NEW SOUTH WALES ROADS AND TRAFFIC AUTHORITY

BYRONS LANE TO SHARK CREEK, SOUTHERN SECTION, HIGHWAY UPGRADE

REVIEW OF ENVIRONMENTAL FACTORS

KINHILL

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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 extent possible, all of the factors listed in Clause 82 of the Environmental Planning and Assessment Regulation 1994.

Roads and Traffic Authority representative

Signed: .....

Designation: Project Manager

Date: 24/3/98

Kinhill Pty Ltd representative

Signed: .....

Designation: Senior Environmental Scientist

Date: 21 March 1998

Summary

INTRODUCTION

The Pacific Highway is the principal road transport corridor between Sydney and Brisbane, the alternative inland route being the New England Highway. The Roads and Traffic Authority of NSW (RTA) has identified that the existing section of the Pacific Highway between Byrons Lane and Shark Creek near Tyndale is of a lower standard than the highway to the north and south. The RTA is consequently proposing an upgrade of the 1.3 km length of the southern section of the Byrons Lane to Shark Creek highway. The upgrade will provide a two lane carriageway with 3.5 m lanes, 2.0 m sealed shoulders, and 0.5–1.0 m sealed verges, a 100 km/h standard alignment, and a sheltered right turn at the Byrons Lane intersection. It is also intended that a bus stop and turn around be constructed in Byrons Lane.

PROPOSAL DESCRIPTION

Location

The location of the proposed section of the Pacific Highway to be upgraded lies between 32.6 km and 33.9 km north of Grafton, and includes the intersection with Byrons Lane near Tyndale.

General features

The 1.3 km section of highway to be upgraded lies north of Tyndale, on a levee bank beside a river floodplain, adjacent to the South Arm of the Clarence River. There are cane fields and scattered residences on the south-eastern side of the highway, while the river is adjacent to the other side. There is only one intersection, at Byrons Lane. The proposed upgrade would follow the current alignment, and widening would be undertaken only the side away from the river.

Timing and costs

The estimated cost of the proposal is $2.5 million. It is anticipated that construction would commence in August 1998, and be completed in April 1999.

SPECIALIST STUDIES AND COMMUNITY INVOLVEMENT

Specialist studies were undertaken for a number of disciplines in order to provide baseline information about the existing characteristics of the study area, and to identify environmental constraints and relative impacts.

Kinhill and the RTA also completed a comprehensive program of community involvement. Local community representatives, affected landowners, and government agencies participated in the process. The consultation program included interviews, community meetings, information sheets, press releases, a Value Management Study, and liaison with Government Agencies.

It was established during this process that there was broad support from the Byrons Lane community.

REGIONAL PLANNING AND THE NEED FOR THE PROPOSAL

The proposed upgrade was considered in the context of the two most relevant regional planning and environmental studies, the North Coast Regional Environmental Plan (REP) (Department of Planning, 1988) and the North Coast Road Strategy (RTA 1993). The proposed upgrade near Byrons Lane would be compatible with both of these studies.

Currently, this section of the Pacific Highway has a substandard alignment, and an unshielded intersection with Byrons Lane. The proposal would provide a standard of highway consistent with sections to the north and south, and improve traffic efficiency.

DESCRIPTION OF THE CORRIDOR OF INTEREST

The existing alignment to be upgraded extends from approximately 390 m west of Byrons Lane (chainage 32460) to approximately 950 m north of Byrons Lane (chainage 33800). The highway lies in the riparian zone of the south east bank of the Clarence River, South Arm. It runs along a levee bank which varies in height, compared to the land to the south and east, by approximately 0.2–0.7 m. There are five residences along the length of the section. In between the residential blocks the land is used for cane farming. No cane land drains enter the river in this section. The corridor has been extensively modified by farming and road construction, such that no undisturbed habitat exists. The riparian vegetation is quite lush, but contains many species of weeds.

CONSTRUCTION OF THE PROPOSAL

Construction of the proposal would require the acquisition of a narrow strip of land, approximately 6–8 m wide, from cane farms and residential blocks. Earthworks would be required to widen the road. Materials for the fill and paving of the upgrade would be imported from local sources. The volumes required would not place an undue demand on local resources, and haulage vehicle movements would not cause a significant increase in commercial vehicle traffic on this section of the highway. There would be minimal clearing of native vegetation. Approximately twenty mature trees would be cleared, and the millable timber recovered.

ENVIRONMENTAL IMPACTS

Landforms

The upgrade would follow the present alignment along the raised levee of the Clarence River. The pavement level would be marginally raised by the upgrade, but no major raising of the levee would be undertaken.

Geology

The geology underlying the proposal comprises sandstones. The soils are silty clays and sands, and loose sands. These have a moderate to high erosion potential, and temporary erosion control measures would be required during construction. During the operational phase, disturbed areas would be stabilised by landscaping.

Air quality

Air quality in the vicinity of the proposal is typical of a rural environment, and the proposed upgrade would not have a significant impact. Dust generation during construction would be effectively mitigated by standard procedures for dust control.

Water quality

Although the section of highway to be upgraded runs close to the Clarence River, no water courses or drains are traversed by the proposed construction area. All widening earthworks are to be done on the side of the road way from the river, and riparian areas will not be disturbed by the proposed construction. During construction, sediment barriers will be used to control sediment runoff towards either the river or cane land. It is unlikely there will be a negative impact to the quality of water in the Clarence River as a result of the proposal.

Hydrology

The upgrade would have a 5 year ARI flood immunity, and would not have a significant effect on inundation times for adjacent cane land.

Vegetation

The flora of the corridor comprise a riparian zone of remnant native species and weeds, and sugar cane and garden plants on the opposite side of the highway. The riparian zone would not be disturbed. There is a small stand of Red Gums (*Eucalyptus tereticornis*) near the southern end of the section, which would be removed by the proposal. The loss of these trees would not have a significant effect on local habitats. No threatened species of plants were identified along the upgrade corridor.

Fauna

The highly altered and degraded nature of the environment which will be subject to disturbance by the proposed highway upgrade would not support a high diversity of fauna species. Five threatened species have been recorded within the wider region of Tyndale. These were:

- Black-necked Stork (*Ephiopiorhynchus asiaticus*)
- Square-tailed Kite (*Lophoictinia isura*)
- Osprey (*Pandion haliaetus*)
- Brolga (*Grus rubicunda*)
- Brush-tailed Phascogale (*Phascogale tapoatafa*).

The proposed construction area does not contain the usual habitat or roosting sites of any of those threatened species. It is, therefore, highly unlikely that any threatened species will suffer adverse impact from the road upgrade.

Furthermore, the area to be disturbed is not part of any corridor between significant habitats that might be used extensively by any fauna. Consequently, the increase in road width and vehicle speed following the upgrade is not expected to significantly increase the incidence of road kills.

Socio-economic considerations

The upgrade would have beneficial effects by improving safety on the highway, having safer bus stop arrangements, and providing better provisions for cyclists and pedestrians.

There would be minor land acquisition from cane farms and residential properties.

Cultural heritage

The implementation of the proposal would not have an impact on either indigenous or non-indigenous cultural heritage.

Landscaping and visual considerations

The proposed upgrade would offer a similar driving experience to the existing highway for motorists. Visual impacts would be minor and related to the removal of trees from land acquired from four residential blocks.

Noise and vibration effects

There are four noise sensitive locations (all residences) within the corridor of interest, and all are currently affected by road traffic noise from the existing highway.

During construction, it is expected that all four residences would experience noise levels similar to that due to traffic currently travelling on the Pacific Highway.

Immediately following the upgrade, noise levels are predicted to remain the same at two residences and increase by 2 dB(A) at the others. By the year 2009, it is predicted that all four residences would experience noise levels above the RTA criteria, due to increased volumes of traffic.

One house may be relocated further back from the highway, and it is recommended that this be to a distance which will mitigate predicted noise impacts. Noise reduction measures, including the construction of barriers, the choice of highway top surface material, and structural modifications to houses, will be discussed with the affected residents to reach a decision on the most suitable methods.

CONCLUSION

Benefits

The most significant benefits associated with the proposed upgrade would be improved safety and traffic efficiency, and associated reductions in cost to the community. It would also form an important link in the upgrade of the Pacific Highway as a whole.

Adverse impacts

The most notable impacts associated with the Byrons Lane upgrade would be:

- increased road traffic noise immediately at two residences due to closer proximity to the highway, and eventually at four residences due to increased traffic volumes;
- the acquisition of small areas of residential and cane land;
- the removal of a small stand of mature trees.

The mitigation measures proposed for the upgrade should reduce adverse impacts to an acceptable level. The construction and operation of the proposal would not result in an unacceptable reduction of the amenity or environmental values of the Byrons Lane area. In addition, the outcome of the 'eight part test' presented in this document indicates that there is not likely to be any significant impact on threatened species, populations or ecological communities, or their habitats.

1 Introduction

The Pacific Highway is the principal road transport corridor between Sydney and Brisbane, the alternative inland route being the New England Highway. The Roads and Traffic Authority of NSW (RTA) has identified that the existing section of the Pacific Highway between Byrons Lane and Shark Creek near Tyndale is of a lower standard than the highway to the north and south. The RTA is consequently proposing a major upgrade for this section.

The specific objectives and benefits of the proposed project are:

- improve road safety
- minimise negative impacts on the environment
- provide best value for money.

This report prepared by Kinhill provides a Review of Environmental Factors (REF) for the southern section of the proposed upgrade of the Pacific Highway between Byrons Lane and Shark Creek, specifically from 32.6 km to 33.9 km north of Grafton. For brevity, this section will be referred to in this document as the Byrons Lane section.

The proposed scope of work is as follows:

- Design speed 100 km/h
- Rehabilitation of some sections of the length
- 20 year ARI flood protection desirable, 5 year ARI acceptable
- Minimise the number of accesses by Controlled Access Road Conditions
- Intersection treatment must consider requirements for the next thirty years
- Provision on the roadway for cyclists.

The REF has been prepared to assess the environmental impacts associated with the proposed realignment, to fulfil the requirements of Part 5, Section 111 of the Environmental Planning and Assessment Act, 1979 (EP&A Act).

It has been prepared in response to a brief from the RTA to:

- carry out extensive community consultation on the proposal
- identify and locate major engineering and environmental constraints to upgrading
- select a preferred alignment option for highway upgrading
- prepare a concept design for the highway

- prepare a Review of Environmental Factors (REF) that presents the outcome of the above factors.

The overall objective of the proposed upgrade and realignment is to provide a road that is safe, accessible and traffic efficient, which is balanced against the need for protection of the environment, and which gives value for money.

This REF has been prepared in accordance with the RTA's EIA Guidelines, and in accordance with Clause 82 of the Environmental Planning and Assessment Regulation, 1994. In addition, consideration was also given to the Department of Urban Affairs and Planning (DUAP) publication, 'EIS Practice Guideline—Roads and Related Facilities' (June, 1996).

