited to attend the next community meeting, to be held on 10 December 1997. The Project Team is keen to hear your comments and any concerns you may have with the project. A plan of the refined route will be on display at Warrell Creek Community Hall and Kempsey Motor Registry from the 2 December 1997.

COMMUNITY MEETING DETAILS:

Where : Warrell Creek Community Hall.
When : 10 December 1997
Time : 7.30 PM. Supper will provided.

FOR MORE INFORMATION:

Phone
Mr Peter Black, RTA Northern Region
☎ 02 6640 1365

or write to
Mr Jim Campbell, Project Manager
Warrell Creek Project, RTA Northern Region,
PO Box 576
Grafton NSW 2460

Appendix B - Flora and Fauna Assessment

PACIFIC HIGHWAY RE-ALIGNMENT

WARRELL CREEK

REVIEW of ENVIRONMENTAL FACTORS

FAUNA and FLORA ASSESSMENT

April 1998

Gunninah Environmental Consultants

PACIFIC HIGHWAY RE-ALIGNMENT

WARRELL CREEK

REVIEW of ENVIRONMENTAL FACTORS

FAUNA and FLORA ASSESSMENT

April 1998

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APPENDICES

1 Inventory of Flora Species recorded.

2 Inventory of Fauna Species recorded.

3 Assessment of Significance under Section 5A of the *Environmental Planning & Assessment Act 1979* (EP&A Act).

PACIFIC HIGHWAY RE-ALIGNMENT
WARRELL CREEK

REVIEW of ENVIRONMENTAL FACTORS

FAUNA and FLORA ASSESSMENT

April 1998

1 INTRODUCTION

The Roads & Traffic Authority (RTA) has proposed an upgrade of the Pacific Highway in the vicinity of Warrell Creek, between Kempsey and Coffs Harbour (Figure 1). The proposed roadworks will involve the construction of a four-lane dual carriageway between Warrell Creek (in the south) and Crouches Creek (in the north) which will include:

- upgrading and minor re-alignment of the existing Highway north from Warrell Creek for a distance of approximately 200 metres;
- diversion to the east of the new alignment from the existing Highway through paddocks to the southern boundary of the developed area of Warrell Creek Village;
- establishment of the new alignment along the existing railway line on the eastern side of Warrell Creek Village, with re-location of the railway line to the east;
- diversion (again through cleared paddocks) of the Pacific Highway alignment from the railway line back to the existing Pacific Highway on the northern side of Warrell Creek Village;
- re-construction of the existing Pacific Highway north from Warrell Creek Village to Crouches Creek.

The proposed roadworks form part of the Pacific Highway reconstruction program, a joint State and Federal Government initiative which is intended to improve traffic flow and to reduce accident levels along the Pacific Highway between Sydney and Brisbane. The approach detailed above will move the Highway away from Warrell Creek itself, and consequently reduces the potential for adverse impacts upon this watercourse.

The aims of this fauna and flora investigation are:

- to describe the fauna and fauna habitats present along the proposed alignment, and to assess their condition and significance;
- to describe the flora and vegetation communities along the proposed alignment, and to assess their condition;
- to determine the conservation significance of fauna and flora identified in the study area or considered likely to occur;
- to determine the potential for significant adverse impacts being imposed on native fauna and flora, or on their habitats or communities;
- to define and consider impact amelioration measures which can be implemented as elements of the project to limit the potential effects of the proposal on native biota, and to enhance the local environment for native fauna and flora conservation, where possible; and
- to determine "*whether there will be a significant effect on threatened species, populations or ecological communities, or their habitats*", using Section 5A of the *NSW Environmental Planning & Assessment Act 1979* (EP&A Act), as modified by the *NSW Threatened Species Conservation Act 1995* (TSC Act).

2 METHODS

Field investigations for fauna and flora were conducted in February 1997, with a supplementary site inspection in June.

The intensity of field investigations and the survey techniques employed were determined on the basis of the nature of the proposed activity (the upgrading and re-alignment of existing road and rail corridors), the largely disturbed and degraded condition of the habitats and landscape along the proposed alignment, and the extremely low likelihood of most threatened fauna or flora species being present in the study area.

Given the nature and condition of the environment and landscape through which the proposed Highway and rail re-alignment are located, a number of investigative techniques for native fauna (*eg* trapping for small terrestrial mammals) were regarded as inappropriate or unnecessary, on the basis that there is no suitable habitat for small terrestrial mammals. Additionally, the investigations for fauna and flora contribute to a Review of Environmental Factors (REF) for the proposed roadworks, which requires a lower intensity of investigation than might be expected for an Environmental Impact Statement (EIS).

On the basis of the field investigations and the condition of habitats in the study area, and given the extremely low likelihood of threatened species being dependent on those portions of the study area which are to be affected by the proposed development, it was concluded that no additional investigations beyond those which have been conducted are warranted.

2.1 Flora

A general flora survey of the subject site was conducted on the 15th of February 1997, utilising a 'random meander' approach (Cropper 1993), and dedicated searches in areas of native vegetation. The flora investigation involved walked surveys over the existing road and railway easements, as well as along the proposed new alignment. Specific searches were conducted in the few areas of vegetation within the study area (although these are predominantly regrowth), for plant species of conservation significance known to occur in the general region. Vegetation surveys did not include the execution of dedicated flora survey quadrats or a quantitative assessment of the vegetation present.

A comprehensive inventory of plant species recorded during the field investigations is provided in Appendix 1.

The condition of stands of vegetation in the study area was assessed according to the following criteria:

- native species composition at ground level, shrub level and tree canopy level;
- the proportion of introduced species and their invasive capacity;
- evidence of die-back in native trees;
- habitat value for native fauna; and
- the presence of rare plant species, the significance of these populations in relation to populations in other areas, and the security of these populations in other areas.

Plant identifications conform to recent nomenclature in Harden (1990, 1991, 1992, 1993) and to recent name changes listed in *Cunninghamia* and *Telopea*. Stands of vegetation were described on the basis of the structural classification of Specht (1970), including details of stratum height and Projective Foliage Cover. The scientific and conservation significance of individual species and vegetation types was established with reference to Briggs & Leigh (1996) in the national context, and to the TSC Act in the state context.

Additional flora records were obtained from previous surveys conducted in the vicinity of the study area (Leonard 1997; G Leonard *pers comm*), and also from the NSW National Parks & Wildlife Service (NP&WS) Wildlife database, for land within 10km of the proposed Highway upgrade (Appendix 1).

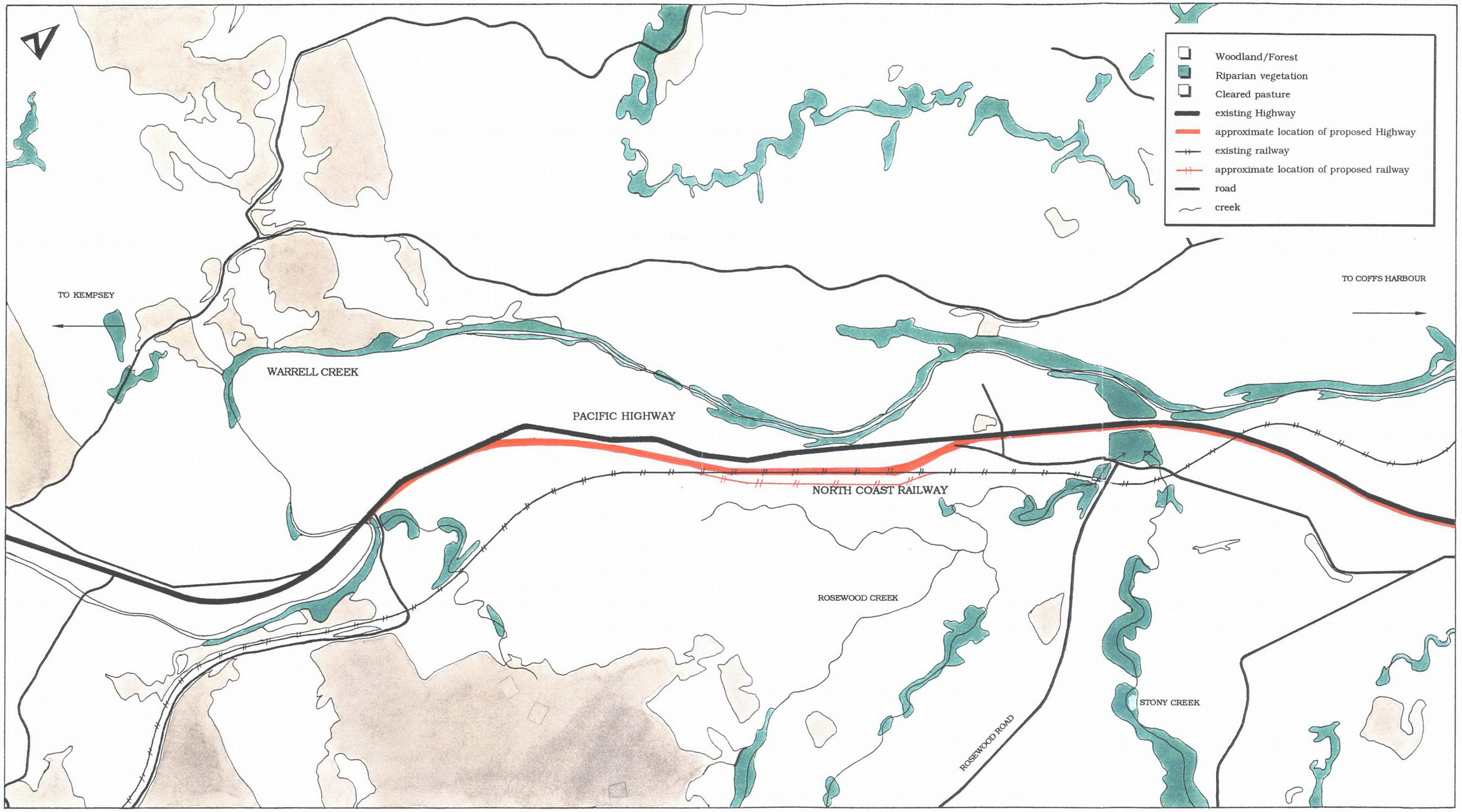

FIGURE 1 Vegetation types in the vicinity of the proposed Pacific Highway upgrade at Warrell Creek.

2.2 Fauna

Field investigations for fauna and fauna habitats were conducted along the existing and proposed alignments and in adjacent areas on the 4th and 5th of February 1997, with a supplementary site inspection in June. Additional fauna records from within 10km of the study area were obtained from the NSW NP&WS Wildlife Atlas, and from a previous survey conducted to the north of the study area, in the vicinity of Warrell Creek (G Leonard *pers comm*). Appendix 2 contains an inventory of fauna species recorded.

Daytime studies involved assessment of habitat structure and value (including searching for hollow-bearing trees), observations of animal activity, as well as specific searches and surveys (see below). Evening investigations involved spotlighting throughout the study area for nocturnal birds, amphibians, reptiles and arboreal mammals, and the detection of microchiropteran bats. Appendix 2 contains an inventory of the fauna species recorded.

Opportunistic bird records were maintained at all times throughout the survey, with dedicated searches being conducted for six person-hours on the morning of February 5th. Birds were surveyed throughout the road and railway easements, as well as in adjacent areas of suitable habitat.

Spotlight surveys were conducted during the evening on both the 4th and 5th of February, with efforts concentrated in the few small vegetated areas (predominantly young regrowth) which occur along the proposed upgrade route. A total of 5.2 person-hours were dedicated to evening spotlight survey transects, which enabled thorough coverage of the vegetated areas along the route (given their limited extent).

Microchiropteran bats were surveyed indirectly with the use of an Anabat II Bat Detector. Bat calls were recorded for 30 minutes at each of eight locations throughout the study area (a total of 4 hours recording), with specialist analysis by Glen Hoye. A lack of suitable flyways along the road and railway easements prevented the use of harp traps and mist nets to sample microchiropteran bats.

Specific amphibian searches (including call playback and listening) were conducted around the wetland area associated with Rosewood Creek during both evenings of the survey (a total of 3 person-hours). However, opportunistic observations of amphibians were collected throughout the study and the majority of amphibian records were obtained opportunistically during other surveying activities.

Reptiles were surveyed opportunistically during the general habitat assessment of the proposed upgrade route. Survey techniques involved the turning over of rocks and logs (or other cover), the searching of fallen hollows and the disturbance of leaf litter around the base of trees. Resources such as these potentially provide shelter for a range of amphibian and reptile species.

Fauna surveys also included searches for indirect evidence of fauna, such as scats and remains (bones, feathers and fur), footprints, diggings, nests, scratches on trees, owl and raptor 'whitewash', burrows and scents.

Weather conditions remained fairly uniform throughout the survey period. Temperatures were warm to hot during the day, and warm to mild in the evening. There was little to no breeze, and skies remained clear with no precipitation. There was very little moon during the survey.

3 LANDSCAPE and VEGETATION of the STUDY AREA

The majority of the study area is located roughly parallel to Warrell Creek, on gently undulating terrain in a broad river valley. The land involved is largely cleared pasture, with isolated trees and occasional patches of disturbed regrowth vegetation. Regrowth generally occurs in gullies, along creeklines and in areas which are little used (such as between the existing road and railway easements). The range of hills located approximately 3 to 6km to the south and southeast of the study area support a significant area of forest vegetation, much of which is included in Way Way State Forest.

3.1 Vegetation Communities

Four broad vegetation communities have been identified within the study area, including riparian forest/open-forest, disturbed open woodland, wetland vegetation, and cleared pasture with isolated trees.

3.1.1 Riparian Forest/Open Forest

This community consists of narrow strips of vegetation which run along the watercourses throughout the area near the proposed roadworks. The northeastern bank of Warrell Creek, near the Pacific Highway bridge in the south of the study area, supports a modest stand of riparian forest. The upper-canopy trees are generally mature, single-trunked specimens of Sydney Blue Gum, with broad canopies. The average tree height is 22m, and the Foliage Projective Cover (FPC) is 30-60%. This stand is largely regrowth, and is too young to provide tree-hollows for use by native fauna.

A variety of native and introduced rainforest species form a relatively continuous mid-storey within the stand on Warrell Creek (Table 1). There is limited species diversity in the understorey, however, and a large number of exotic species occur throughout. Additionally, this riparian forest has been disturbed by previous timber-getting and agricultural activities, and does not constitute a significant stand of vegetation.

This area of vegetation is continuous to the east with Way Way State Forest, whereas to the west the land has been cleared for agricultural pursuits. Whilst a section of the riparian vegetation on the western edge of this community is likely to be removed for the proposed road construction, this constitutes only a small area of already disturbed forest, and is unlikely to involve significant adverse effects on native plant species. Clearing of this vegetation will not contribute significantly to further habitat fragmentation, and should not present any further barrier to fauna movements, beyond those which already exist.

3.1.2 Disturbed Open Woodland

This community occurs along the perimeter of wetlands in the vicinity of Rosewood Creek, and is highly disturbed with a large number of introduced Camphor Laurels in the canopy. Trees are generally up to 14m in height, although emergent specimens of Forest Red Gum occur at heights of up to 18m. The FPC of the community ranges from 0 to 30%.

The shrub-layer in the disturbed open woodland is variable, although is generally dominated by a number of exotic species (Table 1), with native groundcovers limited to hardier species (such as Whiteroot).

3.1.3 Wetlands

Wetlands in the vicinity of the Warrell Creek upgrade of the Pacific Highway are associated primarily with some of the small creeklines and drainage lines in the vicinity. In particular, several small wetlands are located on Rosewood and Stony Creeks, in the vicinity both of the main Northern Railway line and the existing Pacific Highway.

The wetlands in this locality have been modified to varying extents by grazing, agricultural activities and infrastructure construction (roads and the railway line). Most of the wetlands support only small areas of open water, with moderate to high densities of Bullrushes, areas of inundated grass, adjacent pasture, and disturbed weed-infested riparian vegetation. Other wetland areas support stands of Swamp Oak, or sedgelands, which are often disturbed by cattle.

Less disturbed portions of the wetlands in this locality support a moderately diverse native flora assemblage, and are considered likely to provide suitable habitat for a range of amphibians and wetland birds. Aquatic vegetation is present in some areas of open water.

Most of the wetland areas, particularly those associated with Rosewood Creek, are to be avoided by the proposed roadworks. Furthermore, the wetland areas are already modified by existing agricultural and infrastructure activities, and additional wetland areas will be created for water quality and stormwater control, providing supplementary wetland habitat in the locality.

TABLE 1 Characteristic flora species recorded from different strata within the four main vegetation communities identified in the Warrell Creek study area.

COMMUNITY	CHARACTERISTIC SPECIES
Riparian Forest/Open Forest	
Upper canopy	Sydney Blue Gum, Brush Box, Turpentine.
Mid-canopy	Brush Kurrajong, Jackwood, Sweet Pittosporum, Wattle, Camphor Laurel, Privet.
Understorey	White Dogwood, Rasp Fern, Spiny-headed Mat-rush, Red Kennedy Pea, Lily, Rhodes Grass, Cobbler's Pegs, Veined Verbena, Lantana.
Disturbed Open-Woodland	
Upper canopy	Forest Red Gum.
Mid-canopy	Cheese Tree, Camphor Laurel, White Cedar, Lilly Pilly, Forest Oak, Brush Kurrajong.
Shrub layer	Sandfly Zieria, Wattle, White Sally, Elderberry Panax, *Lespedeza juncea*, White Dogwood, Wild Tobacco, Lantana.
Groundcover/Trailers	Whiteroot, Basket Grass, Red Kennedy Pea, Native Passionfruit.
Wetland Vegetation	
Shrubs	*Lespedeza juncea*, Spiny-headed Mat-rush, Montbretia, Japanese Honeysuckle, Lantana, Privet, Climbing Asparagus Fern.
Aquatic/Semi-aquatic species	Broad-leaved Cumbungi, *Juncus planifolius*, Tall Spike-rush, Spike-rush, Dirty Dora, *Cyperus sanguinolentus*, *Juncus usitatus*, *Juncus polyanthemus*, *Bolboschoenus caldwelli*, Umbrella Sedge, Cape Waterlily.
Cleared Pasture	
Upper canopy	Tallowwood, Small-leaved Fig, Hoop Pine, Forest Red Gum, Turpentine.
Shrub layer	Lantana.
Groundcover	Hedgehog Grass, Bordered Panic, Couch Grass, Brown's Lovegrass, Bracken Fern, Pale Pigeon Grass, Veined Verbena, *Stenotaphrum secundatum*, Cobbler's Pegs, Flaxleaf Fleabane, Vasey Grass, Kikuyu Grass.

3.1.4 Cleared Pasture with Isolated Trees

The majority of the study area consists of cleared pasture, with infrequent isolated trees. The trees are generally mature or semi-mature, and are restricted to a small number of native and exotic species (Table 1). Scattered exotic shrubs occur in some areas and the majority of grasses are introduced, although some native grasses do occur amongst the pasture species.

3.2 Conservation Significance

No Rare Or Threatened Australian Plants (ROTAP), as listed by Briggs & Leigh (1996), nor any endangered or vulnerable species, as listed on Schedules 1 or 2 of the TSC Act, were located in the study area during the current survey.

One threatened plant species, the Rusty Plum *Amorphospermum whitei*, has been recorded previously in the region, as listed on the NP&WS Wildlife Atlas. This is a rainforest tree which occurs in littoral and warm-temperate rainforest from the north coast of NSW to southern Queensland. The most recent NP&WS Atlas record in the vicinity of the study area is for one individual, recorded in 1900. Given that much of the nearby landscape has been cleared since that time, and given the condition of the areas proposed for disturbance by the Highway upgrade, it is extremely unlikely that either this species will be present or will be affected. This species was not recorded during the flora survey conducted for this report, nor has it been located during previous surveys conducted in the vicinity (Leonard 1997; G Leonard *pers comm*).

4 FAUNA

4.1 Native Fauna

A total of 50 native vertebrate species were recorded during the fauna surveys conducted for the proposed Highway upgrade at Warrell Creek. Fauna species located include 31 birds, 9 mammals, 6 reptiles and 4 amphibians.

The majority of species recorded are typical of disturbed grassland and agricultural habitats and/or disturbed woodland and forest communities, and are common to abundant across substantial distributions. Most are generally tolerant of some level of habitat disturbance or modification.

4.1.1 Birds

A total of 31 native bird species were recorded during the investigations along the proposed Highway upgrade route at Warrell Creek, most of which are common to abundant, and widespread in distribution. No threatened bird species were recorded during the field investigations, and none are expected to occur other than occasionally, if at all.

The majority of avifauna species recorded are typical of open disturbed habitats, and are commonly recorded during surveys conducted in rural areas. Species recorded include the Welcome Swallow, Kookaburra, Australian Raven, Pied Currawong, Australian Magpie, Willie Wagtail, Magpie-lark, Black-faced Cuckoo-shrike and Eastern Rosella. A number of other birds recorded, including the Pacific Black Duck, Great Cormorant, Great Egret, Australian White Ibis, Straw-necked Ibis, Royal Spoonbill and Dusky Moorhen, are typical of wetland habitats in agricultural areas. These species are all tolerant of some disturbance (as indicated by their presence in the study area), and are considered highly unlikely to be adversely affected by the proposed construction works.

As noted above, no threatened birds were recorded during either the fauna survey conducted for this report or during the previous survey in the vicinity (G Leonard *pers comm*). However, a number of threatened species (listed as Vulnerable in the TSC Act) have been recorded in the region (NP&WS Wildlife Atlas - Appendix 2), and are discussed in further detail in Section 4.2 of this report. Threatened birds recorded within 10km of the subject site include the Glossy Black Cockatoo, Osprey, Barred Cuckoo Shrike, Wompoo Fruit-dove, Brolga, Black Bittern, Masked Owl, Sooty Owl and Square-tailed Kite.

4.1.2 Mammals

Nine native mammal species were recorded in the study area during the fauna surveys conducted for this report, including the Northern Brown Bandicoot, Red-necked Wallaby, Common and Mountain Brushtail Possums, Common Ringtail Possum and four microchiropteran bat species (Appendix 2).

One Common Ringtail Possum and three Common Brushtail Possums were recorded during evening spotlighting on the 5th February. A female Common Brushtail Possum with a juvenile was sighted in vegetation near Upper Warrell Creek, and one Common Brushtail and one Common Ringtail were sighted in forest adjacent to the wetland area at Rosewood Creek.

The only threatened fauna species recorded during the survey was the Little Bent-wing Bat *Miniopterus australis*. This species was recorded by an Anabat II ultrasonic bat detector, and is discussed further in Section 4.2 of this report. No other threatened mammal species were observed or recorded during the fauna surveys conducted along the proposed Highway upgrade route, although one (the Koala *Phascolarctos cinereus*) is included on the NP&WS Wildlife Atlas within 10km of the study area.

No natural roosting resources for microchiropteran bats (such as caves, tunnels or hollow-bearing trees) were located within the area to be affected by the proposed Highway upgrade. Forests and woodland along the proposed new alignment may provide some foraging resources for microchiropteran bats, but these species are highly mobile and wide-ranging, and it is unlikely that the degraded resources present in the study area are of any significance for microchiropteran bats.

Given the nature and condition of the vegetation in the vicinity, it is considered that Koalas are extremely unlikely to occur along the proposed alignments. Only two Koala records are included on the NP&WS Wildlife Atlas, both of which are relatively old (greater than 20yrs), and prior to much habitat clearing along the Highway and railway easements. While it is theoretically possible for Koalas to occur in some of the regrowth in the study area, no evidence for this species was obtained, and the degraded and fragmented resources present are not regarded as of relevance for the Koala.

4.1.3 Reptiles

Six native reptile species were recorded in the study area during the field investigations, including the Eastern Water Dragon, Bearded Dragon, Red-bellied Black Snake, Striped Skink, Garden Sunskink and the Eastern Blue-tongued Lizard. The Upper Warrell Creek contains a variety of submerged and exposed tree debris, providing potential habitat for a number of other reptile species, including freshwater tortoises. All of the species recorded are common to abundant and widespread, and are generally tolerant of some disturbance or of modified environments.

No threatened reptile species were recorded during surveys conducted for this investigation, and none are included on the NP&WS Wildlife Atlas within 10km of the study area. Considering the small area of vegetation to be disturbed and the extensive grassland, woodland and forest habitat available in the region, it is highly unlikely that any threatened reptile species would be adversely affected by the proposed roadworks, if any occur in the immediate vicinity (which is considered unlikely).

4.1.4 Amphibians

Four amphibian species were recorded during the fauna surveys conducted for this report, including the Common Eastern Froglet, Green Tree Frog, Peron's Tree Frog and the Eastern Dwarf Tree Frog. The Green Tree Frog was sighted on a road 500m from the study area, with the others being recorded from the wetlands associated with Rosewood Creek.

No evidence for the presence of any threatened amphibian species was obtained within the study area, and no threatened amphibian species are included on the NSW NP&WS Wildlife Atlas within 10km. However, it is possible that the Rosewood Creek wetlands provide habitat or resources for the Green & Golden Bell Frog, or possibly for the Green-thighed Frog. The latter species, however, has not been recorded in the locality, and is not regarded as likely to be present given the nature and condition of the resources and habitats present.

The Green & Golden Bell Frog has previously been recorded in the Warrell Creek area (Ehmann 1997), in (disturbed) wetlands along Rosewood Creek. However, recent surveys of the Warrell Creek site failed to reveal the presence of this species (Ehmann 1997; A White

pers comm; this study). The proposed Pacific Highway and Northern Railway re-alignments are intended to retain all of the wetlands along Rosewood Creek, and consequently habitat for the Green & Golden Bell Frog, and other amphibian species, will be maintained in this locality. Furthermore, stormwater basins associated with the project could be designed to provide suitable habitat for this species.

4.2 Threatened Fauna

In New South Wales, threatened fauna species are defined as those listed on Schedules 1 (Endangered) and 2 (Vulnerable) of the TSC Act. Threatened species include those which are considered of conservation concern because of restricted distributions or habitat requirements, significant population or distributional range declines, and where threats to species' survival still prevail.

Whilst a number of threatened species have been recorded in the general vicinity of the proposed Pacific Highway upgrade at Warrell Creek, the habitats and resources which are present are highly degraded and the alignment supports few resources of relevance for threatened species. It is of particular note that the proposed new alignments are immediately adjacent to the existing Pacific Highway and North Coast Railway, and consequently involve affecting a portion of land which is already highly disturbed and degraded. Threatened species known from the general locality are discussed below, although none are considered of concern with regard to the proposed upgrade.

4.2.1 Birds

Nine threatened bird species are included on the NP&WS Wildlife Atlas within 10km of the study area. These are discussed below with relation to the proposed Highway upgrade.

The Glossy Black Cockatoo feeds predominantly on the seeds of *Allocasuarina* species and also requires large tree hollows for nesting (Blakers *et* al 1984). No potential food resources were identified along the proposed Highway upgrade route, and no tree-hollows were observed within the study area.

The Barred Cuckoo-shrike and Wompoo Fruit-dove generally inhabit warm temperate to tropical rainforest along the east coast of Australia, and both species feed on rainforest fruits and nest high in the rainforest canopy (Lindsey 1992). The disturbed riparian forest along the northeastern bank of Warrell Creek near the Pacific Highway bridge supports some rainforest understorey species, and provides limited potential resources for these species. However, no native rainforest canopy is present and the community is highly degraded, being dominated by introduced Privet and Camphor Laurel. Similarly, isolated figs in the locality could provide food resources for these species. Whilst it is possible that the Barred Cuckoo-shrike or Wompoo Fruit-dove may utilise the limited resources provided by the occasional figs and introduced Camphor Laurels present, it is unlikely that either species would be dependent on them to any significant extent, if at all.

The Sooty Owl inhabits rainforest and dense eucalypt forest along the east coast of Australia, utilising large high tree-hollows for nesting and shelter (Lindsey 1992). There is no habitat of potential relevance for the Sooty Owl along the proposed alignment, and it is unlikely that this species would rely on the small areas of degraded vegetation which are to be removed for the proposed roadworks.

The Masked Owl is a secretive bird inhabiting eucalypt forest and woodland around coastal Australia. It requires large tree-hollows for nesting, and usually uses the same nest site for several years (Lindsey 1992). The Square-tailed Kite also inhabits eucalypt woodland, and is widespread throughout mainland Australia. Whilst these species could utilise the woodland resources in the locality, on occasions, no tree-hollows were observed within the study area, and the woodland and forest habitats present are highly degraded and fragmented. Only a relatively small area of vegetation is to be removed for the proposed upgrade, and it is extremely unlikely that either the Masked Owl or the Square-tailed Kite would be dependent on the limited resources available in these areas, even if they are present.

The Brolga and Osprey have both been recorded in wetland habitats in the vicinity of the study area (NSW NP&WS Wildlife Atlas). Whilst it is theoretically possible for these species

to utilise the foraging resources provided by Warrell Creek and the Rosewood Creek wetlands on occasions, both species are highly mobile and wide-ranging. They are not likely to be reliant on the limited resources available, particularly when considering the extensive areas of wetland to the east and northeast of the study area. Furthermore, the areas to be affected by the project can only be regarded as marginal (at best) for these species. It is extremely unlikely that the Brolga or the Osprey would occur within the study area on other than a transitory basis, if at all.

The Black Bittern is a wary and secretive bird, feeding predominantly on fish and inhabiting densely vegetated wetlands and the banks of sluggish rivers around the eastern and northern coastlines of Australia (Lindsey 1992). Whilst it is theoretically possible that the Black Bittern may occur along some areas of Warrell Creek to the west of the study area, the watercourses throughout the region have been modified for agriculture, and most areas have a depauperate groundcover and shrub layer. No dense waterside vegetation suitable for the Black Bittern occurs in the areas to be affected by the proposed Highway upgrade, and it is highly unlikely that the disturbed and fragmented vegetation present is of relevance to this species. No significant adverse affects are predicted for this species, even if it occurs.

4.2.2 Mammals

The Little Bent-wing Bat was recorded (by call) near the Rosewood Creek wetland during the fauna survey. This species is wide-ranging, roosts in caves or tunnels and forages for insects beneath the canopy of well-timbered forests (Strahan 1995). Whilst the degraded forest and woodland communities present along the proposed upgrade route could possibly provide some foraging resources for this species, they constitute only a small area of the vegetation present in the region, and the Little Bent-wing Bat is unlikely to be reliant on these resources. It is more likely that the record of this species was of an individual in transit between roosting and foraging sites. No caves or tunnels are located along the proposed route. It is considered unlikely that the proposed Highway upgrade will cause significant (or any) adverse impacts on this species.

Other threatened microchiropteran bats could also occur in the general locality. However, as for the Little Bent-wing Bat, the foraging resources for microchiropteran bats in the vicinity of the proposed upgrade are extremely limited and generally highly degraded, and the very small area to be affected by the proposed roadworks is not considered of relevance. No roosting resources for any microchiropteran bats are to be removed.

Two Koala records (though both are greater than 20yrs old) are included on the NP&WS Wildlife Atlas within 10km of the study area. Koalas feed principally on the leaves of a number of *Eucalyptus* species, and occur in eucalypt forest and woodland throughout eastern Australia (Strahan 1995). Whilst some Koala food trees (Forest Red Gum *Eucalyptus tereticornis* and Tallow-wood *E microcorys*) occur in parts of the study area, the communities are heavily weed-infested, degraded and fragmented, and are of little relevance for Koalas. It is not likely that the proposed upgrade is of any relevance to Koalas.

4.2.3 Amphibians

No threatened amphibians were recorded within the study area during the fauna investigations. However, it is theoretically possible that some threatened amphibians may occur along or near the proposed alignment, including the Green & Golden Bell Frog and the Green-thighed Frog.

There are no records in this vicinity for the latter species, but the Green & Golden Bell Frog has previously been recorded from Warrell Creek. Conversely, an investigation in 1996 failed to locate this species at the Rosewood Creek site from which it had previously been recorded (Ehmann 1997; White *pers comm*). Nevertheless, it is possible for Green & Golden Bell Frogs to utilise the disturbed wetland habitats along Rosewood Creek, and the management of water discharges from the new Highway will need to avoid imposing additional impacts on these habitats.

Indirect impacts resulting from increased run-off and sediment discharge from the roadworks and associated activities can be managed, and should not pose a significant

adverse affect on the wetland habitats. It is unlikely that any threatened amphibian species, if present, would be significantly affected by the proposed Highway upgrade.

5 POTENTIAL IMPACTS of the DEVELOPMENT

The majority of land which will be affected by the proposed Pacific Highway and railway re-alignment is already cleared or has been significantly affected by previous agricultural or residential activities.

Where vegetation does occur along the proposed re-alignments (other than farmland, gardens or horticultural plantings), it generally comprises a limited mixture of native and introduced species, with weed-infestation being acute in some localities. The proposed re-alignment of the Pacific Highway and Northern Railway will not involve the removal of substantial or significant tracts of native vegetation, and those areas which are present are (as noted above) weed-infested and/or already subject to significant 'edge-effects'.

Relatively little native vegetation will require clearing for the proposed Highway and Northern Railway re-alignment. Small areas of native vegetation (albeit considerably weed-infested) occur along Warrell Creek, or are associated with small wetlands in the vicinity. However, most of this vegetation is to be retained. Furthermore, given their condition and nature, and the long-term degradation of habitat in the immediate vicinity, the areas which will require clearing or disturbance are not regarded as of conservation significance. No threatened fauna or flora species are known to or anticipated to rely on the vegetation communities and habitats present.

Notwithstanding their highly modified condition, and the lack of significance for native fauna and flora, some clearing of native vegetation and habitats will be required along the proposed re-alignment corridors for the road and railway. Consequently, the proposed roadworks and railway re-alignment will involve the imposition of some limited adverse impacts upon native species, although no significant effects are anticipated.

In addition to the (limited) potential for imposing direct impacts as a result of the removal of vegetation or other habitats and resources, there is the potential for the roadworks and railway re-alignment to impose indirect adverse impacts on the local environment. Of potential relevance in this regard, at least in a theoretical sense, is the imposition of barriers to fauna movements, alterations to hydrologic regimes, the discharge of contaminants or pollutants into watercourses and natural habitats, the creation or exacerbation of 'edge-effects', and the potential for increases in road mortality of native fauna. These potential indirect adverse impacts are generally characteristic of road and rail construction programs, although, in the case at Warrell Creek, existing disturbance and habitat degradation and modification in the locality significantly reduces the potential for these indirect effects to be of significance. The likelihood of these indirect impacts being imposed at Warrell Creek varies from low to moderate.

With respect to fauna movements and mortalities, the proposed roadworks and railway re-alignment do not involve the imposition of a novel barrier to fauna movements, as both the existing Main Northern Railway line and existing Pacific Highway, as well as the village of Warrell Creek itself and other residential development in the locality, already constitute a significant barrier to fauna movements in this locality. On this basis, and in the absence of areas of significant habitat on either side of the road and railway easements between which fauna may wish to move, it is considered unlikely that the proposed new road and rail alignments will involve any significant increase in constraints on fauna movement.

Similar considerations apply to the potential for an increase in road mortalities as a result of the proposed development. The existing railway line and Pacific Highway, in conjunction with the current development in the locality, already impose significant constraints with respect to fauna movements, and doubtless involves some animal mortalities. However, as noted above, there are no significant fauna movement corridors across the proposed alignments, and the frequency and intensity of fauna mortalities on the Highway is considered likely to be low. The new alignment is not considered likely to significantly increase the rate of mortalities.

There is a greater potential for adverse impacts arising from the proposed new road and rail alignments associated with the potential effects of the discharge of sediment and

contaminants during construction, and of road-based contaminants and excess stormwater following construction. Whilst the areas of cut and fill along the proposed new road and rail alignments are relatively small, inadequate management of erosion and sediment discharge, and of contaminant and waste discharge during the construction process, has the potential to adversely impact on swamps and watercourses in the vicinity.

Conversely, potential erosion and sediment discharge and contaminant discharge from roadworks sites are readily amenable to management protocols. Appropriate bunding and water quality control measures during construction can be provided to avoid the discharge of excess sediment into adjacent watercourses, and appropriate management protocols can be implemented to prevent the discharge of contaminants from works sites and from the roadworks itself.

Similarly, appropriate design measures can be implemented in the roadworks and final road design to minimise the potential for sediment or contaminant discharge into native vegetation communities and habitats in the vicinity. The use of constructed wetlands and drainage swales can minimise the discharge of sediments and contaminants from the roadway and railway, and subsequent landscaping and replanting programs can, in this instance, provide areas of native vegetation of greater extent and better quality than those which currently exist along the proposed alignment. A comprehensive landscaping and rehabilitation program for all exposed earthworks areas, following the completion of construction, will ensure that subsequent discharges to the natural environment are minimal.

Discharges and contaminants from the roadway, and to a lesser extent from the railway, and the discharge of high water flows during rainfall events have the potential to adversely affect local watercourses and small wetlands. However, these impacts already exist to a significant extent (given the current nature of the local environment), and the potential for adverse effects can be partially addressed by the appropriate location of stormwater discharge points, the use of flow control structures, and the use of wetlands constructed initially for sediment control purposes and subsequently re-engineered to treat water quality (by alterations in structure, de-silting and planting with appropriate macrophyte plant species).

Given the nature and condition of the area which is to be affected by the proposed re-alignment of the Pacific Highway at Warrell Creek and of the Northern Railway line, it is considered unlikely that the roadworks and associated activities will adversely affect natural environments or native vegetation communities to any significant or relevant extent. Whilst there is some potential for indirect adverse impacts to be imposed upon the surrounding landscape, these can generally be readily managed and ameliorated. Additionally, given the highly degraded nature of the area, the imposition of significant direct adverse impacts as a result of vegetation clearing is regarded as slight. Measures to minimise the potential for adverse impacts on the natural environment are considered in Chapter 7 of this report.

6 SIGNIFICANCE of IMPACTS on THREATENED SPECIES

The potential for the proposed Pacific Highway and railway re-alignment at Warrell Creek to impose a "*significant effect on threatened species, populations or ecological communities, or their habitats*" has been assessed as specified in Section 5A of the *Environmental Planning & Assessment Act* 1979 (EP&A Act), as amended by the *NSW Threatened Species Conservation Act* 1995 (TSC Act). A detailed assessment in the terms of Section 5A of the EP&A Act is provided in Appendix 3.

Consideration of the eight factors in Section 5A of the EP&A Act indicates, on the basis of the highly disturbed and modified nature of the environment through which the proposed activity is to occur, that there is little likelihood of a significant adverse effect being imposed on threatened biota or their habitats. Whilst the removal of small areas of native vegetation may affect individuals of generally common fauna and flora species, the small areas to be affected and their current highly disturbed and modified nature render the resources present of relatively little consequence.

It is considered extremely unlikely that any threatened fauna or flora species would be present along the alignment other than in very low numbers or on a rare and occasional

basis. It is not considered likely that the areas proposed for activities associated with the Highway and railway re-alignment constitute significant resources or habitat for any threatened fauna or flora species.

As a consequence, it is considered that a Species Impact Statement is not required for the proposed Warrell Creek re-alignment.

7 IMPACT AMELIORATION

Given the highly disturbed and modified nature of the local environment, and the existence of the original Pacific Highway and Main Northern Railway in the area to be affected by the proposed re-alignments, little native vegetation or fauna habitats of significance will be affected. Consequently, in this locality, the avoidance of native vegetation or resources and habitats, is considered of little significance. Conversely, wherever possible, stands of native vegetation and areas of habitat or resources (*eg* the small wetlands on Rosewood Creek) should be protected and avoided during re-alignment and construction activities.

Management protocols which are recommended for application along the proposed Pacific Highway and Main Northern Railway re-alignments, and on associated works and rehabilitation areas, should include:

- minimisation of the removal of native vegetation and trees along areas affected by the proposed re-alignments wherever possible, particularly where large trees are involved or where riparian vegetation and wetlands are located;

- location of the project works site(s) away from native vegetation patches and away from watercourses or wetlands;

- protection of trees which are to be retained along the proposed re-alignments from damage by the use of protective fencing. Soil levels should not be altered within the drip zones of trees wherever possible, and the parking of vehicles and stockpiling of materials under trees to be retained should be avoided;

- the imposition of strict sediment control measures during construction activities (as is normal RTA practice), involving sediment traps, hay bale filters, and sediment control ponds. These measures are intended to limit the quantity of sediment discharged from works and construction sites, particularly in the vicinity of watercourses and wetlands and where Warrell Creek is located close to the proposed roadworks;

- reconstruction of sediment control ponds following the completion of earthworks and roadworks construction, to function as macrophyte wetlands, fauna habitat and water quality control ponds;

- the discharge of stormwater from the finished roadway through grassed floodways or swales and shallow wetlands to remove contaminants prior to discharge into existing watercourses, particularly into Warrell Creek;

- management of general construction activities along the re-alignment routes and rehabilitation areas to manage rubbish and waste materials, to collect and remove excess contaminants and liquids, and to prevent the discharge of contaminants from ablution and work shed facilities;

- implementation of a weed management program to reduce the levels of weed-infestation in native vegetation to be retained adjacent to the proposed re-alignments and in areas which are to be rehabilitated;

- the use of shredded native plant material which is removed from the re-alignments as a mulch and groundcover in areas which are to be rehabilitated and on relevant batters along the road alignment. This approach will utilise local plant material, reduce weed infestation opportunities, and retain native plant propagules for recolonisation;

- where appropriate, significant native plant species known from the region should be used in replanting and landscaping programs. Of particular interest in this regard is the Rusty Plum *Amorphospermum whitei*, which is included on the NPWS Wildlife Atlas

within 10km of the study area. An agenda for replanting and landscaping, involving a range of relevant plant species, should be producted for the project, as part of the overall management plan;

- construction of the approaches to Warrell Creek at the southern end of the Pacific Highway re-alignment to maintain a potential fauna movement corridor along the northern bank of Warrell Creek. Landscaping in this area should particularly address the requirements of water birds and other fauna species which could potentially utilise Warrell Creek as a movement corridor.

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PACIFIC HIGHWAY RE-ALIGNMENT

WARRELL CREEK

APPENDIX 1
Inventory of Flora Species recorded.

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APPENDIX 1 Flora species recorded along the proposed Pacific Highway upgrade route, and in the general vicinity.

KEY

* Introduced species

★ Threatened species as listed on the *Threatened Species Conservation Act* 1995 (TSC Act). Records from the NSW NP&WS Wildlife Atlas within 10km of the study area (AMG's 479000 to 501000 and 6584000 to 6609000).
V Schedule 2 - Vulnerable

A Species recorded in the study area during current investigations.

B Species recorded in the region during previous surveys (Leonard 1997; G Leonard *pers comm*).

SCIENTIFIC NAME	COMMON NAME	A	B
FILICOPSIDA			
Asteliaceae			
Cordyline stricta	Narrow-leaved Palm Lily		✔
Blechnaceae			
Blechnum cartilagineum	Gristle Fern		✔
Blechnum nudum	Fishbone Water Fern		✔
Blechnum wattsii	Hard Water Fern		✔
Doodia aspera	Rasp Fern	✔	
Dennstaedtiaceae			
Histiopteris incisa	Bats Wing Fern		✔
Pteridium esculentum	Bracken Fern	✔	✔
Gleicheniaceae			
Sticherus flabellatus	Umbrella fern		✔
Sinopteridaceae			
Cheilanthes sieberi	fern	✔	
CONIFEROPSIDA			
Araucariaceae			
Araucaria cunninghamii	Hoop Pine	✔	
Pinaceae			
Pinus radiata	Radiata Pine	✔	
DICOTYLEDONS - MAGNOLIOPSIDA			
Amaranthaceae			
Alternanthera denticulata	Lesser Joyweed	✔	
Alternanthera pungens	Khaki Weed	✔	
Apiaceae			
Centella asiatica	Pennywort	✔	
Apocynaceae			
Parsonsia straminea	Common Silkpod	✔	✔
Araliaceae			
Astrotricha longifolia	shrub	✔	
Polyscias sambucifolia subsp A	Elderberry Panax	✔	✔
Asclepiadaceae			
Araujia sericiflora	Moth Vine	✔	✔
* *Gomphocarpus fruticosus*	Narrow-leaved Cotton Bush	✔	
Asparagaceae			
* *Myrsiphyllum asparagoides*	Florist's Smilax	✔	
Asteraceae			
Acomis acoma	herb		✔
* *Ambrosia tenuifolia*	Lacy Ragweed	✔	

APPENDIX 1 cont Flora species recorded along the proposed Pacific Highway upgrade route, and in the general vicinity.

SCIENTIFIC NAME	COMMON NAME	A	B
Asteraceae cont			
* *Bidens pilosa*	Cobbler's Pegs	✔	✔
* *Carduus nutans* ssp *nutans*	Nodding Thistle	✔	
* *Carduus tenuiflorus*	Winged Slender Thistle	✔	
* *Carthamus lanatus*	Saffron Thistle	✔	
* *Cirsium vulgare*	Spear Thistle	✔	
* *Conyza albida*	Tall Fleabane	✔	✔
* *Conyza bonariensis*	Flaxleaf Fleabane	✔	
Glossogyne tannensis	Cobbler's tack	✔	
* *Hypochaeris radicata*	Catsear	✔	
* *Leucanthemum vulgare*	Oxeye Daisy	✔	
Ozothamnus diosmifolius	White Dogwood	✔	✔
Pseudognaphalium luteoalbum	Jersey Cudweed	✔	
Senecio hispidulus var *dissectus*	Hill Fireweed	✔	
* *Senecio madagascariensis*	Fireweed	✔	
* *Sonchus oleraceus*	Common Sowthistle	✔	
* *Tagetes minuta*	Stinking Roger	✔	✔
Bignoniaceae			
* *Jacaranda mimosifolia*	Jacaranda	✔	
Brassicaceae			
* *Capsella bursa-pastoris*	Shepherd's Purse	✔	
* *Coronopus didymus*	Lesser Swinecress	✔	
* *Raphanus raphanistrum*	Wild Radish	✔	
Campanulaceae			
Wahlenbergia communis	Tufted Bluebell	✔	
Wahlenbergia stricta	Tall Bluebell	✔	
Caprifoliaceae			
* *Lonicera japonica*	Japanese Honeysuckle	✔	
Sambucus australasica	Native Elderberry	✔	
Casuarinaceae			
Allocasuarina littoralis	Black Sheoak		✔
Allocasuarina torulosa	Forest Oak	✔	✔
Casuarina glauca	Swamp oak	✔	
Commelinaceae			
Commelina cyanea	Scurvy Weed		✔
* *Tradescantia albiflora*	Wandering jew		✔
Convolvulaceae			
Dichondra repens	Kidney Weed	✔	✔
Cunoniaceae			
Callicoma serratifolia	Black Wattle		✔
Ebenaceae			
Diospyros australis	Black Plum		✔
Epacridaceae			
Lissanthe strigosa	Peach Heath		✔
Escalloniaceae			
Abrophyllum ornans	Native Hydrangea	✔	
Euphorbiaceae			
Breynia oblongifolia	Coffee Bush	✔	✔
Croton verreauxii	Green Cascarilla		✔
Glochidion ferdinandi var *ferdinandi*	Cheese Tree	✔	✔
Phyllanthus gasstroemii	shrub	✔	
Phyllanthus virgatus	herb	✔	
Fabaceae: Faboideae			
Daviesia acicularis	shrub		✔
Desmodium brachypodum	Large Tick-trefoil		✔
Desmodium varians	Slender Tick-trefoil	✔	

APPENDIX 1 cont Flora species recorded along the proposed Pacific Highway upgrade route, and in the general vicinity.

SCIENTIFIC NAME	COMMON NAME	A	B
Fabaceae: Faboideae cont			
Erythrina sykesii	Coral Tree	✔	
Glycine tabacina	Glycine	✔	
Hardenbergia violacea	False Sarsaparilla	✔	✔
Kennedia rubicunda	Red Kennedy Pea	✔	
Lespedeza juncea	shrub	✔	
* *Vicia sativa*	Vetch	✔	
* *Vicia tetrasperma*	Slender Vetch	✔	
Fabaceae: Mimosoideae			
Acacia binervata	Two-veined Hickory		✔
Acacia chrysotricha	Wattle		✔
Acacia diphylla	Wattle	✔	
Acacia falcata	Wattle		✔
Acacia fimbriata	Fringed Wattle		✔
Acacia floribunda	White Sally	✔	✔
Acacia implexa	Hickory wattle		✔
Acacia irrorata ssp *irrorata*	Green Wattle	✔	✔
Acacia longifolia	Sydney Golden Wattle	✔	
Acacia longissima	Wattle	✔	
Acacia maidenii	Maiden's Wattle		✔
Acacia melanoxylon	Blackwood	✔	
Acacia sophorae	Coastal Wattle		✔
Acacia stricta	Wattle		✔
Gentianaceae			
* *Centaurium erythraea*	Common Centaury		✔
Haloragaceae			
Gonocarpus teucrioides	herb		✔
Lamiaceae			
Westringia blakeana	Westringia		✔
Lauraceae			
Cinnamomum camphora	Camphor Laurel	✔	
Cryptocarya glaucescens	Jackwood	✔	✔
Cryptocarya microneura	Murrogun		✔
Endiandra discolor	Rose Walnut	✔	
Linaceae			
* *Linum usitatissimum*	Flax	✔	
Lobeliaceae			
Pratia purpurascens	Whiteroot	✔	
Loranthaceae			
Amyema pendulum subsp *pendulum*	Mistletoe		✔
Malvaceae			
* *Pavonia hastata*	herb	✔	
Hibiscus heterophyllus	Native Rosella		✔
* *Sida rhombifolia*	Paddy's Lucerne	✔	✔
Meliaceae			
Melia azedarach var *australasica*	White Cedar	✔	
Synoum glandulosum	Scentless Rosewood		✔
Toona ciliata	Red Cedar		✔
Monimiaceae			
Wilkiea huegeliana	Veiny Wilkiea		✔
Moraceae			
Maclura cochinchinensis	Cockspur Thorn		✔
Ficus obliqua	Small-leaved Fig	✔	
Ficus coronata	Sandpaper Fig		✔

APPENDIX 1 cont Flora species recorded along the proposed Pacific Highway upgrade route, and in the general vicinity.

SCIENTIFIC NAME	COMMON NAME	A	B
Myoporaceae			
Eremophila debilis	Winter Apple	✔	
Myrsinaceae			
Rapanea variabilis	Muttonwood		✔
Myrtaceae			
Acmena smithii	Lilly Pilly	✔	
Angophora floribunda	Rough-barked Apple		✔
Baeckea virgata	shrub		✔
Backhousia anisata	Aniseed Tree		✔
Backhousia myrtifolia	Grey Myrtle		✔
Corymbia gummifera	Red Bloodwood		✔
Eucalyptus acmenoides	White Mahogany		✔
Eucalyptus fusiformis	Grey Ironbark		✔
Eucalyptus microcorys	Tallow-wood	✔	✔
Eucalyptus paniculata	Grey Ironbark		✔
Eucalyptus pilularis	Blackbutt		✔
Eucalyptus propinqua	Small-fruited Grey Gum		✔
Eucalyptus saligna	Sydney Blue Gum	✔	✔
Eucalyptus siderophloia	Grey Ironbark		✔
Eucalyptus tereticornis	Forest Red Gum	✔	
Eucalyptus tetrapleura	tree		✔
Lophostemon confertus	Brush Box	✔	✔
Syncarpia glomulifera	Turpentine	✔	✔
Syzygium francisii	Giant Water Gum		✔
Tristaniopsis laurina	Water Gum		✔
Waterhousea floribunda	Weeping Lilly Pilly		✔
Nymphaeaceae			
* *Nymphaea capensis*	Cape Waterlilly	✔	
Oleaceae			
* *Ligustrum lucidum*	Large-leaved Privet	✔	✔
* *Ligustrum sinense*	Small-leaved Privet	✔	
Notelaea longifolia	Large Mock-olive		✔
Onagraceae			
Ludwigia peploides ssp *montevidensis*	Water Primrose	✔	
Oxalidaceae			
* *Oxalis corniculata*	Creeping Oxalis	✔	
* *Oxalis purpurea*	herb		✔
* *Oxalis pes-caprae*	Soursob	✔	
Passifloraceae			
Passiflora herbertiana	Native Passionfruit	✔	
Pittosporaceae			
Citriobatus pauciflorus	Orange Thorn		✔
Pittosporum undulatum	Sweet Pittosporum	✔	✔
Phytolaccaceae			
* *Phytolacca octandra*	Inkweed		✔
Plantaginaceae			
* *Plantago lanceolata*	Plantain	✔	
* *Plantago varia*	herb	✔	
Polygonaceae			
Persicaria strigosa	Knotweed	✔	
Persicaria hydropiper	Water Pepper		✔
Persicaria lapathifolia	Pale Knotweed	✔	
* *Polygonum aviculare*	Wireweed	✔	
* *Rumex crispus*	Curled Dock	✔	
Proteaceae			
Alloxylon pinnatum	Dorrigo Waratah		✔

APPENDIX 1 cont Flora species recorded along the proposed Pacific Highway upgrade route, and in the general vicinity.

SCIENTIFIC NAME	COMMON NAME	A	B
Primulaceae			
* *Anagallis arvensis*	Scarlet Pimpernel	✔	
Ranunculaceae			
Clematis aristata	Old Man's Beard		✔
Ranunculus inundatus	Buttercup	✔	
Rhamnaceae			
Alphitonia excelsa	Red Ash		✔
Pomaderris lanigera	shrub		✔
Rosaceae			
* *Rubus fruticosus* sp aggregate	Blackberry	✔	
Rubus parvifolius	Native Raspberry		✔
Rubus hillii	Molucca Bramble		✔
Rubiaceae			
Opercularia varia	Variable Stinkweed	✔	
Morinda jasminoides	woody climber		✔
Rutaceae			
Bosistoa floydii	Five-leaved Bosistoa		✔
Melicope micrococca	Hairy-leaved Dough-wood		✔
Zieria smithii ssp A	Sandfly Zieria	✔	
Salicaceae			
* *Salix fragilis*	Crack Willow	✔	
Santalaceae			
Exocarpos cupressiformis	Cherry Ballart		✔
Sapindaceae			
Dodonaea triquetra	Common Hop-bush		✔
Sapotaceae			
★(V) *Amorphospermum whitei*	Rusty Plum		
Smilacaceae			
Smilax australis	Sarsaparilla		✔
Solanaceae			
Duboisia myoporoides	Corkwood		✔
* *Solanum mauritianum*	Wild Tobacco	✔	✔
Sterculiaceae			
Commersonia fraseri	Brush Kurrajong	✔	✔
Ulmaceae			
Trema aspera	Native Peach		✔
Verbenaceae			
* *Lantana camara*	Lantana	✔	✔
* *Verbena rigida*	Veined Verbena	✔	✔
Vitaceae			
Cissus hypoglauca	Giant Water Vine		✔
Xanthorrhoeaceae			
Xanthorrhoea macronema	Grass Tree		✔
MAGNOLIOPSIDA - MONOCOTYLEDONS			
Asparagaceae			
* *Protasparagus plumosus*	Climbing Asparagus Fern	✔	
Cyperaceae			
Bolboschoenus caldwellii	sedge	✔	
Carex breviculmis	herb		✔
Cyperus difformis	Dirty Dora	✔	

APPENDIX 1 cont Flora species recorded along the proposed Pacific Highway upgrade route, and in the general vicinity.

SCIENTIFIC NAME	COMMON NAME	A	B
Cyperaceae cont			
* *Cyperus eragrostis*	Umbrella Sedge	✔	
Cyperus sanguinolentus	sedge	✔	
Eleocharis acuta	Spike-rush	✔	
Eleocharis sphacelata	Tall Spike-rush	✔	
Iridaceae			
Crocosmia crocosmiiflora	Montbretia	✔	
Juncaceae			
Juncus continuus	rush		✔
Juncus planifolius	rush	✔	
Juncus polyanthemus	rush	✔	
Juncus usitatus	rush	✔	
Liliaceae			
* *Lilium formosanum*	Lily	✔	
Lomandraceae			
Lomandra longifolia	Spiny-headed Mat-rush	✔	✔
Phormiaceae			
Dianella caerulea	Blue Flax Lily		✔
Poaceae			
* *Chloris gayana*	Rhodes Grass	✔	✔
* *Cynodon dactylon*	Couch Grass	✔	
Echinopogon caespitosus var *caespitosus*	Hedgehog Grass	✔	✔
Entolasia marginata	Bordered Panic	✔	✔
Eragrostis brownii	Brown's Lovegrass	✔	✔
Imperata cylindrica var *major*	Blady Grass		✔
Oplismenus imbecillis	Basket Grass	✔	✔
* *Panicum repens*	Torpedo Grass		✔
* *Paspalum urvillei*	Vasey Grass	✔	✔
* *Pennisetum clandestinum*	Kikuyu Grass	✔	✔
* *Phalaris sp*	Canary Grass		✔
* *Setaria pumila*	Pale Pigeon Grass	✔	✔
* *Stenotaphrum secundatum*	Buffalo Grass	✔	
Themeda australis	Kangaroo Grass		✔
Typhaceae			
Typha orientalis	Broad-leaved Cumbungi	✔	

PACIFIC HIGHWAY RE-ALIGNMENT

WARRELL CREEK

APPENDIX 2
Inventory of Fauna Species recorded.

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APPENDIX 2 Fauna species recorded during surveys conducted along the proposed Pacific Highway upgrade route.

KEY

* Introduced species.

★ Threatened Species, as listed on the *Threatened Species Conservation Act 1995* (TSC Act).
E Schedule 1 - Endangered
V Schedule 2 - Vulnerable

A Species recorded in the study area during the investigations conducted for this report.

B Species recorded during previous surveys conducted in the general vicinity (G Leonard *pers comm*).

C Threatened fauna listed on the NSW NP&WS Wildlife Atlas within 10km of the study area (AMG's 479000 to 501000 and 6584000 to 6609000).

COMMON NAME	SCIENTIFIC NAME	A	B	C
BIRDS				
Anatidae				
Pacific Black Duck	*Anas superciliosa*	✔		
Phalacrocoracidae				
Great Cormorant	*Phalacrocorax carbo*	✔		
Ardeidae				
White-faced Heron	*Egretta novaehollandiae*		✔	
Great Egret	*Ardea alba*	✔		
★(V) Black Bittern	*Ixobrychus flavicollis*			✔
Threskiornithidae				
Australian White Ibis	*Threskiornis molucca*	✔		
Straw-necked Ibis	*Threskiornis spinicollis*	✔		
Royal Spoonbill	*Platalea regia*	✔		
Accipitridae				
★(V) Osprey	*Pandion haliaetus*			✔
Gruidae				
★(V) Brolga	*Grus rubicunda*			✔
Rallidae				
Purple Swamphen	*Porphyrio porphyrio*		✔	
Dusky Moorhen	*Gallinula tenebrosa*	✔		
Charadriidae				
Masked Lapwing	*Vanellus miles*		✔	
Columbidae				
★(V) Wompoo Fruit-Dove	*Ptilinopus magnificus*			✔
Cacatuidae				
★(V) Glossy Black-Cockatoo	*Calyptorhynchus lathami*			✔
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	✔		
Psittacidae				
Rainbow Lorikeet	*Trichoglossus haematodus*		✔	
Eastern Rosella	*Platycercus eximius*	✔	✔	
Cuculidae				
Fan-tailed Cuckoo	*Cacomantis flabelliformis*		✔	
Tytonidae				
★(V) Masked Owl	*Tyto novaehollandiae*			✔
★(V) Sooty Owl	*Tyto tenebricosa*			✔
Halcyonidae				
Kookaburra	*Dacelo novaeguineae*	✔	✔	
Sacred Kingfisher	*Todiramphus sanctus*	✔	✔	

APPENDIX 2 cont Fauna species recorded during surveys conducted along the proposed Pacific Highway upgrade route.

COMMON NAME	SCIENTIFIC NAME	A	B	C
Coraciidae				
Dollarbird	*Eurystomus orientalis*	✔		
Maluridae				
Fairy-wren	*Malurus* sp	✔		
Pardalotidae				
White-browed Scrubwren	*Sericornis frontalis*	✔		
Brown Thornbill	*Acanthiza pusilla*	✔		
Meliphagidae				
Lewin's Honeyeater	*Meliphaga lewinii*	✔		
Eastern Yellow Robin	*Eopsaltria australis*	✔		
Dicruridae				
Flycatcher	*Myiagra* sp	✔		
Magpie-lark	*Grallina cyanoleuca*	✔	✔	
Grey Fantail	*Rhipidura fuliginosa*	✔		
Willie Wagtail	*Rhipidura leucophrys*	✔	✔	
Campephagidae				
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	✔	✔	
Oriolidae				
Olive-backed Oriole	*Oriolus sagittatus*	✔		
Artamidae				
Pied Butcherbird	*Cracticus nigrogularis*	✔		
Australian Magpie	*Gymnorhina tibicen*	✔	✔	
Pied Currawong	*Strepera graculina*	✔		
Grey Currawong	*Strepera versicolor*		✔	
Corvidae				
Australian Raven	*Corvus coronoides*	✔		
Passeridae				
Red-browed Finch	*Neochmia temporalis*	✔		
Hirundinidae				
Welcome Swallow	*Hirundo neoxena*	✔	✔	
Tree Martin	*Hirundo nigricans*	✔		
Sylviidae				
Little Grassbird	*Megalurus gramineus*	✔		
Zosteropidae				
Silvereye	*Zosterops lateralis*		✔	
AMPHIBIANS				
Myobatrachidae				
Common Eastern Froglet	*Crinia signifera*	✔	✔	
Hylidae				
Green Tree Frog	*Litoria caerulea*	✔		
Peron's Tree Frog	*Litoria peronii*	✔		
Eastern Dwarf Tree Frog	*Litoria fallax*	✔		
REPTILES				
Agamidae				
Eastern Water Dragon	*Physignathus lesueurii*	✔		
Bearded Dragon	*Pogona barbatus*	✔		
Scincidae				
Garden Skink	*Lampropholis delicata*	✔		
Striped Skink	*Ctenotus robustus*	✔		
Common Blue-tongue Lizard	*Tiliqua scincoides*	✔		

APPENDIX 2 cont Fauna species recorded during surveys conducted along the proposed Pacific Highway upgrade route.

COMMON NAME	SCIENTIFIC NAME	A	B	C
Elapidae				
Red-bellied Black Snake	*Pseudechis porphyriacus*	✔		
MAMMALS				
Peramelidae				
Northern Brown Bandicoot	*Isoodon macrourus*	✔		
Phascolarctidae				
★(V) Koala	*Phascolarctos cinereus*			✔
Pseudocheiridae				
Common Ringtail Possum	*Pseudocheirus peregrinus*	✔		
Phalangeridae				
Mountain Brushtail Possum	*Trichosurus caninus*	✔		
Common Brushtail Possum	*Trichosurus vulpecula*	✔		
Macropodidiae				
Red-necked Wallaby	*Macropus rufogriseus*	✔		
Vespertilionidae				
Chocolate Wattled Bat	*Chalinolobus morio*	✔		
Gould's Wattled Bat	*Chalinolobus gouldii*	✔		
Little Forest Bat	*Vespadelus vulturnus*	✔		
★(V) Little Bent-wing Bat	*Miniopterus australis*	✔		

PACIFIC HIGHWAY RE-ALIGNMENT

WARRELL CREEK

APPENDIX 3

Assessment of Significance under Section 5A of the *Environmental Planning & Assessment Act 1979* (EP&A Act).

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PACIFIC HIGHWAY RE-ALIGNMENT
WARRELL CREEK

ASSESSMENT of SIGNIFICANCE under SECTION 5A of the EP&A ACT

April 1998

1 INTRODUCTION

The NSW *Threatened Species Conservation Act 1995* (TSC Act) has modified the *Environmental Planning & Assessment Act 1979* (EPA Act) by including, in Section 5A, eight factors which are to be considered when determining "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*". These factors "*must be taken into account*" by a determining or consent authority in administering Sections 77, 90 and 112 of the EP&A Act.

2 FACTORS for CONSIDERATION

(a) in the case of a threatened species, whether the life cycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction

There is no evidence for, or likelihood of, a "*viable local population*" of any threatened plant or animal species occurring in the area to be affected by the proposed roadworks at Warrell Creek. Furthermore, it is considered extremely unlikely that any threatened fauna or flora species would be dependent on the resources or features which are to be affected by the proposed activity.

The Green & Golden Bell Frog had been recorded from a wetland on Rosewood Creek, but recent investigations at this locality have failed to locate the species (Ehmann 1997; White *pers comm*). In any case, the current preferred alignment has been located away from the Rosewood Creek wetlands, and will not involve the imposition of any adverse impacts upon that wetland, or Green & Golden Bell Frogs (even if they are present).

Whilst some threatened birds and microchiropteran bats could potentially utilise the small areas of disturbed forest and woodland present along the proposed Highway upgrade route on occasions, either for foraging or to move through the area generally, the habitats and features present on the site are not considered of special significance or relevance. The majority of the area to be affected is highly degraded or modified, and does not support features or resources upon which any of the threatened species known to occur in the general locality could be considered to depend. Only small areas of modified vegetation are to be disturbed or affected, and these areas are considered of no significance with respect to the foraging or breeding requirements, or the movement needs, of any threatened fauna which could potentially occur in the locality. Similarly, no threatened flora species are regarded as likely to be present in the highly disturbed habitats present along the proposed alignment.

There is no likelihood that a "*viable local population*" of any threatened species will be "*disrupted*" to the extent that any such population (even if present) would be "*likely to be placed at risk of extinction*".

(b) in the case of an endangered population, whether the life cycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised

An "*endangered population*" is defined in the TSC Act as "*a population specified in part 2 of Schedule 1*".

At the time of writing, no endangered populations of native fauna or flora from within or near the Warrell Creek area have been listed on the TSC Act. Consequently, the proposed Highway upgrade cannot be assessed with respect to any "*endangered populations*" of fauna or flora.

(c) in relation to the regional distribution of the habitat of a threatened species population or ecological community, whether a significant area of the known habitat is to be modified or removed

In terms of "*the regional distribution*" of habitat, the subject site represents an inconsequential area. The TSC Act defines 'region' as "*a bioregion defined in a national system of bioregionalisation that is determined (by the Director-General by other published in the Gazette) to be appropriate for those species*". The Director-General of the NSW NP&WS, has given notice that the *Interim Biogeographic Regionalisation of Australia* (IBRA) published by the Australian Nature Conservation Agency (ANCA), is the appropriate definition of "*region*" for the TSC Act (Government Gazette No 65 - 24 May 1996).

On the basis of the IBRA, the subject site is located within the NSW North Coast region, which stretches from approximately Port Stephens in the south to the Queensland border in the north and inland to the western side of the Great Dividing Range. The proposed Highway upgrade route and associated areas of disturbance clearly supports only an extremely small proportion of the "*regional distribution of the habitat*" of any fauna or flora species or populations which could theoretically be present. Consequently, it appears highly unlikely that "*in relation to the regional distribution*" of potential or suitable habitat, "*a significant area of known habitat is to be modified or removed*" by the proposed roadworks and associated activities.

The proposed activity will not involve the removal of a "*significant area of known habitat*" for any threatened species. Little native vegetation is to be removed, and the few resources present along the alignment are widely distributed in bushland through the greater region.

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population of ecological community

Given the lack of evidence for the presence of "*a threatened species, population or ecological community*", and the existing infrastructure, residential and agricultural development in the vicinity, there is no likelihood that any "*area of known habitat*" will "*become isolated from currently interconnecting or proximate areas*".

The proposed upgrade of the Pacific Highway will not involve any additional fragmentation to fauna habitat other than that already provided by the existing Highway and North Coast Railway easements, and existing residential and agricultural land uses. The majority of the proposed alignment is cleared pasture and the small amount of vegetation to be removed is either already isolated and highly disturbed.

The proposed Highway upgrade will not involve "*an area of known habitat*" becoming isolated.

(e) whether critical habitat will be affected

The TSC Act 1995 defines "*critical habitat*" as "*habitat declared to be critical habitat under part 3*" of the Act.

At the time of preparation of this report, no "*critical habitat*" had been declared by the Director-General of the NSW NP&WS. As a consequence, "*whether critical habitat will be affected*" by the proposed activity is of no relevance.

(f) whether a threatened species, population or ecological community, or their habitats are adequately represented in conservation reserves (or other similar protected areas) in the region

In general terms, few threatened species are likely to be "*adequately conserved in conservation reserves (or other similar protected areas) in the region*". Conversely, the proposed activity is not considered likely to impose any adverse effect on any "*threatened species, population or ecological community*".

(g) whether the development or activity is of a class of development or activity that is recognised as a threatening process

The TSC Act 1995 defines "*threatening process*" as "*a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities*".

Schedule 3 of the TSC Act is intended to provide a list of the key threatening processes which are regarded as of relevance to the TSC Act and its implementation. Three threatening processes have been listed by the NSW Scientific Committee - predation by the European Red Fox *Vulpes vulpes*, the removal of bush rock and bycatch of long-line fishing. The proposed development is of no relevance to any of these processes. Road construction and use are not currently listed as a "*key threatening process*" under Schedule 3 of the TSC Act.

A range of other threatening processes have been identified generally, including habitat clearance and degradation, the introduction of weeds and the introduction and spread of feral animals. All of these processes have occurred widely throughout the study area for an extended period of time, and the habitats present have been extensively cleared and are highly degraded and weed-infested.

Whilst the proposed roadworks will involve the clearing of some extremely small areas of native and exotic vegetation, these areas are generally highly disturbed and degraded, and are isolated by large areas of previously cleared agricultural land. Given that no threatened flora or fauna species are considered likely to depend on these small patches of vegetation, their clearing or disturbance is extremely unlikely to further threaten any "*threatened species*" which may occur in the area, on occasions.

Feral animals including foxes, cats, dogs and rabbits are considered pests in the area by farmers and conservationists alike. The proposed development is not of a nature that will be likely to increase the presence of feral animals.

Given the nature and circumstances of the proposed activity, the upgrade of the Pacific Highway at Warrell Creek cannot reasonably be regarded as "*a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities*".

(h) whether any threatened species, population or ecological community is at the limit of its known distribution

The only threatened species known from the study area is the Little Bent-wing Bat *Miniopterus australis*. This species occurs along the east coast of Australia from Cape York in Queensland to just north of Newcastle in NSW (NP&WS 1994), and is not "*at the limit of its known distribution*"' in the study area.

Of those threatened fauna species known from the general vicinity, none is "*at the limit of its known distribution*" in this general locality. Similar considerations apply to threatened plants which could theoretically be present.

3 CONCLUSIONS

The eight factors which are required to be considered under the EP&A Act in the determination of "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*" as a result of the proposed upgrade of the Pacific Highway at Warrell Creek are discussed in detail above.

The proposed re-alignment of the Pacific Highway and the North Coast Railway in the vicinity of Warrell Creek are not considered likely to impose any adverse effect on any "*threatened species, populations or ecological communities, or their habitats*".

A Species Impact Statement is not required for the proposed activity.

PACIFIC HIGHWAY RE-ALIGNMENT

WARRELL CREEK

REVIEW of ENVIRONMENTAL FACTORS

SUPPLEMENTARY FAUNA and FLORA SURVEY

April 1998

Gunninah Environmental Consultants

PACIFIC HIGHWAY RE-ALIGNMENT

WARRELL CREEK

REVIEW of ENVIRONMENTAL FACTORS

SUPPLEMENTARY FAUNA and FLORA SURVEY

April 1998

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PACIFIC HIGHWAY RE-ALIGNMENT
WARRELL CREEK

REVIEW of ENVIRONMENTAL FACTORS

SUPPLEMENTARY FAUNA and FLORA SURVEY

April 1998

1 INTRODUCTION

The Roads & Traffic Authority (RTA) has proposed an upgrade of the Pacific Highway in the vicinity of Warrell Creek, between Kempsey and Coffs Harbour (Figure 1). The proposed roadworks form part of the Pacific Highway reconstruction program, a joint State and Federal Government initiative which is intended to improve traffic flow and to reduce accident levels along the Pacific Highway between Sydney and Brisbane.

The proposed roadworks will involve the construction of a four-lane dual carriageway between Warrell Creek (in the south) and Crouches Creek (in the north), the details for which are provided in the previous Fauna & Flora Assessment Report (GECon 1997), and in the Review of Environmental Factors (REF) prepared by Sinclair Knight Merz.

This supplementary report has been prepared to detail and discuss additional fauna and flora surveys conducted along the route, as required by the NSW National Parks & Wildlife Service (NP&WS). The additional surveys target a number of threatened fauna and flora species considered (by the NP&WS) as potentially present in the vicinity of the proposed roadworks, based on habitat modelling and previous records from the region, supplementary to the previous field investigations for these and other biota in the study area.

2 METHODS

2.1 Fauna

Additional fauna investigations were conducted on the 15th, 16th and 17th of April 1998, at three locations (survey sites) along the proposed Pacific Highway re-alignment route (Figure 1). These sites were selected as representative of the three broad habitat types occurring in the immediate vicinity of the route (*ie* disturbed riparian woodland/forest, modified freshwater wetlands and predominantly cleared agricultural land), and based on advice provided by the NP&WS.

Trapping for small terrestrial mammals and other small terrestrial fauna (Appendix 1) was conducted on three nights at each of the three survey locations, as discussed between the NP&WS and the RTA (Mr Greg Collins *pers comm*). All animals trapped were identified and released on location during the evening, with species details provided in Appendix 2.

Supplementary spotlighting was conducted in the vicinity of each of the three survey sites, and along adjoining roads and tracks (Appendix 1), with records of all observations maintained (Appendix 2). Specific amphibian surveys were conducted in the vicinity of the survey sites, in areas of potentially suitable habitat. Specific surveys involved visual and aural detection of species, and utilised call playback and spotlight searches (Appendix 1).

Opportunistic observations of fauna were maintained at all times throughout the survey period, while conducting trapping and spotlighting activities, and when travelling between sites (Appendix 2). Weather conditions are provided in Appendix 1.

2.2 Flora

A walked survey of the Pacific Highway re-alignment route was conducted on the 15th of April 1998, to specifically search for the threatened plant *Parsonsia dorrigoensis*. The search was conducted along the full length of the route, and extended to a distance of 20m on either side.

General observations throughout the walked survey also targeted other threatened plant species which could potentially or theoretically occur along the route.

3 FAUNA

No evidence for any threatened fauna species was recorded during the supplementary field investigations along the proposed re-alignment route, despite targeted trapping and additional spotlighting surveys.

Two observations of the Squirrel Glider *Petaurus norfolcensis* (listed on Schedule 2 of the TSC Act) were recorded in Way Way State Forest, however, approximately 4km from the existing Highway along Rosewood Road, and 3-4km from the proposed re-alignment. The observations were recorded on consecutive nights (16th and 17th of April 1998), and within several hundred metres of each other (amg's 492666, 6593951 and 492439, 6594210). Squirrel Gliders generally inhabit dry sclerophyll forest and woodland, and are dependent on medium sized tree-hollows for shelter and nesting. They are considered relatively tolerant of temporary habitat disturbance, particularly those activities which encourage regeneration and fresh regrowth (*eg* logging operations).

As discussed in the previous Fauna & Flora Assessment Report (GECon 1997), Way Way State Forest to the east of the study area includes relatively extensive tracts of native vegetation in moderate condition, and provides an array of habitat types. The presence of Squirrel Gliders in the State Forest is not unexpected, given that it fulfils their habitat requirements.

Conversely, the small, isolated and degraded areas of 'woodland' and 'forest' habitat to be removed from along the re-alignment route are not considered of any relevance to the Squirrel Glider, particularly given that they are also isolated from Way Way State Forest.

A total of 35 additional fauna species were recorded during the supplementary field investigations, including 28 birds, 2 amphibians and 5 mammals, yielding a total of 85 species of vertebrate fauna recorded during the combined 1997 and 1998 fauna surveying periods (Appendix 2). All of these are common to abundant and widespread, except for the Squirrel Glider (which was not recorded on the proposed alignment).

4 FLORA

No specimens of the Silky Milkpod *Parsonsia dorrigoensis* were located along the proposed re-alignment route during the specific walked survey. Additionally, no other threatened plant species were recorded during general random observations in the study area and along the route.

Silky Milkpod is a twining climber which exudes a characteristic milky latex from cut stems. It occurs in tall open-forest and temperate and sub-tropical rainforest, generally in more open areas and along the margins of rainforest communities. It is believed that Silky Milkpod may be favoured by some moderate disturbance, but is not likely to be present in cleared paddocks.

Given that no specimens of Silky Milkpod were recorded during the specific and thorough walked survey of the route (15th of April 1998) and that none have been recorded previously from the route or in the vicinity (GECon 1997; Leonard 1997; NPWS database), and given the nature and condition of the proposed route, it is considered highly unlikely that this species would be present along the Pacific Highway re-alignment route. There is no likelihood of this species being affected by the proposed roadworks.