A purpose of the REF is to ascertain the need for the preparation of an Environmental Impact Statement based on the existing environmental attributes of the area likely to be affected and the significance of the likely impacts of the highway upgrade.

Investigations conducted for the REF have indicated that the preparation of an EIS should not be warranted based on the outcome of the '8 part test' presented in a later section of this document.

2 Project identification

The following are the means for identification of the subject section of highway:

Project Short Title:	Byrons Lane to Shark Creek (Southern Section)
RTA Region:	Northern
Local Government Area:	Maclean Shire Council
State Project No.:	65178
Type of Work:	Upgrade—two lane single carriageway
Project Location:	Byrons Lane, 32.6 km to 33.9 km north of Grafton

3 Description of the proposal

3.1 LOCATION

The location of the proposed section of the Pacific Highway to be upgraded lies between 32.6 km and 33.9 km north of Grafton, and includes the intersection with Byrons Lane near Tyndale. The location is shown in regional and local context in Figures 3.1 and 3.2. Tyndale is within Maclean Shire.

3.2 GENERAL FEATURES

The 1.3 km section of highway to be upgraded lies north of Tyndale, on a levee bank beside the river floodplain, adjacent to the South Arm of the Clarence River. There are cane fields and scattered residences on the south-eastern side of the highway, while the river is adjacent to the other side. There is only one intersection, at Byrons Lane.

The upgrade will provide a two lane carriageway with 3.5 m lanes, 2.0 m sealed shoulders, and 0.5–1.0 m sealed verges, and a sheltered right turn lane at the intersection with Byrons Lane. There will also be the provision of a bus bay and turn-around at Byrons Lane.

3.3 COSTS

The estimated cost of the proposal described in this REF is $2.5 million. This includes the estimated cost of investigation, REF, property acquisition, utilities, construction works, engineering services and contingency allowances.

3.4 TIMING

It is proposed that the detailed design and property acquisition would be completed to permit a commencement of construction in August 1998, with completion in April 1999.

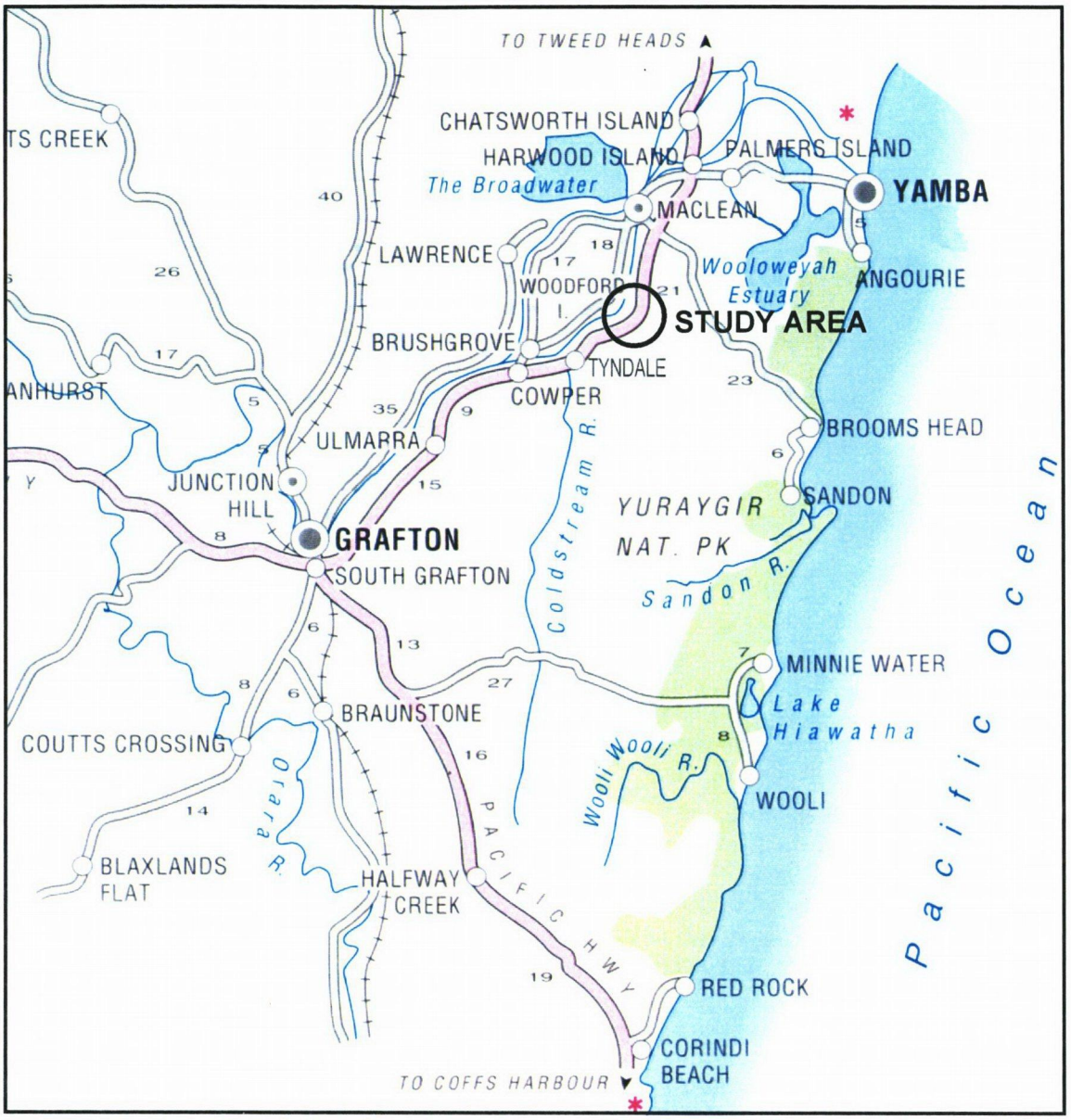


Figure 3.1
LOCATION OF PROPOSED BYRONS LANE UPGRADE—REGIONAL CONTEXT

Figure 3.2
LOCAL EXTENT OF THE PROPOSED ROAD WIDENING

4 Specialist studies and community involvement

4.1 SPECIALIST STUDIES

Specialist studies were undertaken for a number of disciplines in order to provide baseline information about the existing characteristics of the study area, and to identify environmental constraints and relative impacts associated with the options. The information obtained from specialist studies was used to identify engineering constraints and options.

The section of road covered by this report is part of a longer section which is proposed for upgrade from 32.6-36.8 km north of Grafton. Originally, that whole length was to be treated as one project, and the specialist studies covered the entirety from east of Byrons Lane (32.6 km) to the southern bank of Shark Creek (36.8 km). It is now proposed to undertake the work in two stages, requiring two separate REF documents, one for the southern section (32.6-33.9 km) and another for the middle and northern sections (33.9-36.8 km).

The body of this REF document is limited to the southern section (32.6-33.9 km), but because the specialist studies were undertaken before the decision to split the Byrons Lane to Shark Creek project into two stages, some appendices contain reports from sub-consultants which describe the whole 32.6-36.8 km study area. Some appendices also contain references to a third study area nearby at Tyndale Village which is associated with another upgrade project.

The study area varied depending on the needs of particular studies. For site specific issues, such as landscape, soils, flora and cultural heritage, the studies were bounded longitudinally by the proposed limit of works at 32.6 km and 33.9 km, and laterally by a corridor which spanned from the river water line to 10 m into the cane land and residential properties on the other side of the highway. The fauna study concentrated on the same corridor, but for review purposes included a 11 km by 11 km square area centred on the nearby Tyndale Village. The noise study area included the highway and the residences adjacent to it, while the flooding study covered an area encompassing the river, the road and the flood plain between the Clarence River and Shark Creek.

The specialist studies, which are discussed in detail in Section 7 of this report, were as follows.

4.1.1 Ecological assessment

Assessment of the fauna within the study area was conducted by Kinhill (refer Appendix A), while the flora assessment (refer Appendix B) was conducted by a Subconsultant, Landscape Assessment, Management and Rehabilitation Pty Ltd (LAMR).

The fauna site inspection was divided into two separate visits on 14 April 1997 and 10 February 1998. The length of the proposed construction area was traversed and records taken of incidental sightings of birds, mammals, reptiles and amphibians. The stand of *Eucalyptus tereticornis* was inspected for nest, hollows and scratch marks. Searches for road kills were also undertaken. A total search effort of approximately three hours was employed.

The weather during the initial survey was warm (approximately 26°C), with light winds and 0–10% cloud cover. This survey concentrated on inspections of habitat, searches for nests and hollows, and recording incidental observations. The second survey was undertaken during light to moderate rainfall, with 100% cloud cover and temperatures around 27°C. This survey targeted amphibians and road kills.

Information was also obtained from NSW National Parks and Wildlife Service (NPWS) publications and database, and from the observations of local residents.

The flora survey was undertaken in Summer 1997, and involved a full inspection of the site on foot. An inventory was made of species, both on the eastern and western (riparian) sides of the highway. A total of approximately two hours was spent on the survey.

4.1.2 Indigenous and non-indigenous heritage

An assessment of indigenous heritage issues associated with the proposal was undertaken (refer Appendix C). This involved a review of existing information and the subsequent preparation of a predictive statement of the archaeological potential of the study area. Consultation with the Yaegl Local Aboriginal Land Council was undertaken. The Land Council indicated no particular concern over the proposal, other than a need to monitor for artefacts during construction.

The assessment of non-indigenous heritage issues (refer Appendix D) included a review of available historical and heritage literature, checking the Register of the National Estate and the National Trust Register, and discussions with Maclean Shire Council and the Department of Urban Affairs and Planning.

4.1.3 Noise and vibration studies

These studies were carried out by specialist Subconsultants, Kamst and Simpson Pty Ltd, in order to predict the relative impacts of the various options on nearby residences (refer Appendix E). Baseline noise monitoring was conducted at several representative noise sensitive locations within the area.

4.1.4 Climate/air quality

Assessments of the climatic conditions and air quality of the study area were carried out by specialist subconsultants Katestone Scientific Pty Ltd.

The climate study was based on a review of Bureau of Meteorology data on temperature, rainfall, wind, fog and frost (refer Appendix F). It was conducted principally to evaluate whether the design of the proposal needed to take account of special climatic conditions.

The air quality assessment (refer Appendix G) involved an estimation of likely traffic emission rates based on traffic data and transport efficiency, and comparison of these with estimates of typical background levels. The potential for dust impacts during construction was also assessed.

4.1.5 Traffic studies

Annual average daily traffic (AADT) levels for this section of the Pacific Highway have been determined by RTA from Highway traffic counts (refer Appendix H). The proportion of commercial vehicles and historical accident data were also available from RTA. The highway traffic levels are common to each of the alignment options considered.