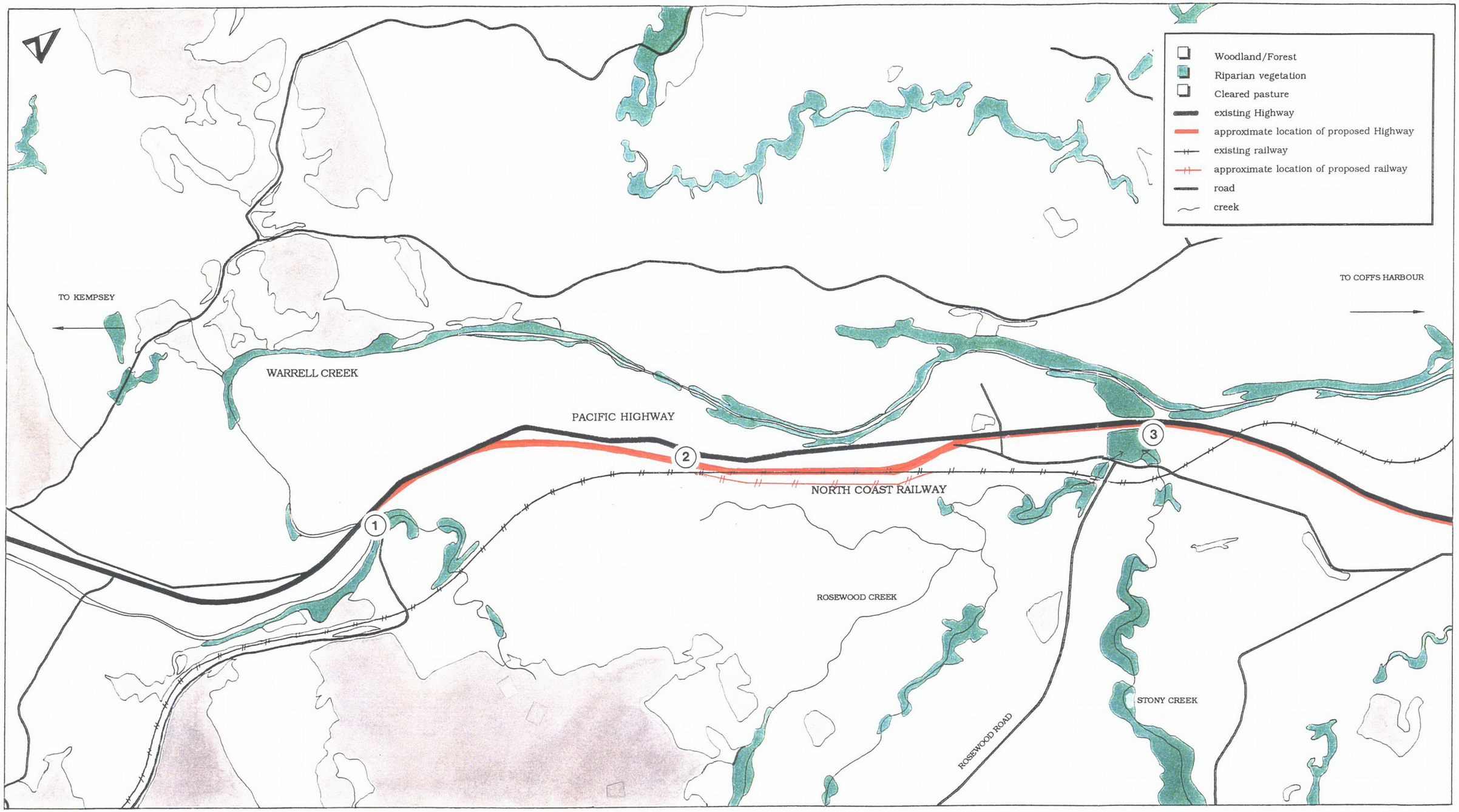

FIGURE 1 Location of the three supplementary survey sites along the proposed Pacific Highway Upgrade at Warrell Creek.

5 CONSERVATION SIGNIFICANCE

No fauna or flora species of national or state conservation significance were identified along the proposed Pacific Highway re-alignment route during the supplementary investigations conducted for this report. Only one threatened species, the Little Bent-wing Bat *Miniopterus australis* was recorded during the original investigation, this species is discussed in the previous Fauna & Flora Assessment Report (GECon 1997), and is considered highly unlikely to be significantly affected by the proposal.

As stated previously (GECon 1997), it is theoretically possible that some of the more mobile and wide-ranging threatened species known from the region may occur on the site on an occasional or transitory basis (*eg* some birds and microchiropteran bats). However, it is highly unlikely that any of these would be dependent on the few resources available along the alignment, given the large tracts of vegetation in better condition in Way Way State Forest and the general vicinity.

Threatened biota known from the region have been discussed in the main Fauna & Flora Assessment Report (GECon 1997), and have been considered in relation to the proposed roadworks. Given their apparent absence from the site, and given the nature and condition of the local landscape and the circumstances of the proposal, it is extremely unlikely that any "*threatened species, populations or ecological communities, or their habitats*" would be significantly affected by the proposed upgrade of the Pacific Highway at Warrell Creek.

6 CONCLUSION

The proposed construction of a four-lane dual carriageway between Warrell Creek and Crouches Creek, as detailed previously (GECon 1997), will involve some limited clearing of habitat for native fauna and flora. However, the habitats and areas to be cleared have been extensively disturbed and modified from their original condition, and are considered highly unlikely to be of any special relevance for any threatened fauna or flora species.

No evidence for any threatened flora species was recorded along the proposed Pacific Highway re-alignment route during the supplementary surveys conducted for this or the previous report. The only threatened fauna species recorded (1 record in 1997) was the Little Bent-wing Bat *Miniopterus australis*, which is a wide-ranging and highly mobile species. It is not considered likely to be dependent on the limited and degraded resources present along the alignment. On this basis, and given the lack of suitable habitat for most of the threatened species known from the region, the fauna and flora assessment provided previously (GECon 1997) adequately describes the biota present, and its significance.

Given the nature and condition of the study area, and the design of the activity, it is not likely that the proposed roadworks will impose "*a significant effect on threatened species populations or ecological communities, or their habitats*".

7 REFERENCES

GECon. 1997. *Fauna & Flora Assessment for the proposed Pacific Highway re-alignment at Warrell Creek.* Gunninah Environmental Consultants, Crows Nest.

Leonard G. 1997. *Flora Survey conducted for the Construction of a South-bound Carriageway of the Pacific Highway at Eungai, Shire of Nambucca.* Report for Environmental Planning and the RTA.

PACIFIC HIGHWAY RE-ALIGNMENT

WARRELL CREEK

APPENDIX 1
Details of survey methods for fauna and flora.

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APPENDIX 1 Details of survey methods employed during the initial and supplementary field investigations conducted along the proposed re-alignment route at Warrell Creek.

Field investigations for fauna and flora were initially conducted along the proposed route on the 4th and 5th of February 1998, with a later site inspection conducted in June 1997. Additional supplementary investigations have been conducted on the 15th, 16th and 17th of April 1998, with all initial and supplementary survey methods and weather conditions provided in Tables 1 to 5 of this Appendix.

1 BIRD SURVEYS

- Specific bird surveys were conducted along the road and railway easements on the 5th of February 1997, a total of 6 person-hours;
- opportunistic records were maintained at all times whilst in the study area, during both the 1997 and 1998 survey periods.

2 AMPHIBIAN SURVEYS

- Evening amphibian surveys were conducted around the wetland area associated with Rosewood Creek on the 4th and 5th of February 1997, and 15th, 16th and 17th of April 1998, a total of 9 person-hours;
- additional general amphibian surveys were conducted at Warrell Creek and in other potentially suitable areas during the 1998 survey;
- specific Green & Golden Bell Frog surveys were conducted in the vicinity of the Rosewood Creek wetlands in June 1997;
- call playback was employed at suitable locations during each of the survey periods (including playing of the Green & Golden Bell Frog call);
- opportunistic observations were maintained at all times.

3 REPTILE SURVEYS

Reptiles were surveyed opportunistically during the general habitat assessment of the upgrade route in 1997;
searches involved the turning of rocks, logs and rubbish, and investigation of fallen tree-hollows etc;
opportunistic observations were maintained at all times.

4 MAMMAL SURVEYS

4.1 Spotlighting

- The initial spotlighting surveys (on the evenings of the 4th and 5th of February 1997), concentrated on the few vegetated areas occurring along the re-alignment route, a total of 5.2 person-hours were spent spotlighting in February;
- supplementary spotlighting was conducted in April 1998 around each of the survey sites, and along adjoining roads and tracks, a total of 5 person-hours were spent spotlighting in April.

4.2 Microchiropteran Bat surveying

- Microchiropteran bats were surveyed indirectly through the use of an Anabat 11 Bat Detector;
- recording was conducted for 30 mins at each of 8 sites during the February 1997 survey, a total of 4 hours recording;
- specialist analysis by Glen Hoye;
- harp traps and mist nets were not utilised due to a lack of suitable flyways along the road and railway easements.

4.3 Trapping Transects

- Trapping for small terrestrial fauna (in particular the Common Planigale) was conducted at three locations (Figure 1), on each of three survey nights (15th, 16th and 17th of April), a total of 9 nights trapping;
- the transects at sites 2 and 3 included 10 Elliott traps and 6 Pitfall traps, whilst the transect at site 1 included 12 Elliott traps and 5 Pitfall traps, a total of 96 Elliott trap-nights and 51 Pitfall trap-nights;
- drift fences were utilised where considered appropriate;
- all species captured were identified, and are recorded in Appendix 2.

7 GENERAL FLORA SURVEYS

- A general walked survey of the study area was conducted in February 1997 (according to the methods described in Cropper 1993);
- dedicated searches were conducted in the few areas of native vegetation occurring along the alignment;
- specific searches were conducted for those threatened plant species known to occur in the general region.

7.1 Specific *Parsonsia Dorrigoensis* Searches

- Specific searches for Silky Milkpod *Parsonsia dorrigoensis* were conducted along the entire length of the proposed Pacific Highway re-alignment on the 15th of April 1998, and extended to several metres on either side;
- 4 person-hours were spent searching for this species.

8 WEATHER CONDITIONS

TABLE 1 Weather conditions recorded during field investigations conducted at Warrell Creek.

04/02/97	day	warm to hot, clear skies, no breeze.
	evening	warm to mild, clear skies, no breeze.
05/02/97	day	warm to hot, clear skies, no breeze.
	evening	warm to mild, clear skies, no breeze.
15/04/98	day	cool to mild, overcast, intermittent light showers.
	evening	cool, overcast, intermittent light showers.
16/04/98	morning	mild, scattered cloud, intermittent sun-showers.
	afternoon	cool to mild, overcast, intermittent light showers.
	evening	cool, overcast, intermittent showers, becoming heavy rain.
17/04/98	morning	cool to mild, scattered cloud, intermittent sun-showers.
	afternoon	cool to mild, overcast, occasional showers.
	evening	cool, overcast, intermittent showers, no breeze.
18/04/98	morning	warm, clear, fine.

PACIFIC HIGHWAY RE-ALIGNMENT

WARRELL CREEK

APPENDIX 2
Inventory of Fauna Species

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TABLE 1 Inventory of fauna species recorded during surveys conducted along the proposed Pacific Highway upgrade route.

KEY

* Introduced species

★ Threatened species, as listed on the *NSW Threatened Species Conservation Act 1995* (TSC Act)
V Schedule 2 - Vulnerable

A Species recorded during the previous Fauna & Flora Assessment investigations (GECon 1997).

B Species recorded during the supplementary investigations (April 1998).
survey site
1 riparian vegetation adjacent to the Warrell Creek Pacific Highway bridge (Figure 1)
2 agricultural land to the south of the Warrell Creek township (Figure 1)
3 wetland habitats in the vicinity of Rosewood Creek (Figure 1)

COMMON NAME	SCIENTIFIC NAME	A	B
BIRDS			
Anatidae			
Pacific Black Duck	*Anas superciliosa*	✔	
Phalacrocoracidae			
Great Cormorant	*Phalacrocorax carbo*	✔	
Ardeidae			
Cattle Egret	*Ardea ibis*		2
Great Egret	*Ardea alba*	✔	3
Threskiornithidae			
Australian White Ibis	*Threskiornis molucca*	✔	
Straw-necked Ibis	*Threskiornis spinicollis*	✔	2
Royal Spoonbill	*Platalea regia*	✔	
Accipitridae			
White-bellied Sea Eagle	*Haliaeetus leucogaster*		3
Brown Goshawk	*Accipiter fasciatus*		2
Rallidae			
Purple Swamp-hen	*Porphyrio porphyrio*		1, 3
Dusky Moorhen	*Gallinula tenebrosa*	✔	1, 3
Columbidae			
Brown Cuckoo-dove	*Macrophygia amboinensis*		1
White-headed Pigeon	*Columba leucomela*		1
Topknot Pigeon	*Lopholaimus antarcticus*		1, 3
Cacatuidae			
Yellow-tailed Black-Cockatoo	*Calyptorhynchus funereus*	✔	3
Psittacidae			
Rainbow Lorikeet	*Trichoglossus haematodus*		1
Australian King Parrot	*Alisterus scapularis*		1
Eastern Rosella	*Platycercus eximius*	✔	
Cuculidae			
Fan-tailed Cuckoo	*Cacomantis flabelliformis*		3
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*		3
Halcyonidae			
Kookaburra	*Dacelo novaeguineae*	✔	
Sacred Kingfisher	*Todiramphus sanctus*	✔	
Coraciidae			
Dollarbird	*Eurystomus orientalis*	✔	

TABLE 1 cont Inventory of fauna species recorded during surveys conducted along the proposed Pacific Highway upgrade route.

COMMON NAME	SCIENTIFIC NAME	A	B
Maluridae			
Fairy-wren	*Malurus* sp	✔	1, 3
Pardalotidae			
White-browed Scrubwren	*Sericornis frontalis*	✔	
Brown Gerygone	*Gerygone mouki*		1
Striated Thornbill	*Acanthiza lineata*		1, 3
Brown Thornbill	*Acanthiza pusilla*	✔	1
Meliphagidae			
Noisy Friarbird	*Philemon corniculatus*		1
Eastern Spinebill	*Acanthorhynchus tenuirostris*		1
Scarlet Honeyeater	*Myzomela sanguinolenta*		1
Lewin's Honeyeater	*Meliphaga lewinii*	✔	1, 3
Yellow-faced Honeyeater	*Lichenostomus chrysops*		1
Black-faced Honeyeater			3
Petroicidae			
Rose Robin	*Petroica rosea*		3
Eastern Yellow Robin	*Eopsaltria australis*	✔	1, 3
Cinclosomatidae			
Eastern Whipbird	*Psophodes olivaceus*		1, 3
Pachycephalidae			
Rufous Whistler	*Pachcephala rufiventris*		3
Golden Whistler	*Pachycephala pectoralis*		1, 3
Grey Shrike-thrush	*Colluricincla harmonica*		1, 3
Crested Shrike-tit	*Falcunculus frontatus*		3
Dicruridae			
Flycatcher	*Myiagra* sp	✔	
Magpie-lark	*Grallina cyanoleuca*	✔	1, 2, 3
Grey Fantail	*Rhipidura fuliginosa*	✔	1, 3
Willie Wagtail	*Rhipidura leucophrys*	✔	1
Campephagidae			
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	✔	3
Oriolidae			
Olive-backed Oriole	*Oriolus sagittatus*	✔	
Artamidae			
Pied Butcherbird	*Cracticus nigrogularis*	✔	
Australian Magpie	*Gymnorhina tibicen*	✔	3
Pied Currawong	*Strepera graculina*	✔	
Corvidae			
Torresian Crow	*Corvus orru*		1, 3
Australian Raven	*Corvus coronoides*	✔	
Ptilonorhynchidae			
Satin Bowerbird	*Ptilonorhynchus violaceus*		1
Passeridae			
Double-barred Finch	*Taeniopygia bichenovii*		3
Red-browed Finch	*Neochmia temporalis*	✔	1
Hirundinidae			
Welcome Swallow	*Hirundo neoxena*	✔	1
Tree Martin	*Hirundo nigricans*	✔	
Sylviidae			
Little Grassbird	*Megalurus gramineus*	✔	
Zosteropidae			
Silvereye	*Zosterops lateralis*		1, 3

TABLE 1 cont Inventory of fauna species recorded during surveys conducted along the proposed Pacific Highway upgrade route.

COMMON NAME	SCIENTIFIC NAME	A	B
AMPHIBIANS			
Myobatrachidae			
Common Eastern Froglet	*Crinia signifera*	✔	3
Brown-striped Frog	*Limnodynastes peronii*		3
	Uperoleia laevigata		3
Hylidae			
Green Tree Frog	*Litoria caerulea*	✔	
Peron's Tree Frog	*Litoria peronii*	✔	
Eastern Dwarf Tree Frog	*Litoria fallax*	✔	
REPTILES			
Agamidae			
Eastern Water Dragon	*Physignathus lesueurii*	✔	1
Bearded Dragon	*Pogona barbatus*	✔	
Scincidae			
Garden Skink	*Lampropholis delicata*	✔	1
Striped Skink	*Ctenotus robustus*	✔	
Common Blue-tongue Lizard	*Tiliqua scincoides*	✔	
Elapidae			
Red-bellied Black Snake	*Pseudechis porphyriacus*	✔	
MAMMALS			
Peramelidae			
Northern Brown Bandicoot	*Isoodon macrourus*	✔	
Petauridae			
★(V) Squirrel Glider	*Petaurus norfolcensis*		3
Pseudocheiridae			
Common Ringtail Possum	*Pseudocheirus peregrinus*	✔	
Phalangeridae			
Mountain Brushtail Possum	*Trichosurus caninus*	✔	
Common Brushtail Possum	*Trichosurus vulpecula*	✔	
Macropodidiae			
Red-necked Wallaby	*Macropus rufogriseus*	✔	
Vespertilionidae			
Chocolate Wattled Bat	*Chalinolobus morio*	✔	
Gould's Wattled Bat	*Chalinolobus gouldii*	✔	
Little Forest Bat	*Vespadelus vulturnus*	✔	
★(V) Little Bent-wing Bat	*Miniopterus australis*	✔	
Muridae			
Bush Rat	*Rattus fuscipes*		3
Water Rat	*Rattus lutreolus*		3
Introduced Mammals			
* Black Rat	*Rattus rattus*		3
* House Mouse	*Mus musculus*		3

TABLE 2 Details of the fauna species trapped during supplementary investigations (April 1998).

Survey site	Date	Species	Number	Trap type
1 Riparian	15/04/98	*Rattus fuscipes*	1	Elliot
	16/04/98	*Rattus fuscipes*	1	Elliot
	17/04/98	Nil	-	-
2 Pasture	15/04/98	*Rattus lutreolus*	1	Elliot
	16/04/98	*Rattus lutreolus*	1	Elliot
	17/04/98	*Rattus lutreolus*	3	Elliots
		Uperoleia laevigata	1	Pitfall
3 Wetland	15/04/98	*Rattus rattus*	2	Elliots
		Mus musculus	1	Elliot
	16/04/98	Nil	-	-
	17/04/98	*Rattus rattus*	1	Elliot
		Mus musculus	1	Elliot

Appendix C - Visual Assessment

STATE HIGHWAY 10 - PACIFIC HIGHWAY
SHIRE OF NAMBUCCA

WARRELL CREEK REALIGNMENT

LANDSCAPE AND VISUAL ASSESSMENT

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1 **Landscape Concept**

1.0 Visual Character Assessment

1.1 General

The 11 corridors were assessed in terms of a broad range of factors, including the visual assessment. On the basis of the overall assessment relating to the economic, environmental, engineering and cultural constrains, Option D has been selected as the preferred corridor. This corridor was later modified after community consultations in order to satisfy the various environmental, engineering and social requirements.

This section of the report describes the assessment of the visual character of the proposed highway realignment and the extent to which it would be visible. The assessment was carried out on the proposed route and conceptual road design information for the proposal.

The Visual Character Assessment evaluates the visual effect of the proposed realignment of Pacific Highway on the existing environment and the visual sensitivity of the potential viewers of the proposed highway realignment.

1.2 Visual Effect of the Proposed Highway Upgrade

The visual effect of the proposal can be evaluated from the interaction of the physical form of the proposal and the existing landscape through which it passes. It is described in terms of the level of contrast between the proposed highway realignment and the existing environment relating to form, scale, colour, and texture of the landscape elements. It also varies according to the distance of the viewer from the proposal.

Evaluation of the visual effects of the proposed highway realignment is presented in the description of ;

(1) Visual Character of the Proposed Realignment

(2) Visibility of the Proposed Realignment

1.2.1 Visual Character of the Proposed Realignment

The Proposed Route

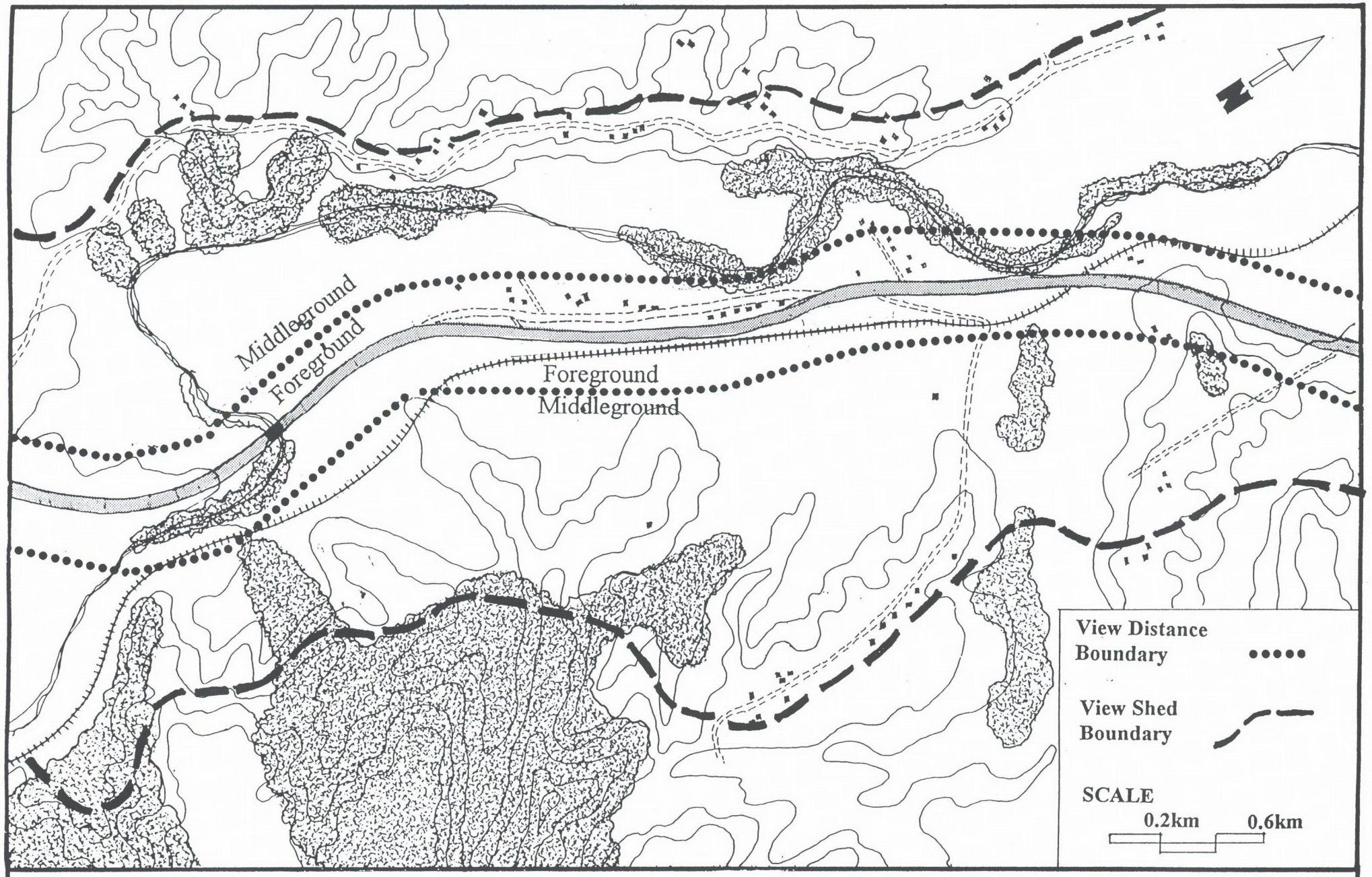
The proposed route for the Pacific Highway Upgrade at Warrell Creek is shown in plan in Figure A. The route commences at Upper Warrell Creek bridge and joins up with the existing highway intersection with Albert Drive. The total construction length of the proposed realignment is approximately 4 km.

The Proposed Highway Realignment

The preferred route for the highway upgrade Option D would involve relocation of the railway (located adjacent to Warrell Creek village) some 50 metres to the east and a realignment of the Pacific Highway from its current location to partly utilise the existing railway alignment. This approach would marginally move the highway further away from Warrell Creek village itself. The proposed road and rail alignment can be seen at the back of this report in Figure A.

The proposed highway realignment would consist of two lanes in each direction separated by a 17 metre wide median. Each traffic lane would be 3.5 metre wide with a 2.5 metre wide shoulder. The road reserve widths adjoining the residential side is 17 metres whilst adjoining the railway side is 25 metre. The proposed realignment would generally be in low fills and minor cuttings up to a height of 3m or at grade with the existing highway. There would be a bridge duplication for the northbound traffic at the Upper Warrell Creek. As well, there would be a need to install noise barrier/mitigation measures along the rear of the residential properties to minimise likely noise increase from the highway realignment.

The new highway realignment would be built in two stages. Initial development would be for a single carriageway to Albert Drive following this Review of Environmental Factors for the project. A dual carriageway and other bridge duplications would be built at a later stage. However, for ease of landscape/visual assessment, strategies and conceptual plan requirements, the ultimate highway realignment proposal would be evaluated and presented as a whole. This would ensure that better consistency, standard and the ultimate landscape intentions can be elaborated and conveyed to satisfy the various visual, environmental and community requirements in the report.



WARRELL CREEK REALIGNMENT

Figure A
Visual Character Assessment

1.2.2 Visibility of the Proposed Route

Background

Visibility factors reflect the manner in which the proposed route would be experienced, both in terms of motorists travelling on it and adjacent land users viewing it. Visibility relating to the adjoining land users is governed by landform, vegetation, distance and elevation of the viewer from the motorway, the viewing angle, the form and scale of the proposed route components within that view catchment.

On the other hand, the extent to which the surrounding areas are visible to the road user would significantly influence the motorist's experience. It is largely governed by landform and vegetation, and the distance between the motorist and the objects being viewed.

Viewing distance is a major factor influencing visibility, and three view distance scales have been considered to assess the level of interaction between the proposed realignment and surrounding landscape.

- **foreground** - areas immediately adjacent to and up to 200m from the route
- **middleground** - areas between 200 m and 2 km from the route
- **background** - areas more than 2 km from the route

Visibility of the Proposed Realignment

The visual catchment is that portion of the study area from which any section of the proposed road alignment and associated cut and fill are potentially visible. The visual catchment is determined by the relationship between landform, drainage systems and vegetation. Figure A illustrates the visual catchment of the proposed route as well as the extent of foreground, middleground and background zones within this overall visual catchment.

The primary areas from which the proposed highway realignment would be visible within the view catchment include:

- various local roads which traverse the area
- the railway corridor
- local residential dwellings of the Warrell Creek village and the surrounding farm properties
- other areas including farm paddocks

It is important to note that these potential views may be easily blocked at a local level by objects such as vegetation, buildings, structures, local landform or earthworks. The degree of visibility of the proposed realignment from each of these locations would vary according to a range of factors such a distance from the route, elevation of the view point, angle of view, existing of proposed screening vegetation and sound attenuation structures or earthbanks.

1.3 Visual Sensitivity

Visual sensitivity is a measure of the sensitivity of the viewer to changes in the visual environment as influenced by such factors as the distance to the viewer, the number of viewers, activity of viewers, duration of the view.

2.0 Visual Impact Assessment

2.1 General

The Visual Impact Assessment evaluated the likely visual impact of the proposed route on the existing environment. This involved:

(1) identifying landscape sub units along the proposed realignment

(2) assessing the likely visual impact of the proposed realignment

2.2 Existing Visual Environment Of The Study Area

The existing visual environment comprises a combination of natural and rural land use features. Natural features include landform, vegetation and hydrology characteristics. Landuse features comprise open farmland, disbanded orchards, Warrell Creek village fruit-stall, rest-house, and isolated rural dwellings. The juxtaposition of the landform, vegetation, hydrology, landuse features and the existing road formation all contributes to provide the visual character and sensitivity of the area.

2.2.1 Landform Characteristics

The area is located parallel to Warrell Creek, on relative flat terrain in a broad river valley. The new alignment is bounded by Upper Warrell Creek to the west, and Stoney Creek to the north. The landform is generally under 10 metres Australian Height Datum with rolling to elevated hills to the east and low undulating hills to the west of the Warrell Creek. Elevated hills adjacent to the study area gives rise to good regional and localised views from the road corridor and village centre. As well, these elevated landform to the east and west provides strong visual definition and enclosure to the study area.
Along the proposed alignment, most of the road corridor has been cleared, except for pockets of native regeneration next to the rail reserves. A number of shallow depressions are identified within the road corridor next to Rosewood Creek and Stony Creeks. These low depressions that retain much of run-off from the adjoining catchment support existing wetland ecology found at the site.

2.2.2 Vegetation Characteristics

The road corridor is located on grazing land, railway reserves and a few residential properties. A few matured exotic trees are located within the road corridor and patches of previously cleared land within the rail reserve have now regenerated with native species.
Isolated remnant rainforest species such as lily pilly, white cedar, and culturally significant exotic trees are to be found scattered in the farm paddock outside the corridor. Otherwise the road corridor is predominantly vegetated with introduced grasses through the farming practices. A number of noxious weeds are found along the road corridor and its vicinity. These are Rhodes Grass, and Brown's Lovegrass, etc.
Wetlands in the vicinity of the corridor are associated primarily with some of the small creeklines and drainage lines in the vicinity. The wetlands with only small areas of open water supports rushes, sedges, cumbungi and disturbed weed-infested riparian vegetation

2.2.3 Hydrology Character

The study ares is bounded by the Upper Warrell Creek in the south and west, and Stoney Creek in the north. The area is subject to occasional floodings due to low elevation of the corridor and its close proximity to the creeks.

2.2.4 Landuse Character

Landuse within the study area is predominantly rural and sparsely populated by small farm lots. Open diary /ostrich farms and abandoned orchards are the two major landuses that contrasted strongly with the dense natural forest on steep hills in the distance background. Warrell Creek village which nestles close to Warrell Creek, is the historical, cultural, and social focus for the village residents. There are currently less than 40 residential houses flanking the Pacific Highway in the village. There are two sawmills, a fruit stall, a guest house, and a community hall, servicing the needs of the local population and the passer-bys.

2.2.5 Visual Character

The study area is located within a well-defined valley, featuring dense vegetation on steep hills in the background and rural patterning of open farmland on undulating terrain in the immediate foreground. The Upper Warrell Creek provides good local identity and feature to the village. The creek is in most sections visually defined by dry rainforest trees and tall eucalypts that have survived past land clearing for farm establishment. Excellent glimpses of the creek can be obtained from the Pacific Highway and existing bridge crossing over the Upper Warrell Creek.
A significant scenic element from the area is the strong distance hill system that extends in a north-south direction to the east, and the undulating hills to the west of the proposed corridor. The landform provides strong visual containment as well as significant background views from the highway and the village.

The dominance of the adjoining forested hills, creeks, strong rural patternings of cleared farmland on undulating landform, the village, and presence of culturally significant trees in private properties have all contributed to the unique landscape of the area.

2.3 Landscape Sub Units

2.3.1 Background

Within the dominance of the landscape character described above, four landscape sub units are identified. Each landscape sub unit depicts a homogenous landscape identity unique to the area. Each sub unit is described in terms of the landform and the land cover that reflects a combination of land use and vegetation. The landscape sub units as shown in Figure B are:

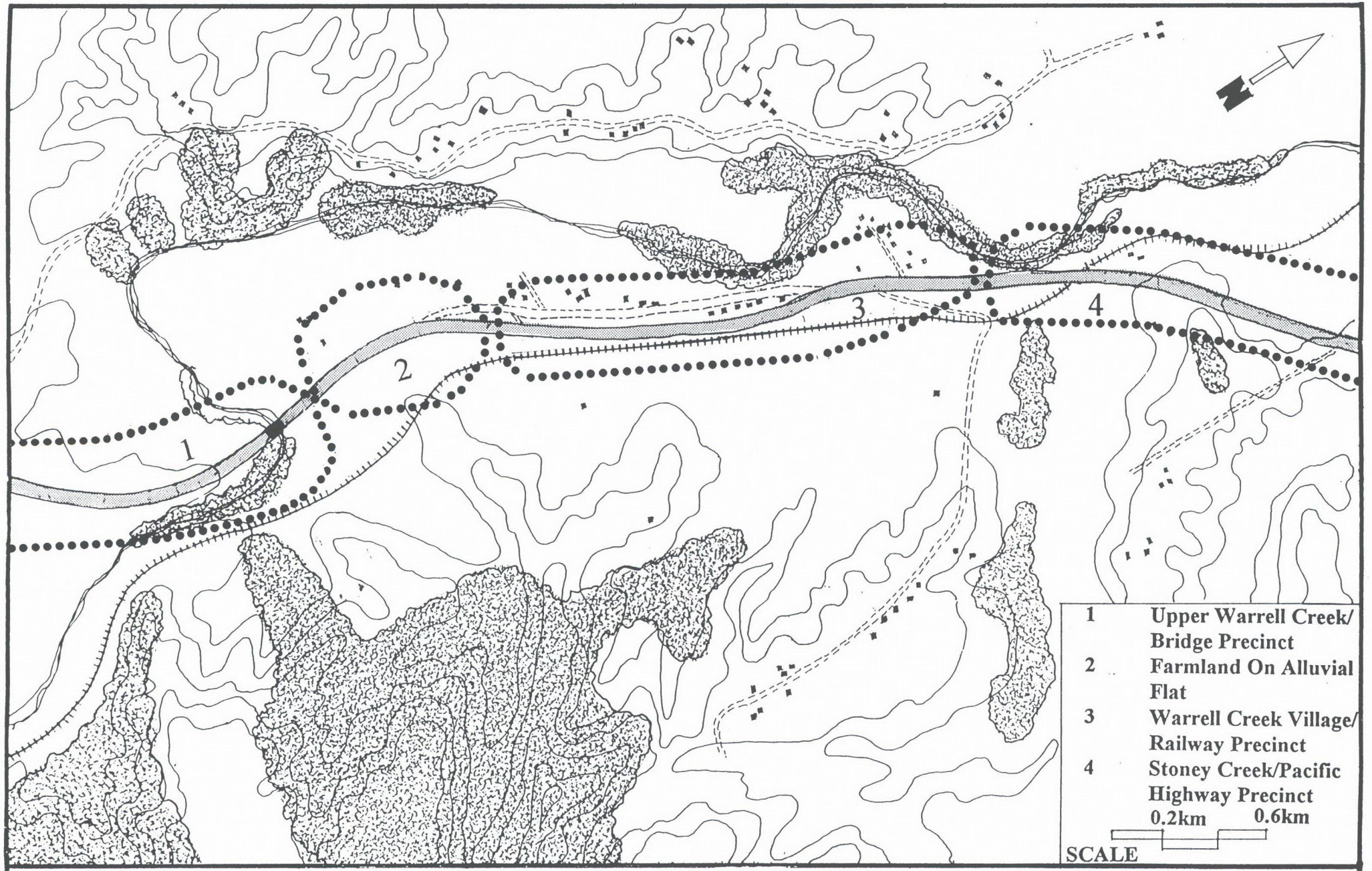
1. **Upper Warrell Creek / Bridge Precinct**
2. **Farmland On Alluvial Flat**
3. **Warrell Creek Village / Railway Precinct**
4. **Stoney Creek / Pacific Highway Precinct**

The descriptions of these sub units and the extent of the visual impact of the proposed highway realignment are described in the following section.

2.4 Visual Impact of the Proposed Highway Realignment

2.4.1 Background

The visual impact of the proposed alignment is determined by the degree of contrast between the existing landscape and the form of the proposed road alignment and the proximity of potential viewers. Visual impact is measured by the combined effect of visual effect of the new road and visual sensitivity of the surrounding land uses, and is expressed in terms of very high, high, moderate and low visual impact as provided in the following Table A.



WARRELL CREEK REALIGNMENT

Figure B
Landscape Sub Units

Table A - Visual Impact of the Proposed Route

Visual Effect	Visual Sensitivity			
	Very High	**High**	**Moderate**	**Low**
Very High	Very High	Very High	High	Moderate
High	Very High	High	High	Moderate
Moderate	High	High	Moderate	Low
Low	Moderate	Moderate	Low	Low

The following is the description of the visual impact of the proposed route on each of the landscape sub units within the study area. It is summarised in Table B.

1. Upper Warrell Creek / Bridge Precinct

Visual Effect

Located on the existing highway and on the alluvial flats adjacent to the Upper Warrell Creek, this section of the proposed road would closely follow the existing grade and alignment. A new bridge would be duplicated for the north bound traffic at location immediately west of the existing bridge. The new bridge would be similar in form and scale to the existing bridge and would constructed on a cleared creek embankment.
South of the creek, the proposed route would also closely follow the existing grade and alignment. The road would generally incur minor cut and fill embankments over the flat landform. Overall, the relatively flat landform and the gentle curve of the road alignment would enable this section of the proposed route and the bridge structure to be readily integrated with the surrounding landscape.

There is potential for landscape treatment to ameliorate visual impacts in this landscape sub unit to assist the integration of the proposed road into the overall landscape setting. The corresponding visual effect of this section of the proposed road is considered to be moderate.

Visual Sensitivity

This section of the highway realignment proposal involves primarily in widening of the existing highway and any road and landscape changes are clearly visible to motorists.
Residences on the surrounding hills would have elevated views of the proposed highway realignment from the middleground and background distances. Two dwellings and the existing sawmill north of the bridge would have clear foreground views of the highway.
The visual sensitivity of this area is considered moderate due to the fact that a few houses would have middleground and background views of the road widening.

Visual Impact

The visual impact of this section of the proposed road is moderate due to the combination of moderate visual effect and moderate visual sensitivity.

2. Farmland On Alluvial Flat

Visual Effect

The proposed route would move away from the existing highway and traverse across farm paddocks and the railway reserve on the alluvial flat. The proposed road would be constructed on fill embankment of up to 1.5 metres in height. These low fills associated with the roadworks would generate minor contrast with the adjoining flat landscape.
The minor extent and scale of some of the earthworks would result in a visual effect that would be easily integrated into the landscape setting. The visual effect of this section of the proposed road would be moderate. There is potential for landscape treatments to ameliorate visual effect in this section of the proposed road.

Visual Sensitivity

The proposed road is readily visible to five nearby farm properties that are at similar grade with the carriageways on open flat terrain. The road would also be readily visible to a range of viewpoints at middleground and background distances by the surrounding residential houses situated on elevated hillside especially the McDonnell residence. The visual sensitivity of this area is moderate.

Visual Impact

The combination of moderate visual effects and moderate visual sensitivity would produce a moderate visual impact for this section of the proposed road.

3. Warrell Creek Village / Railway Precinct

Visual Effect

The proposed road alignment is located immediately at the rear of residential houses of Warrell Creek village. A section of the carriageway would be located on the existing railway reserve and would require the relocation of the affected railway section to the east of the existing rail line. Four houses would be removed under the proposal to make way for the new road realignment. The road would incur minor fill embankments over the flat landform. Nevertheless, the combined scale of road and railway realignments would generate a significant visual contrast with the adjoining flat landscape. The visual effect of this section of the proposed road would be high.

Visual Sensitivity

This section of the proposed road on flat terrain is clearly visible to all residents living next to the new road alignment. Approximately 20 residents would have foreground views of the new road either in the front and at the rear of their properties. As well, residents living on the surrounding hills would have views of the proposed road from the middleground and background distances. The visual sensitivity of this area is considered high.

Visual Impact

The combination of high visual effect and very high visual sensitivity would produce a high visual impact for this section of the proposed road.

4. Stoney Creek / Pacific highway Precinct

Visual Effect

This section of the proposed road basically follows the existing Pacific Highway. The proposal would involve widening the eastern side of the existing carriageway with fill embankments adjacent to abandoned orchard of up to 5 metre deep. As well, 3:1 cut batters of up to 6 metres high by 40 metres wide would be required. The proposed scale of cut batters and fill embankments would generate a moderate level of contrast against the existing undulating landscape. However, there remains opportunities to ameliorate the visual impacts in this landscape with appropriate landscape treatment to ensure that the proposed road can be readily integrated with the surrounding landscape. The visual effect of this section of the proposed road would be moderate.

Visual Sensitivity

The proposed route is readily visible to the motorists in the immediate foreground. It is also visible to a range of viewpoints at middleground and background distances by the surrounding residential houses situated on elevated hill of the Donnellyville suburb. The visual sensitivity of this area is considered moderate.

Visual Impact

The combination of moderate visual effect and moderate visual sensitivity would produce a moderate visual impact for this section of the proposed road.

Table B - Summary of Visual Impacts of the Proposed Route

SUB UNITS		VISUAL	IMPACT	
	V High	High	Moderate	Low
Upper Warrell Creek/Bridge Precinct			Moderate	
Farmland On Alluvial Flat			Moderate	
Warrell Creek Village/Railway Precinct		High		
Stony Creek/Pacific Highway Precinct			Moderate	

From the above assessment, the following adverse impacts within each of the landscape sub units have been identified:

- Four houses of the Warrell Creek village would be demolished to make way for the construction of the new highway realignment.
- A few culturally significant matured trees would be removed. A long term landscape strategy of replanting with similar species would be required to compensate for loss of these trees in the landscape.
- Approximately 16 houses would be impacted upon to the front and back of the properties because of the close proximity of the proposed highway. An appropriate landscape plan would be required to minimise this adverse impact by screening while at the same time taking consideration the need to retain existing excellent views of the hills and open farmland from the rear of the properties.
- Sections of cut batters and fill embankments along existing Pacific Highway between Stoney Creek and Rosewood Road created by road widening would generate a moderate visual impact to the existing undulating landscape.

Visual Impact During Construction

During construction, the short term visual impact would include the loss of approximately 18 mature trees scattered along the road corridor in farm paddock and existing highway reserve as well as exposed cut and fill embankments. However, the immediate implementation of landscape revegetation and planting works as outlined in the landscape strategies and concept plan below would assist to minimise these short term visual impacts. Growth of native revegetation and planting are anticipated to gradually modify and enhance the roadscape environment in accordance with the proposed landscape concept.

Visual Impact Of Noise Barriers

The noise report identifies noise mitigation measures for the following locations:

- All the houses along the highway 150 metres north of Albert Drive
- Rear of all the Warrell Creek properties less than 50 metres from the proposed roadway.
- Front of McDonald residence.

In general, the report recommends sections of noise barriers of varying heights up to a maximum of 5 metres above the proposed roadway for these locations. If installed, the solid noise barrier would generate adverse visual impact to the surrounding environment and would be visible to both the local residents and motorists. The proposed barrier would be visible as an adverse intrusion to the idyllic village because of its imposing scale and incongruous form in this rural landscape. The barrier would effectively block the excellent rural and mountain views currently available to the properties affected by the noise. Although it is possible to minimise visual impact of the barrier by appropriate landscape treatment with dense shrubs and tall trees, the likely loss of valuable views and adverse impact on the rural landscape of Warrell Creek should be avoided. From the landscape view point, it is preferable that solid noise barrier should be avoided in order that the unique visual environment and character of Warrell Creek village is not compromised.

Other alternative noise reduction solution such as double glazing all windows and insulation of noise affected properties should be investigated as part of the noise/visual impact mitigation strategies. This solution would retain all the existing views and would not generate any adverse impact to the surrounding landscape. However, the decision to install whatever noise attenuation measure is best left to the process of community consultation for determination so that local resident's requirements can be satisfied.

3.0 Landscape Mitigation Strategies

The visual impacts of the proposed highway realignment can be minimised by sympathetic landscape treatment carried out in conjunction with the road construction works. The landscape strategies seek to maintain and reinforce the character of the existing environment of Warrell Creek village and its surround along the proposed route, rather than develop a uniform vegetation treatment along the whole corridor.

In mitigating the disturbance created by construction of the proposed highway realignment, the following visual guidelines and treatments have been developed.

These guidelines and treatments address visual impacts identified. They are intended to improve the visual amenity of the proposed route for the motorists, the adjacent land users, and local residents. A landscape concept plan has also been developed for the proposed realignment. This concept plan together with the visual guidelines briefly described below would ensure that the visual impact generated by the project can be minimised and the landscape environment protected and enhanced for the project.
The Warrell Creek highway reconstruction project would be staged over a number of years. Stage 1 of the project will involve construction of the southbound carriageway, to be followed by stage 2 northbound highway reconstruction at a later date. Permanent landscape work would be implemented for all road reserve and median in accordance with the landscape concept plan immediately followed completion of all roadworks for the southbound carriageway. It is also intended that temporary landscape revegetation works would be implemented for all disturbed areas along the northbound carriageway in order to minimise visual impact generated by the earthwork, the spread of weed and erosion problem for all disturbed area.

The visual guidelines are :

1. Provide a thematic landscape design approach to the planting layout and species selection in order to visually reinforce the unique character of Warrell Creek village.

2. Enhance the visual environment of the road corridor by creating a visually bold and attractive landscape character along the highway for the enjoyment of motorists using it.

3. Retain existing excellent views by the motorists and local residents to the mountains, open farm properties and creeks wherever possible.

4. Provide visual definition and formality to Warrell Creek village at important road intersection and entry from the new highway realignment.

5. Provide visual separation with appropriate landscape treatment between the new highway realignment and the affected properties.

6. Retain existing culturally significant trees such as Araucaria cunninghamii, Ficus spp, Pinus spp, Jacaranda mimosifolia etc as far as possible.

7. Initiate a minor on site seed collection of local tree species for future landscape planting works. Minimise ongoing landscape maintenance requirements by selecting plant material that is adapted to the prevailing growing conditions.

8. Initiate top soil management to minimise spread of noxious weeds found at the site.

9. Revegetation and stabilisation of all cut batters and fill embankments with locally collected seed to ensure similar species composition ; to reduce the visual impact of the cut and fill slopes associated with the proposed highway realignment and to enhance native fauna corridor.

10. Maximise the wildlife habitat value of the landscape treatment where possible by selecting indigenous plant species of known habitat value especially along Warrell Creek and beneath the Highway Bridge.

11. Planting of culturally significant trees to replace those required to be removed as well as endemic species to maintain vegetation that is both compatible visually with the existing cultural/natural landscape. Avoid introducing new or invasive species.

12. Install screen planting along road reserves for affected properties that are directly exposed to views of the carriageway. Maintain existing excellent views to the mountain currently available at the back of the affected properties

13. Install screen planting/revegetation for headlight glare reduction along the median and where possible between the new railway and the highway realignment.

Informal tree groupings with eucalypts to enframe existing views to the broad rural farmland

Formal planting with clear trunk trees with Eucalyptus microcorys or lilly pillies and low shrub understorey to visually to
- register arrival at Warrell Creek village precinct
- maintain/frame existing excellent mountain view from the residential properties
- provide visual separation to the properties from the highway and railway corridor

Landscape treatment with tall Eucalyptus saligna plantings at bridge crossing to visually signal entry to Warrell Creek village

Informal tree groupings with eucalypts

Native revegetation along median to 1m high to retain view for the neighbourhood

Native revegetation to provide visual linkage to existing revegetated bushland along the Highway

Cultural tree planting with Araucaria cunninghamii and colourful ground cover at this significant visual node to visually register entry to the village

Wetland tree planting with Casuarina glauca to visually relate to the immediate foreground of Warrell Creek

Native revegetation on batters with tall shrubs

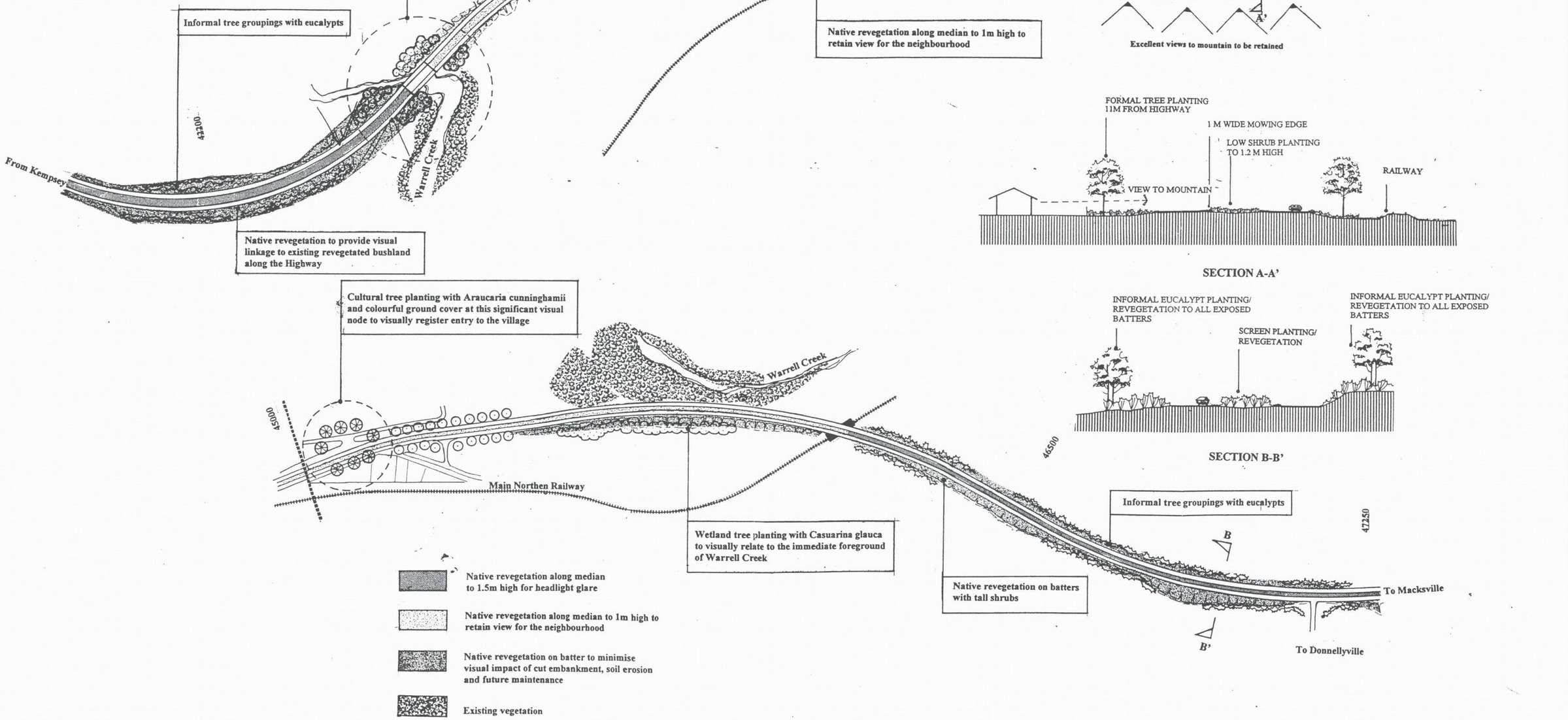
Informal tree groupings with eucalypts

Native revegetation along median to 1.5m high for headlight glare

Native revegetation along median to 1m high to retain view for the neighbourhood

Native revegetation on batter to minimise visual impact of cut embankment, soil erosion and future maintenance

Existing vegetation



SECTION A-A'

SECTION B-B'

PLAN REVIEW			
Date:	Review No:	Initial	Detail

AMENDMENTS			
Date:	Issue No:	Initial	Description

RTA TECHNOLOGY

ECOLOGICAL LANDSCAPE
ROAD TECHNOLOGY BRANCH

SCALE: 1:4000
0 80 160 240 320 400

Checked:

Date:

Authorised:

Date: Jan/98

ROADS AND TRAFFIC AUTHORITY

SH. 10 PACIFIC HIGHWAY
WARRELL CREEK REALIGNMENT
42.9KM TO 47.0KM NORTH OF KEMPSEY
LANDSCAPE CONCEPT

Region: NORTHERN	City, Muni, Shire: NUMBUCCA	Sheet No: 1
Issue No:	Date: OCT 97	of 1
Drawing No: 0010 317 LP 0001		

Appendix D - Water Quality Results

Warrell Creek Water Quality Monitoring

Site 1 - Warrell Creek upstream of Upper Warrell Creek Bridge

Dry

1997	March	April	May	June	July	August	Median	ANZECC Criteria (freshwater)
Turbidity (NTU)	**5.7**	**6**	**3.7**	**6.2**	**2.9**	**1.2**	**4.7**	**<10% change seasonal mean**
TN (mg/L)	0.8	0.3	1.4	0.1	<0.10	0.5	0.4	0.1 - 0.75
TP (mg/L)	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.01 - 0.1
Total Hydrocarbons (mg/L)	<0.1	<0.1	3.20	0.50	0.70	0.60	0.55	
Copper (mg/L)	<0.005	<0.005	<0.005	0.0	0.0	<0.001	<0.005	0.002 - 0.005
Zinc (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.005 - 0.05
Lead (mg/L)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.001 - 0.005
Cadmium (mg/L)	0.004	0.001	0.001	0.010	0.001	0.002	0.001	0.0002 - 0.002
Aluminium (mg/L)	0.03	0.29	0.1100	0.15	0.13	0.1100	0.12	< 0.005 (if pH <= 6.5) 0.1 (if pH >6.5)
Iron (mg/L)	1.700	1.900	1.200	0.900	1.100	0.400	1.150	1

Wet

1997	May	June	Median	ANZECC Criteria (freshwater)
Turbidity (NTU)	**N/A**	**6.5**	**6.5**	**<10% change seasonal mean**
TN (mg/L)	0.34	0.55	0.46	0.1 - 0.75
TP (mg/L)	0.02	<0.01	0.02	0.01 - 0.1
Total Hydrocarbons (mg/L)	0.50	<0.2	0.350	
Copper (mg/L)	<0.005	0.0	0.00	0.002 - 0.005
Zinc (mg/L)	<0.1	<0.1	<0.1	0.005 - 0.05
Lead (mg/L)	<0.005	0.0	<0.005	0.001 - 0.005
Cadmium (mg/L)	0.001	<0.001	<0.001	0.0002 - 0.002
Aluminium (mg/L)	0.02	0.274	0.147	< 0.005 (if pH <= 6.5) 0.1 (if pH >6.5)
Iron (mg/L)	1.200	0.600	0.900	1

Numbers in shaded boxes represent exceedance of acceptable ANZECC crtiteria

Warrell Creek Water Quality Monitoring

Site2 - Warrell Creek downstream of Upper Warrell Creek Bridge

Dry

1997	March	April	May	June	July	August	Median	ANZECC Criteria (freshwater)
Turbidity (NTU)	8.1	6.4	3.0	5.7	2.5	1.0	4.4	<10% change seasonal mean
TN (mg/L)	0.71	0.37	0.40	0.32	0.10	0.60	0.39	0.1 - 0.75
TP (mg/L)	0.13	0.02	0.01	0.02	<0.1	0.16	0.06	0.01 - 0.1
Total Hydrocarbons (mg/L)	<0.1	<0.1	2.1	0.5	0.4	<0.1	0.25	
Copper (mg/L)	<0.005	0.008	<0.005	0.004	0.010	0.008	<0.005	0.002 - 0.005
Zinc (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.005 - 0.05
Lead (mg/L)	<0.100	<0.005	<0.005	<0.005	<0.005	0.008	<0.005	0.001 - 0.005
Cadmium (mg/L)	0.006	<0.0004	0.0009	0.01	0.0005	0.0030	0.00055	0.0002 - 0.002
Aluminium (mg/L)	0.089	0.140	0.011	0.130	0.220	0.120	0.125	< 0.005 (if pH <= 6.5) 0.1 (if pH >6.5)
Iron (mg/L)	1.6	1.7	0.7	0.7	1.0	0.2	0.9	1.0

Wet

1997	May	June	Median	ANZECC Criteria (freshwater)
Turbidity (NTU)	N/A	5.9	5.9	<10% change seasonal mean
TN (mg/L)	0.45	0.57	0.51	0.1 - 0.75
TP (mg/L)	0.02	<0.01	0.015	0.01 - 0.1
Total Hydrocarbons (mg/L)	2.9	<0.2	1.55	
Copper (mg/L)	<0.005	0.003	0.004	0.002 - 0.005
Zinc (mg/L)	<0.1	<0.1	<0.1	0.005 - 0.05
Lead (mg/L)	<0.005	0.002	0.0035	0.001 - 0.005
Cadmium (mg/L)	0.0007	<0.001	0.00085	0.0002 - 0.002
Aluminium (mg/L)	0.050	0.174	0.112	< 0.005 (if pH <= 6.5) 0.1 (if pH >6.5)
Iron (mg/L)	0.9	0.6	0.75	1.0

Numbers in shaded boxes represent exceedance of acceptable ANZECC crtiteria

Warrell Creek Water Quality Monitoring

Site 3 - Rosewood Creek, upstream of railway

Dry

1997	March	April	May	June	July	August	Median
Turbidity (NTU)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TN (mg/L)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TP (mg/L)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total Hydrocarbons (mg/L)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Copper (mg/L)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Zinc (mg/L)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Lead (mg/L)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cadmium (mg/L)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Aluminium (mg/L)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Iron (mg/L)	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Wet

1997	May	June	Median	ANZECC Criteria (freshwater)
Turbidity (NTU)	**N/A**	**5**	**5**	**<10% change seasonal mean**
TN (mg/L)	0.2	0.42	0.31	0.1 - 0.75
TP (mg/L)	0.02	0.03	0.03	0.01 - 0.1
Total Hydrocarbons (mg/L)	2.70	<0.2	1.450	
Copper (mg/L)	<0.005	0.0	0.00	0.002 - 0.005
Zinc (mg/L)	<0.1	<0.1	<0.1	0.005 - 0.05
Lead (mg/L)	<0.005	<0.001	0.0	0.001 - 0.005
Cadmium (mg/L)	0.001	<0.001	0.0045	0.0002 - 0.002
Aluminium (mg/L)	0.03	0.195	0.1125	< 0.005 (if pH <= 6.5) 0.1 (if pH >6.5)
Iron (mg/L)	0.800	0.500	0.650	1

Numbers in shaded boxes represent exceedance of acceptable ANZECC crtiteria

Warrell Creek Water Quality Monitoring

Site 4 - Rosewood Creek upsteam of Pacific Highway

Dry

1997	March	April	May	June	July	August	Median	ANZECC Criteria (freshwater)
Turbidity	5.0	3.8	3.6	3.2	1.8	7.9	3.7	<10% change seasonal mean
TN (mg/L)	0.27	0.39	0.6	0.31	0.22	0.98	0.35	0.1 - 0.75
TP (mg/L)	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.01 - 0.1
Total Hydrocarbons (mg/L)	<0.1	<0.1	3.6	0.2	1.2	<0.1	0.15	
Copper (mg/L)	<0.005	<0.005	<0.005	<0.001	0.006	<0.001	<0.005	0.002 - 0.005
Zinc (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.005 - 0.05
Lead (mg/L)	<0.005	<0.005	<0.005	<0.005	<0.005	0.006	<0.005	0.001 - 0.005
Cadmium (mg/L)	0.02	<0.0004	0.0010	0.01	<0.0004	0.0030	0.0020	0.0002 - 0.002
Aluminium (mg/L)	0.120	0.130	0.072	0.100	0.150	0.220	0.125	< 0.005 (if pH <= 6.5) 0.1 (if pH >6.5)
Iron (mg/L)	2.5	2.5	1.3	0.9	0.9	1.3	1.3	1.0

Wet

1997	May	June	Median	ANZECC Criteria (freshwater)
Turbidity	N/A	5.3	5.3	<10% change seasonal mean
TN (mg/L)	0.52	0.55	0.535	0.1 - 0.75
TP (mg/L)	0.02	0.03	0.025	0.01 - 0.1
Total Hydrocarbons (mg/L)	6.6	<0.2	3.4	
Copper (mg/L)	<0.005	0.004	0.0045	0.002 - 0.005
Zinc (mg/L)	<0.1	<0.1	<0.1	0.005 - 0.05
Lead (mg/L)	<0.005	0.008	0.0065	0.001 - 0.005
Cadmium (mg/L)	0.002	<0.001	0.0015	0.0002 - 0.002
Aluminium (mg/L)	0.050	0.133	0.0915	< 0.005 (if pH <= 6.5) 0.1 (if pH >6.5)
Iron (mg/L)	1.7	0.5	1.1	1.0

Numbers in shaded boxes represent exceedance of acceptable ANZECC crtiteria

Warrell Creek Water Quality Monitoring

Site 5 - Stony Creek downsteam of Pacific Highway

Dry

1997	March	April	May	June	July	August	Median	ANZECC Criteria (freshwater)
Turbidity (NTU)	9.1	6.3	6.8	3.5	1.5	9.3	6.6	<10% change seasonal mean
TN (mg/L)	<0.10	0.25	0.42	<0.10	0.1	0.24	0.17	0.1 - 0.75
TP (mg/L)	0.10	0.02	0.02	<0.01	<0.10	0.01	0.02	0.01 - 0.1
Total Hydrocarbons (mg/L)	<0.1	0.4	0.2	0.5	0.3	<0.1	0.25	
Copper (mg/L)	<0.005	<0.005	<0.005	0.001	<0.001	<0.001	0.003	0.002 - 0.005
Zinc (mg/L)	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	0.005 - 0.05
Lead (mg/L)	<0.005	<0.005	<0.005	<0.005	<0.005	0.007	<0.005	0.001 - 0.005
Cadmium (mg/L)	0.0080	<0.0004	0.0010	0.0200	<0.0004	0.0020	0.0015	0.0002 - 0.002
Aluminium (mg/L)	1.000	0.160	0.040	0.070	0.020	0.130	0.100	< 0.005 (if pH <= 6.5) 0.1 (if pH >6.5)
Iron (mg/L)	2.6	3.3	1.3	0.8	0.7	1.0	1.15	1.0

Wet

1997	May	June	Median	ANZECC Criteria (freshwater)
Turbidity (NTU)	N/A	6.5	6.5	<10% change seasonal mean
TN (mg/L)	0.48	0.46	0.47	0.1 - 0.75
TP (mg/L)	0.02	0.02	0.02	0.01 - 0.1
Total Hydrocarbons (mg/L)	2.7	<0.2	1.45	
Copper (mg/L)	<0.005	0.002	0.0035	0.002 - 0.005
Zinc (mg/L)	<0.1	<0.1	<0.1	0.005 - 0.05
Lead (mg/L)	<0.005	0.001	0.003	0.001 - 0.005
Cadmium (mg/L)	0.0007	<0.0010	0.0009	0.0002 - 0.002
Aluminium (mg/L)	0.050	0.175	0.113	< 0.005 (if pH <= 6.5) 0.1 (if pH >6.5)
Iron (mg/L)	2.1	0.5	1.3	1.0

Numbers in shaded boxes represent exceedance of acceptable ANZECC crtiteria

Warrell Creek Water Quality Monitoring

Site 6 - Warrell Creek upstream of Railway Bridge over Warrell Creek

Dry

1997	March	April	May	June	July	August	Median	ANZECC Criteria (estuarine)
Turbidity (NTU)	1.8	2.6	7.9	4.1	1.6	0.6	5.3	<10% change seasonal mean
TN (mg/L)	0.22	0.54	0.43	0.51	<0.1	0.32	0.375	
TP (mg/L)	0.03	0.02	0.04	0.01	0.01	0.01	0.015	
Total Hydrocarbons (mg/L)	<0.1	0.2	2.5	0.4	0.3	<0.1	0.25	
Copper (mg/L)	<0.005	<0.005	<0.005	0.004	0.010	0.006	<0.005	0.005
Zinc (mg/L)	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	0.05
Lead (mg/L)	<0.005	<0.005	<0.005	<0.005	0.005	0.020	<0.005	0.005
Cadmium (mg/L)	0.0070	0.0007	0.0005	0.0090	<0.0004	0.0020	0.0014	0.002
Aluminium (mg/L)	0.23	0.08	0.058	0.079	0.058	0.23	0.0795	
Iron (mg/L)	1.1	0.9	0.4	0.2	0.2	0.2	0.3	

Wet

1997	May	June	Median	ANZECC Criteria (estuarine)
Turbidity (NTU)	N/A	2.6	2.6	<10% change seasonal mean
TN (mg/L)	0.63	0.30	0.465	
TP (mg/L)	0.02	0.03	0.025	
Total Hydrocarbons (mg/L)	7.9	<0.2	4.05	
Copper (mg/L)	<0.005	0.003	0.004	0.005
Zinc (mg/L)	<0.1	<0.1	<0.1	0.05
Lead (mg/L)	<0.005	0.001	0.003	0.005
Cadmium (mg/L)	0.0005	<0.0010	0.0008	0.002
Aluminium (mg/L)	0.071	0.109	0.090	
Iron (mg/L)	0.7	0.1	0.4	

Numbers in shaded boxes represent exceedance of acceptable ANZECC crtiteria

Appendix E - Air Quality Assessment

ADDENDUM TO AIR QUALITY ASSESSMENT

DUAL CARRIAGEWAY CONFIGURATION OF THE PROPOSED REALIGNMENT OF THE PACIFIC HIGHWAY AT WARRELL CREEK

12 February 1998

Prepared
for
Sinclair Knight Merz

by

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1. INTRODUCTION

This report has been prepared by Holmes Air Sciences for Sinclair Knight Merz in order to assess the air quality impacts of the proposed realignment of the Pacific Highway at Warrell Creek on the mid-north coast of New South Wales (**Figure 1**). An original report by Holmes Air Sciences assessed a single lane configuration, and this assessment will be an addendum to that report and assess a dual carriageway configuration. Traffic volumes and the methods of assessment remain unchanged from the original report and will not be described in detail here.

The assessment of the impacts of motor vehicle emissions along the road is based on the use of a computer model to determine the dispersion of emissions and to predict ground-level concentrations of the various exhaust components in the area close to the road. In the first year of operation (2000) the primary pollutants of concern are carbon monoxide, hydrocarbons, nitrogen oxides, particulate matter and lead. It has been assumed that by 2010, the tenth year of operation, lead will no longer be a significant emission.

2. AIR QUALITY CRITERIA

The New South Wales Environment Protection Authority (EPA) notes air quality goals for nitrogen dioxide, carbon monoxide and particulate matter determined by the World Health Organisation (WHO), the United States Environmental Protection Agency (US EPA) and the National Health and Medical Research Council of Australia (NHMRC). Air quality goals for hydrocarbons have been used previously, but these have been discarded because they are not specific for **reactive** species which are the important elements in the formation of photochemical smog.

Table 1 lists the EPA's air quality goals for New South Wales. Not all of these are major emissions from motor vehicles. The basis of these air quality goals and the safety margins which they provide are outlined in the original report.

Table 1 - NSW Air Quality Goals

Pollutant	Standard*	Agency
Total suspended particulate matter (TSP)	90 $\mu g/m^3$ (annual mean)	NHMRC
Particulate matter < 10 μm (PM_{10})	50 $\mu g/m^3$ (annual mean) 150 $\mu g/m^3$ (24-hour maximum)	US EPA US EPA
Lead	1.5 $\mu g/m^3$ (90-day average)	NHMRC
Carbon monoxide	87 ppm or 108 mg/m^3 (15-minute maximum) 25 ppm or 31 mg/m^3 (1-hour maximum) 9 ppm or 10 mg/m^3 (8-hour maximum)	WHO WHO NHMRC
Nitrogen dioxide	0.16 ppm or 320 $\mu g/m^3$ (1-hour maximum) 0.05 ppm or 103 $\mu g/m^3$ (annual mean)	NHMRC US EPA
Ozone	0.10 ppm or 210 $\mu g/m^3$ (1-hour maximum) 0.08 ppm or 170 $\mu g/m^3$ (4-hour maximum)	NHMRC NHMRC
Sulphur dioxide	0.25 ppm or 700 $\mu g/m^3$ (10-minute maximum) 0.20 ppm or 570 $\mu g/m^3$ (1-hour maximum) 0.02 ppm or 60 $\mu g/m^3$ (annual mean)	NHMRC NHMRC NHMRC

** : all concentration units have been converted at 0°C*

It should be noted that the National Environment Protection Council (NEPC) is currently determining a new set of air quality goals for adoption at a national level. These are likely to be more stringent than the current goals.

3. AIR QUALITY ISSUES

3.1 Vehicle emissions and photochemical smog

Apart from local air quality impacts, motor vehicle emissions have the potential to contribute significantly to photochemical smog in an urban environment. Photochemical smog is formed by the reaction between nitrogen oxides and reactive hydrocarbons in the presence of sunlight. Models for the formation of photochemical smog envisage hydrocarbon emissions mostly from motor cars, facilities for the storage of hydrocarbons or spray painting operations and so on, mixing with nitrogen oxides from either industrial sources or from motor cars. The mixture of pollution from these sources then reacts photochemically to form photochemical smog comprising mainly ozone, but also including other oxidants. At sufficient concentrations the smog can affect the eyes and respiratory system and can adversely affect plants and materials.

Photochemical smog is often a concern on the fringes of large cities as parcels of smog-laden air can travel to areas remote from the source. However in the Warrell Creek area there are unlikely to be any regional air quality problems associated with vehicle emissions. The most important air quality issue associated with the proposed road development would be the local impacts at kerbside and nearby residences from specific emissions from vehicles.

3.2 Conversion of nitric oxide to nitrogen dioxide

As discussed previously there are no ambient air quality goals for nitric oxide, the major nitrogen oxide emission from motor vehicles. However, nitric oxide is converted to nitrogen dioxide and its rate of conversion is dependent on the presence of oxidising agents. The issue here is the rate at which NO converts to NO_2. Analysis of the EPA's NO_x monitoring data reveals that the percentage of NO_2 in the air is inversely proportional to the total NO_x concentration. **Figure 2** presents a plot of the mean total NO_x (calculated from the mean NO_2 concentration and the mean total NO_x concentration, in ppm) against the mean nitrogen oxide concentration recorded at five sites in Sydney, namely Earlwood, Eagle Vale, Lidcombe, Kensington and Rozelle, from 1988 to 1992.

The trend in the graph shows an inverse correlation between total NO_x concentration and percentage of NO_2. Average percentages of NO_2 in the EPA monitoring data range from 5 to 50%, with a mean value of about 30%.

Monitoring data collected by the RTA in Sydney (**RTA, 1997**) indicate that close to the roadways, NO_2 would make up from 5 to 20% by weight of the total NO_x. A conservative value of 15% by weight at 0-10 m from the roadway and 20% by weight at 30 - 50 m from the roadway has been used in the impact assessment presented in **Section 7.0**.

4. EXISTING AIR QUALITY

Site-specific air quality monitoring has not been carried out for this study. However, similar rural roadway studies for Pacific Highway upgrades have been carried out near Billinudgel on the far north coast and at Bulahdelah to the north of Newcastle (**Nigel Holmes & Associates, 1993, 1994**). Some monitoring of carbon monoxide has been

undertaken for these projects. The results indicate that in general, hourly concentrations of carbon monoxide in this type of environment are quite low, averaging between 2-5 ppm. However on occasions, quite high readings were obtained in these studies, (up to 17 ppm) but these did not appear to be associated with roadway emissions. Other local factors such as cane-burning or bushfires may contribute more significantly to air pollution in rural areas than motor vehicle emissions.

5. METHODS FOR ASSESSING IMPACTS

The Caline4 dispersion model has been used to estimate the concentration of oxides of nitrogen, carbon monoxide, hydrocarbons and particulate matter, that are likely to be produced in the vicinity of the highway.

It is neither feasible nor necessary within the scope of this study to assess air quality at every sensitive receptor along each section of road, taking account of terrain, road grade and distance of receptor from the road, although it is technically possible to do so. This very detailed approach is warranted for model validation which has already been carried out in Sydney for Caline4 (**Williams and others, 1994**) for the RTA.

The approach in this report has been to identify worst case conditions which comprise 1-hour peak hour traffic flow, combined with the poorest dispersion conditions, equivalent to atmospheric inversions with very light winds. The traffic flow has been assumed to be constant (at peak levels) along sections of the route, and although this is clearly a simplification, it is a reasonable approximation to what could happen in practice.

The position of the receptor with respect to the road is also a factor when determining "worst-case" conditions along a roadway. Distances of 0 m, 10 m, 30 m and 50 m have been used here. Traffic numbers in each direction were obtained from measurements carried out over a week in June/July 1997.

An estimation of these emissions has been made by **Pengilley (1989)** and US EPA emission factors (**US EPA, 1985**). These data have been used in previous roadway studies, however a comprehensive emissions inventory which relates vehicle emissions to different travel conditions in NSW has now been prepared for the Metropolitan Air Quality Study (MAQS) (**Carnovale & Tilly 1995**). These emission rates have been combined with traffic flow data to determine air quality impacts for peak traffic flow. **Appendix A** provides a detailed description of the calculation of vehicle emissions. A brief description of the methods used to calculate the major emissions from vehicles, namely nitrogen oxides, carbon monoxide, hydrocarbons, particulate matter and lead can be found in the original report. This information is required as input to the dispersion models used to predict ground-level concentrations of the various pollutants.

The proposed bypass has been classified as freeway/highway with 18% of the fleet being heavy vehicles during peak times. Emission rates for different vehicle categories have been determined. Details of these are presented in **Appendix A**.

6. ESTIMATED EMISSIONS

Emission rates during the hour of peak traffic flow for the two scenarios (2000 and 2010) are estimated from the total traffic volume and the emission rate per vehicle. Details of assumptions relating to the percentages of heavy vehicles, petrol and diesel fuelled, are presented in **Appendix A**. The estimated peak hour traffic flows for 2000 and 2010 are summarised in **Table 2**.

Table 2 - Estimated peak hour traffic volumes				
Roadway Section	2000		2010	
	Northbound	Southbound	Northbound	Southbound
Peak traffic flow	345	293	486	414

Emission estimates are presented in detail in **Appendix A** and are summarised in **Table 3.**

Table 3 - Estimated peak hour traffic emissions - (kg/km/hour)						
Roadway Section		Carbon Monoxide	Nitrogen Oxides	Hydrocarbons	Particulate Matter	Lead
2000	Northbound	3.91	1.40	0.40	0.07	0.0010
	Southbound	3.32	1.19	0.34	0.06	0.0008
2010	Northbound	4.51	1.88	0.48	0.10	
	Southbound	3.84	1.60	0.41	0.09	

7. ASSESSMENT OF IMPACTS

This section assesses the air quality impacts of the proposal by comparing the predicted ground-level concentrations of roadway emissions with air quality goals or other air quality criteria where specified goals are not available. Predictions have been made for peak hour flows.

Table 4 presents the maximum predicted 1-hour average increase in ground-level concentrations of carbon monoxide, hydrocarbons, nitrogen oxides, nitrogen dioxide, particulate matter and lead, at 0 m, 10 m, 30 m and 50 m from the roadway edge. Predictions at 30 m and 50 m have been made to assess impacts at any nearby residences. Assuming a wind speed of 1.0 m/s and that F-class stability conditions occur, the model has been set to determine the worst-case wind angle.

The exact relationship will vary with roadway configuration, but typically, concentrations at 10 m from the roadway edge are approximately 55% of concentrations at the kerbside, and around 40% at 30 m. This will not be the case for NO_2 however, since the NO in the exhaust emission will be oxidised to NO_2 over time. That is, as the exhaust plume disperses and the overall NO_x concentration decreases, the percentage of NO_2 will increase. Monitoring data collected by the RTA in the vicinity of freeways and arterial roads (**RTA, 1997**), indicates that the concentration of NO_2 remains fairly constant over a distance of 60 m from the road. In other words the increase in NO_2 concentration due to oxidation of NO is offset by the dilution due to dispersion.

Table 4 - Predicted increase in 1-hour average ground-level concentrations of vehicle emissions at various distances from the roadway edge

	Distance from kerb (m)	Carbon Monoxide (mg/m^3)	Nitrogen Oxides ($\mu g/m^3$)	Nitrogen Dioxide* ($\mu g/m^3$)	Hydrocarbons (mg/m^3)	Particulate Matter ($\mu g/m^3$)	Lead ($\mu g/m^3$)
2000	0	2.3	833	83	0.24	44	0.6
	10	1.3	476	71	0.14	25	0.3
	20	1.1	378	76	0.11	20	0.3
	30	0.9	324	65	0.09	17	0.2
	50	0.7	255	51	0.07	13	0.2
2010	0	2.6	924	92	0.27	48	
	10	1.5	521	78	0.15	27	
	20	1.2	415	83	0.12	22	
	30	1.0	353	71	0.10	19	
	50	0.8	279	56	0.08	15	

** Assumed to be 10% by weight of total nitrogen oxides at the kerbside, 15% at 10 m and 20% at 20 m, 30m and 50 m from the roadway edge, (**RTA, 1997**).*

Carbon Monoxide

It can be seen from **Table 4** that the highest predicted 1-hour carbon monoxide concentration 10 m from the road is 1.3 mg/m^3 in 2000 and 1.5 mg/m^3 in 2010. This is well below the EPA's 1-hour goal of 31 mg/m^3 and levels at 30 m and 50 m are even lower. Levels at kerbside are also below the 1-hour EPA goal.