An initial assessment was made to confirm that 'at-grade' access would be sufficient for all options. A more detailed assessment of intersection options has been conducted for the proposed upgrade, based on recommendations from the Value Management Study (VMS), which discussed preferred intersection layouts and the provision of local access.

4.1.6 Planning/zoning and land use

An assessment of current zoning and land use and the effects of the proposal on these factors was conducted by Kinhill. This included the identification of all approving authorities for the proposal, identification of strategies being developed by the Department of Urban Affairs and Planning which may affect the proposal, the relevant State Environmental Planning Policy requirements, and a summary of how the proposal would conform to the local, regional, and state planning strategies and objectives.

4.1.7 Hydrology studies

Investigations carried out by Kinhill included the development of a hydraulic model to assess the flood aspects of the proposal (refer Appendix I). Modelling included an assessment of the impacts associated with raising the road levels to provide improved flood immunity. The alternative levels considered were to provide flood immunity with Average Recurrence Intervals (ARI) of 5 years, 10 years and 20 years respectively. Design levels and resulting flood immunity for the options with an ARI of 5 years were chosen to minimise impacts, and to match the recently constructed section of highway to the North.

4.1.8 Geotechnical studies

Geotechnical investigations were carried out by specialist subconsultants, Golder Associates. Stage 1 of the geotechnical investigation involved describing the geology and soils of the subject site and identifying any geological constraints associated with the alignment. This involved the excavation of test pits using a backhoe, logging of soil profile morphology, collection of samples for laboratory analysis (grading analysis, Atterberg Limit determination and CBR), and determining the position and level of the test pits. Refer to Appendix J for the full report.

An initial assessment was made of the likely presence of acid sulphate soils (ASS), along each of the options. This involved an assessment of ASS Risk Maps published for the area by the Soil Conservation Service of New South Wales, and the collection of soil samples from the test pits for POCAS analysis if required.

4.1.9 Preliminary contaminated site assessment

A preliminary contaminated site assessment was conducted by Kinhill. This involved discussions with local landholders and residents, and research on the industrial history of the area. The results of the survey are presented in Appendix Q.

4.2 COMMUNITY INVOLVEMENT

Kinhill and the RTA undertook a comprehensive programme of community involvement as an integral part of the decision making and impact assessment process. Local community representatives, affected landowners and government agencies participated in the process of identifying objectives, evaluating options and selecting a preferred alignment for the upgrading of the highway. They were also involved in refining the preferred alignment and developing management strategies to mitigate potential impacts associated with the proposal.

The principal objectives of this community involvement were to:

- ensure the participation of all relevant stakeholders in the concept planning for the proposal;
- obtain information from stakeholders that was relevant to concept planning;
- explain the proposal development, concept planning, and environmental assessment processes to stakeholders;
- inform stakeholders of the progress of concept planning and specialist studies;
- ensure that the interests of all relevant stakeholders were considered in the development of alignment options, and the selection of the preferred alignment.

4.2.1 Community Involvement Plan

To achieve the objectives listed above required the development of a programme of community involvement which was an effective and integral part of the concept planning and impact assessment process, provided adequate opportunities for stakeholder input, and was relevant to the context of the proposed Byron's Lane to Shark Creek upgrade.

To this end, Kinhill prepared a Community Involvement Plan at the time of project inception. This Community Involvement Plan has been included as Appendix K. It detailed the proposed community consultation program for the concept design and environmental studies, and included:

- interviews with landowners and other key stakeholders;
- preparation and distribution of three community information sheets;
- the operation of a 'freecall' telephone service;
- invitations to make written submissions;
- consultation with local and state government agencies and authorities during the course of the project;
- Value Management Study;
- public display of the REF.

The Community Involvement Plan was framed around the work programme associated with concept planning and environmental studies. Community information sheets, and interviews were timed to deliver a logical plan of project information, and convey to stakeholders and the community a sound understanding of the project.

To administer the Community Involvement Plan, Kinhill established a database into which relevant contact details were entered. Sources for these details included Maclean Shire Council's rating records for landowners, previous government contacts with the RTA from earlier projects, community members who made a written submission or request, and the Maclean Shire Community Directory 1996/97. The database was used primarily for mailing out information sheets, making telephone contacts, and recording and managing submissions. The database contains more than 80 contact records.

Components of the above consultation program which have yet to be completed are the public display of the REF, and the publication of the final community information sheet. These will ensure that stakeholders have the opportunity to suggest improvements to the proposal, and see that their earlier comments have been represented and considered fairly.

4.2.2 Interviews with affected landowners

Interviews were conducted with potentially affected landowners in several different ways:

- In May 1997, structured discussions were conducted in order to gain a better understanding of the study area (for example property features, access, land use) and of the potential impacts of different options.
- The RTA's and Kinhill's respective Project Managers met with local residents on 12 and 13 August 1997.
- Less structured interviews (both in person and via telephone) were progressively carried out during the course of the project as landowners made contact and raised issues.

- The RTA's and Kinhill's respective Project Managers met with land owners affected by the preferred alignment to discuss property implications.

Landowner interview responses varied, depending on the location of houses and business and the sensitivity of business separations, and each landowner's perceptions of the options available to the RTA in upgrading the Pacific Highway.

4.2.3 Community information sheets

Kinhill prepared and distributed three community information sheets prior to the publication of this REF. A fourth issue was released to coincide with the commencement of public display of the REF. Table 4.1 summarises the role and distribution of the community information sheets. A copy of each information sheet is contained in Appendix L.

The first information sheet introduces the proposal to upgrade Byrons Lane section of highway, which is covered by this document, together with proposals to upgrade the section immediately to the north terminating at Shark Creek, and the section through Tyndale Village. The other information sheets refer to the Byrons Lane to Shark Creek proposals only.

Table 4.1 Community information sheets

Number and stage	Main purpose	Distribution
1. Project start-up	Announce commencement, summarise process, invite registration on contacts list	Approximately 120 copies to all postal addresses between Shark Creek Road and Coldstream River
2. Route options	Explain route options, invite submissions, invite registration on contacts list	Approximately 80 mailed to contacts on the database
3. Post route selection	Announce the preferred route	Approximately 80 mailed to contacts on database (including property owners, state agencies, registrants from information sheets 1 and 2, and other stakeholders)
4. Concept design and REF display	Present further details about interchanges, access and the results of community involvement; advise about REF display details; advise how to be involved.	Approximately 80 mailed to contacts on database
5. Project conclusion	Provide update of decision about the need for an EIS, and the submissions received in response to the display of the REF; thank community for involvement	Approximately 80 to be mailed to contacts on database

4.2.4 'Freecall' telephone service

Kinhill maintained a 1800 freecall service, which was publicised in each information sheet, for the duration the project. The community mainly used this as a convenient and inexpensive way to contact the project team. Because of the infrequency of calls Kinhill provided the service via an answering machine which allowed appropriate staff to respond to enquires within twenty-four hours.

4.2.5 Written submissions

Each Community Information Sheet was presented in such a way as to encourage the community to respond in writing. Kinhill received 8 written submissions in response to Information Sheet 3.

Summary of issues raised by the community is contained in Appendix M.

4.2.6 Consultation with government agencies

All relevant government agencies and service providers were invited to the Planning Focus Meeting held on 10 April 1997. Representatives from the Department of Urban Affairs and Planning, Clarence River County Council, Lower Clarence Water Supply County Council, Telstra, North Power, NSW Agriculture–Wollongbar Agricultural Institute, Department of Land & Water Conservation, Yaegl Local Aboriginal Land Council, Maclean Shire Council attended along with a number of other non-government stakeholders. Other government agencies have been included on the contacts database and kept up to date with regular community information sheets.

Members of Kinhill's project team have subsequently met with representatives of key government departments to discuss their respective interests.

All relevant Government agencies and public organisations are invited to comment on the proposal and this REF.

4.2.7 Value management study

A two day Value Management Study was held in Maclean at the Lower Clarence Skills Centre on 16 and 17 September 1997. This study was carried out to ensure that all issues associated with the proposed upgrade were fully assessed, to nominate a preferred alignment for the upgrade, and to ensure that economic and natural resources were allocated responsibly.

Participants in this study included representatives of all key stakeholders, namely the Byron's Lane to Shark Creek Community, Maclean Shire Council and relevant Government Agencies, the RTA Project Team and Kinhill.

4.2.8 Public display of REF

The study has not included any static public displays other than the one which has been established for the purpose of displaying this REF.

The purpose in displaying the REF is to make available to the public:

- the research carried out through specialist studies
- the rationale for the proposal and its design
- a description of the process
- an invitation to find out more and to pass on comments, including suggested improvements.

4.2.9 Summary of consultation

Based on the extensive community involvement carried out to date, there is broad community endorsement of the proposal. On the whole, the community agrees that the highway needs upgrading.

During the course of the study the community has had considerable involvement. This has contributed to the selection and concept design of an upgrade that best suits the interests of all stakeholders. While the full range of issues that have been raised are addressed later in this REF and summarised in Appendix M, the following list outlines the nature of key concerns raised by the local community during consultation:

- *Potential impacts on agricultural lands:* Loss of cane land, impacts on productivity.
- *Potential community impacts:* Disturbed lifestyle, noise, visual impacts, land use changes.
- *Property implications:* Loss of development potential, devaluation, severance, expectations and certainty.
- *Engineering considerations:* Route length, safety, geotechnical, local flooding, and construction costs.
- *Ecological impacts:* Removal of native vegetation, especially on the river bank.

5 Regional issues and the need for the proposal

5.1 PLANNING AND ENVIRONMENTAL BACKGROUND

The North Coast Regional Environmental Plan (REP) (Department of Planning, 1988) emphasises the vital link that the Pacific Highway serves between North Coast towns, as well as long distance Sydney–Brisbane traffic. The extensive use of the route for private and business travel, as well as the transport of goods is also raised in highlighting its importance as a component of the regional infrastructure.

A major concern addressed in the REP is that the current highway construction standard is inadequate for its present and future role.

The North Coast Road Strategy prepared by the RTA in 1993 represented a significant strategic planning effort focused on the future direction and priorities for road infrastructure provision and management of the region.

The Strategy presented two distinct approaches to providing road infrastructure over the next 20–30 years. These included upgrading the highway to high standard dual carriageway or establishing an access controlled Motorway Pacific involving private sector financing.

In 1996, the NSW State Government and the Commonwealth Government established the Pacific Highway Reconstruction Program with a commitment to spend $2.2 billion over the next ten years to improve the Pacific Highway in New South Wales. In addition, the NSW State Government has agreed to separately fund other projects as priority projects over the next three years. A set of objectives and draft strategies has been developed for the Pacific Highway Reconstruction Program, and the proposed upgrade is consistent with these.