The average "background" level of carbon monoxide, that is carbon monoxide which is due to all other sources apart from the road, is likely to be of the order of 2 to 5 mg/m^3. Monitoring data from a similar study near Billinudgel (**Nigel Holmes & Associates, 1994**) indicates that the maximum 1-hour average background concentration could be up to 17 mg/m^3 although not from roadway sources (see **Section 4**). Adding this to the maximum predicted increase of 1.3 mg/m^3 and 1.5 mg/m^3 at 10 m from the kerb, gives maximum concentrations of 18.3 mg/m^3 and 18.5 mg/m^3 in 2000 and 2010 respectively This is still less than the goal of 31 mg/m^3.

Nitrogen Dioxide

Estimating nitrogen dioxide concentrations is more complicated than estimating carbon monoxide concentrations. As discussed previously, nitrogen oxides are initially emitted as a mixture of nitric oxide and other oxides of nitrogen, which are oxidised to nitrogen dioxide. At the point of emission the mixture is generally about 5% nitrogen dioxide by mass. However, while the maximum concentrations of total oxides of nitrogen generally occur during peak hour, this is not necessarily the case for nitrogen dioxide. An extensive monitoring program undertaken by the RTA indicates that during peak hour the percentage NO_2 at 10 m from the roadway edge is likely to be about 5%. The conversion rate from NO to NO_2 at other times of the day may be significantly higher than this although the total NO_x levels may be significantly lower than peak hour levels. It is necessary therefore to assume some intermediate value for a worst-case assessment.

Data from the RTA program indicates that at 10 m from the roadway a conversion rate of 15% by weight is still conservative but more realistic than the 20% assumed in previous EIS studies. At distances of 30-60 m from the kerbside the 20% conversion

rate appears to be appropriate. There are no monitoring data for the kerbside location in the present study, but it is considered that a 10% conversion rate is likely to still be conservative.

Taking this into consideration, the highest predicted 1-hour nitrogen dioxide concentration 10 m from the road in 2000 is 71 $\mu g/m^3$, and 78 $\mu g/m^3$ in 2010, both of which are well below the 1-hour goal of 320 $\mu g/m^3$. Concentrations at 50 m from the roadway are expected to be as low as 51 $\mu g/m^3$ and 56 $\mu g/m^3$ in 2000 and 2010 respectively. These predictions do not take into account background concentrations which are likely to be in the range of 30-50 $\mu g/m^3$.

It should be noted that predictions do not take into account fully the benefits of three-way catalytic converters which are fitted to all new (fuel-injected) petrol-fuelled passenger vehicles in Australia and which substantially reduce NO_x emissions. Nor (more significantly) do they take account of controls on diesel vehicles which are being implemented through new design rule ADR 70.

Hydrocarbons

Hydrocarbon concentrations are no longer specified in the EPA's air quality goals. This is largely due to the fact that a simple hydrocarbon concentration goal is now recognised as not being useful for the purposes of assessing health impacts or identifying the need for air quality management requirements. More detailed information on specific hydrocarbons is required. As previously noted, hydrocarbons, in particular those associated with motor vehicles, are a common contaminant of urban atmospheres and have been for many years. Emission controls on Australian cars and equivalents since 1978 have resulted in a considerable reduction in both evaporative and exhaust emissions of hydrocarbons.

One of the components of hydrocarbons that has become a concern in the community is benzene, which is a known carcinogen (**WHO 1987**). **Appendix B** (data from **Nelson and Quigley, 1982**) shows an analysis of the hydrocarbon content of fuel and exhaust. It can be seen that benzene is a component of petrol comprising approximately 2.6%. It can also be seen that the percentage benzene (by mass) in vehicle exhausts was approximately 5% (note these data relate to leaded petrol, but there has not been any substantial change in the benzene content with the introduction of unleaded petrol).

From **Table 4** the predicted maximum 1-hour increase in total hydrocarbons is of the order of 0.14 mg/m^3 in 2000 and 0.15 mg/m^3 in 2010 at 10 m from the roadway. Assuming a 5% benzene composition in the exhaust the benzene concentration at 10 m from the roadway edge would be approximately 0.007 mg/m^3 or 7 $\mu g/m^3$ (1-hour average), under unfavourable dispersion and with peak traffic flows in 2000, and 0.008 mg/m^3 or 8 $\mu g/m^3$ in 2010. Both these values are below the proposed UK goal of 16 $\mu g/m^3$ (the UK goal however is an annual average). Concentrations of total hydrocarbons are of course substantially lower at the locations of residences 30 m from the road, 0.10 mg/m^3 (5 $\mu g/m^3$ benzene) being the maximum predicted in 2010. It is nevertheless recognised that there may be no safe limit for benzene, but the risks to a particular individual over a lifetime is small, and on a population and individual basis could be offset by lower risks through safer roads, although to an undetermined extent.

The current understanding of long-term health risks is that they are a function of average lifetime exposure levels. For example WHO estimated that the risk of

developing leukemia with a lifetime exposure to ambient concentrations of 1 $\mu g/m^3$ of benzene is $4x10^{-6}$. This is referred to as a unit risk estimate.

Levels of benzene can range from 3 $\mu g/m^3$ in a rural environment to up to 160 $\mu g/m^3$ in an urban environment (higher close to service stations and storage tanks) with typical levels of about 20 $\mu g/m^3$ in residential areas. Most people would be exposed to much higher levels on occasions, for example when filling their car with petrol or in a smoke-filled indoor environment. The daily intake from ambient air in an urban environment is estimated to range from 30 to 300 $\mu g/m^3$ and smoking one pack of cigarettes per day can add approximately 600 μg to this intake.

Particulate Matter and Lead

The predicted levels of PM_{10} are for 1-hour averaging periods, while the air quality goal refers to a 24-hour period. Comparing these is therefore a conservative approach (that is an over-prediction) as the maximum predicted 1-hour average will always be higher than the predicted 24-hour average.

The highest predicted increase in PM_{10} at 10 m from the proposed roadway in 2000 is 25 $\mu g/m^3$. This is expected only to increase slightly to 27 $\mu g/m^3$ by 2010. These levels are well below the EPA 24-hour goal of 150 $\mu g/m^3$. There are no data available on background PM_{10} levels but EPA monitoring data from Sydney indicate that average background levels are not likely to exceed 30 $\mu g/m^3$.

All predicted increases in PM_{10}, including kerbside predictions, are less than 50 $\mu g/m^3$ (the annual goal), even under the worst-case dispersion conditions combined with peak traffic flow. Concentrations over a year would be substantially less and concentrations at sites further removed from the road would again be reduced. Similarly the NHMRC 90 $\mu g/m^3$ (annual average) TSP goal is unlikely to be exceeded.

Lead impacts have also been assessed for 2000, assuming that about 15% of vehicles will still be using leaded petrol. It should be noted that the lead goal applies to a 90-day average, and the predicted level is for a "worst-case" 1-hour period. However, none of the predicted values here are above the 90-day average of 1.5 $\mu g/m^3$. It should be noted that these are short term predictions. Actual levels are likely to be even further below the long term goals since "worst-case" conditions are unlikely to prevail for any significant period of time.

8. CONCLUSIONS

This study has assessed air quality impacts along the proposed route for the Warrell Creek realignment, dual carriageway configuration.

The results of the assessment conclude that:

1. Due to the present emission controls on motor vehicles and the projected traffic conditions for 2000 and 2010, the EPA's carbon monoxide 1-hour or 8-hour goals are not expected to be exceeded during the operation of the bypass.

2. The predicted increases in concentration of nitrogen dioxide indicate that the EPA's goals would not be exceeded at any distance from the roadway.

3. The PM_{10} annual and 24-hour maximum air quality goals, are not likely to be exceeded at any nearby residences. This is also the case for the 90-day lead goal which is not even exceeded in the short-term.

4. Predicted concentrations of benzene (and other pollutants) are not at levels which should pose health effects. However it is recognised that there may be no safe level for exposure to benzene.

As discussed earlier, the introduction of catalytic converters has resulted in a substantial reduction in carbon monoxide and hydrocarbon emissions from motor vehicles. This is also true for nitrogen oxides, as all new fuel-injected passenger vehicles are fitted with three-way catalytic converters which reduce nitrogen oxide emissions. However the increased speed on upgraded roads results in increased nitrogen oxide emissions and this has offset to some extent the gains from the improved technology. Nevertheless the proposed roadway is predicted to result in nitrogen dioxide levels which are substantially below the air quality goal.

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APPENDIX A
EMISSION CALCULATIONS

VEHICLE EMISSIONS FACTORS

The emissions from vehicles on NSW roads were assumed to all fit into three classes:

1. Light duty petrol vehicles (LDPV)
2. Heavy duty petrol vehicles (HDPV)
3. Heavy duty diesel vehicles (HDDV)

These classes of vehicles account for more than 99% of all vehicle kilometres travelled on NSW roads (**Pengilley 1989**). The following assumptions were made regarding the vehicles in the years 2000 and 2010;

Year 2000

- 85% of passenger vehicles were assumed to be fitted with catalytic converters
- 18% of the vehicles were assumed to be heavy duty.
- Of the heavy vehicles category, 90% are considered to be HDDV and 10% are considered to be HDPV for all sections.

Year 2010

- 100% of passenger vehicles were assumed to be fitted with catalytic converters
- 18% of the vehicles were assumed to be heavy duty.
- Of the heavy vehicles category, 90% are considered to be HDDV and 10% are considered to be HDPV for all sections.

The emissions of CO, NO_x, hydrocarbons and particulate matter were taken from estimates in the Sydney Metropolitan Air Quality Study (MAQS) (**Carnovale & Tilly, 1995**). It was assumed that traffic on the roadway was in freeway/highway travel mode. It was also assumed that the deterioration of catalytic converters was as in the 1992 MAQS estimates of passenger vehicle emission rates.

The emission of particulate matter from vehicles is made up of lead salts, organic and sulphate components. The total emissions comprise exhaust emission plus airborne brake wear particulate emission and airborne tyre wear particulate emissions. In the case of passenger vehicles, the PM_{10} fraction comprises 74% of the total particulate exhaust emissions. The PM_{10} fraction of HDDV and HDPV particulate exhaust emissions is 100% and 64% respectively. Brake and tyre emissions are assumed to be essentially all PM_{10}.

Calculation of vehicle emission rates

Details of emission calculations for the route sections during peak hours for 2000 and 2010 are presented in the following tables.

Emission rates for CO, NO_x, hydrocarbons and particulate matter corresponding to a given section of the route are presented for each class of vehicle and expressed as g/km/vehicle. The total emissions (tot CO etc) during the peak period have been calculated by multiplying the emission rate by the total number of vehicles estimated to be using the road in the one hour peak period. These values are expressed as g/km/h. Finally these values have been converted to kg/km/h and g/vehicle mile (the latter is used as input to the model).

Estimated emissions for the proposed roadway in 2000 and 2010

Section	Northbound - 2000										
Freeway		Emission rate g/km/vehicle					Total emissions g/km/h				
Vehicle	Number	CO	NOx	HC	PM10	Pb	totCO	tot NOx	tot HC	tot PM10	tot Pb
total no	345.00										
total heavy	62.10										
LDPV	282.90	10.08	1.73	0.78	0.021	0.0028	2851.63	489.42	220.66	5.94	0.7921
HDDV	55.89	7.11	15.72	2.58	1.150		397.38	878.59	144.20	64.27	
HDPV	6.21	107.09	4.59	5.82	0.081	0.0322	665.03	28.50	36.14	0.50	0.2000
Brake & Tyre					0.009					3.11	
Total kg/km/h							3.91	1.40	0.40	0.07	0.0010
g/v-mi							18.15	6.48	1.86	0.34	0.0046
Section	Southbound - 2000										
Freeway		Emission rate g/km/vehicle					Total emissions g/km/h				
Vehicle	Number	CO	NOx	HC	PM10	Pb	totCO	tot NOx	tot HC	tot PM10	tot Pb
total no	293.00										
total heavy	52.74										
LDPV	240.26	10.08	1.73	0.78	0.021	0.0028	2421.82	415.65	187.40	5.05	0.6727
HDDV	47.47	7.11	15.72	2.58	1.150		337.48	746.17	122.46	54.59	
HDPV	5.27	107.09	4.59	5.82	0.081	0.0322	564.79	24.21	30.69	0.43	0.1698
Brake & Tyre					0.009					2.64	
Total kg/km/h							3.32	1.19	0.34	0.06	0.0008
g/v-mi							18.15	6.48	1.86	0.34	0.0046
Section	Northbound - 2010										
Freeway		Emission rate g/km/vehicle					Total emissions g/km/h				
Vehicle	Number	CO	NOx	HC	PM10		totCO	tot NOx	tot HC	tot PM10	
total no	486.00										
total heavy	87.48										
LDPV	398.52	7.57	1.51	0.56	0.021		3016.80	601.77	223.17	8.37	
HDDV	78.73	7.11	15.72	2.58	1.150		559.78	1237.67	203.13	90.54	
HDPV	8.75	107.09	4.59	5.82	0.081		936.82	40.15	50.91	0.71	
Brake & Tyre					0.009					4.37	
Total kg/km/h							4.51	1.88	0.48	0.10	
g/v-mi							14.86	6.19	1.57	0.34	
Section	Southbound - 2010										
Freeway		Emission rate g/km/vehicle					Total emissions g/km/h				
Vehicle	Number	CO	NOx	HC	PM10		totCO	tot NOx	tot HC	tot PM10	
total no	414.00								-		
total heavy	74.52										
LDPV	339.48	7.57	1.51	0.56	0.021		2569.86	512.61	190.11	7.13	
HDDV	67.07	7.11	15.72	2.58	1.150		476.85	1054.31	173.04	77.13	
HDPV	7.45	107.09	4.59	5.82	0.081		798.03	34.20	43.37	0.60	
Brake & Tyre					0.009					3.73	
Total kg/km/h							3.84	1.60	0.41	0.09	
g/v-mi							14.86	6.19	1.57	0.34	

APPENDIX B
HYDROCARBON ANALYSIS OF VEHICLE EXHAUST, PETROL AND PETROL VAPOUR

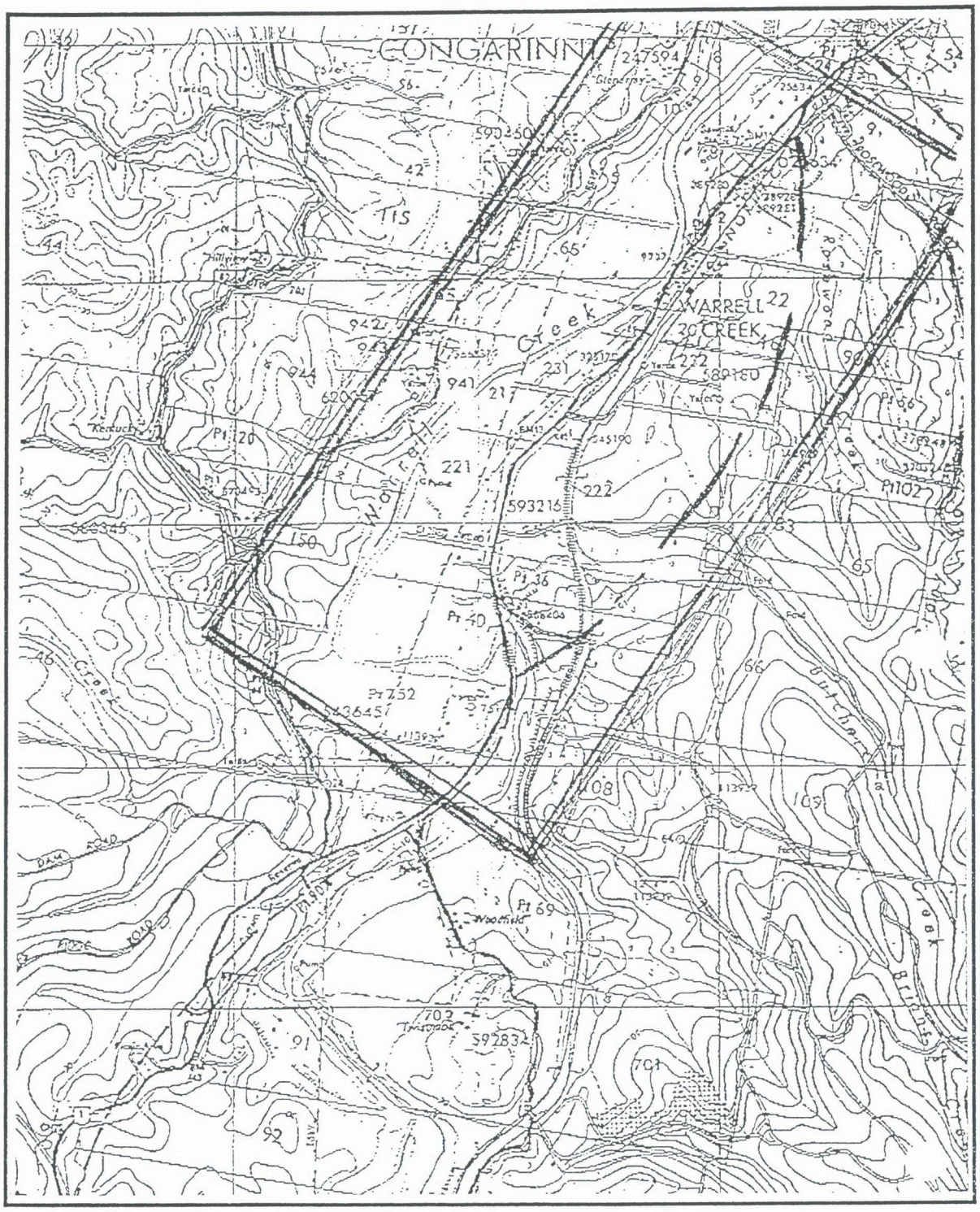
HYDROCARBON COMPOSITION OF VEHICLE EXHAUST, PETROL AND PETROL VAPOUR

Hydrocarbon	Exhaust		Petrol		Petrol Vapour
	Average	SD	Average	SD	
ethane	1.4	0.5			
ethylene	11.2	3.2			
acetylene	8.7	2.7			
propane	0.1	0.1	0.1	0.1	1.5
propylene	5.0	1.6			
methylacetylene	0.4	0.3			
n-butane	2.1	0.6	2.9	0.4	18.7
i-butane	1.0	0.3	1.2	0.3	11.1
1-butene	0.9	0.3	0.2	0.1	1.6
i-butene	1.4	0.6			
trans-2-butene	0.6	0.4	0.6	0.1	3.7
cis-2-butene	0.5	0.2	0.5	0.1	2.9
n-pentane	3.0	0.7	6.0	0.6	10.7
i-pentane	4.8	0.9	10.6	0.5	25.4
cyclopentane	0.4	0.1	0.5	0.1	0.6
1-pentene	0.2	0.1	0.3	0.1	0.7
trans-2-pentene	0.3	0.2	0.8	0.1	1.5
cis-2-pentene	0.3	0.2	0.5	0.1	0.9
2-methyl-1-butene	0.3	0.2	0.6	0.1	1.3
2-methyl-2-butene	0.5	0.2	1.6	0.2	2.6
n-hexane	1.9	0.4	3.5	0.3	1.9
2-methylpentane	2.3	0.4	4.9	0.2	3.5
3-methylpentane	1.6	0.3	3.2	0.1	2.2
2,2-dimethylbutane	0.3	0.2	0.5	0.1	0.6
2,3-dimethylbutane	0.6	0.1	1.3	0.1	1.1
methylcyclopentane	1.0	0.2	1.9	0.1	0.9
cyclohexane	0.6	0.2	0.8	0.1	0.3
1-hexene	0.3	0.2	0.4	0.1	0.3
other C_6 olefins	0.7	0.2	1.6	0.1	1.0
benzene	5.0	0.7	2.6	0.2	0.9
n-heptane	0.8	0.2	1.6	0.1	0.3
2-methylhexane	1.5	0.3	2.9	0.1	0.7
3-methylhexane	1.2	0.3	2.3	0.1	0.5
2,4-dimethylpentane	0.3	0.1	0.7	0.1	0.2

Hydrocarbon	Exhaust		Petrol		Petrol Vapour
	Average	SD	Average	SD	
methylcyclohexane	0.6	0.2	1.1	0.2	0.2
other C_7 cycloalkanes	0.3	0.2	0.6	0.1	0.1
toluene	10.2	0.9	9.6	0.6	1.0
n-octane	0.4	0.1	0.7	0.1	
2,2,4-trimethylpentane	1.0	0.4	2.1	0.5	0.4
other C_8 alkanes	3.2	0.7	7.1	0.6	0.6
ethylbenzene	1.9	0.2	1.6	0.1	0.1
m, p-xylenes	6.5	0.9	6.5	0.4	0.2
o-xylene	2.5	0.4	2.3	0.2	0.1
n-nonane	0.2	0.1	0.3	0.1	
other C_9 alkanes	1.7	0.4	2.1	0.3	
n-propylbenzene	0.4	0.1	0.4	0.1	
i-propylbenzene	0.2	0.1	0.2	0.1	
1,2,4-trimethylbenzene	1.9	0.3	1.8	0.2	
1,3,5-trimethylbenzene	0.7	0.1	0.7	0.1	
m, p-ethyltoluenes	2.0	0.3	1.8	0.2	
o-ethyltoluene	0.6	0.2	0.5	0.1	
n-decane	0.4	0.1	0.4	0.1	
other C_{10} alkanes & aromatics	0.9	0.4	1.2	0.3	
C_{11} and C_{12} alkanes & aromatics	3.6	1.1	4.2	0.7	
	100.40		99.80		100.30

*Source: **Nelson & Quigley (1982)***

FIGURES



LOCATION OF STUDY AREA

FIGURE 1

Correlation between % NO_2 and total NO_x
EPA monitoring data

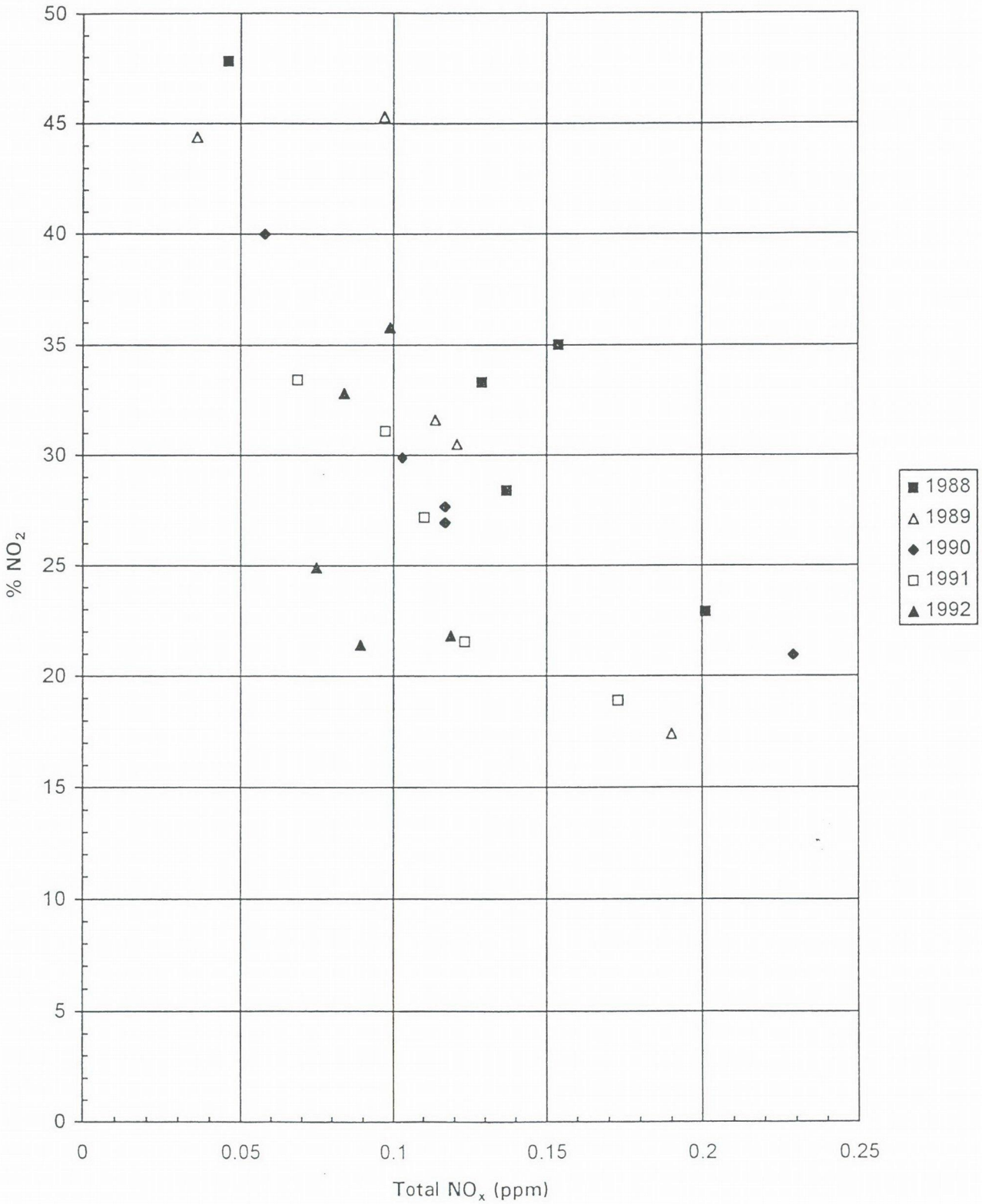


FIGURE 2

Appendix F - Heritage Assessment

An Archaeological Survey for the Proposed realignment of the Pacific Highway for the Warrell Creek Bypass

Commissioned by Sinclair Knight Merz
for the Roads and Traffic Authority

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April 1998

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Executive Summary

Sinclair Knight Merz commissioned Robynne Mills, archaeological consultant, to conduct an archaeological survey of the proposed realignment of the Pacific Highway for the Warrell Creek Bypass. The heritage assessment was designed to identify potential impacts of the proposed development on Aboriginal relics ('relics' as defined by the New South Wales National Parks and Wildlife Act 1974) and non-indigenous heritage items as defined by the NSW Heritage Act and the Environmental Planning and Assessment Acts of 1975 and 1979 respectively.

The field component of the study was conducted by Robynne Mills and Jim Kelton, archaeological consultants on Tuesday 8th July, 1997. The Unkya Local Aboriginal Land Council (LALC) was represented during the survey by Reginald Donovan and Neville Buchanan (Elder). A *Statement of Involvement in the field survey* from the Unkya LALC is included as Appendix 5.

This report provides details of local environmental observations relevant to the archaeological sensitivity of the study area. It identifies all known archaeological sites in the vicinity of the study area as recorded in the site registers of the Australian Heritage Commission, NSW Heritage Council, NSW National Trust, NSW National Parks and Wildlife Service (NPWS) and the Heritage Schedules of Nambucca Shire Council. Survey methods and significance assessments are in accordance with NPWS and DUAP guidelines. Where appropriate, the report recommends site management options to minimise impact on areas of heritage sensitivity and items within the study area.

No Aboriginal sites or significant places were identified by the survey. One area of potential archaeological deposit (PAD) was identified in the survey area. This PAD area is located on a small raised spur on the southern side of the present railway line to the west of Rosewood Road **(Sketch 2)**. This spur area has been previously impacted by a Telstra cable, the installation of a sewer line and the construction of a railway cutting. However, there is still a section of the spur which appears to be relatively undisturbed and this area will be directly impacted by the proposed bypass.

A local resident informed the consultant that in recent times, there had been Aboriginal dwellings on vacant land adjacent to the Fawcett-Williams house. However, this fact was refuted by Mrs Donnelly who has lived in Sunnys Lane for 70 years. The consultant contacted the LALC in September 1997 and requested that this issue be raised in the Community and any relevant information conveyed to the consultant. Despite many attempts to gain information from the LALC on this issue (see diary in Appendix 5) no information was forth coming. However on Monday 30th March 1998 in response to a final telephone call to the LALC from the consultant prior to the completion of this report, Reg Donovan informed the consultant that Clary Hoskins, a member of the Aboriginal community, had indicated that he had concerns to raise. The consultant requested some written documentation as to the nature of Mr Hoskins' concern, however none was forth coming at the time of the preparation of this report.

Five non-indigenous sites will be impacted by the proposed Bypass road and re-routed railway line. These sites include 2 houses, one converted dairy building, one timber/corrugated iron shed and one colorbond shed. The site of the original Warrell Creek Railway Siding is also within the impact zone. This siding was located approximately 600m south of the rail crossing in Warrell Creek Village. This siding was never manned and with rationalisation of country rail services, was closed on 30th June 1974 and the station buildings and platform area demolished.

Assessment of the above non-indigenous items using the NSW Heritage Council Assessment Guidelines **(Appendix 7**) concluded that none of these items was of heritage significance. However the area in the vicinity of the railway station has been identified as an area of potential archaeological deposit

This survey concludes that there is no objection on archaeological grounds to the project proceeding as proposed, provided recommendations in Section 9 of this report are implemented.

These recommendations are made on the basis of the National Parks and Wildlife Act of 1974 (as amended), whereby it is illegal to damage, deface or destroy an Aboriginal relic without the written permission of the Director. Should any further relics be encountered during the course of the development, officers of the National Parks and Wildlife Service should be informed without delay.

1. Details of the Development Proposal and Consultancy Brief.

1.1 Development Proposal

The Roads and Traffic Authority (RTA) proposes to divert a 4500m section of the present Pacific Highway to bypass the township of Warrell. The Bypass will extend east from the Warrell Creek Road Bridge to Crouches Creek Crossing **(Map 2)**. The proposed Bypass construction will involve the re-routing of approximately 1000m of the present Pacific Highway from Warrell Creek Bridge, to the current Northern Railway easement. The re-alignment is within this rail easement for approximately 1400m to Rosewood Road. The route then rejoins the current Pacific Highway for approximately 2100m to Crouches Creek. This section of the highway will be widened and upgraded to Couther Creek. The section of railway line which will be impacted by the road construction will be moved immediately south from its present location.

1.2 Consultancy Brief

The consultant was commissioned to:

- consult with the Unkya LALC prior to the survey, to identify any areas of special significance to the Aboriginal community eg sacred or ceremonial areas and identify issues of community concern.

- arrange for a representative of the Unkya LALC to participate in the field work to ensure that the Aboriginal community was included in all discussions relating to the significance, protection and management of relics and archaeologically sensitive areas identified in the survey.

- examine the proposed route for evidence of indigenous and non-indigenous heritage items, sites and places which could be impacted, either directly or indirectly by the bypass construction.

- assess the significance of heritage sites/items/places recorded and make recommendations for the protection and management of these items.

- prepare a report on the heritage investigation which meets the requirements of the NPWS and DUAP.

1.3 Impacts

1.3.1 Previous impacts to the proposed development area

Prior to European occupation, the Macksville region was vegetated by sub-tropical rainforest and open sclerophyll forest. Clearing of these forest areas began in 1841 with the arrival of the cedar cutters (Rich 1990:108-113). Following this initial clearing, the area was more systematically cleared for pastoral activities which included ploughing and cropping, grazing, drainage of wetland areas and the creation of artificial channels and drainage lines. The impacts of the clearing of the forest and subsequent invasive agricultural activities would have caused major destruction to Aboriginal sites.

1.3.2 Recent Impacts relevant to the archaeology of the proposed development area. (Sketch 1)

Recent developments which have heavily impacted the proposed development area include the construction of a saw mill complex, major and minor road construction, the laying of the Main Northern Railway Line and telecommunication and sewer line installations. Although the present development has the potential to impact heavily on archeological sites, the route chosen is an excellent one, from a heritage point of view because the major impact of the development is contained within an area of previous heavy disturbance.

2. Aboriginal Community Consultation

The survey area is located within the area administered by the Unkya Local Aboriginal Land Council (LALC). Reginald Donovan from the LALC was consulted during the preliminary assessment of route options for the proposed bypass. This consultation involved supplying the LALC with aerial photographs and maps of the proposed routes for their consideration. The consultant requested that details of the development be discussed by the local Aboriginal Community and Elders and the consultant informed of any issues or concerns which the Aboriginal Community had concerning the impact of the proposed development on Aboriginal Cultural Heritage items or places. The Aboriginal Community did not identify any issues of concern **(Appendix 5)**.

Once the final route was determined, the LALC was informed of the decision and a fax formally requesting LALC involvement in the field survey was sent on 26th April, 1997. A request was also made that at the conclusion of the field survey, a *Statement of Involvement* in the survey should be supplied by the LALC. This statement should include any concerns the Community may have with regard to the proposed development proceeding as planned. At the completion of the field survey, the LALC representative and the consultant discussed the survey results and recommendations. A summary of these recommendations was drafted for consideration by the LALC at the next meeting of the Cultural Heritage Committee. The LALC was advised that it would be provided with a copy of the final report.

When the consultant was notified of changes to the central section of the route, LALC was informed of the changes. LALC was also made aware of information received by the consultant from a local resident who stated that in recent times, there had been Aboriginal dwellings on the land through which the realigned route would pass. This statement was refuted by Mrs Donnelly who has lived in Sunnys Lane for 70 years. The consultant requested that the LALC re-survey the area which had been briefly assessed as heavily disturbed by the initial survey; inform the community of the issues raised regarding Aboriginal dwellings in the area and inform the consultant of any community concerns. The survey was carried out by Reg Donovan and Clary Hoskins in November, 1997 and by the consultant at a subsequent visit in November, 1997. Although no formal report was received from the LALC, many phone discussions took place during which it was confirmed that there were no archaeological sites or areas of archaeological sensitivity in the area, a fact confirmed by the consultant's inspection of the area in December, 1997. Despite many attempts to gain information from the LALC regarding the issue of Community concerns, (see diary in Appendix 5) no information was forthcoming. However, on Monday 30th 1998, in response to a final telephone call to the LALC from the consultant prior to the completion of this report, Reg Donovan informed the consultant that Clary Hoskins, a member of the Aboriginal community, had indicated that he had concerns to raise. The consultant requested some written documentation as to the nature of Mr Hoskins concern, however none was forthcoming at the time of the preparation of this report.

3. Study Area.

3.1 Location

The Warrell Creek Bypass is located at Warrell Creek township which is approximately 4km south of Macksville **(Map 1)** on the NSW North Coast. The development extends from the existing Warrell Creek Road Bridge on the Pacific Highway approximately 1.5 km south of the township to Crouches Creek Bridge, approximately 2.5km north of the township, a distance of approximately 4500m **(Map 2).**

3.2 Environmental Observations.

The study area lies within the flood plain of the Nambucca River and Warrell Creek. From the 1:25000 maps (Eungai and Macksville) it can be seen that the bypass route runs parallel and east of Warrell Creek. The southern and northern sections of the route pass through the low-gradient hill slopes. Immediately to the east of the route are the foot slopes of the Macleay Hills which separate the Warrell Creek flood plain from the coast. The Macleay Hills include the Yarrahapinni Range to the south east and Bald Hill to the north-east. The central section of the route passes through low lying boggy ground which is crisscrossed by ephemeral creek lines many of which have been contained within the swampy ground. However all would flow into Warrell Creek in times of flood. The major creek lines are Stony Creek and Crouches Creek.

Dry sclerophyll forest is the dominant vegetation type with wet sclerophyll and rainforest remnants occurring on sheltered slopes and in gullies alongside creeks. In the study area, the predominant geology is a mixture of sandstones and conglomerates of the Clarence Morton Basin. Hall and Lomax suggest that although sandstones are poor in flakeable material, the conglomerates may have provided a local source for artefact manufacture (Davies 1993). Although no stone suitable for the manufacture of stone tool was noted during the survey, Neville Buchanan indicated that suitable stone had been observed by LALC members in the Yarrahapinni Mountain area. The entire route has been cleared of original vegetation. No old growth trees remain.

4. Archaeological Context.

Archaeological evidence shows that Aboriginal people have been present in the north coast region for at least 22,000 years (Neal and Stock 1986). However most sites postdate the Pleistocene sea level stabilisation which occurred about 6000 years ago. Although the cause is subject to debate, evidence suggests that an increase in population occurred in the region after 4000 years ago. This increase is represented in the archaeological record by a dramatic increase in the numbers of sites, the intensity of use of sites and more extensive resource exploitation characterised by use of new habitats, resource types, extractive technologies and management strategies (Collins 1993 p.12). By approximately 2500 years ago the north coast region was populated by numerous language groups, linked through extensive systems of marital exchange and ceremonial obligation.

The study area is Gumbangara Tribal Land. The following explanation of the relationship of the current Gumbangara people to their land is taken from a report by Ray Kelly to NPWS in a report by Howard Creamer (1979-81). *"On 28th October 1974, I commenced field work in part of the Gumbangara tribal areas, the Nambucca District on the Mid north Coast of NSW.*

Some of the sites in this report overlap into the Thungetti tribal area to the south. Although these sites have been often used by both the Gumbangara and Thungetti tribes, it was pointed out to me quite clearly that the sites south of the Nambucca River belonged to the Thungetti tribal people having ownership of that area. The Gumbangara tribal area extends along the Nambucca River northwards to the Clarence River where they joined the Banjalung tribe. Their area was shared with the Bandai tribe.

Since I began my work of surveying sacred sites in the Nambucca Heads area, I have worked closely with Harry Buchanan, one of the few remaining initiated Gumbangara tribesmen. He is a man about 78 years of age who has knowledge of a wide range of sacred and significant sites in both Gumbangara and Thungetti tribal areas. Harry has lived on the Nambucca River for most of his life and has participated in many of the initiations up until the 1920's when they were last performed. He speaks both Gumbangara and Thungetti tribal languages fluently and has a fascinating memory of sites in the area... I am under the impression that Harry is the most knowledgable initiated person of the Mid North Coast of NSW."

4.1 Academic Studies

Academic Studies in the region have been carried out by McBryde (1974, 1978, 1982), Coleman (1982), Lilley (1984), Hall (1982), Lane (1970, 1974, 1978).

McBryde (1982), produced the first regional study of Aboriginal prehistory in the Clarence River and its tributaries. Her excavation of a rock shelter site at Seelands, on the southern side of the Clarence River produced a date of 6400BP and this remains the oldest evidence of human occupation so far recorded in the north coast region. In this report McBryde proposed the model that Aboriginal people migrated to the inland areas and returned to the coast at what was perceived by them to be a favourable time. This model was disputed by Godwin (1989) who proposed that Aboriginal People remained within the resource rich estuarine areas for long periods of time.

There has been extensive academic debate of the issue of the seasonal movement of Aboriginal groups between coastal and inland zones. McBryde (1974) carried out a broad based study of the movement of Aboriginal people between the New England Tableland area and the coast and presented a model for seasonal mobility characterised by the exploitation of coastal resources during the summer months and upland resources during the winter. This hypothesis was supported by a number of ethnohistorical observations made by early settlers and archaeological evidence of the movement of goods, if not people between the two areas (Kuskie 1993:5).

Coleman (1982) disputed this hypothesis, concluding from his investigations that the availability of resources in coastal areas was adequate to support a largely sedentary Aboriginal population which moved along the coastal zone rather than into the tableland areas which he proposed were used only for ceremonial gatherings and as pathways for trade and limited exchange of goods. This view was supported by Lilley and Hall (1984) who identified evidence of semi-sedentary coastal populations, which, though not entirely marine orientated, had little need at any time of the year to move far from the coastal strip in search of resources.

Coleman's hypothesis is supported by ethnographic and early historical records obtained from the diaries of early North Coast settlers, Hodgkinson (1845), Henderson (1851) and Bundock (1898). Hodgkinson (1845: 22) notes that "*the blacks on the banks of the numerous coastal rivers beyond Port Macquarie are able to procure an abundance of food with very little trouble*" ....he comments on the abundance of fish, shell fish and marine

crustaceans in the rivers stating that *"fish forms a never failing article of food for blacks whom I have seen at the Macleay and Nambucca Rivers, spear in a few minutes sufficient food for the whole tribe" (1845: 23)* .

More recent ethnographic investigations by Lane (1970), Campbell (1978), Pierce (1978), Sullivan (1979) and Callaghan (1980) suggest that North Coast Aboriginal groups of the Tweed, Richmond, Nambucca and Macleay river valleys were generally more sedentary than those of inland NSW. Callaghan (1980:24) notes that succulent edible fruit was available almost all year round and Campbell (1978: 100) has listed over twenty animal and reptile species including snakes, goannas, macropods, possums and flying foxes known to have been hunted by Aboriginal people in the region.

Lane (1970, 1974)) examined the ethnohistoric sources for the Nambucca River region and provided information on the economic resources, material culture and hunting and gathering practices of the region. His 1978 report documents the association between carved trees and initiation sites in the Nambucca Region.

4.2 NPWS commissioned studies

NPWS have initiated two important surveys in the area which include a major survey and ethnographic study of sacred/ceremonial sites and places on the mid-north coast and a Management Study for Aboriginal Historic Sites in the north coast region.

The ethnographic survey was part of the NPWS Aboriginal Sites Survey Project which was coordinated by Howard Creamer and carried out by Elders of the Aboriginal Community. The survey recorded Dreamtime stories and the location of ceremonial and mythological sites significant to both the Gumbangara and Thungetti Aboriginal people. Reporting of these areas and stories was done by Tribal Elders Harry Buchanan and Mr Terry Donovan (Creamer, 1979). Sites were identified at Mount Sullivan, Mount England, Pickett's Hill, Scotts Head, Yarrahapinni Mountain and Bald Mountain. No details of these sites and places are recorded in this report as during the current survey Neville Buchanan, Elder of the Gumbangara Tribe expressed concern that details of these sacred sites should not be available to the general public.

A study entitled *Aboriginal Historic Sites in North East NSW: Management Study* was carried out by Rich (1990). This report recorded and assessed Post Contact sites important to the present Aboriginal Community. Listed are Cultural sites (ceremonial sites, tribal battles, warfare sites, massacre sites), Reserves, institutions (schools, children's homes, Native Police headquarters). The following site types were identified in the area between Nambucca and Kempsey; first Contact sites with explorers Cook and Flinders; two massacre sites; six un-managed reserves and missions and one home/orphanage site. Although none of these sites is affected by the current development, these sites are a vital part of current Aboriginal History of the area and as such are significant to the local Aboriginal Community.

4.3 Surveys associated with development applications

More recent surveys in the area have been carried out as the result of development applications. In the Macksville area archaeological investigations have been carried out by Lance (1990), Navin (1991), Rae (1991), Godwin (1989), Appleton (1993), Davies (1991,1993), Kuskie (1993), Collins (1991, 1995)

Lance (1990) investigated an area bordering Swampy Creek at Nambucca Heads. In this investigation of an area approximately 200 sq metres, 1200 auger pits were dug in anticipation of locating burials. No burials were found but two definite pebble artefacts and a *'small displaced patch of shell midden"* were located.

Navin (1991) This survey is close to the present development area and investigated options for the upgrade of the Pacific Highway immediately north-east of the present study area. One site was located during the survey. This site was reported by a land owner who showed the consultant a number of artefacts including two ground hatchet heads, broken pebbles and flaked pebbles. The items had been collected from a low ridge line which extends northwards into the Nambucca River.

Godwin (ND) investigated development areas around the township of Scotts Head east of the present development area. Godwin recorded thirteen sites which included six midden sites, two open camp sites, one possible stone arrangement, three middens sites with stone artefacts present and one PAD.

Appleton (1993) surveyed a proposed quarry development, north of Scotts Head. He recorded one midden site and a possible PAD. The midden contained shell and one artefact. The PAD was a dune area where it was thought that other midden sites may be present but were not visible at the time of the recording because of dense vegetation cover.

Rae (1991) prepared a conservation plan for the complex of sites at Bellwood Road Nambucca Heads for the Nambucca LALC. This survey was a follow up from the survey by Lance (1990). The report assessed the report by Lance (1990) and presented a statement of Aboriginal significance for the site complex in which problems involved in establishing authenticity for the notion of Cultural Value for "spiritual sites" were addressed.

Davies (1991) Carried out an archaeological survey of the proposed Telecom Optic Fibre Cable Route from Crowdy Bay, north of Taree to Coffs Harbour. The survey corridor was 6m wide and passed through the present development route. No sites were located in the survey area. **Davies (1993)** carried out a survey of the State Forests of NSW Coffs Harbour-Urunga Management Areas. The aim of the survey was to locate sites within the forest and develop a predictive model of site location and consider the impact of proposed forestry activities on the archaeological resource. In her assessment, Davies classifies the present study area as coastal ranges and summarises site distribution patterns in this zone as follows. *Most open sites previously recorded in the coastal ranges appear to be located on ridges, spurs, saddles and crests with sites occurring less frequently on and adjacent to streams.*

Kuskie (1993) conducted a survey for the installation of Optus Optic Fibre Cable between Clybucca Creek and Coffs Harbour. The route surveyed runs parallel to the present development but west of Warrell Creek. Kuskie observed sediment aggradation in excess of 1.2m in the banks of both Upper Warrell and Algomera Creeks and concluded that sites were therefore unlikely to be identified in these creekline areas. Kuskie located one site containing three artefacts on a low spur line above the Nambucca River floodplain, north-west of the present development. The location of this site endorses the site distribution models developed by Davies (1993) which identified the most sensitive archaeological areas to be low spur lines and ridges associated with water courses.

Collins (1991) examined a section of sand dune to the west of Clybucca Creek south-east of the present proposed development. This survey identified one open camp site and two shell midden areas. **Collins (1995)** carried out sub-surface assessment of a storm water drain which passed in the vicinity of twelve previously identified areas of shell midden deposit at South West Rocks (NPWS survey 1988). Sub-surface investigation concluded that there was little archaeological deposit outside the "mound areas" but identified the fact that these sites had been badly damaged by grazing cattle and residential development. The density of sites in this coastal area supports the site location model proposed by Coleman (1982) and supported by Godwin (1989), Lilley and Hall (1982) and Kuskie (1993), which proposed that Aboriginal groups in the North Coast region were a semi sedentary group who utilised the large variety of food resources readily available to them in the immediate coastal, estuarine and riverine environments.

4.4 National Parks and Wildlife Sites Register

A search of the National Parks and Wildlife Service (NPWS) register of known sites showed that there are 12 sites recorded within a 6km radius of the proposed development. No sites were within the proposed development area.

21-6-0124	(4km west of proposed development)	midden
21-6-0128	(1.5km west)	open camp site
21-6-0129	(3km east)	midden
21-6-0085	(Dead man's gully 1.5km south)	Burial/story site
21-6-0127	(800m west)	midden
21-6-0137	(5km east)	open camp site
21-6-0097	(6.5km east)	mythological site
21-6-0095	(2.5km north-west)	carved tree/Bora
21-6-0039	(4.5km north-east)	open camp site
21-6-0007	(5.5km north-west)	mythological site
21-6-0126	(6km west)	midden
21-6-0016	(5km north-east)	mythological site

4.5 Development of a predictive model for site type and distribution within the proposed study area.

When considering the types of Aboriginal activities which would have occurred in the development area, it is important to take into consideration, the range of landform units in the immediate vicinity. These landform units include the fertile river valleys of the Macleay-Bellinger Rivers to the south and the Nambucca River to the north, the steeply dissected foothills of the New England Tableland to the west, the Macleay Hills and the coastal and estuarine environments to the east. All these micro environments would have been utilised by Aboriginal people. However it does appear from archaeological and anthropological evidence that the largest population groups were centred in the coastal, estuarine and riverine environments where a wide diversity of food was available. The number of the sites sacred to the Gumbangara tribal are an indication of a large population of Aboriginal people living in the coastal and riverine area in prehistoric and more recent times.

From an assessment of the distribution patterns of sites identified by recent surveys associated with development applications, the following site prediction model was evolved. The largest numbers of sites have been identified in coastal, estuarine and riverine landform areas. Although the sampling may to some degree be a direct reflection of the numbers of development related surveys in this landform area, the size and distribution of sites is evidence for presence of a large population in the area. Undulating hilly areas, spur lines

and ridges tops close to fresh water creeks and/or rivers have also been identified by these surveys to be areas of possible archaeological sensitivity. This model is supported by the investigations of Kuskie (1993), Navin (1991) and Davies (1993).

It is concluded that the most likely site types to occur in the development area are:

- **Ceremonial, sacred sites and sites of high Aboriginal cultural significance.** It is unlikely that any additional sites in this category will be present in the proposed development area. Sites previously identified by tribal Elders include NPWS sites (21-6-0085, 21-6-0097, 21-6-0007, 21-6-0016).

- **Open Camp sites** may occur almost anywhere that Aboriginal people have travelled, however they are usually associated with fresh water sources, especially the larger camp sites. They can vary from a few artefacts to hundreds and may be associated with hunting and gathering activities, domestic camps and/or the manufacture and maintenance of stone tools.

- **Midden sites** are concentrations of artefactual debris that includes a significant percentage of marine or freshwater shell. Smaller middens may be the result of just one 'dinner time camp', however larger middens are thought to be the result of continued use of the site.

- **Scarred and Carved trees** The occurrence of scarred and carved tree sites over the survey area is largely determined by the presence of remnant old growth native timber.

Axe grinding groove sites contain elongated depressions in sandstone outcrops and were formed by the rubbing of axe blades across the stone to sharpen the cutting edges. These grinding grooves can vary in number from a single groove to multiple grooves. They are usually associated with water which was used somewhat similarly to the way a wet stone is used to sharpen blades.

4.6 Predicted Archaeological Sensitivity

Based on an assessment of site types and distribution patterns in the immediate area and the identification of landscape units present within the development area, it was predicted that the most archaeologically sensitive micro-landform units in the study area would be associated with raised spurs and low ridge lines adjacent to permanent water sources. The low lying flood plain area was considered as having low archaeological sensitivity.

5. Field Survey Methods

5.1 Pre-field Survey Investigation

Initial investigations carried out prior to commencement of the field survey included site and archival searches of the NPWS site data base, and the Register of the National Estate, Canberra. Consultation also took place with Reg Donovan, Chairperson of the Unkya LALC and Neville Buchanan, Tribal Elder.

5.1.1 Archival searches

According to the NPWS data base, no sites have been previously recorded within the study area. There were no Aboriginal sites in the vicinity of the proposed development listed on the Register of the National Estate at the time of the search.

5.2 Pre-Field Survey Assessment

Prior to the commencement of the field survey, a desk top study of the survey area landform and archaeological land systems was conducted. As a result of this assessment, a site prediction model was developed **(Section 4.4)** in conjunction with a strategy for survey area coverage **(Section 5.4).**

5.3 Landscape Classification

Within the proposed Bypass route there are three micro-landform units. These include approximately 1.5 km of low lying, boggy ground, 2.5 km of gently undulating hill slopes and 0.5 km of creek line and associated raised terrace/spur areas. Archaeological land systems correspond to these landform units.

5.4 Field Survey Strategy

A 'total coverage' survey strategy was adopted for the entire By-pass route **(Map 2).** This involved four on-foot transects approximately 15m wide along the entire route.

5.5 Field Recording Methods

The field survey was conducted using the Macksville and Eungai 1:25,000 topographic map sheet and maps and aerial photographs of the proposed development supplied by Sinclair Knight Merz. Where sites were present, site details, landform and environmental conditions relating to the detectability of sites were recorded on data sheets developed for the survey. Where appropriate, copies of site/artefact recording forms are provided and copies of NPWS site forms with relevant field notes attached. Photographs were taken of all sites and PADs.

5.6 Surface visibility

Surface visibility within an archaeological context generally refers to the degree of impediments on the surface which might obstruct surface observation of archaeological material. The main factor to affect visibility is vegetation cover, although features such as rock outcrops and other natural or man-made obstructions on the landscape can also affect surface visibility. Surface visibility can be expressed as a percentage of the surface which is visible (Bonhomme 1986:11). **Table 1** provides a basis for surface visibility assessment.

Table 1: Surface Visibility Criteria

a	Nil soil visibility	0-5%
b	Occasional glimpses of bare ground	5-10%
c	Frequent patches of bare ground	20-50%
d	Approximately 50% bare surface	50-70%
e	>70% bare surface	75-100%

Surface visibility varied within and between different landform areas and these differences are shown in Table 2. The high level of previous disturbance to the area increased surface visibility, but in the hill slope landscape unit visibility was low which allowed only a limited level of archaeological assessment of this unit. Visibility in all other landscape units varied from 10-60%.

5.7 Field Survey Methods and Coverage Data

The total survey area has been assessed from development plans supplied by Sinclair Knight Merz as approximately 4.5km x 100m or 45 ha. *'Effective coverage'* of the areas surveyed has been calculated from a total coverage strategy and is set out in Table 2.

Table 2: Effective Coverage

Landform Unit	Sample unit Dimensions (LxB)m approx)	Sample Unit area Area in hectares	Coverage method % of Sample Unit Vehicle/Foot	% visib-ility	Effective Coverage of Total survey area	% area effect surveyed
gentle hill slopes	2500 x100m	25 ha	100% foot	10%	2.5ha	5.6%
low lying boggy ground	1500x100m	15 ha	100% on foot	30%	4.5ha	10.0%
creeklines & associated terraces/spur	500 x 100m	5 ha	100% on foot	20%	1ha	2.2%
Totals		45 ha	100% on foot		8ha	17.8%

Site detectability varied over the survey area and was determined by factors such as surface visibility (see Table 2), geomorphology and the type of sites present. The measurement of site detectability is difficult given the range of factors which may influence site detection, some of which are mentioned above. Effective coverage assessment can be determined by the interpreted accuracy of a field investigation (Witter 1990b). For the current study, a method of coverage analysis where effective coverage can be reasonably accurately calculated, was adapted from Witter (cited Bonhomme 1993:50) where the following applies:

Survey Coverage Assessment formula (Boot 1996 pers. com.)
L x W x % of visible ground surface = effective survey coverage
where L is the length of the of the survey area/unit/transect in metres, W is the width of the survey unit/area/transect in metres. **Therefore** the total survey area was approximately 45ha of which 8ha were effectively surveyed.

5.8 Surface Exposure

Surface exposure of archaeological sites is linked with visibility but should not be confused with surface visibility, in that exposure usually refers to the results or the effects of geomorphic processes on archaeological deposits. For example, a level of exposure of archaeological materials may occur due to wind, rain or other erosive agents. The major factor in site detectibility in this area was water erosion of road verges and rail cuttings.

5.9 Definition of Sites and establishing site boundaries

For the purposes of surface archaeological surveys, site boundaries are most frequently determined by the presence of Aboriginal cultural material. NPWS guidelines indicate that a site may be determined by the presence of two artefacts located within 50m of each other. However, Witter (pers. com. 16/5/96) describes a cultural site as ...*"a place identified as such by an observer (including someone listening to oral accounts)...a site should be a unit of management."* This statement infers that an archaeological 'site' may be a place where physical evidence of past Aboriginal occupation has occurred eg open camp sites, stone arrangement, whilst other site types may be determined by the presence of a single artefact (eg a scarred tree) or even by the presence of a recognised significant area based on anecdotal information and often occurring in an area where no visible artefacts are present (eg places of ceremonial or religious significance such as natural geological formations).

The extent of a site, particularly in the case of open camp sites, is often difficult to assess owing to the effects of the geomorphic processes which may have impacted on a particular area and its archaeological deposits. However, surface deposits of archaeological material are usually, but not always a reliable guide to site locations. It should be acknowledged that EIA related studies do have their limitations and where the archaeologist believes there is a potential for the presence of sub-surface archaeological deposit, the issue should be raised and steps taken to accommodate that potential within a management framework which may include recommendations for further archaeological investigations, monitoring of the area or else simply taking into account the likelihood of sub-surface deposits during the development of management recommendations.

6. Survey Results and Discussion

No indigenous sites were identified during this survey, however one area of potential archaeological deposit (PAD) was identified.

6.1 PAD 1: Raised spur adjacent to Rosewood Creek

This PAD area is located adjacent to and north-west of Rosewood Creek (49016E 659625N) **(Map 3, Sketch 2, Photos 5, 6)**. At this location, it is proposed to re-route the railway line immediately to the south of its present position. The new route for the rail line will impact on a raised spur area above and west of Rosewood Creek. This spur is approximately 100m long by 30m wide and the crest of the spur is a flat area at its western boundary adjacent to the present rail cutting. The spur then falls away sharply to the east into Rosewood Creek. The entire PAD area has been cleared and ploughed and impacted by the present rail cutting on its western boundary, a Telstra Cable and sewer easements located approximately 15m east of the rail line and through the central section of the PAD area. Despite this heavy disturbance, a narrow section of the spur line between the rail line, the Telstra cable route and the sewer main appears to be relatively undisturbed. However in view of the degree of disturbance to the PAD area, it is most likely that the integrity of any site in the vicinity would have been severely compromised. Another factor to be considered when determining management options for this area is the fact that no cultural material was located in the area during the Telstra or sewer main installation surveys. Harry Buchanan who represented the LALC on this survey, had participated in the Telstra survey with Davies and confirmed this result.

7. Significance assessment

7.1 Criteria for Significance Assessment

A statement of significance has been prepared for all sites and PAD areas identified during this survey. The assessment of an individual site's significance is determined by a number of criteria, which in their broadest terms and under NPWS guidelines include consideration of a site's scientific and educational value as well as giving consideration to the value of a site to the Aboriginal community.

Scientific Significance: requires an assessment of the site's integrity, preservation, contents, location, uniqueness, representativeness and potential for future scientific research.

Educational Value/Public significance: assesses the potential of the site as an educational resource. It is important to acknowledge that this potential will not be the same for all groups which will include: educational institutions, general public and Aboriginal communities.

Aboriginal Value: The Aboriginal community places a range of values on sites. Aboriginal values can often vary from those held by the non-Aboriginal community. In some instances, the archaeological significance of a site is considered by an Aboriginal community to be a secondary consideration when assessing a site's significance. The Aboriginal community may place a greater emphasis on the socio-cultural significance of a site, or upon its educational value, (particularly for teaching community members about the lifestyles of their ancestors) and the value of a site in providing a 'link' with living community members and their ancestors. It appears that in many cases, Aboriginal communities tend to place far greater significance on sites relating to contemporary Aboriginal Heritage and historic events, for example mission sites and fringe camp sites. However the reverence for burial or sacred sites is never compromised.

7.2 Significance assessment and discussion.

PAD 1: Spur area above Rosewood Creek

The archaeological significance of this area has been assessed as low to moderate. This assessment is based on the following observations. Although no artefacts were noted, the location of the area fits the criteria identified in the predictive model for potential archaeologically sensitive areas ie it is a raised spur area above a permanent creek line (Section 4.4). However in a previous survey carried out for Telstra, no sites or PADs were identified in this area. The Telstra Cable runs through the identified PAD area (Davies 1991). Also there is a sewer line passing through the PAD area but there is no record of any archaeological assessment having been undertaken for this development. The PAD area has been cleared and ploughed. Although the integrity of the area has been compromised to some degree by previous disturbance, the consultant concludes that there remains, within the impact zone, an area of the spur which appears relatively undisturbed. The potential educational and scientific value of the PAD is unknown at this point in time. **(Sketch 2)**

8. Non-indigenous Heritage Assessment

8.1 Archival Research and results

A review of the heritage registers and schedules of the following heritage bodies was carried out.

Australian Heritage Commission Canberra

The Australian Heritage Commission maintains the Register of the National Estate. This register lists both indigenous and non-indigenous heritage sites and is organised by both Local Government Area and Locality. Places on this list are classified as:

"Indicative Places": not on the register, but identified as important
"Interim Places": currently being evaluated for inclusion on the Register
"Registered Places": listed

There is one item listed in Nambucca LGA and that is the Bowra Hotel , High Street Bowraville. This item is outside the development area.

Register of the NSW Heritage Council.

The Heritage Council of NSW includes on its list only items under Conservation Instruments. These Instruments are Interim Conservation Orders (ICO's) and Permanent Conservation Orders (PCO's). These lists are organised by Local Government Area.

There are no items listed in the NSW Heritage Council Register for the Nambucca LGA area.

Register of the National Trust

The National Trust of Australia (NSW) is a non-government, community organisation which promotes the conservation of both built and natural heritage. The Trust maintains a register of landscapes, townscapes, buildings, industrial sites, cemeteries and other items or places which the Trust determines have heritage significance and are worthy of conservation. Items listed in the Trust's Register are said to be classified. The listing of a place in the Trust's Register has no legal force however the Trust does encourage owners of listed places to respect their heritage significance. The Trust often helps local councils in the preparation of Local Environmental Plans and encourages local councils to refer development applications affecting properties listed on the Register for advice and comment by the Trust's Architectural Advisory Committee.

There are no items listed on the National Trust Register in the Nambucca LGA.

Heritage Schedules of Nambucca Shire Council

The heritage schedules compiled by Nambucca Shire Council were examined. Under the NSW Environmental Planning and Assessment Act (1979) local Councils and the Department of Urban Affairs and Planning (DUAP) prepare local and regional environmental planning instruments (LEPs and REPs), to give statutory force to planning controls. These plans incorporate provisions for the conservation and management of archaeological sites and Heritage items.

Nambucca Shire heritage schedules list a total of 37 items. Two are at Macksville, 34 in Bowraville and one Osprey nesting area on the eastern side of Warrell Creek in Congarinni.

Records of the State Rail Authority

From the records held by the NSW Railway Archives at Redfern and Transport House, the following details of location and lay out of the Warrell Creek Railway Siding were obtained (Sketches 4, 5, 6).

The Northern Rail line reached Kempsey in 1917. The station at Warrell Creek, noted as being 544.46km from Sydney, was opened in 1919. It featured a platform on the up (toward Sydney) side and a goods siding on the down side. This arrangement is shown in the signals diagram **(Appendix 8).** The railway station building was a standard A2 provision featuring a lockable store, waiting room and water tank. This was a timber framed structure with fibro-cement sheet cladding. The station was never manned and with rationalisation of country rail services, it was closed on 30th June 1974 and the buildings removed.

8.2 Historical Background of the Warrell Creek Area.

Permanent white settlement of the Nambucca Valley substantially commenced around 1865 when changes to land title first allowed leasehold and freehold tenure. Prior to this period, most occupancy was on conditional purchases, many of which did not lead to permanent ownership. This transience was associated with the uncertain economic returns from timber and the unsustainable early pastoral ventures which brought the first settlers to the area.

In 1841 the first cedar getters moved into the area after cedar along the Macleay River was worked out. These early ventures did not last long as the cost of transporting timber from the Warrell Creek area to Grassy Head ended operations, leaving good stands of cedar remaining.

The mid 1850's saw a resurgence in cedar getting, largely in response to higher market prices resulting from increased development following the gold rush boom of the 1850's. This provided the impetus for the start of permanent settlement in the Nambucca area. Initially cedar getting involved using bullock teams to haul logs to the cedar dealers hut at Warrell Creek from where they were punted to Scott's Head, then taken by dray to Grassy Head for shipping to Sydney and Newcastle. It was not until 1871 that the first mill appeared on the Nambucca. By 1900, there are records of a mill at Warrell Creek which was run by the Eichmann family. Dunne (1990) notes that the mill was producing hardwood girders 20'x8'x6' for boat building and bridge construction. Eichmann's mill provided timber for the Eungai Progress hall in 1907 and was still operating in 1922 when it supplied timber for the Eungai Soldiers' Memorial Hall.

From all accounts, cedar getting was a difficult occupation. Most cedar cutters were ticket of leave convicts who lived for long periods in the forest, protected only by rough huts made of bark. Surprisingly, they were mostly married or with female companions. It was common for them to spend up to 2 months at a time in the bush, only coming to town for their pay and provisions.

It is thought that the name "Warrell Creek" dates from around 1842 and that it may be a corruption of the aboriginal word "warral." This coincided with the period when the area was first subject to pastoral selection. These pastoral runs proved to be difficult to maintain and many were abandoned within a few years of their commencement. Early records indicate that the runs supported few stock, perhaps an indication that the major interest was cedar felling, and that there was a shortage of fresh water, most of the creeks being brackish. A William Scott leased the "Werral Creek Run" in the early 1840's. It was noted in the

Government Gazette of the day as having 5000 acres, but only 4 horses and 10 cattle. Robert Massie, a Crown Lands Commissioner, writing in the Macleay Letter-Books 1842-46 (NSW Archives) refers to the "bad nature of the country" as a serious problem. As a result of these conditions, most of the runs which were established in the early 1840's had been abandoned by 1850.

The Warrell Creek area was subject to increased selection during the period 1870-1884. (Townsend 1993 p 62 & 65)). It was always destined to be a small settlement, given the dominance of Macksville and Nambucca, together with the added constraint that the site of the village was marshy, low lying and flood prone. An elementary school was opened in 1889, but appeared to experience difficulties as there was a subsequent petition for its reopening in 1899. This was most likely as result of low attendance resulting from children being involved in seasonal farming activities.

Around the turn of the century, there was a rapid growth in dairying. This was associated with the clearing of the tropical rainforest and the successful introduction of paspalum which provided nutrients which were lacking in the local native grasses. The extension of the northern rail line from Hexham in 1906 caused a demand for hardwood sleepers which led to a resurgence in timber felling in the area. This was welcome as cedar supplies were all but exhausted by 1900. In 1913, the Macleay Chronicle recorded that there were 60 bullock teams working in the local forests, 30 in the Warrell Creek area. The First World War further increased demand for local hardwood timber.

8.3 Site Prediction Model

A model for the site type and distribution patterns for heritage items in the survey area was developed from a review of the records of the Australian Heritage Commission, NSW Heritage Council and the Nambucca Shire Council.

It was considered that the following heritage items and places may be located within the survey area: remains of early farm buildings, logging and mill site remains, machinery and fencing. These remains could include both standing structures and archaeological sites.

8.4 Field Investigations

The survey for indigenous and non-indigenous sites was carried out concurrently (see Section 5 of this report for details)

Survey Methods and Strategies

This survey is designed to:

- identify areas of possible heritage significance within the study area
- make a brief assessment of the heritage significance of sites where possible.
- recommend additional investigation if required.

8.5 Results of non-indigenous heritage survey.

2 houses, a converted dairy and 2 farm sheds will be directly impacted by the re-routing of the railway line **(Sketch 3)**. Although the railway structures were removed, the site of these buildings will be impacted by the development.

All structures directly impacted by the proposed by-pass and railway line re-routing were assessed for heritage significance. This assessment was made from an external evaluation,

discussions with property owners and representatives from the Nambucca Heads Historical Society. No structures have been assessed as having heritage significance. **(Appendices 6, 7).**

- **House 1** : **(Sketch 1, Photo 9, Appendix 7)** This house which is located within the railway easement was constructed in the late 1940's. The cottage is a weatherboard construction with a tin roof. The house represents the past practice of the NSW Department of Railways to allow staff members to build private houses within the railway easement. Although the Waters own their home they do not own the land on which it is built. It is proposed to relocate this house to another site.

- **Converted dairy building: (Sketch 1, Photo 10, Appendix 7).** This structure was originally a timber dairy building on the Apps property. However, it has undergone substantial conversion and is now a fibro and timber clad structure which is used as residential accommodation. Most of its original features have been lost in this conversion. This structure is not classified as a heritage item.

- **House 2: Fawcett-Williams (Sketch 1, Photo 12, Appendix 7)** This house was constructed over 70 years ago by the Reedy family. Although the external dimensions of the house appear basically unchanged, the house has recently undergone substantial renovations which include the modification of the front section of the house by closing in the original verandah, the replacement of original windows with aluminium and the use of metal verandah posts and lace work.

- **Dairy and outbuildings adjacent to house 2 (Sketch 1, Photo 11)** The original timber dairy has been converted to a machinery shed. The dairy is similar to many dairy buildings in the area. Immediately adjacent to the dairy a new colour bond shed and plastic water tanks have been constructed and incorporated within a new colour bond shed.

9. Site Management Recommendations for both indigenous and non-indigenous heritage sites identified by the survey.

The RTA, as a developer, has an obligation under the National Parks and Wildlife Act 1974, the NSW Heritage Act 1975 and the EP& A Act 1979, to determine if their proposed bypass proposal will impact upon indigenous and non-indigenous heritage and where required implement recommended management actions. The following recommendations have been developed to minimise the potential impact of the development on indigenous and non-indigenous heritage items and places and ensure that the proposed development is accommodated within a management framework endorsed by DUAP and NPWS and includes consultation with the local community and Unkya LALC.

Recommendation 1

There is no archaeological reason why the proposed By-pass development should not proceed, providing the following recommendations are adhered to by the RTA (in conjunction with any additional requirements imposed by NPWS).

Recommendation 2

If the Unkya LALC supports the concerns expressed to the LALC by Mr Clary Hoskins, it is recommended that these concerns be addressed by the RTA prior to work commencing. However it is now six months since the LALC was first consulted about the realignment of the central section of the bypass and to date no formal expression of concern has been raised by LALC officials despite continuous discussions between the consultant and the LALC. NB Confirmation was received in writing from the Unkya LALC on 3rd April, 1998, informing the consultant that the issues raised by Mr Hoskins had been settled and the LALC now has no objections to the bypass proceeding as planned (Appendix 5)

Recommendation 3

Prior to commencement of development related earthworks, the RTA should acknowledge in writing to the Coffs Harbour office of NPWS, Northern Region Zone, their awareness of the location of the indigenous PAD area, and their knowledge of and willingness to comply with management recommendations. In addition, the RTA should provide to NPWS a copy of a letter to all field road works management staff (or any contractors involved in the proposed development) advising them of the location of this indigenous PAD area and of their obligations under the Act.

Recommendation 4 PAD 1: Spur above Rosewood Creek.

Because of the high degree of disturbance which has occurred in this area, no sub-surface investigation is recommended. However it is recommended that the areas be monitored for the presence of Aboriginal cultural heritage items during the removal of top soil and sub-soil to a depth of approximately 1m. This monitoring process should be carried out by a qualified member of the Unkya LALC. The RTA or their representatives are required to notify the Unkya LALC, in writing of the dates and times of the proposed work, at least 14 days before work is to commence in this section of the Bypass route. No work on this section of the route should begin until a representative of the LALC is on site.

Recommendation 5

No work camps, spoil dumps or strorage of machinery or car parking should take place in the identified PAD area.

Recommendation 6

Should any Aboriginal cultural heritage items be identified by the LALC representative, all work should cease in this section of the route and representatives of the NPWS at Coffs Harbour must be contacted so that appropriate management actions can be taken.

10. Legal Requirements and Obligations

All non-indigenous heritage items are protected by the NSW Heritage Act (1975 and the EP & A Act (1979). All indigenous relics (sites and objects), other than those made for sale, are protected under the New South Wales National Parks and Wildlife Act 1967 (amended 1974). Archaeological sites are a non renewable resource, valued for the information they can provide on the lifestyles of people in the past, and are also valued by local communities who maintained cultural links with the past through these sites and places. **It is illegal to damage or destroy a site or relic without the prior consent of the Director of NSW NPWS and/or DUAP. Any such disturbance requires a permit from the Director. The NPW Act requires that relics recovered under such a permit come under the custody of the Australian Museum in Sydney or the LALC if an application has been made by that group for a Care and Control Permit.**

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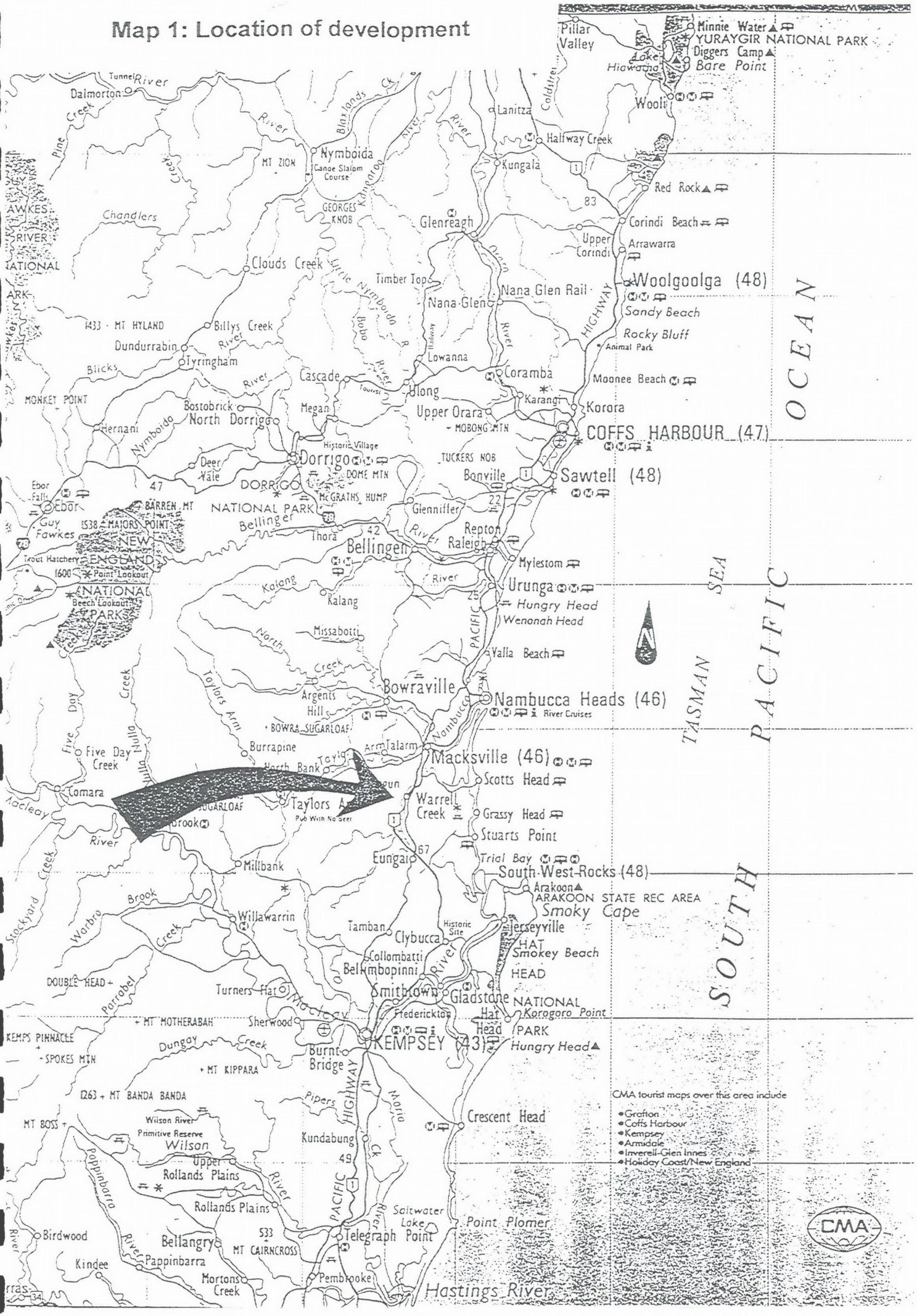
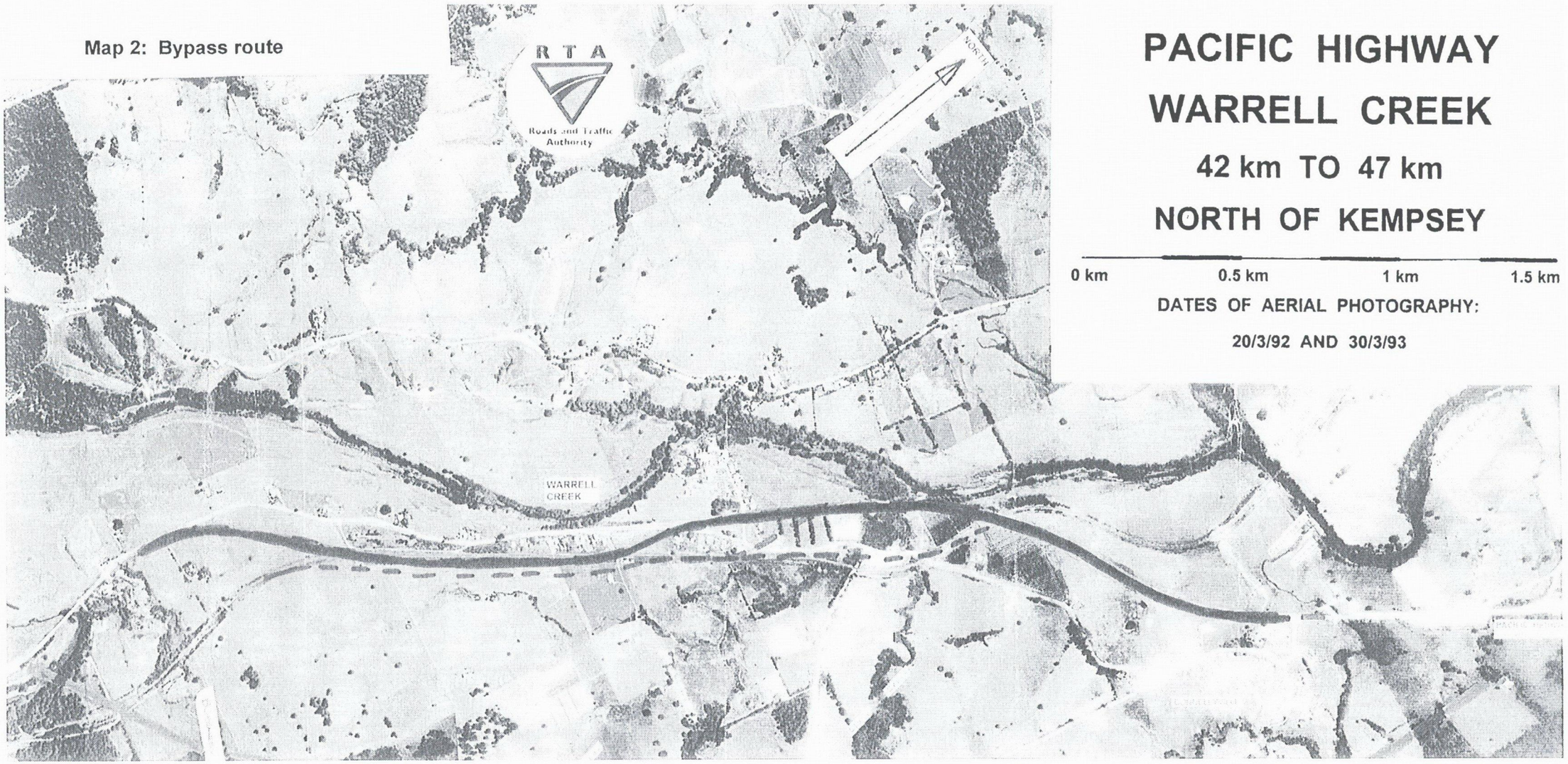
Appendix 1: Maps