5.2 STRATEGIC JUSTIFICATION AND NEEDS JUSTIFICATION

The strategic justification and need for this proposal has been addressed in the RTA's North Coast Road Strategy and more recently in the objectives formulated for the Pacific Highway Redevelopment Program. The standard of the existing section of the highway is inadequate for its present and future role.

The strategic objectives for the proposal are to upgrade the defined section of the existing Pacific Highway to allow for:

- increased traffic efficiency
- enhanced safety
- ensure compatibility with RTA's North Coast Road Strategy context.

Currently, this section of the Pacific Highway has a substandard alignment, limited overtaking opportunities, and an unshielded intersection with Byrons Lane. The proposal would provide a standard of highway consistent with sections to the north and south, and improve traffic efficiency.

6 Option development and local planning

6.1 OBJECTIVES

The overall objective of the road upgrading is to develop and implement a cost-effective proposal consistent with the objectives of the RTA's Pacific Highway Reconstruction Programme. In the area of Byrons Lane this involves the design of an upgrade to a single carriageway suitable for 100 km/h speeds. The selection was judged against objectives such as:

- safety;
- value for money;
- minimisation of land acquisition, road construction and travel costs;
- minimisation of disturbance to existing and future land uses and the people involved in them;
- minimisation of impact to the environment;
- community opinion.

6.2 DESIGN OPTIONS

The following section describes the development, investigation and evaluation of feasible options for the design of the proposal.

6.2.1 Development of the concept design

There were no compelling reasons to seek alternative alignments as the existing alignment is the best practical choice and is relatively flood free. Therefore the only suitable alignment option, and the only one considered for the southern section of the Byrons Lane to Shark Creek upgrade, was to follow the existing alignment. The alternative was to leave the highway as it is, i.e. the 'do nothing' option.

Hydraulic modelling indicated that it would not be necessary to raise the level of the road over this section to meet the proposed 5 year ARI flood immunity. The need for structural pavement overlay will be considered in concept design.

The proximity of the existing road to the river dictates any widening should be to the south and east, away from the river. In line with action identified at the VMS, the extent of separation required from the river has been considered in consultation with Department of Land and Water Conservation during concept design.

To improve safety and reduce delay at the Byron's Lane intersection, a 'Modified' AUSTROADS Type B intersection with the highway is warranted. The need for this form of intersection to improve safety was confirmed at the VMS. A concept design drawing for this intersection is included in Appendix P.

6.2.2 Selection of the preferred design

An assessment of the two options (widen or do nothing) was carried out at the VM Study. Comprehensive information was presented to the VM Study, to allow a evaluation of the options, and ultimately nomination of a preferred option. This information had been gathered through planning studies, specialist site investigations and consultation with stakeholders.

The evaluation of the options was therefore based on comprehensive, site specific information and considered the social, environmental, engineering and financial implications associated with each option. It was decided that the Byrons Lane to Shark Creek southern section should be widened.

6.3 PROPOSAL SELECTION

This section presents a justification of the proposed upgrade within the following contexts:

- Biophysical context
- Social/community context
- Economic context
- Principles of ecologically sustainable development.

6.3.1 Biophysical context

The choice of the proposed concept design will allow the proposal to be constructed and operated without significant impact to the natural environment.

The land adjacent to the highway has no natural bush, and has been extensively modified by cane farming. Therefore the principal impacts on the natural environment which were considered were:

- impacts to riparian and other habitats;
- potential impacts to water quality in the Clarence River from the disturbance of acid sulfate soils and sediment runoff;
- potential impacts to adjacent cane land from land acquisition and flooding.

Although the preferred option runs beside the river, the potential for impact to the riparian environment is negligible. This will be achieved by widening only on the side away from the river, and by including in the design appropriate alignment and cross-sectional details, particularly those that relate to pavement drainage and other riparian protection, such as traffic barriers. The nature and control of potential impacts to riparian and other habitats will be discussed in detail in Section 7 of this report.

Effective mitigation measures will be included in the construction design and environmental management plan to avoid impact to riparian habitats. Those measures will include minimisation of disturbance to riparian vegetation, and control of sediment runoff by the use of fences, barriers and/or traps. These same measures will protect adjacent cane land from similar impacts.

The proposed work, by closely following the existing alignment, will minimise the disturbance of soil, thereby minimising the potential for impact from acid sulfate soils and sediment runoff. The benefits to other considerations such as cost and safety are, however, maximised by the proposed concept design.

6.3.2 Social and community context

The local community has expressed general support for the upgrade of this section of highway and has provided input to the development of the concept design. Community input and the VM Study agreed that the 'do nothing' option should be rejected in favour of upgrading the highway. This would improve both safety and traffic flow through the section.

In terms of noise impacts, the proposed upgrade will have negligible impact. Also, with regard to property, the preferred option will requiring minimal land acquisition, and maintain access between road and residences.

6.3.3 Economic context

There are no retail businesses along the southern section of the Byrons Lane to Shark Creek section of highway, therefore the main economic considerations are the cost of construction and the potential for loss of productive agricultural land.

Widening the existing alignment, rather than pursuing a realignment away from the river, will minimise both the costs of construction and the loss of productive land

6.3.4 Principles of ecologically sustainable development

While the definition of Ecologically Sustainable Development (ESD) can vary, there are four guiding principles which are common to most definitions. These are:

- *The precautionary principle:* This principle 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:* This 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.*
- *Improved valuation and pricing of environmental resources.*

In order to consider whether the proposed Byrons Lane to Shark Creek upgrade would be compatible with the principles of ESD, it is necessary to consider it in the context of each of these guiding principles.

The precautionary principle

The most relevant application of the precautionary principle to the proposal is the consideration of potential fauna impacts. It is recognised that there are limitations associated with the fauna field survey techniques which can be feasibly employed for a study such as this REF. In particular, field investigations may not identify the presence of all fauna species present in the study area, and are unlikely to take account of the effects of seasonality on fauna populations.

To overcome these limitations, the precautionary principle has been applied. This was achieved by assessing the types of habitats present in the subject area, and examining fauna records for the wider area to determine the threatened species which may occur in the subject area. In this approach, any of these species with a likelihood of utilising in the habitat types within the study area were assumed to be present, and the assessment of potential impacts and the preparation of mitigation measures were based on this assumption. This approach ensures that, the failure to identify the presence of fauna species during field survey will not result in unacceptable fauna impacts, such as the threat of local extinction of important fauna species.

Intergenerational equity

This principle has been applied to the assessment of the proposed upgrade in a number of ways.

Firstly, the implementation of the proposal is a critical element of improving the transport efficiency of the Pacific Highway as a whole, and would improve the transport efficiency of the section of highway near Tyndale, as well as reducing the cost to the community associated with traffic accidents. The assessment of potential impacts associated with the proposal has shown that in achieving these benefits, there would not be unacceptable impacts on the health, diversity or productivity of the local environment. In particular, the careful design of the proposed upgrade, the application of the precautionary principle and the implementation of mitigation measures would ensure that resulting impacts on the natural environment, the local community, and downstream systems would be minimised.

There would be some impacts associated with the construction of the proposal, such as the loss of a small amount of native vegetation, loss of a small amount of agricultural land and the consumption of resources. There would also be the potential for runoff water clarity deterioration. These would be offset by the benefits associated with the operation of the proposal, and these benefits would accrue during the life of the proposed upgrade.

Conservation of biological diversity and ecological integrity

While the implementation of the proposal would require the minor loss of some native vegetation, it would not result in the loss of biological diversity or ecological integrity in the long term. Confidence in this conclusion is increased by the use of rigorous concept design process, the application of the precautionary principle, and the mitigation of impacts, including landscaping with locally endemic species.

Improved valuation and pricing of environmental resources

Currently, the techniques available for placing dollar values on environmental resources are not reliable or robust, and are open to subjective interpretation. To address this principle of ESD, three techniques have been employed.

The first is the calculation of the road user benefit cost ratio. This is a comparative operational analysis and does not include any valuation of environmental resources. The road user benefit cost ratio is 2.3 for the Byrons Lane to Shark Creek (southern section) proposal. This assessment has been discussed in Section 7 of this document, and is presented in Appendix O.

Secondly, the potential economic impacts on the local community have been considered. No significant adverse impacts on the local economy are anticipated, and there are likely to be some economic benefits associated with the construction phase of the proposal.

Thirdly, and of significant importance to the consideration of ESD, a Value Management (VM) Study of the proposal was conducted. The VM Study is a robust method for considering a wide range of environmental, economic, social, transport, land use, and planning issues and reaching a balanced decision which maximises the 'value' of the proposal. This is an effective means of achieving joint consideration of economic and environmental values. Within this methodology, it is quite possible for environmental or community considerations to outweigh the road user benefit cost analysis, and in this way, the 'value' of environmental and community resources is recognised.

In the case of the Byrons Lane to Shark Creek (southern section) proposal, the VM Study group ranked the loss of productive land above all other evaluation criteria, and nominated a design which would minimise this impact. The concept design also achieves the other objectives of the community and the RTA.

6.4 STATUTORY PLANNING

The environmental planning system in New South Wales operates under the *Environmental Planning and Assessment Act, 1979*. It allows planning decisions to be made in a context of environmental, economic and social impacts—at local, regional and State levels.

The Act itself does not permit or prohibit types of development—this is the function of the following statutory planning instruments:

- State Environmental Planning Policies (SEPP)
- Regional Environmental Plans (REP)
- Local Environmental Plans (LEP).

Under the legislation local government is responsible for local planning. The Act separates the functions of local government from the State Government. The State is able to provide Councils with policies and guidelines for matters that are of State and regional significance. The Act provides for local Councils to:

- prepare LEPs;
- in most cases to be the *consent authority* thus allowing them to determine development applications;
- give advice on REPs.

LEPs and REPs are to be grounded on an *environmental study* that aims to produce an informed context and to resolve competing objectives and environmental conflicts early in the process rather than later, e.g. when a development proposal requires an environmental impact assessment.

Considering environmental impacts

Information on likely environmental impacts of proposals must accompany all development applications.

- *Designated Development* is a development that is likely to have a significant environmental impact. Local Environmental Plans, Regional Environmental Plans or the regulations to the Act can designate development—in which case an *environmental impact assessment* should accompany the development application.
- The Act requires all public authorities to consider the environmental impact of proposed activities before making a decision. Activities prescribed by the regulations or proposals that are likely to have a significant impact require an EIS. An EIS must be exhibited to allow people to make submissions.

6.4.2 Local Environmental Plan

The Byron's Lane to Shark Creek study area is located in the Maclean Shire and is covered by the Maclean Local Environmental Plan (1992).