Map 1: Location of development



Map 2: Bypass route



PACIFIC HIGHWAY
WARRELL CREEK
42 km TO 47 km
NORTH OF KEMPSEY

0 km 0.5 km 1 km 1.5 km

DATES OF AERIAL PHOTOGRAPHY:

20/3/92 AND 30/3/93

KEY	
	Proposed bypass route
	Proposed rail realignment

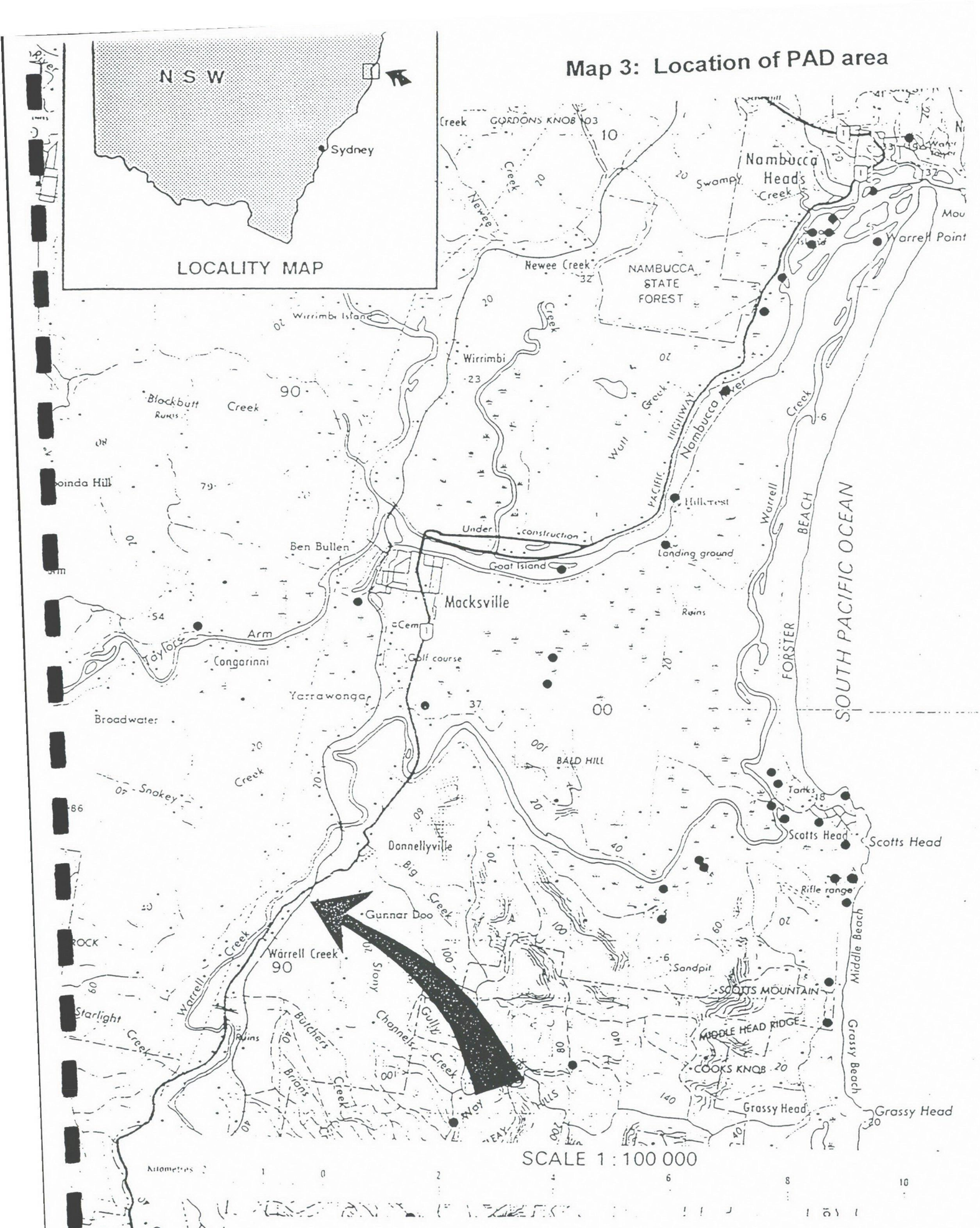
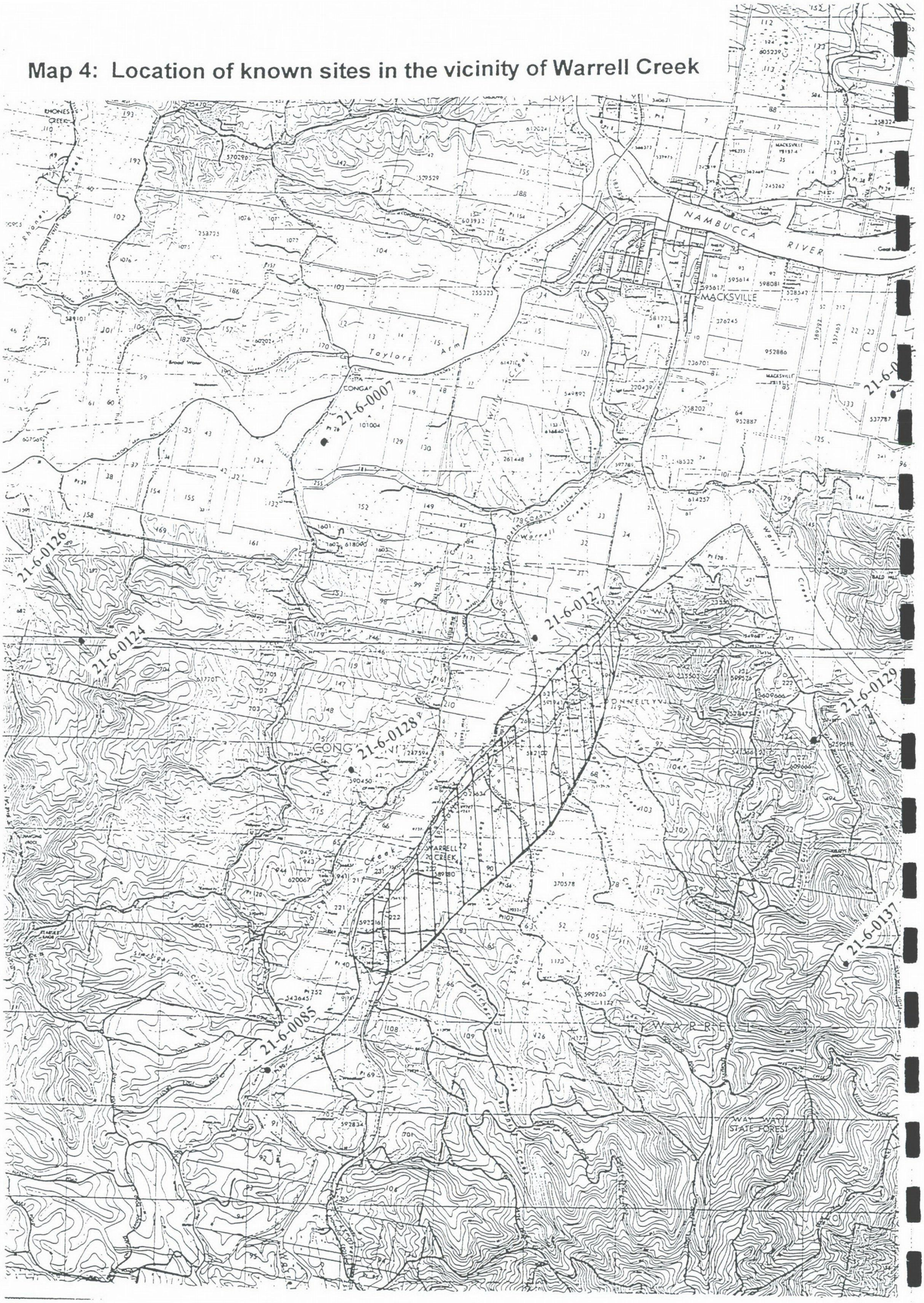
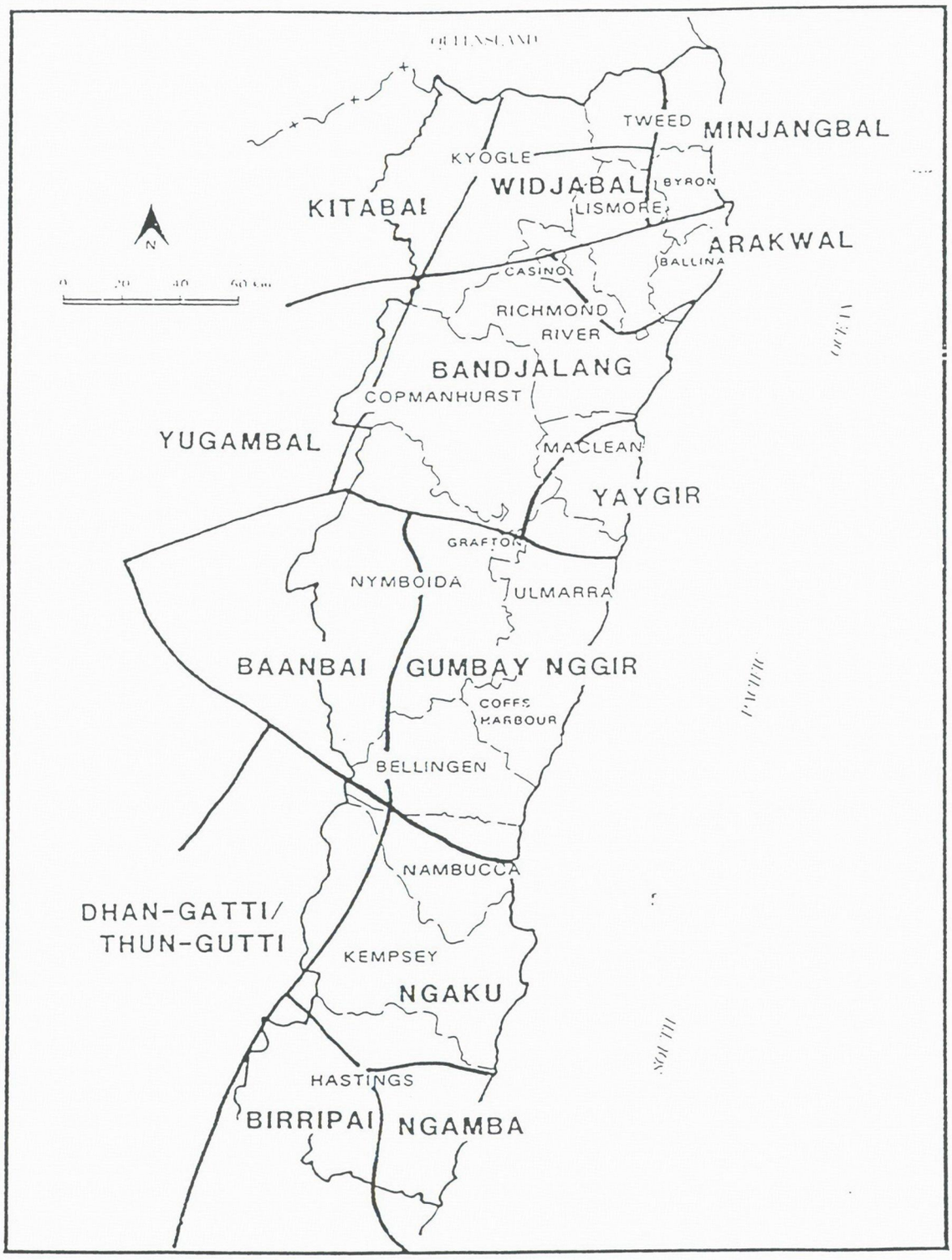


Fig. 1. Topographic map 1: 100,000 of the general survey area.

Map 4: Location of known sites in the vicinity of Warrell Creek



Map 5: Aboriginal Tribes of Australia- North Coast Extract (Tindale 1974: in Byrne 1984 : 6)



Appendix 2: Tables

Table 1: Surface Visibility Criteria

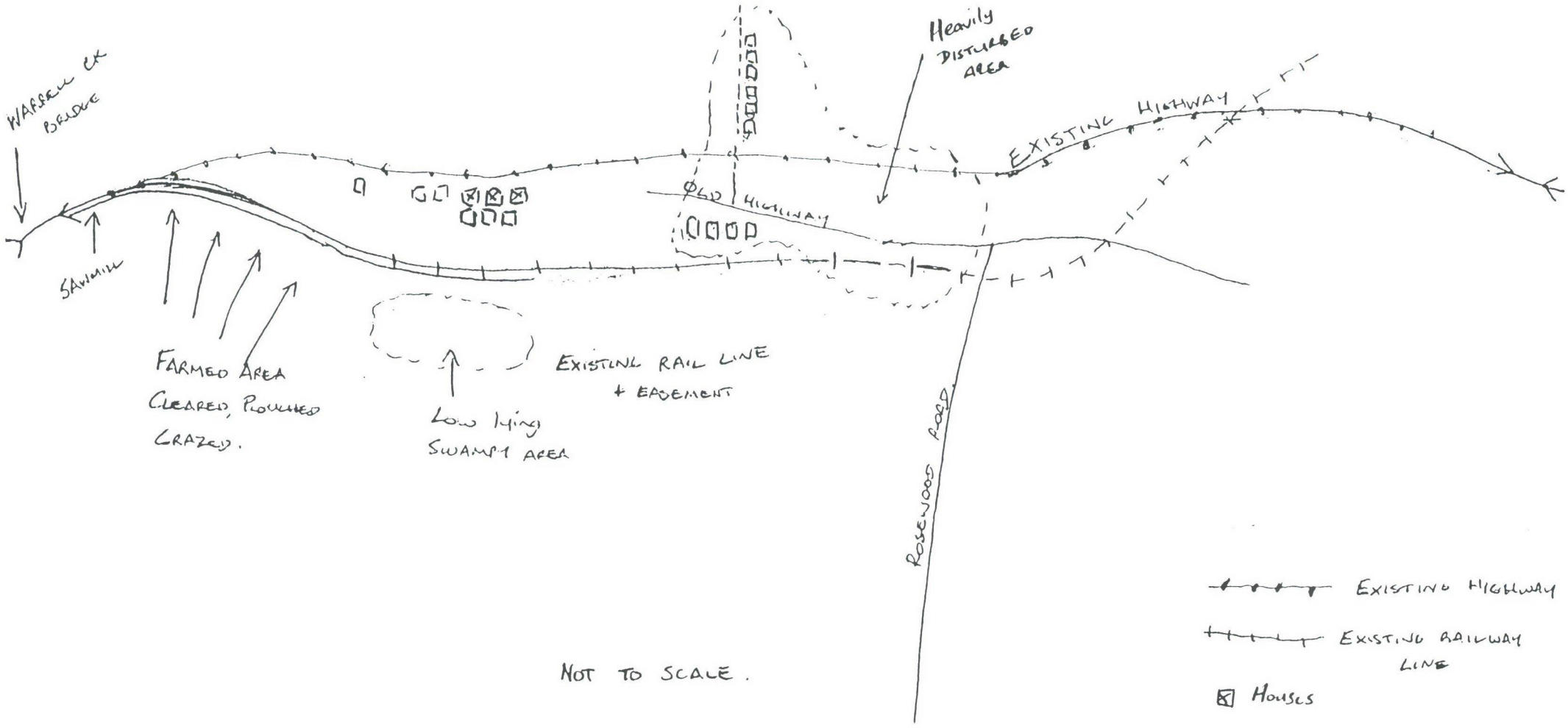
a	Nil soil visibility	0-5%
b	Occasional glimpses of bare ground	5-10%
c	Frequent patches of bare ground	20-50%
d	Approximately 50% bare surface	50-70%
e	>70% bare surface	75-100%

Table 2: Effective Coverage

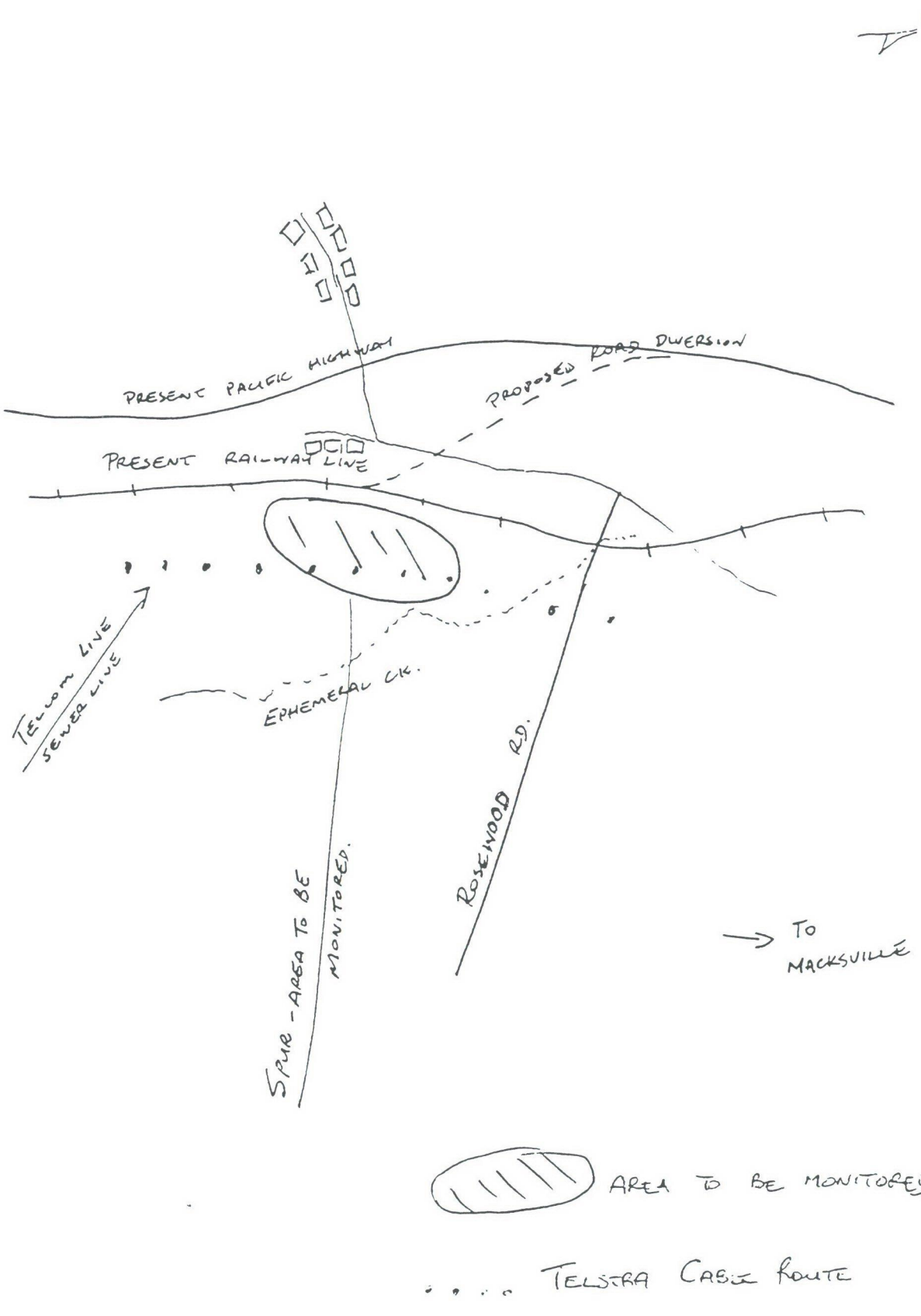
Landform Unit	Sample unit Dimensions (LxB)m approx)	Sample Unit area Area in hectares	Coverage method % of Sample Unit Vehicle/Foot	% visib-ility	Effective Coverage of Total survey area	% area effect surveyed
gentle hill slopes	2500 x100m	25 ha	100% foot	10%	2.5ha	5.6%
low lying boggy ground	1500x100m	15 ha	100% on foot	30%	4.5ha	10.0%
creeklines & associated terraces/spur	500 x 100m	5 ha	100% on foot	20%	1ha	2.2%
Totals		45 ha	100% on foot		8ha	17.8%

Appendix 3: Sketches

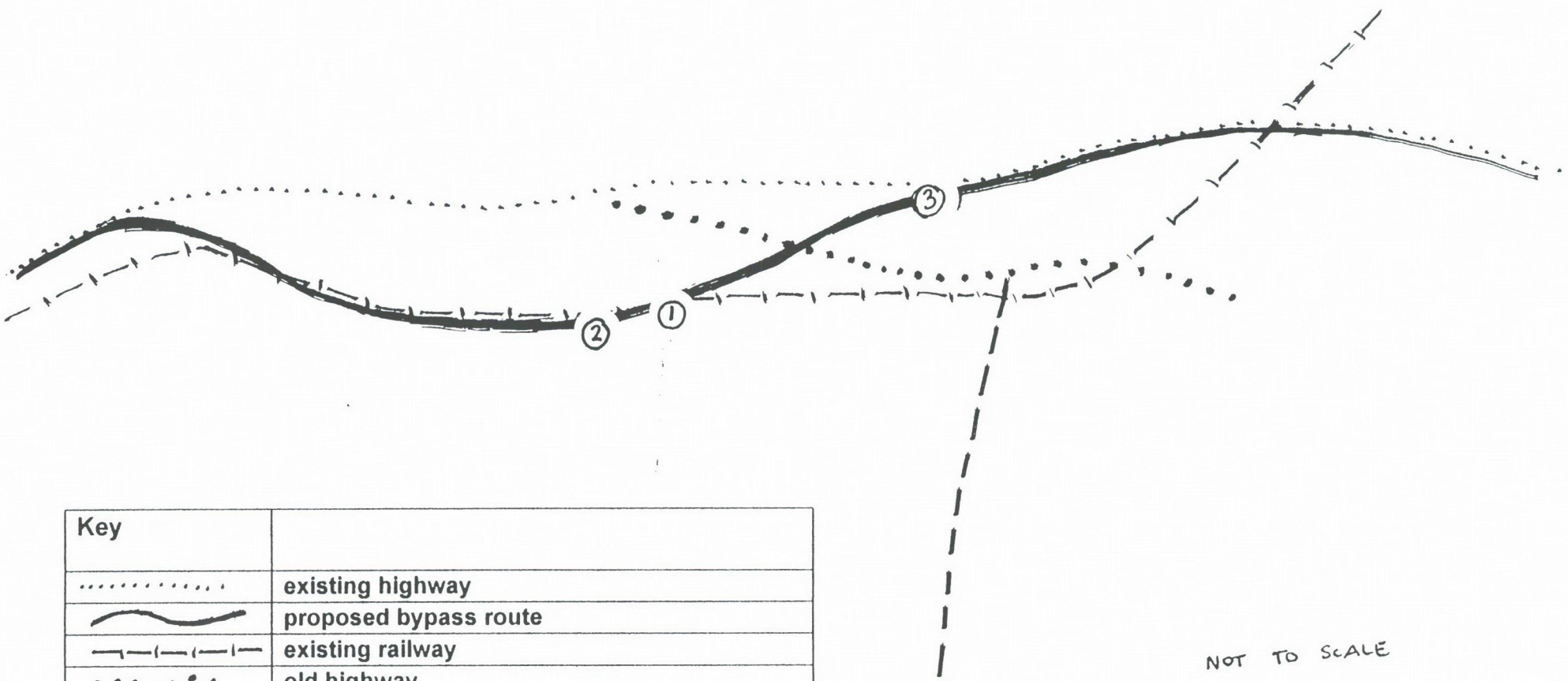
Sketch 1: Previous impacts to proposed By-pass area



Sketch 2: Area of potential sensitivity



Sketch 3: Location of houses, sheds and converted dairy in the direct path of the proposed bypass.



Key	
.....	existing highway
~	proposed bypass route
—|—|—|—	existing railway
• • • • •	old highway
①	house 1: railway cottage
②	converted dairy
③	house 2: Fawcett Williams House and sheds

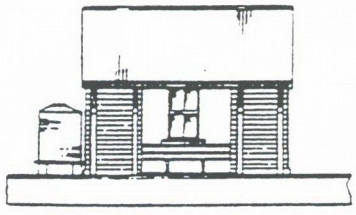
Sketch 4: Scale drawing of Warrell Creek Railway siding buildings

N.S.W.R.

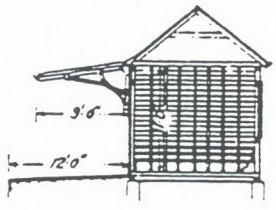
Station Building

Scale: 16ft. to 1in.

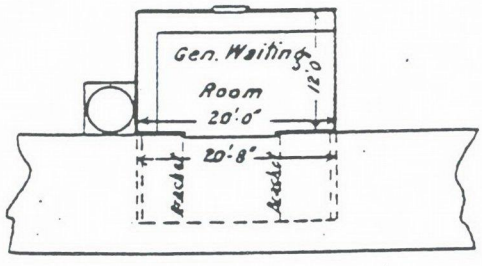
Wm. Hutchinson
20.6.13



Elevation



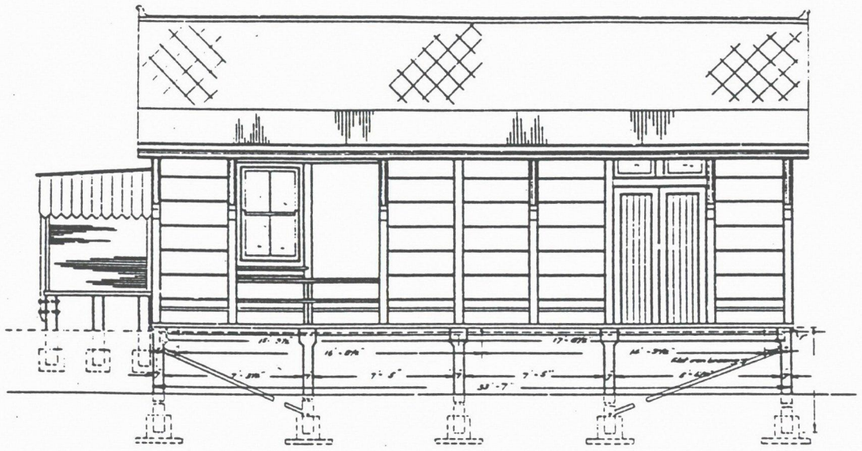
Section



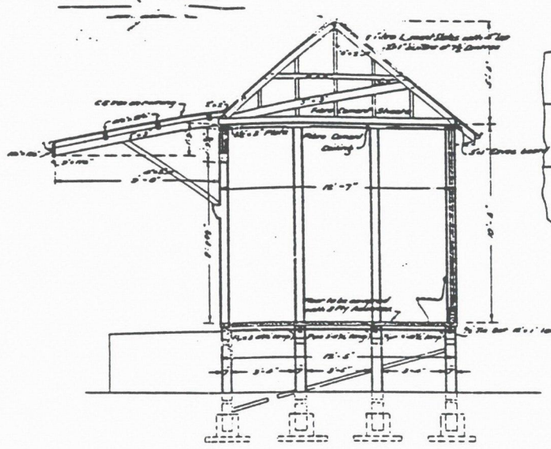
Plan

STATION BUILDING
A.2 TYPE

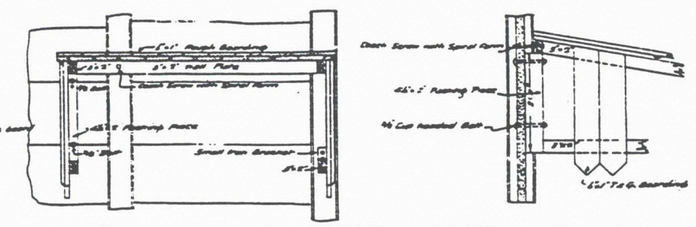
DS 1741



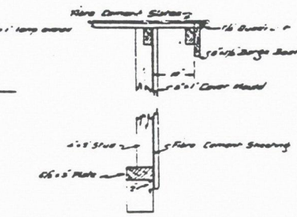
ELEVATION



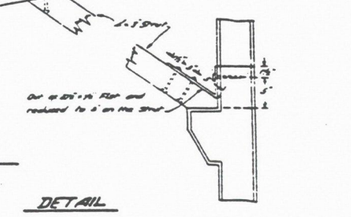
SECTION A.A.



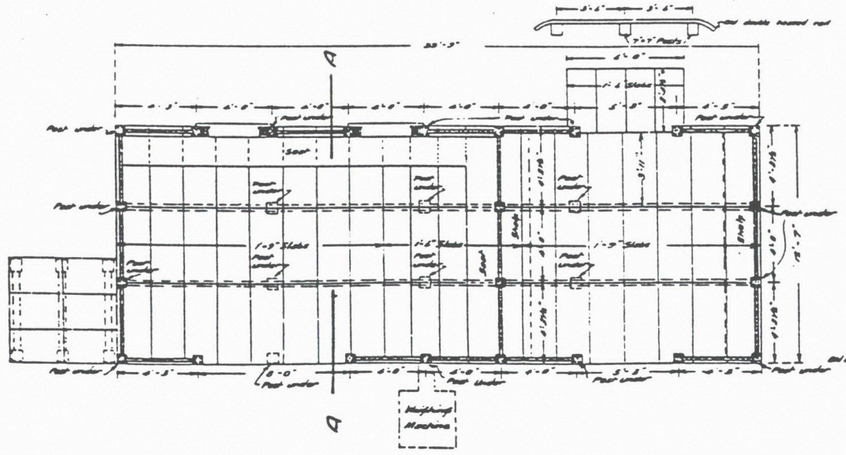
DETAILS OF TANK SHELTER



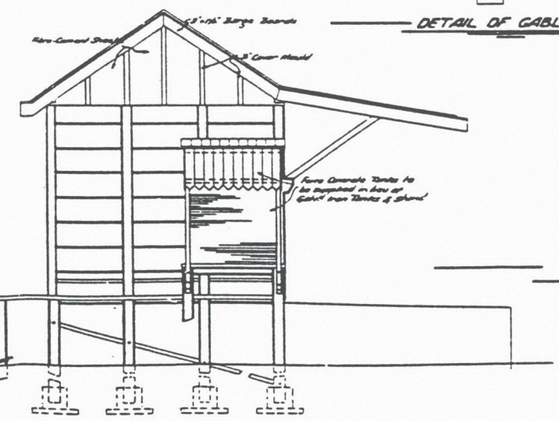
DETAIL OF GABLE END



DETAIL



PLAN



END ELEVATION

N.S.W.R.

WARRELL CREEK and COLOMBATTI

SCALE 3/16" 1' & 1½" TO 1 FOOT

Sketch 5: Scale drawing of Warrell Creek Railway siding buildings

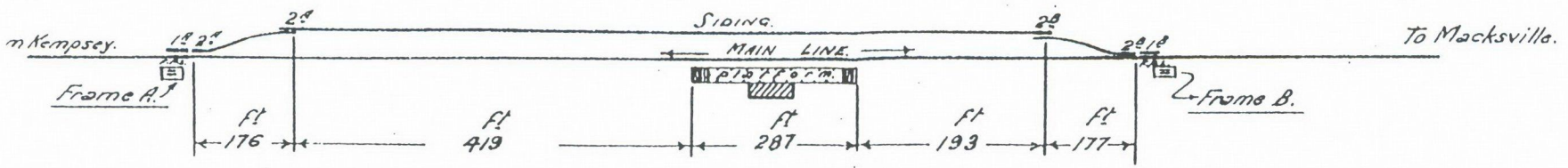
N.S.W.R.

Kempsey to Macksville.

WARRELL CREEK.

Diagram Shewing Interlocking Arrangements.

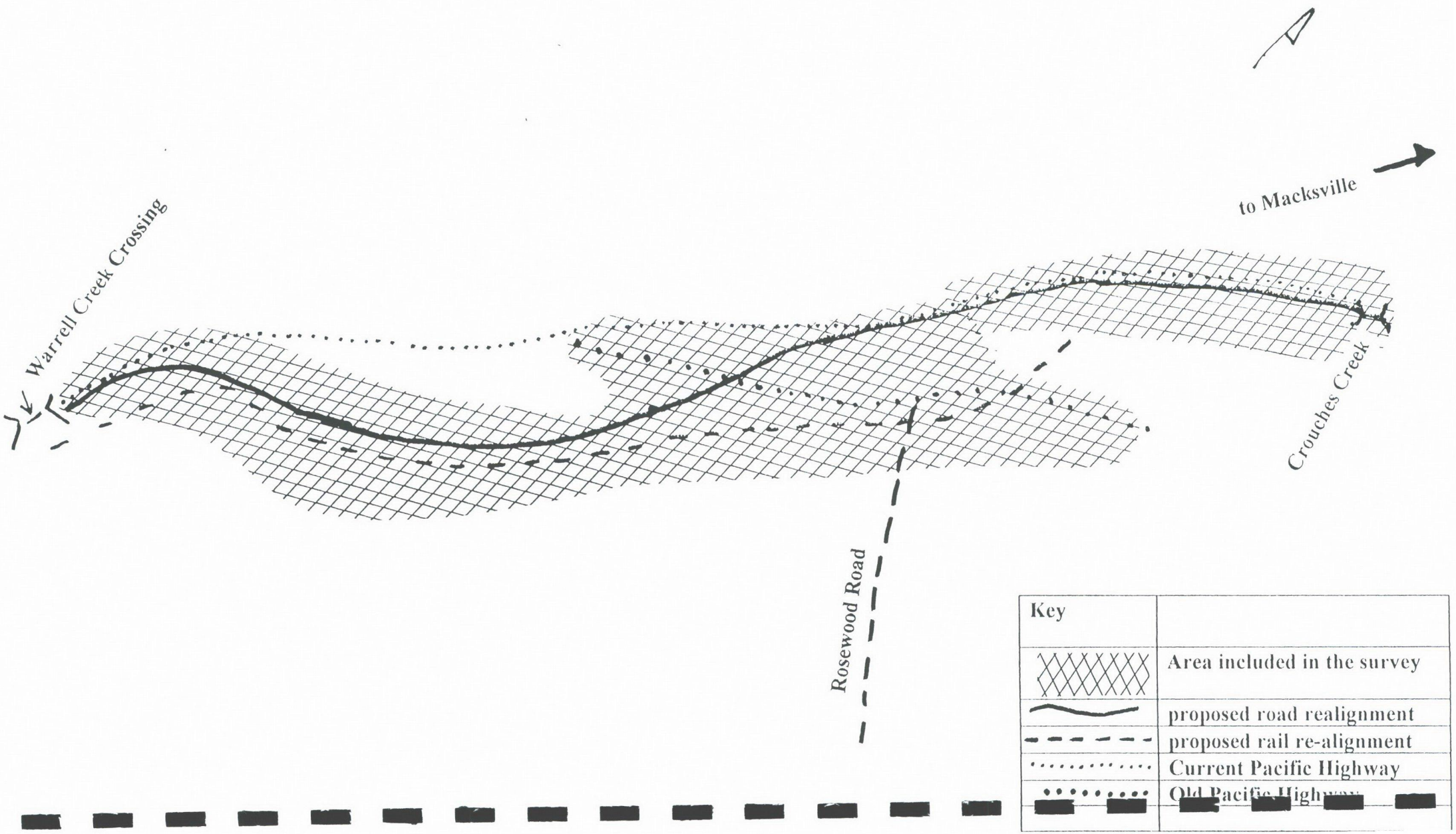
C.B. Byles.
Signal Engineer.



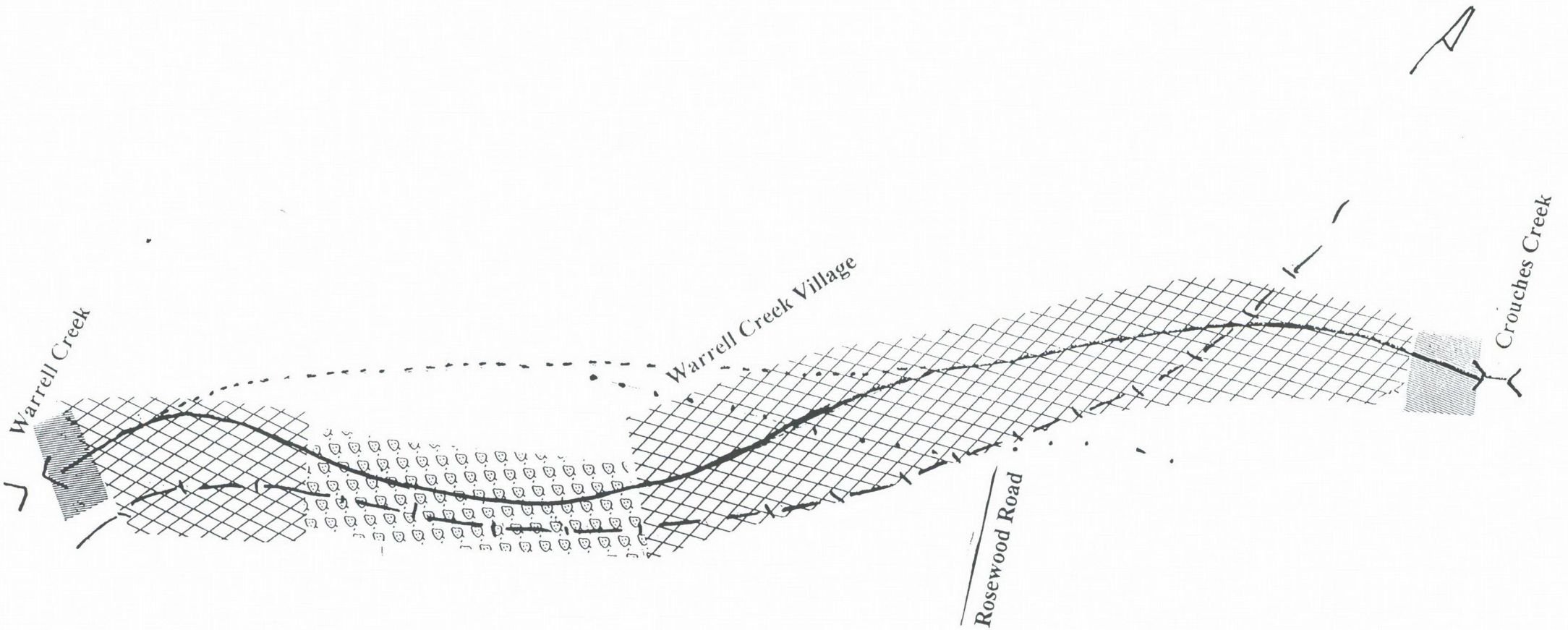
N.S.W. Rys Signal Engineer's Office, Sydney, 11th March, 1919.