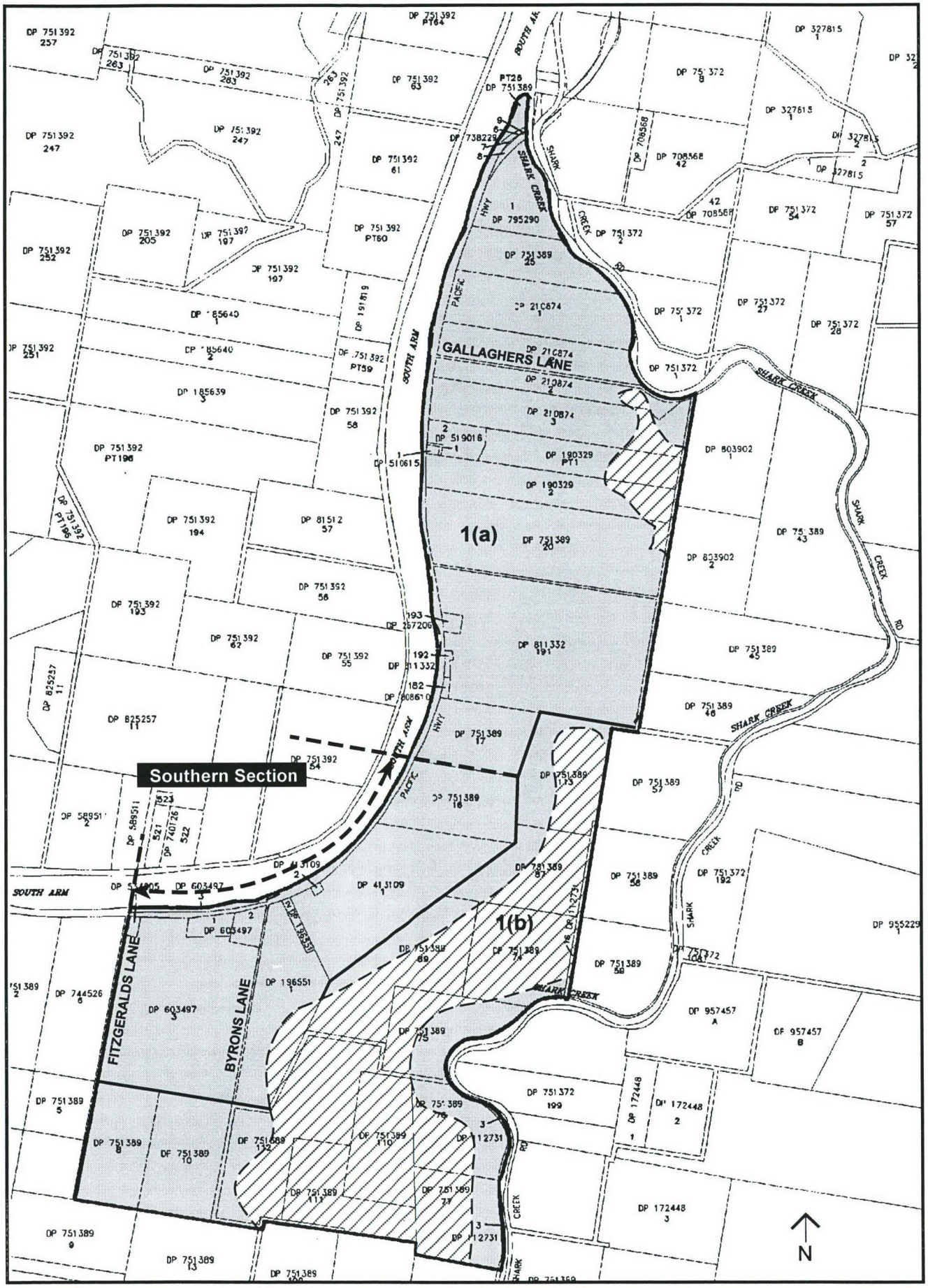
Figure 6.1 shows the LEP zonings. The study area contains land in the 1(a) Rural (Agricultural Protection) Zones and surrounding land in the 1(b) Rural (General Rural Land) Zone.

An arterial road is defined in the LEP as an existing road indicated on the LEP map by heavy broken lines. Clause 46(d) of the LEP stipulates that development listed in Schedule 1 to the Environmental Planning and Assessment Model Provisions of the EP&A does not require consent for development. The construction of roadways is listed in Part 6 of Schedule 1, and therefore consent for development is not required. Advice from Council has confirmed that this is the planning mechanism which will apply to the approval process for the upgrade.

Zone 1(a) Rural (Agricultural Protection)

The aim of this zone is to ... *protect, reserve and limit the use of land in this zone for agriculture and uses compatible with agriculture*. More specifically the objectives of the zone are to:

- promote agricultural developments;
- ensure that the integrity of agricultural land is not compromised by incompatible land uses;



1(a) Rural (Agricultural Protection) Zone

1(b) Rural (General Rural Land) Zone

Study Area

Figure 6.1
ZONING MAP

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- avoid degradation and alienation of agricultural land;
- exclude urban development.

The LEP permits without development consent the following development:

- Agriculture (other than horticulture or intensive animal husbandry)
- Bus stops
- Bushfire control
- Clearing not referred to in Item 5
- Dams with a capacity of 2 ML or less
- Dams requiring licensing under Part 2 of the Water Act 1912
- Forestry.

The zoning table in the LEP also lists a number of defined purposes for which development consent is required and which are prohibited uses. Uses that are neither *permitted* nor *prohibited* are *permissible* and require the consent of the Council. Although the proposed upgrade would require the consent of Council by this definition, consent will not be required because of Clause 46(d) of the LEP.

Zone 1(b) Rural (General Rural Land)

Land included within the 1(b) Rural (General Rural Land) Zone is intended to be reserved for rural uses in particular agriculture and uses compatible with agriculture. The objectives of this zone are similar to the 1(a) Rural (Agricultural Protection) Zone. However, they allow for a broader range of development while still maintaining agriculture as a dominant purpose.

Uses for which development consent is not required are the same as those tabled in the 1(a) Rural (Agricultural Protection) Zone. Clause 46(d) of the LEP is also relevant when considering the implications of the proposed upgrade in this zone, and Council consent will not be required.

Restriction on subdivision

All subdivision of land requires the consent of the Council[1]. Within the 1(a) Rural(Agricultural Protection) Zone minimum allotment sizes are determined according to the proposed purpose of the allotment.

The following table details minimum allotment sizes for subdivision of land within the 1(a) Rural (Agricultural Protection) Zone:

[1] Requirements are set out in Part 3 of the LEP.

Table 6.1 Minimum allotment sizes for subdivisions within 1(a) Rural zones

Purpose	Allotment size (ha)
Aquaculture	10
Forestry	20
Horticulture	10
Intensive animal husbandry	20
Other agriculture	50
Poultry farming	5
Sugarcane farming	40

The LEP permits the subdivision of land into rural-residential allotments only when:

- the land is not prime crop land, pasture land, or flood prone land
- the land is not more than two kilometres of land within Zone No. 2 Village Zone.

Development approvals

Their are no approvals that are either in process or approved but not commenced relevant to the proposed upgrade of the highway.

6.4.3 State environmental planning policies

State Environmental Planning Policies provide consent authorities and development proponents with guidelines about issues of state significance. The following sections explain the significance of the most relevant policy to the proposal.

SEPP Number 46—Protection and Management of Native Vegetation

Activities exempt to the provisions of SEPP 46 are listed in Schedule 3 to the policy. The schedule states that clearing of up to 2 ha/a is exempt. The proposal requires the clearing of an area of less than 2 ha, and is therefore exempt. However, the impact of clearing of native vegetation to accommodate the proposal has been considered under the provisions Part V of the EP&A Act. These issues are addressed in Section 7 of this REF.

6.4.4 Regional Environmental Plan

The *North Coast Regional Environmental Plan* (REP) has been guiding land release and development since 1988. The REP contains criteria and policies that are used to determine rezoning proposals and to assist decision-making on certain development applications.

The provisions of the REP apply to 17 local government areas, including Maclean Shire (and therefore the Byron's Lane to Shark Creek study area).

Transport-related objectives include:

- safeguarding the role and efficiency of the main road system of the region, particularly by recognising the importance of primary arterial roads;
- facilitating the maintenance and improvement of transport in the region.

6.4.5 North Coast Urban Planning Strategy

The *North Coast Urban Planning Strategy into the 21st Century* was published by the State Government in 1995. The strategy 'provides a framework in which to make decisions about growth and development and to coordinate service provision.'

The strategy seeks a settlement pattern that is a series of sub-regions with each served by a sub-regional centre such as Tweed Heads, Lismore, Grafton, and Coffs Harbour. The strategy intends that higher order services, such as major hospitals, specialist medical services, tertiary education, regional entertainment and sporting facilities, be located in these sub-regional centres. The strategy identifies development constraints and urban expansion opportunities. There are no identified urban expansion areas relevant to the subject proposal as the study area is constrained by agricultural lands.

The proposed upgrade would not constrain urban expansion opportunities and is otherwise consistent with the planning strategy.

7 Detailed assessment

7.1 GENERAL DESCRIPTION OF THE CORRIDOR AND SURROUNDINGS

7.1.1 Biophysical characteristics and built environment

The existing alignment to be upgraded has been shown in Figure 3.2. It extends from approximately 390 m west of Byrons Lane (chainage 32460) to approximately 950 m north of Byrons Lane (chainage 33800).

The highway lies in the riparian zone of the south-east bank of the Clarence River, South Arm. It runs along a levee bank which varies in height, compared to the land to the south and east, by approximately 0.2 m to 0.7 m.

There are five residences scattered along the length of the section, the locations of which are apparent in Figure 3.2 (note: the two dwellings shown on Figure 3.2 immediately to the north-east of Byrons Lane have been removed since the aerial photograph was taken). In between the residential blocks the land is used for cane farming.

No cane land drains enter the river in this section.

From an environmental perspective, the corridor has been extensively modified by farming and road construction, such that no undisturbed habitat exists. The riparian vegetation is quite lush, but contains many species of weeds. The riparian fringes, however, do possess environmental values, and provide habitat for native fauna.

7.1.2 Surrounding areas

The areas surrounding the corridor, on both sides of the river, are given over to cane farming and relatively small residential blocks. The Woodford State Forest lies approximately 1.25 km away to the east across the river, while the Pine Brush State Forest lies a similar distance away to the south-east. There is, however, no physical connectivity with those areas of natural bushland.

The cane fields extend some 400 m to the east of the highway. Further east still, approximately 1 km away, lies Shark Creek, which meanders over a floodplain, with swamps between it and the cane fields.

7.2 DESIGN CONSIDERATIONS

7.2.1 The existing road

The existing section of the Pacific Highway at Byrons Lane is a two lane rural highway, with a speed limit of 100 km/h. The alignment of this section has been shown in Figure 3.2. Road shoulders are narrow, especially on the river side. There are no table drains present, and drainage from approximately chainage 32540 onwards is towards the river; prior to that (chainage 32460-32540) the road is crowned and water sheds to both sides of the road.