Sketch 6: Scale drawing of Warrell Creek Signal/Platform structures

Sketch 7: Area surveyed



Sketch 8: Landform units within the survey area



Key	
	Creekline and associated terraces
	Gentle hill slopes
	Low lying boggy ground

Photo 1: Southern end of By-pass easement (present highway to left and sawmill to right)

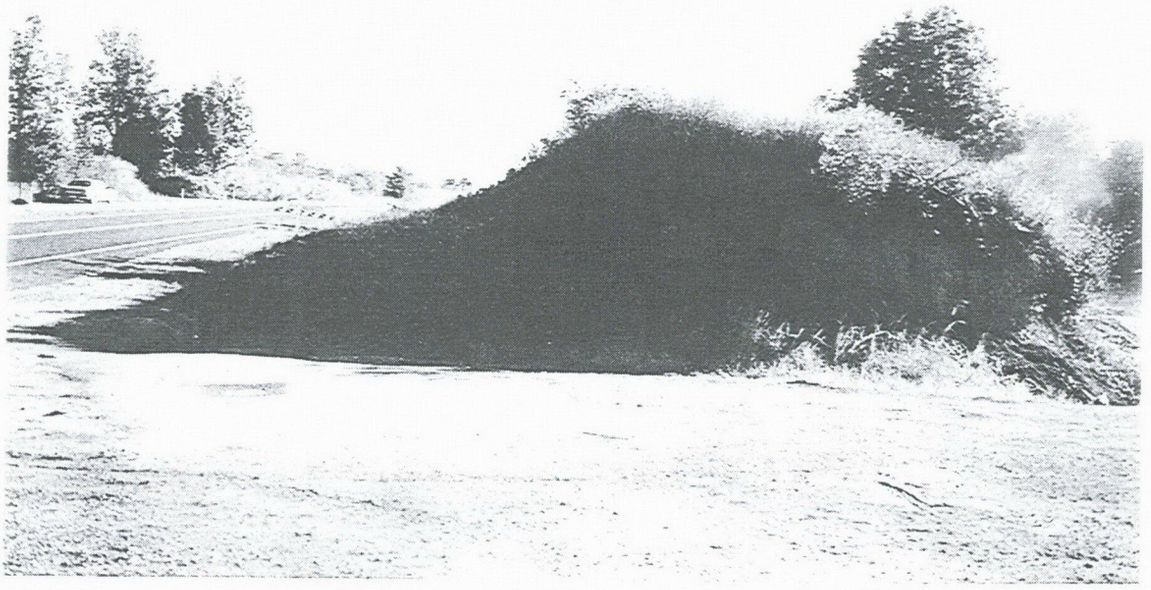


Photo 2: By-pass easement adjacent to present highway 50m north from sawmill

Photo 3: Northern Railway Line easement

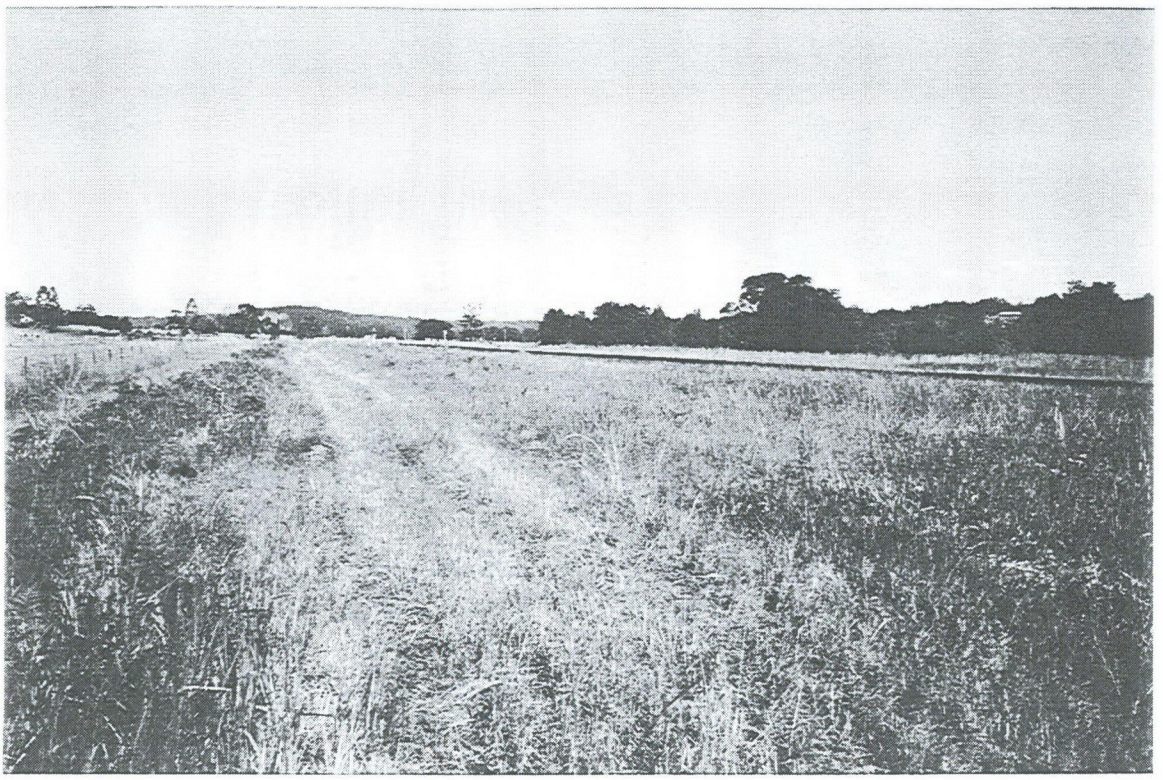


Photo 4: Location of southern on ramp

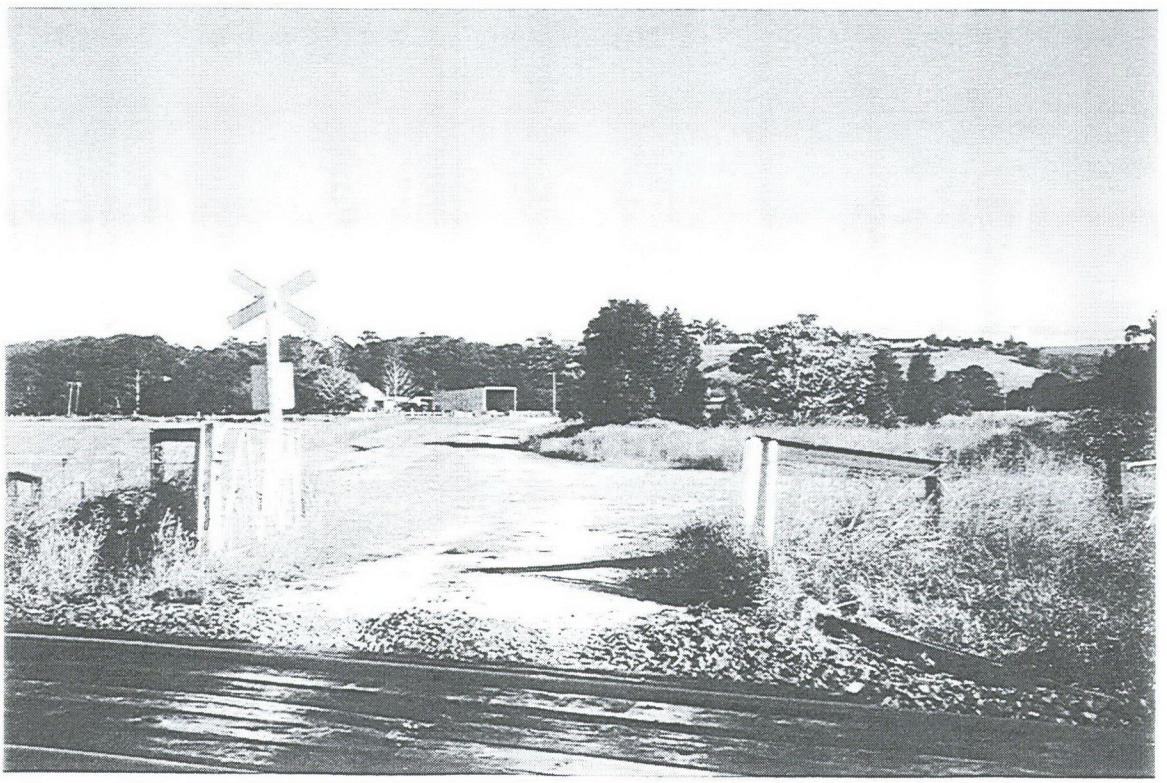


Photo 5: PAD at northern end of rail easement showing Telstra Cable

Photo 6: Sewer line through possible PAD area.

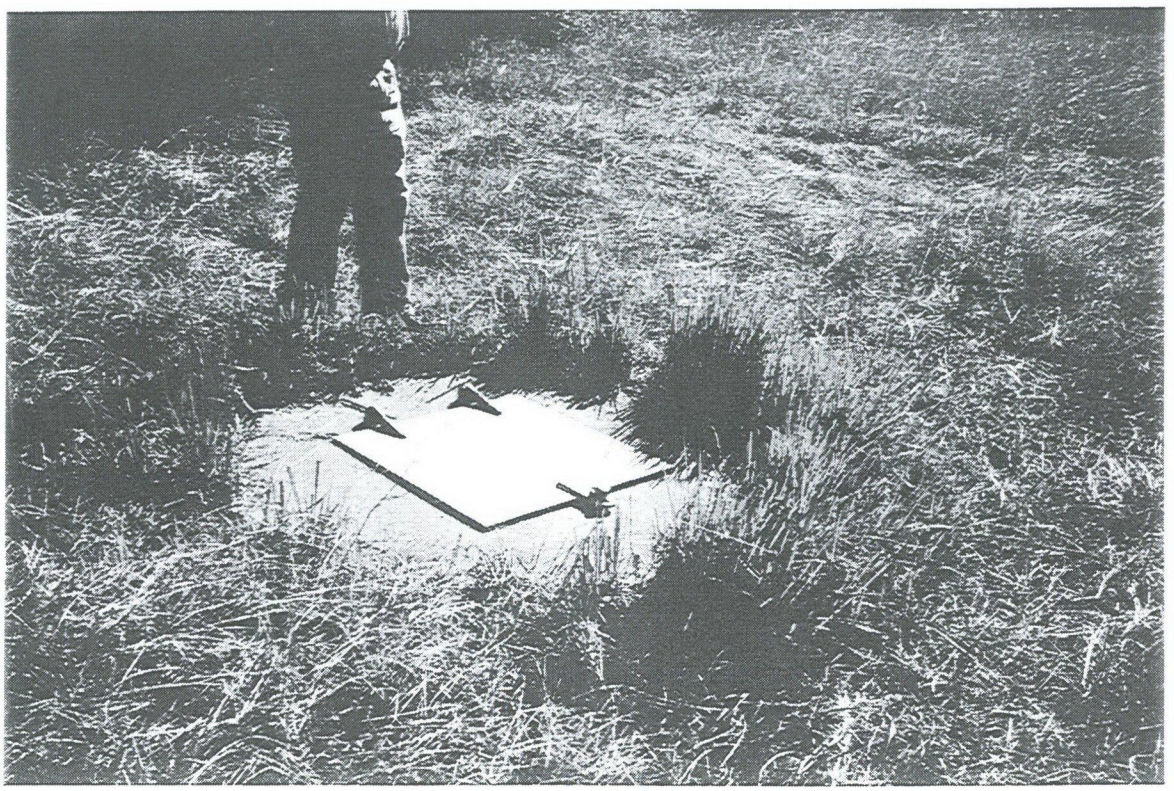


Photo 7: Elevated bridge at Crouches Creek

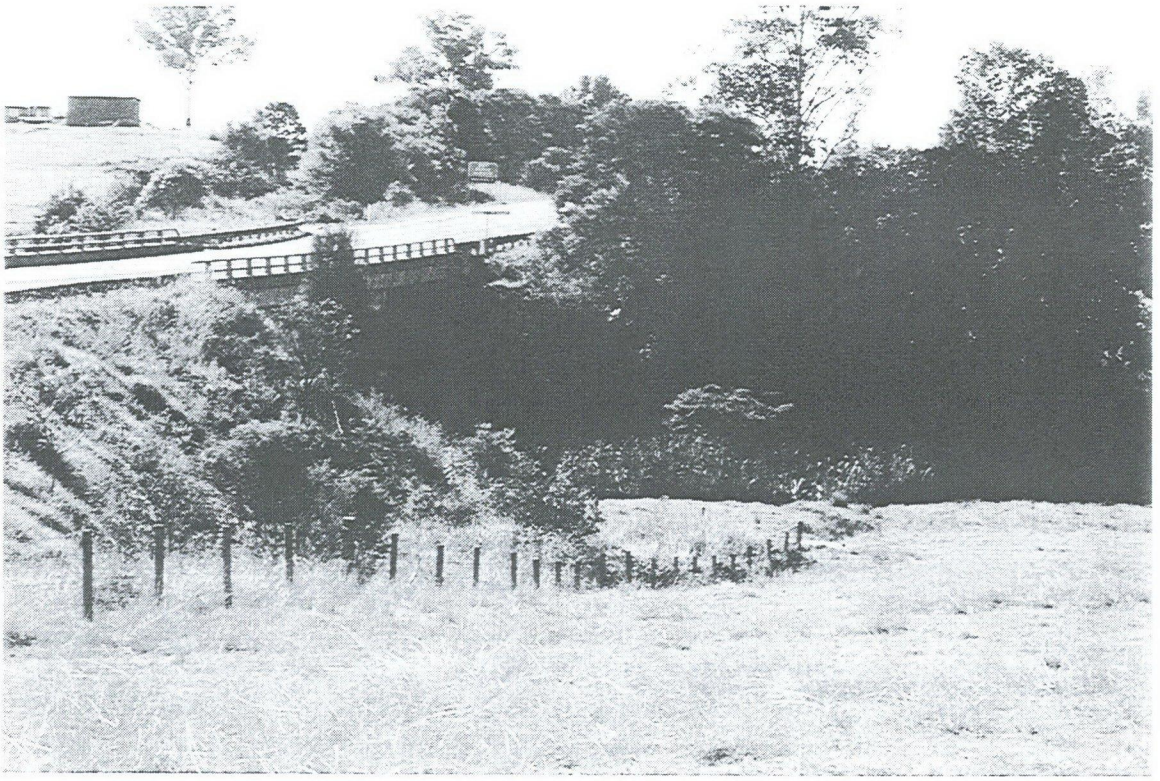


Photo 8:
Soil profile adjacent to Crouches Creek

Photo 9: Railway Cottage (Waters)

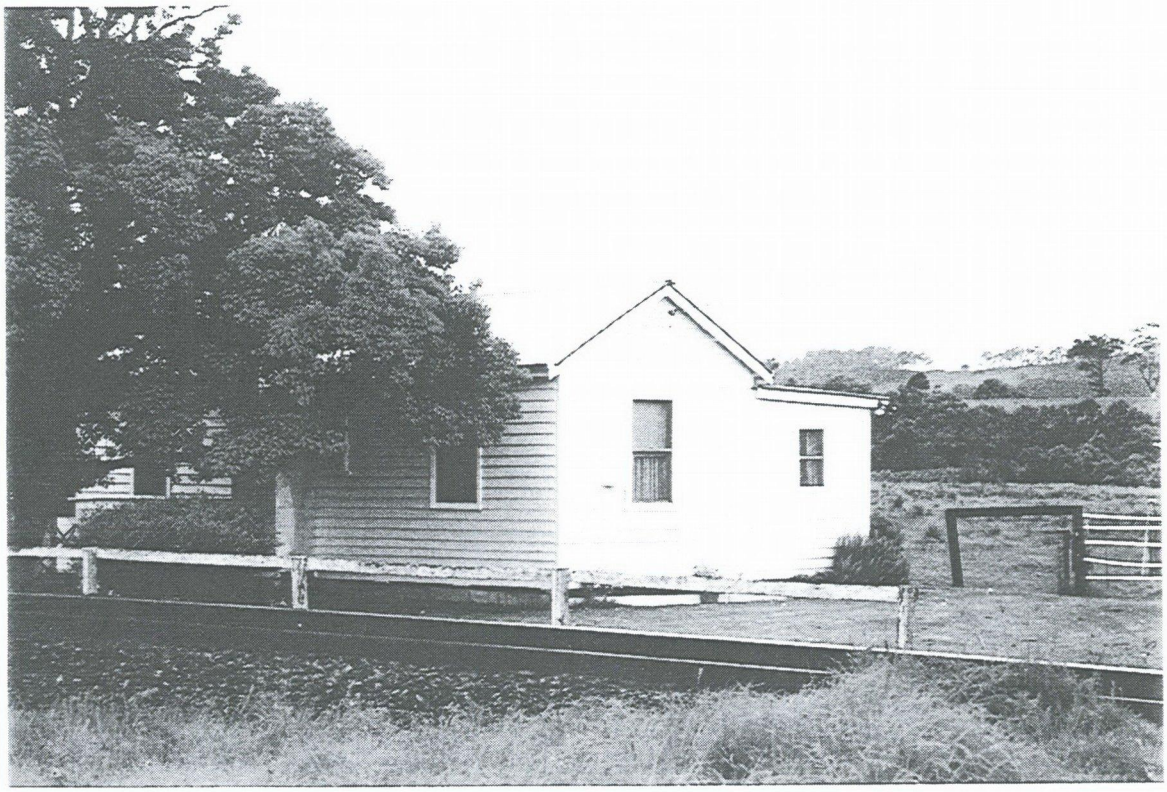


Photo 10: Converted Dairy (Apps)

Appendix 5: Correspondence with and Statement from Unkya LALC.

UNKYA
LOCAL ABORIGINAL LAND COUNCIL

03-04-98

ATTENTION: ROBYNNE MILLS

RE: WARRELL CREEK BYPASS.

Robynne,

I spoke to Clarrie Hoskins yesterday 02-04-98, and he said that he had no objections to the new route for the Warrell Creek Bypass. We have no objections to any part of the Bypass Route.

Once again I apologise for the lateness of this reply.

Yours sincerely,

Reginald Donovan.

Suite 7, Skylight Arcade
or
P.O. Box 319 7-19 Wallace Street, Macksville NSW 2447
Ph:(065) 682 786 Fax:(065) 682 786

UNKYA
LOCAL ABORIGINAL LAND COUNCIL

14th of July 1997.

On Tuesday the 8th of July Neville Buchanan an Elder and Knowledge holder, and myself Reginald Donovan Sites Officer for the Unkya Local Aboriginal Land Council accompanied Archaeological consultants Robynne Mills and Jim Kelton on a survey at Warrell Creek, south of Macksville.

RECOMMENDATION:
The Survey involved the route of the proposed Bypass of Warrell Creek. No Aboriginal sites were found during the survey, however it is recommended that a LALC member should be present when topsoil is being removed from a small raised spur on the eastern side of the present railway line and west of Rosewood road. Furthermore the LALC wishes there be no Work camps, spoil dumps or storage of machinery in the vicinity of this spur.

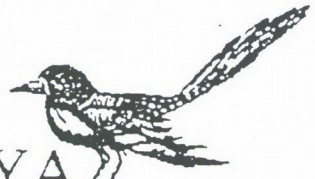
RESULT:
The Survey was performed and completed with great professionalism, and the Unkya LALC fully supports these Recommendations put up by the four (4) man survey team. The Unkya LALC have no objections to the Route of the Bypass of the Warrell Creek section of the Pacific Highway, south of Macksville.

Yours sincerely,

Reginald Donovan
Unkya LALC.

Neville Buchanan
Elder.

or
P.O. Box 319 7-19 Wallace Street, Macksville NSW 2447
Ph:(065) 682 786 Fax:(065) 682 786



UNKYA
LOCAL ABORIGINAL LAND COUNCIL

21st October, 1996.

Robynne Mills
Archaeological and Heritage Service
60 Watkin Street,
Newtown.
Sydney NSW 2042

RE: Proposed upgrade of Pacific Highway at Warrell Creek, south of Macksville.

An Elders meeting was held on friday 18th of October and unfortunately I had to attend a funeral in Coffs Harbour on the same day and could not attend the meeting. However Neville Buchanan, an Elder, has informed me that there are Aboriginal sites in the Warrell Creek area. We had difficulty plotting the sites on a map. Neville will be accompanying us when the survey is being done. Also could you get back to me when the date is set for the survey. I need this date as soon as possible because Neville might be on holidays, and there is not that many people who hold this knowledge that he has for this particular area. Thank you.

Reginald Donovan.

Suite 7, Skylight Arcade
or
P.O. Box 319 7-19 Wallace Street, Macksville NSW 2447
Ph:(065) 682 786 Fax:(065) 682 786

Robynne Mills
Archaeological and Heritage Services
60 Watkin Street
Newtown
Sydney 2042

23rd September, 1994

The Cultural Heritage Officer
Unkya Local Aboriginal Land Council

My name is Robynne Mills and I have been commissioned by Sinclair Knight Merz for the RTA to carry out a survey of a section of the Pacific Highway which has been scheduled for upgrading. This section of road is located to the south of Macksville at Warrell Creek.

I have tried to ring several times and couldn't get you so I rang Rebecca Edwards at Coffs and she gave me your fax number.

There are two parts to the study.

Part 1: is just looking at known sites in the area. I would appreciate it if at your next cultural heritage meeting you could discuss the area (indicated on the map by a dotted line) with Tribal Elders and other interested Community members to find out if there are any places of special importance for Aborigjnal people within this area.

Part 2: will be a survey of the route chosen for the road upgrade. Once this route has been chosen there will be a full heritage assessment and survey of the area. This should take place later in the year around November or December. I will contact you well before this date and arrange for representatives of the Land Council to take part in the survey.

I will ring you again when the Land Council representatives and Elders have had an opportunity to talk about the proposal and discuss any concerns the Community may wish to raise about the proposal.

If you would like to contact me I can be reached on (02)5171413.

Many thanks for your help,

Robynne

Robynne Mills.

FAX

Robynne Mills
Archaeological Consultant
60 Watkin Street
Newtown 2042
Phone/Fax (02) 517 1413

****

Date: 23 - 10 - 96
To UNKYA Local Aboriginal Land Council

ATTENTION : REG DONOVAN

Fax No:
Number of Pages (3)

****

Dear Reg,

I've finished my preliminary summary for the Macksville road diversion area, however I would like to include a statement from the Land Council before I complete the job. Macksville area from the map references I got from the NPWS sites register. There is also a description of the sites.

How did the Elders meeting go? If you could just write down a few comments which include: when the meeting was held, who was represented ie Land Council, Elders etc, what everyone thought, any problems the Land Council or Elders see with the project and any suggestions they would like to make for the survey of the preferred route when it happens.

The usual charge for report writing and consultation is $30.00 per hour. If you could judge your time spent on this issue and send me an invoice I will see that the account is paid by Sinclair Knight Merz who are the project co-ordinators.

Thanks for you help. I will give you a call on Thursday,

In the event of difficulties with transmission, please contact (02) 517 1413

****

FAX

Robynne Mills
Archaeological and Heritage Services
60 Watkin Street
Newtown 2042

Ph/Fax (02) 95171413

****

Date: 26th September, 1997
Attention: Unkya LALC
Fax No:
Number of pages: 1

****

Dear Reg,

Re: Warrell Creek By-pass survey

There has been a minor change to the route of this by-pass (Map enclosed). If you remember where we stopped for morning tea to the south of Rosemont Road, on the Old Princes Highway, well the route now is proposed to pass through an open space area to the south rather than through the orchard.

The shed on the northern side of this area and one house will be affected by the re-routing. If you consider that this area needs to be looked at by the LALC then that is fine. From memory, I think the whole area had been heavily disturbed. Anyway I will ring you. I have tried a few times that was why I thought I would send the fax.

Did you get the copy of the fax I sent to TransGrid?

Talk with you soon (good luck in the Football carnival, the Redfern mob have been talking about it at school this week)

Robynne.

FAX

Robynne Mills
Archaeological and Heritage Services
60 Watkin Street
Newtown 2042

Ph/Fax (02) 95171413

****

Date: 30th September
Attention: Reg Donovan LALC
Fax No:
Number of pages: 2

****

Reg,
Just a note to confirm our conversation of yesterday. As I said I was talking to a local about the pine trees on the highway where the new route comes in and he said that he thought that some Aboriginal people had some rough houses on that block in recent times. If you could ask around the community and see if there is anyone who knows anything about this and if there are any members of the community with any concerns about the area give me a call.

Send me your account for the survey and a brief report would be great,

Regards,

Robynne.

Record of communication with LALC regarding the realigned section of the Warrell Creek Bypass route

Notes taken from Work Diary

- September 26th 1997 Phone call re changes to alignment and request for both investigation of area by LALC and discussions with community about concerns
- September 26th 1997 fax with details, map etc of realignment area
- 29th September Phone call re suggestion by local resident that Aboriginal housing dwellings were in the area
- 30th September Fax confirming phone call of 29th
- Phone calls and discussion with Reg Donovan regarding issues related to realignment October 10th , 22nd (secretary) , 24th (secretary), November 4th, 7th (consultant in Macksville but LALC not available),
- Phone call to Reg Donovan Unkya LALC to discuss consultants assessment of the area Reg told the consultant the Clary Hoskins knew about the area and he was being consulted by the LALC December 10th
- Phone call February 2nd to find out what was happening re Clary Hoskins nil result for LALC, Phone call 24th Feb please can I have something in writing, no response.
- March 2nd , report due end of the Month are there any issues? None raised.
- March 30th a final courtesy call to tell LALC that if no response was forthcoming I could assume that there were no problems. Reg states that Clary Hoskins has concerns but that he is unaware as to what they are. Confirmation requested
- Phone call April 2nd still no confirmation from Clary. Report has to be in by Friday. Reg said he would try to have something to me in writing Friday morning 3rd April
- Phone call April 2nd (PM) secretary message left

Appendix 6: Gazetteer of previously recorded sites from Heritage Registers.

MACKSVILLE AND EUNGAI

Minark Report Page 1 Printed 11Sep96 11:15

Site Number	Location and Sitename		Amg E	Amg N	Date Recorded	Recorder	Assoc Report	Sitetype	
✓21-6-0004	Mucki Site	Macksville	496600	6602900	1976	Kelly		Nat. Myth. (Rit)	
✓21-6-0005	Macksville	Tilly Willy Cam	491200	6601900	1976	Kelly	C-1746	Open camp site	
✓21-6-0006	Macksville	Goat Island	494700	6602400	1976	Kelly		Nat. Myth. (Rit)	
✓21-6-0007	Congarinni	Whale Increase	488600	6601300	1976	Kelly		Bora / ceremonial	Nat. Myth.
✓21-6-0009	Scotts Head	Ngumbar Ceremon	498400	6598800	1976	Kelly		Bora / ceremonial	
✓21-6-0011	Scotts Head	Ngumbar Campsit	498400	6597550	1976	Kelly		Open camp site	
✓21-6-0016	Scotts Head Hea	Scotts Head	499670	6598590	1977	Creamer		Nat. Myth. (Rit)	
✓21-6-0039	Bald Mountain	Macksville	494700	6600989	1976	Kelly		Nat. Myth. (Rit)	
✓21-6-0085	Dead Man Gully	Warrell Creek	487800	6593600	1978	Creamer		Burial	
✓21-6-0095	Kaparra Ridge	Macksville	494500	6600400	1980	Bell		Carved tree	Bora / ceremon
✓21-6-0097	Middle Head	Scot's Mountain	499600	6595300		RESTRICTED		Nat. Myth. (Rit)	
21-6-0122	?		496700	6596600	00NOV1981	Godwin, L	c-331	Open camp site	
✓21-6-0123	?		499700	6597800	00NOV1981	Godwin, L.	C-331	Midden	
✓21-6-0124	?		498600	6598100	00NOV1981	Godwin, L.	C-331	Midden	
✓21-6-0125	?		498400	6598400	00NOV1981	Godwin, L.	C-331	Midden	
✓21-6-0126	?		498500	6598800	00NOV1981	Godwin, L.	C-331	Midden	
✓21-6-0127	?		499100	6598100	00NOV1981	Godwin, L.	C-331	Midden	
✓21-6-0128	?		498900	6596700	00NOV1981	Godwin, L.	C-331	Open camp site	
✓21-6-0129	?		499400	6597100	00NOV1981	Godwin, L.	C-331	Midden	
✓21-6-0130	?		499800	6597100	00NOV1981	Godwin, L.	C-331	Stone arrangement	
21-6-0131	?		497300	6597200	00NOV1981	Godwin, L.	C-331	Midden	
21-6-0132	?		497200	6597300	00NOV1981	Godwin, L.	C-331	Midden	
21-6-0133	?		496700	6596800	00NOV1981	Godwin, L.	C-331	Midden	
✓21-6-0137	Middle Head Hea	Yarrahapinni St	499450	6594730	07JUN1991	Collins, J.	?	Open camp site	
✓21-6-0139	Pines Picnic Ar	Way Way State F	495060	6593940	09JUN1991	Collins, J.	?	Open camp site	
21-6-0141	Bald Hill Road	Macksville	492400	6600130	00DEC1992	Navin, K.	C-2240	Open camp site	
✓21-6-0142	Warrell Ja-1		497850	6593300	11MAR1993	Appleton, J.	c-2510	Open camp site	Midden
21-6-0161	Tilly Willy Ck		490400	6600800	12AUG1993	Kuskie, P	?	Open camp site	
✓21-6-0163	Biddis Farm		498300	6599300	18MAR1994	Appo,L.	?	Nat. Myth. (Rit)	

Nambucca District Historical Society

ALL CORRESPONDENCE TO BE ADDRESSED TO THE SECRETARY, P.O. BOX 128, NAMBUCCA HEADS 2448

18th October, 1996

Ms. R. Mills,
Archaeological and Heritage Services,
60 Watkin Street,
NEWTOWN NSW 2042

Dear Robynne,

In reply to your letter to our Historian, Ev Dorrough, dated 8th October, 1996 and our 'phone conversation last Tuesday, I advise that the Historical Society is not aware of any historic places or items in the area proposed for the up-grading of the Pacific Highway at Warrell Creek.

As mentioned, one of our members is an Aboriginal Elder and after examining your letter and attached map at our meeting on Tuesday, 17th October, he stated that he did not know of any aboriginal sites in the area marked.

If we can be of help in any way, please let us know.

Yours sincerely,

Rhona Bunton

(Mrs) Rhona Bunton
Honorary Secretary

FAX

1.15 28/10/97

Robynne Mills
Archaeological and Heritage Services
60 Watkin Street
Newtown 2042

Ph/Fax (02) 95171413

****

Date: 28th October, 1997
Attention: Stuart Sharpe
Heritage Branch
Railway Archives
State Rail
Fax No: 9 224 3544
Number of pages: 1

****

Dear Stuart,

Thanks for the plan of Warrell Creek Station. It complemented the signals diagram I received from the Railway Historical Society.

I am presently interested in identifying any information which you might hold on any possible heritage items at the Clyde Railway Workshops and the section of railway line in the immediate vicinity of the workshops and the Duck River Crossing of Parramatta Road, Granville. While the historical background of the workshops is of interest, I am mainly concerned with that section which fronts Parramatta Road.

I will give you a call later in the week to see if there are any items of relevance.

Regards

Greg Mills

****

NAMBUCCA SHIRE COUNCIL

24 PRIN[illegible] STREET MACKSVILLE
DX 7517

All communications to be addressed to:
General Manager
PO Box 177
MACKSVILLE NSW 2447

phone 065 682 555

FACSIMILE TRANSMISSION
(065) 682201

DATE 4/10/96

TRANSMISSION TO Robyn Mills

FACSIMILE NUMBER (02) 517 1413

TRANSMISSION FROM Helen Hagston

Number of pages including cover sheet 7

Robyn,

Please find attached Comals Schedule of 'Heritage Items'. Also attached is a list of addresses of Historical societies and the local Aboriginal Land Councils.

HH

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Should this transmission be unclear or incomplete, please phone 065 682 555.

SCHEDULE 3 - Clause 41

HERITAGE ITEMS

Macksville

Nambucca Hotel - Corner of Cooper and Wallace Streets, Macksville.
The Star Hotel - River Street, Macksville.

Bowraville

St James Anglican Church - 19 High Street, Bowraville.
Bowraville Central School - 23 High Street, Bowraville.
Police Station and Court House - 25 High Street, Bowraville.
Post Office - 27 High Street, Bowraville.
Former Council Chambers - 29 High Street, Bowraville.
Sullivans Bowra Hotel -33 High Street, Bowraville.
Dwelling -34 High Street, Bowraville.
Dwelling -36 High Street, Bowraville.
Dwelling -38 High Street, Bowraville.
Bananacoast Credit Union -39 High Street, Bowraville.
Dwelling - 40 High Street, Bowraville.
Dwelling - 42 High Street, Bowraville.
Shop - 45 High Street, Bowraville.
Shop - 45A High Street, Bowraville.
Commercial Building - 46 High Street, Bowraville.
Shop - 47 High Street, Bowraville.
Scout Hall - 48 High Street, Bowraville.
Medical Rooms - 49 High Street, Bowraville.
Dwelling - 52 High Street, Bowraville.
Fire Station - 55 High Street, Bowraville.
Garage/Workshop - 56 High Street, Bowraville.
Bowraville Services Club - 57-59 High Street, Bowraville.
Shop/Dwelling - 58A High Street, Bowraville.
Shop - 64 High Street, Bowraville
Pioneer Community Centre - 70 High Street, Bowraville.
State Bank - 72 High Street, Bowraville.
The Remnant Basket - 74 High Street, Bowraville.
Shop - 80 High Street, Bowraville.
Grants Hall - 82 High Street, Bowraville.
Royal Hotel - 84 High Street, Bowraville.
Museum and Former Presbyterian Church - 86-88B High Street, Bowraville.
Dwelling - 86C High Street, Bowraville.
[illegible] and Joseph Newman Folk Museum - 86D High Street, Bowraville.
The Bank - 88 High Street, Bowraville.

Osprey nest sites and land within 100 metres of those sites - Portion 22, Parish of Bowra, Lot 1, DP 256205, Parish of Valley Valley and Portion 189, Parish of Bowra and Crown Reserve, Parish of Congarinni (eastern side of Warrell Creek).

Appendix 7: Site Assessment of Non-Indigenous properties impacted by the proposed development

DAIRY – OUTBUILDINGS (FAWCETT – WILLIAMS)

NSW State Heritage Inventory Evaluation Criteria for Heritage Items recorded during archaeological surveys

To be classified as a heritage item, the item or place must meet :

At least one the Nature Criteria (1-5)

AND

Meet at least one of the Comparative Criteria (6-7)

AND

Retain the integrity of its attributes.

A. Nature of Significance Criteria- Type

Criterion 1: Evolution and Associated (Historic)

Low.

Criterion 2: Creative and Technical Accomplishment

Low.

Criterion 3: Community Esteem (Social)

NIL

Criterion 4: Research Potential (Scientific)

NIL

Criterion 5: Other

—

B. Comparative Significance Criteria

Criterion 6: Rarity

Dairies of this period are common in the north coast area.

Criterion 7: Representativeness

This dairy is <u>not</u> a good example of this heritage type.

Assessment:

This is not a heritage item.

FAWCETT - WILLIAMS HOUSE.

NSW State Heritage Inventory Evaluation Criteria for Heritage Items recorded during archaeological surveys

To be classified as a heritage item, the item or place must meet :

At least one the Nature Criteria (1-5)

AND

Meet at least one of the Comparative Criteria (6-7)

AND

Retain the integrity of its attributes.

A. Nature of Significance Criteria- Type

Criterion 1: Evolution and Associated (Historic)

Low because of the extensive modifications which have been made to the structure.

Criterion 2: Creative and Technical Accomplishment

NIL

Criterion 3: Community Esteem (Social)

NIL

Criterion 4: Research Potential (Scientific)

NIL

Criterion 5: Other

—

B. Comparative Significance Criteria

Criterion 6: Rarity

Integrity of the structure has been greatly compromised.

Criterion 7: Representativeness

Representative of early Warrell Ck. homes but better examples which have not been so extensively modified exist in Warrell Ck. Village.

Assessment:

House I: Railway cottage.

NSW State Heritage Inventory Evaluation Criteria for Heritage Items recorded during archaeological surveys

To be classified as a heritage item, the item or place must meet :

At least one the Nature Criteria (1-5)

AND

Meet at least one of the Comparative Criteria (6-7)

AND

Retain the integrity of its attributes.

A. Nature of Significance Criteria- Type

Criterion 1: Evolution and Associated (Historic)

Example of 1940's working persons cottage

Criterion 2: Creative and Technical Accomplishment

NIL

Criterion 3: Community Esteem (Social)

NIL

Criterion 4: Research Potential (Scientific)

NIL

Criterion 5: Other

Represents a period of NSW Social history in which Dept. of Railways allowed workers to build private houses on public land.

B. Comparative Significance Criteria

Criterion 6: Rarity

Low.

Criterion 7: Representativeness

Low.

Assessment:

House is not a heritage item in the terms of the NSW Heritage Act.

CONVERTED DAIRY. (APPS)

NSW State Heritage Inventory Evaluation Criteria for Heritage Items recorded during archaeological surveys

To be classified as a heritage item, the item or place must meet :

At least one the Nature Criteria (1-5)

AND

Meet at least one of the Comparative Criteria (6-7)

AND

Retain the integrity of its attributes.

A. Nature of Significance Criteria- Type

Criterion 1: Evolution and Associated (Historic)

NIL -

Criterion 2: Creative and Technical Accomplishment

NIL - Integrity of the structure has been lost.

Criterion 3: Community Esteem (Social)

NIL

Criterion 4: Research Potential (Scientific)

NIL

Criterion 5: Other

NIL

B. Comparative Significance Criteria

Criterion 6: Rarity

Low.

Criterion 7: Representativeness

Low.

Assessment:

This is not a heritage item.