There is one 'T' intersection at Byrons Lane. There are also conflicts between through and local traffic requiring access to Byrons Lane, and conflicts associated with bus movements.

Traffic volumes for this section are predicted for the year 2015 AD to be 28,500 AADT.

7.2.2 Design parameters

The proposal provides for the following design parameters:

- A reconstructed and widened pavement
- Two 3.5 m travel lanes
- 2.0 m sealed shoulders
- 1.0 m sealed verges on the river side, and 0.5 m sealed verges on the opposite side
- A Modified Type B intersection at Byrons Lane
- An off-road bus stop and turn area in Byrons Lane.

A set of engineering drawings has been included in Appendix P.

Horizontal alignment

The horizontal alignment provides for:

- a curve of radius 1050 m between chainage 32564 and 32964
- a curve of radius 575 m between chainage 33024 and 33298
- a curve of radius 700 m between chainage 33464 and 33588.

Vertical alignment

The vertical alignment is relatively flat with no gradient exceeding 0.589%, and with the following vertical curves:

- A curve of radius 57,082 m between chainage 32705 and 32975
- A curve of radius 35,840 m between chainage 33190 and 33290
- A curve of radius 49,834 m between chainage 33345 and 33495
- A curve of radius 133,928 m between chainage 33645 and 33795.

Provision for pedestrians, cyclists and buses

Pedestrians would not be encouraged to walk alongside the highway. However, the proposed widened shoulders (2.0.m) would be sealed and may be used by both pedestrians and cyclists. Regular access to the river side by pedestrians is not required, as there are no dwellings, businesses or amenities of any kind on the river bank, therefore no crossing points are planned.

Buses would be required to use the proposed bus stop and turn area in Byrons Lane rather than stop along the highway.

Provision for fauna movement

Because of the nature of the countryside and the lack of areas of significant habitat on the south-eastern side of the highway, it is not proposed to provide either fauna-proof fencing or fauna culverts.

Landscaping

Landscaping is not a large requirement for this project. The riparian areas will not be disturbed, and the batters on the other side of the highway will be grassed as they are a present. The landscaping to be employed will:

- stabilise batters and prevent erosion
- minimise colonisation of weeds and reduce roadside maintenance
- maintain required sight distances.

Design constraints

Design constraints affecting the proposal were identified and addressed in the VMS. Those constraints include:

- no encroachment on the riparian vegetation
- minimum acquisition of land.

Local access

Access points to the highway are proposed to be limited to:

- chainage 32500, private access point to Lot 3 on DP 603497 (river side)
- chainage 32600, private access point to Lot 1 on DP 603497
- chainage 33280, private access point to Lot 1 on DP 413109
- chainage 33600, private access point to Portion 16 on DP 751389.

Construction staging

Construction will commence at the southern end, and progressively fill, pave and finish concurrently in sections. Construction will take place under traffic, with a 60 km/h speed limit.

7.2.3 Construction activities

The construction of the proposal is currently expected to commence in August 1998, and continue for eight months. Normal working hours would be between 7.00 a.m. and 6.00 p.m. Monday to Friday, and 7.00 a.m. to 1.00 p.m. Saturday, with no construction work to be carried out on Sundays or public holidays. If construction is audible at residences, then working hours on Saturdays would be from 8.00 a.m. to 1.00 p.m. Non-routine tasks may be required outside of these hours.

Typical plant and equipment types, and numbers for a road construction project, such as that proposed, would be:

- one excavator
- two graders
- four tip trucks
- one water truck
- two rollers (1 x vibrator, 1 x smooth)
- one paving machine
- generators
- compressors
- assorted small items of equipment.

The requirement for the machinery listed would depend on the stage of construction, and not all plant listed would be on site at any given time.

The construction would be undertaken by RTA crews.

The major activities associated with the construction of the proposal would be:

- project 'start-up', including the establishment of the construction crew on site;
- clearing of vegetation, topsoil stripping and removal of existing pavement/ structures;
- earthworks—fill and embankment construction;
- construction of road pavement—stabilisation of sub-base, followed by a bridging layer of asphalt concrete, followed by asphalt surface;
- finishing works—foundation of road shoulders complete, finalise landscaping, construction signage and guardrails.

There will be a requirement to import construction materials. The most notable of these would be materials for pavement construction, gravel (selected fill), concrete and asphalt. Gravel would also be required for the construction of road shoulders.

The fill will be obtained from local quarries, and will consist of sandstone and overburden. The required volumes are discussed in Section 7.2.5. The traffic implications of the import of these materials to the construction site are described in Table 7.1 below.

Table 7.1 Traffic implications for import of pavement materials

Material	Volume required (m^3)	Duration of import (weeks)	Volume per truck load (m^3)	Total no. Of truck trips (return)	Average trip frequency *	% of existing commercial vehicle frequency	Likely distance per trip (approx.) (km)
Asphalt	4,000	6	6 **	670	20 per day	3.0	220
Concrete/cement stabilised	4,000	4	6	670	2.5 per hour	4.5	40
Gravel—for selected fill	9,400	10	12 **	780	14 per day 2.0 per hour	2.0	40

* *Assuming five and a half day working week and eight hour working day.*

** *Allows for compaction when placed.*

Because of the location of the proposed upgrade and the sources of materials, the majority of these vehicle movements would be on the existing highway. The traffic implications of material import have therefore been considered in the context of the existing highway.

Table 7.1 indicates that, although the number of truck trips required to deliver construction materials appears significant when considered in isolation, they would represent only a small percentage (maximum approximately 5%) of the existing heavy vehicle traffic on this section of the Pacific Highway. There would therefore be no significant adverse impact on the local or regional road network as a result of the construction of the proposal.

It is anticipated that this section of road and the overlay of the existing road would be constructed under traffic, and would require formal traffic management plans in accordance with RTA's Traffic Control Manual. Access to and from the construction site would be by means of this traffic control, and utilise access via Byrons Lane where practical.

7.2.4 Waste management

Waste disposal issues associated with the proposal would primarily be linked to the construction phase, and would include:

- handling and disposal of cleared vegetation;
- collection and disposal of construction debris and domestic rubbish;
- handling and storage of dangerous goods including fuels, oils, greases or other chemicals;
- the provision of toilet/washroom facilities, and the collection and disposal of wastewater.

The overriding principles applied to waste management would be to minimise the amount of waste generated, recycle wastes wherever this is possible, and dispose of the remainder in a responsible manner. This approach is in accordance with the objectives of the Waste Minimisation and Management Act 1995.

The amount of cleared vegetation would be reduced where possible by minimising the width of clearing, and by clearly defining and enforcing clearing limits. Where possible, millable timber will be recovered.

Vegetation which could not be recovered or recycled for mulch, including exotic weed species, would be disposed of in accordance with local Council regulations.

The remaining waste management issues associated with the proposal, such as the collection and disposal of construction debris and domestic rubbish, and the storage and handling of fuels and chemicals, are standard issues routinely associated with road construction projects. They would be dealt with through the implementation of relevant RTA policies and procedures, and compliance with relevant Australian standards and legislation. These issues will be addressed further in the EMP for the proposal. No special design considerations are required to address these remaining waste management issues.

7.2.5 Demand on resources

This section discusses the likely effects of the proposal on local resources, and the energy sources required to construct the project compared with energy savings which would result form the operation of the proposal.

Local resource issues

Resources which would be used in the construction of the proposal, and which would be sourced from the local area (Alstonville, the Maclean Shire, Grafton and Coffs Harbour) are likely to include:

- gravel
- pavement materials
- fuels and oils
- sand and cement
- labour resources.

There would be a requirement to import materials for pavement and earthworks construction. It is proposed that the pavement would be an asphalt surface on a lean mix concrete or cement stabilised sub-base. This would require the importing of asphalt, cement and gravel. A source of water would also be required. Sources are described as follows:

- *Asphalt:* It is estimated that 4,000 m^3 of asphalt (approximately 9,600 t) would be required over a six week period. The nearest asphalt plants are located at Coffs harbour and Alstonville (100 km to the south and north respectively). Coffs Harbour has a capacity of 500 t/d. the demand for asphalt would be approximately 150 m^3/d (approximately 360 t/d), which would be within the capacity of the Coffs Harbour plant. The demand for asphalt would exceed the capacity of the Coffs Harbour plant however, if the asphalt laying period was reduced to less than five weeks. If necessary, additional asphalt could be obtained from Alstonville.
- *Cement stabilised material/concrete:* The volume required for pavement construction is estimated to be approximately 4,000 m^3 over a four week period. This represents a demand of approximately 200 m^3/d, or on average, approximately 25 m^3/h. The nearest concrete batching plant is located 30 km to the south at Grafton, and has a production capacity of 100 m^3/h. It should be

within the capacity of this plant to supply the concrete required for pavement construction. *In situ* stabilisation of pavement gravel is an alternative.

- *Gravel:* The principal activities requiring gravel (selected fill) would be earthworks construction. These would require a total of approximately 9,400 m^3 of material (compacted in place). Construction would require approximately a ten week period. There are several sandstone quarries in the area of Shark Creek and Woodford Island, which could be used to source this relatively low volume of gravel.
- *Water:* A supply of water would also be required for a range of construction activities, including dust suppression. It is estimated that up to 2,000 m^3 may be required, spread over the whole construction period. There are water mains along the highway, and water would not need to be tankered to the construction site.

The calculations above demonstrate that construction of the proposed upgrade could be completed without undue pressure on local supplies of resources.

Fuel and oils would be consumed during the construction process through the operation of construction machinery and the transport of construction materials to the site. This increase in local consumption is not expected to place any undue pressure on local suppliers. In the longer term, this 'cost' will be offset by 'savings' associated with the improved transport efficiency of the proposal, and by reductions in community costs associated with a reduced traffic accident rate.

In addition, the local community would derive some benefit from the employment of local persons on the construction workforce, and from the sale of fuel and other materials needed for construction.

There would also be some local resources required during the operation of the proposal. These would include materials, labour and fuel required for maintenance and repair. Because of the design of the road and associated landscaping, maintenance is expected to include routine repairs to the road surface and shoulders, infrequency replacement of landscaping plant stock, control of exotic weed species and mowing grass. It is expected that the labour and resources required for maintenance would be within the capabilities of RTA's Ballina District Office.

7.3 DETAILED DESCRIPTION OF EXISTING CHARACTERISTICS AND ENVIRONMENTAL IMPACTS

7.3.1 Landform

The existing road runs along a levee bank on the south eastern side of the Clarence River. The western side of the highway, beyond the road verge, has a relatively narrow level area of varying width which then falls away quite steeply by approximately 5 m to the river.

At the northern limit of the works of this section of the highway, the land to the east is slightly lower than the road by approximately 0.4 m. The cane land throughout the Byrons Lane section has a very slightly undulating form with low gradients (0-1%). In the mid and southern parts of the proposed work area, the land to the east is noticeably lower than the road by approximately 1 m. Further west than Byrons Lane

the land rises again, but at the limit of the works is still slightly lower than the road by approximately 0.2 m.

7.3.2 Soils

Kinhill commissioned a specialist geotechnical sub-consultant, Golder Associates, to investigate the soils along the proposed construction area. Detailed findings of these investigations have been presented in Appendix J, while a summary is presented below.

Test pits

Test pits were dug at the locations shown in Figure 7.1. The soils encountered are described below (distances are depths below ground level):

TP20

- 0-0.3 m black organic silty clay
- 0.3-2.3 m loose fine to medium sand.

TP21

- 0-0.3 m black silty sand
- 0.3-2.3 m loose fine to medium sand
- 2.3-2.5 m loose silty sand.

TP22

- 0-0.4 m black organic silty
- 0.4-1.0 m loose silty sand
- 1.0-1.6 m loose clayey silty sand
- 1.6-2.5 m medium dense clayey silty sand.

TP23

- 0-0.25 m fill (stony clay matrix)
- 0.25-0.65 m black silty fine grained sand
- 0.65-1.4 m loose to medium dense silty sand
- 1.4-2.3 m stiff sandy silty clay
- 2.3-2.7 m loose to medium dense sand.

Groundwater was not encountered in any of the pits.

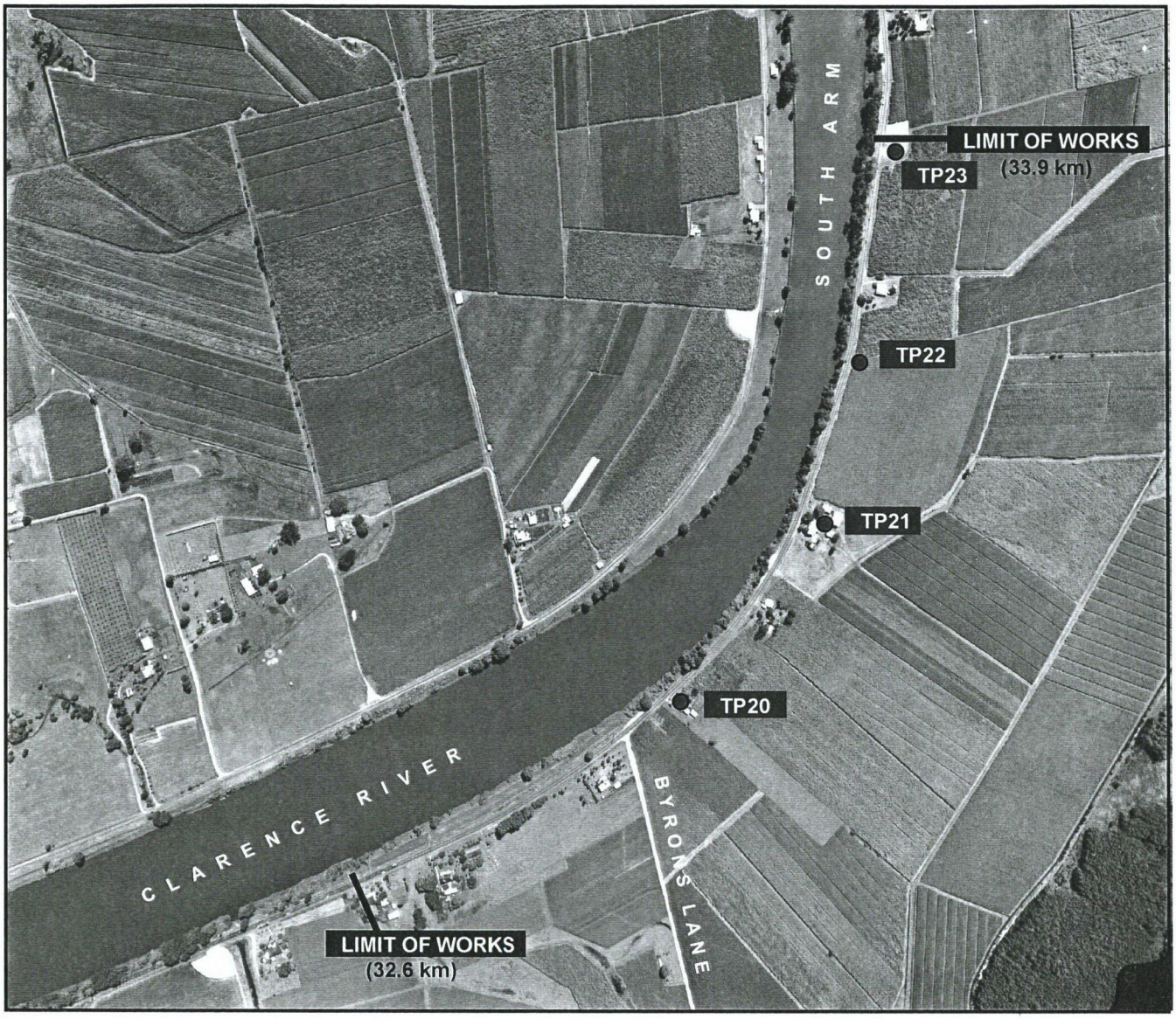


Figure 7.1
LOCATIONS OF SOIL TEST PITS

Acid sulfate soils

The elevation of the cane land is approximately 5 m AHD, which places it in an at-risk category for acid sulfate soils. The NSW Acid Sulfate Soils Risk Map (Tyndale, 22) describes that risk as having a high probability with the depth to acid sulfate soil materials varying between 1–3 m and >3 m. However, apart from some topsoil stripping, the proposed earthworks will not disturb the deeper local soils. The topsoil to be disturbed, is well above the watertable, and has already been well oxidised and leached. It is therefore proposed that any stripping be limited to a depth no deeper than 1.0 m. Provided this management measure is followed, the potential for impact from acid sulfate soils for the proposed work is considered negligible.

Potential impacts from soil erosion and mitigation measures

Areas of fill and areas exposed by stripping of the existing pavement have the potential to be eroded through the action of rain and surface water runoff. To mitigate this potential, batter slopes would generally be established at 1V:4H, with a maximum of 1V:2H on the riverside at the southern end of the job and on the eastern side of the road between chainages 32780 and 32840. The steeper batters at these locations will avoid encroachment on the riparian zone and minimise encroachment on cane lane. The movement of sediment would be restricted by the use of temporary structures, such as silt fences, hay bail barriers, and bunding of stockpiled material. Disturbed areas should be covered by pavement or landscaped as soon as practical. The 'Best Practice' methods to be used can be found in the RTA's Road Design Guide.

7.3.3 Climate

An assessment of the implications of local climate for the proposed upgrade was carried out by Katestone Scientific. Detailed findings of this assessment have been presented in Appendix F.

The most relevant historical meteorological data for the Byrons Lane site have been collected by the Bureau of Meteorology at Grafton and Lismore. The implications of the climatic conditions can be summarised as follows.

Wind

Strong winds in excess of 15 m/s (54 km/h) may cause significant dust problems during construction and impact on the stability of traffic, especially high-sided vehicles. Wind directions at Grafton are commonly experienced from all quadrants, due to:

- various combinations of the synoptic wind directions (generally south-easterly during summer and south-easterly to south-westerly during winter);
- daytime onshore sea breeze components;
- offshore night-time land drainage components.

Morning winds are generally light (<3 m/s) south-east to south-westerlies; while afternoon winds are dominated by the north-east to easterly seabreeze. The seabreeze is generally light to moderate, with approximately 97% of winds less than 9.7 m/s.

Bureau of Meteorology observations at Grafton record nine days per year with strong winds (>15 m/s) and one day per year with gales (>20 m/s). 9 a.m. observations indicate a very low proportion of strong winds occurring in the morning and virtually no observations of gales. 3 p.m. observations indicate a greater proportion of strong winds and gales occurring in the afternoon.

The strongest winds experienced in the area are commonly associated with strong pressure gradients producing westerly or southerly winds, and with thunderstorms which produce winds of varying directions dependant on the movement of individual storms.

Bureau of Meteorology climatological observations record on average nine days per year with strong winds and 1 day per year with gales at both Lismore and Grafton. Strong wind gusts may be also associated with thunderstorms.

Night-time winds are generally much weaker than the daytime winds due to a combination of offshore-drainage wind tendencies opposing the general onshore flow, and decreased convective mixing of faster upper-level winds to the surface. The existence of strong night-time winds would be rare and possibly in the order of one or two hours per year.

Rain

The monthly and annual distributions of rainfall from long term monitoring sites at Grafton and Alstonville are listed in Table 7.2 (Alstonville near Lismore is approximately the same distance from the coast as Tyndale).

Table 7.2 Mean rainfall and rain days statistics for Grafton and Alstonville

Period	Mean rainfall (mm)		Number of rain days	
	Alstonville	Grafton	Alstonville	Grafton
January	158	147	13	15
February	182	139	14	15
March	191	123	15	15
April	128	98	12	10
May	116	89	11	11
June	97	68	9	8
July	81	43	8	7
August	56	33	7	6
September	51	32	7	7
October	73	75	9	10
November	95	104	10	12
December	123	124	11	13
Annual	1351	1075	129	129

Source: Bureau of Meteorology

The Bureau of Meteorology's records reveal:

- there is a strong seasonal variation in rainfall;
- the highest rainfalls occur during the period December–March;
- the lowest rainfalls occur during the period July–October;
- the average rainfall during the wetter period of the year is generally about 12 mm per rain day; this rainfall is largely due to convective cloud activity, is relatively heavy, and commonly lasts for only a short period of the day;
- the average rainfall during the drier period of the year is generally between 7 mm and 10 mm per rain day; this rainfall is largely due to stratiform cloud activity, is relatively light, and commonly last for longer periods of the day;
- a maximum rainfall of approximately 96 mm over twenty-four hours can be expected to fall over the region once per year.

Thunderstorms

Thunderstorms may significantly interrupt construction and traffic. The observations a Grafton suggest that thunderstorms in the area of the roadworks would occur on average approximately thirty-four days per year.

Fog

One of the greatest hazards to safe driving is the occurrence of fog when visibility is reduced to less than 1 km. Fog formation in a moist airmass is generally due to night-time cooling, or the coincidence of low-level clouds with terrain. The movement of cooler air down sloping terrain at night tends to favour the formation of fog in lower lying areas. Such fogs commonly form from about midnight, and last until about 9 am. Fog may occur any time of the year, especially after rain. Fogs are most frequent between the hours of 3 am and 8 am, unless associated with or following heavy rain.

The observations at Grafton and Lismore record that fogs occur, on average, eighteen days and thirty-seven days per year respectively. The area in the vicinity of the upgrade should experience a frequency of fogs in a similar range.

Frost

Frost on roadways can produce slippery conditions hazardous to motorists. The movement of cooling night-time air down sloping terrain favours the formation of frosts in lower lying areas. On average, Grafton experiences seven days per year with frost, and Lismore experiences nine days per year. Frosts are less frequent close to the coast and occur more often with increasing distance inland. The study area would experience frosts on average approximately seven days per year.

Haze

The average number of hazy days reported per year for Grafton and Lismore are 21 days and thirty-nine days respectively. The area in the vicinity of the upgrade should experience a frequency of hazy days in a similar range.

Temperatures

The warmest months occur during December, January and February, while the coolest months are June, July and August. The occurrence of temperatures >35°C and <2°C is very low.

Implications

Construction schedules should avoid erosion sensitive earthworks during the periods of highest expected rainfall, i.e. December–March. During this period the closest attention should be paid to erosion controls and water quality monitoring.

The driest period is between July and October, and a dust control program should be in readiness during these months. However, this period has a lower potential for strong winds than the summer months, which reduces the potential for dust dispersal, mitigating the risk of dust nuisance.

7.3.4 Air quality

Operational phase

An assessment of the implications of the proposed upgrade for local air quality was carried out by Katestone Scientific. The detailed findings of this assessment have been presented in Appendix G.

Likely air quality impacts have been estimated based on existing traffic volumes and detailed dispersion modelling of air quality along the Pacific Highway in northern New South Wales.

Background air quality

Dominant air quality influences will include rural activities and vehicle emissions along the Pacific Highway. Results of a one-day background air quality study, previously conducted by Katestone Scientific in northern New South Wales, found one hour average concentrations of carbon monoxide to be below 1 ppm. Based on monitoring at similar sites, background air pollutant concentrations have been estimated and are presented in Table 7.3.

Table 7.3 Estimated background pollutant concentrations, and guideline values

Parameter	Estimated background concentration	Recommended equivalent	
		Guideline value	Source
Carbon monoxide (CO)	0.1-1.0 ppm	25 ppm	WHO
Nitrogen dioxide (NO_2)	10 ppb	160 ppm	NH&MRC
Total suspended particulates (TSP)	50 $\mu g/m^3$	1000 $\mu g/m^3$	NH&MRC
Particulate matter (PM_{10})	30 $\mu g/m^3$	200 $\mu g/m^3$	USEPA

Estimated background levels are much lower than the recommended guideline values.

Predicted air quality adjacent to the proposed upgrade

Estimates of ground-level concentrations of vehicle emissions have been made based on dispersion modelling studies using CALINE-4 conducted by Katestone Scientific for similar sections of the Pacific Highway, and assumed traffic volumes of 9,164 vehicles per day. Table 7.4 presents the results of the modelling together with guideline values for each parameter.

Table 7.4 Estimated maximum hourly roadside pollutant concentrations at 1 m distance from the kerb

Parameter	Estimated concentration	Guideline value
Carbon monoxide (CO)	1.6 ppm	25 ppm
Nitrogen dioxide (NO_2)	12.5 ppb	160 ppb
Total suspended particulates (TSP)	59 $\mu g/m^3$	1000 $\mu g/m^3$

Estimates of pollutant concentrations are well below guideline values for all pollutants at 1 m from the kerb.

Construction phase

Construction activity has the potential to generate dust which may become a nuisance unless dust management techniques are employed. Dust suppression would be critical during construction to avoid dust nuisance to nearby residences and to traffic on the highway. The implementation of an effective management programme for construction would ensure that dust concentration levels would be maintained below those known to cause a nuisance. This would require thoughtful planning of material handling and stockpiling, and topsoil removal; regular cleaning of sealed highway lanes next to the construction zone; and suspension of dust-generating activities until dust suppression is effective, e.g. by spray wetting.

Conclusion

Provided an effective dust management programme is in place during construction, the highway upgrade should not have an adverse effect on air quality during either the construction or operational phases.

7.3.5 Drainage and water quality

Although the section of highway to be upgraded runs close to the Clarence River, no water courses or drains are traversed by the proposed construction area. All widening earthworks are to be done on the side of the road way from the river, and riparian areas will not be disturbed by the proposed construction. The riparian communities are quite heavily vegetated, and the river bank quite stable. During construction, sediment barriers will be used to control sediment runoff towards either the river or cane land.

Following construction, the pavement design will direct water runoff towards the river. Drains will not be constructed, however, and runoff will flow diffusely, as it does at present, to the river bank. Rehabilitation of the batters with grass will provide a sediment and pollutant trap before water reaches the river bank.

If erosion and sediment runoff controls are managed effectively, it is unlikely there will be negative impact to the quality of water in the Clarence River.

7.3.6 Flooding considerations

The proposed upgrade should not have a significant affect on either the depth or persistence of flooding in the Byrons Lane area.

Details flooding studies are presented in Appendix I, and may be summarised as follows:

5 year ARI flood immunity

The Byrons Lane section of the highway is relatively flood free compared to the sections immediately north. The southern end of this section already provides a 5 year ARI flood immunity, and with the slight additional height provided by the reconstructed pavement, the whole of this section should meet this criterion.

Inundation periods

Inundation times for the cane fields to the east of the highway are important in that the length of time sugar cane is under water has a pronounced effect on its viability. Hydrological studies, which are presented in full in Appendix I, have shown that inundation times for the cane fields to the east of the highway should not be significantly affected by the proposed work on this section of the highway.

7.3.7 Vegetation

The findings of the vegetation assessment are detailed in Appendix B, and are summarised below.

The major feature of this site is the narrow riparian fringe which lies between the current highway alignment and the Clarence River. Cultivated sugar cane lands with associated rural housing and other infrastructure abut the other side of the highway. There is no physical connectivity with the Woodford State Forest which lies nearby.

The rural lands are dominated by introduced flora, while the sliver of remnant native vegetation along the river reflects its past disturbance history. Natural disturbances such as floods have been a major evolutionary influence on the substrate and the stability of the vegetation mosaic which established there. A plethora of weed species occupy all regularly disturbed sites. In addition, several environmentally serious weeds, eg. *Anredera cordifolia* (Mignonette vine), have invaded areas not exhibiting recent disturbance to either substrate or vegetation. Introduced species are preventing the regeneration of the remnant canopy.

No threatened of significant species were recorded during extensive foot traverses in the study area. A diversity of riparian rainforest and associated taxa remain, but the degraded nature of the remnant vegetation and on-going threats diminish significantly the biotic values (from a flora perspective) of the study area.

A small stand of red gums (*Eucalyptus tereticornis*) is present beside the road to the west of Byrons Lane inside a residential property; these have been indicated on Figure 3.2. Approximately twenty mature trees would probably be removed by the proposed widening, although assessment would be undertaken to determine whether they can be safely included in the landscaping of the verge. These trees were inspected, and no nests were apparent, neither was there evidence of active use by koalas. The trees are isolated from other woodland, and not part of a corridor between areas of significant habitat. Also, trees of similar age and species are present in abundance in nearby State Forests. It is therefore unlikely that their removal would have a significant impact on the local ecology.

The majority of trees to be removed for road widening are garden ornamentals and fruit trees, such as mangoes, tibouchinas and frangipanis, which stand on the seven current or former residential blocks within the study area. These trees do not provide significant habitat for native fauna, and their removal would be unlikely to impact on the local ecology.

There are some individual trees which are likely to be significant to the fauna locally and regionally. In particular, several specimens of *Ficus macrophylla* (Moreton Bay fig) occur along the river side road verges. *Ficus macrophylla* are subject to a tree protection order throughout Maclean Shire, and will not be disturbed by the proposed upgrade.

Potential impacts

Site inspections revealed a distinct lack of natural biotic resources between the existing highway alignment and the cultivated sugar cane lands. As all construction works will be placed to the landward side of the existing highway alignment, there will be no significant impact upon noteworthy native flora.

The riparian vegetation, on the other hand, would be retained in its entirety and its long term viability and integrity enhanced via rehabilitation based management strategies. This would primarily be directed towards introduced flora management undertaken conjointly with planting activities in the more seriously degraded sites.

7.3.8 Fauna

A fauna investigation was conducted by Kinhill. This involved a two day site inspection by a qualified ecologist, plus a review of the NSW National Parks and Wildlife Service (NPWS) Atlas database and other relevant scientific publications.

The highly altered and degraded nature of the environment which will be subject to disturbance by the proposed highway upgrade, i.e. the south-eastern roadside verge and adjacent cane land, would not support a high diversity of fauna species

A review of the NPWS database, for a 11 x 11 km square block centred on Tyndale, identified five threatened species recorded within that block. These were:

- Black-necked Stork (*Ephiopiorhynchus asiaticus*)
- Square-tailed Kite (*Lophoictinia isura*)
- Osprey (*Pandion haliaetus*)

- Brolga (*Grus rubicunda*)
- Brush-tailed Phascogale (*Phascogale tapoatafa*).

A search (by means of binoculars) was made of trees within the area to be disturbed by construction works, and no Osprey nests were evident. Regarding the other four noted species, although one, a Square-tailed Kite, has been recorded in the vicinity (on the bank of Shark Creek approximately 1 km to the east of the highway), the proposed construction area does not contain the usual habitat or roosting sites of any of those four threatened species. It is, therefore, highly unlikely that any threatened species will suffer adverse impact from the road upgrade.

Furthermore, the area to be disturbed is not part of any corridor between significant habitats that might be used extensively by any fauna. Consequently, the increase in road width and vehicle speed following the upgrade is not expected to significantly increase the incidence of road kills.

7.3.9 Compliance with Section 5A of the Environmental Planning and Assessment Act (amended 1995)

It is a requirement that this study address the 'eight part test' for the significance of impacts under Section 5A of the *Environmental Planning and Assessment Act* (amended 1995). This test is analogous to the now repealed 'seven point test' under Section 4A of the *Environmental Planning and Assessment Act 1979*.

No threatened flora species were recorded within or adjacent to the proposed works. A total of five threatened fauna species have previously been recorded within a 121 km^2 block centred on the township of Tyndale (NSW NPWS Wildlife Atlas databases). As noted in the previous section of this document, it is unlikely that any of the threatened species would be directly impacted as a consequence of the proposed highway upgrade. Nevertheless, for completeness, issues relevant to each of these species were addressed within the following eight part test.

(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.

A brief description of the life cycle of each of the five threatened fauna species is provided in Appendix A of this report. The proposal is not considered to impact on preferred or even suitable breeding, nesting or feeding habitat of any of the five threatened species. Sugarcane land and a few mature eucalypt trees only would be disturbed as a result of this proposal. Those eucalypt trees to be felled were searched thoroughly for the presence of raptor nests, nests of other birds, and for the presence of hollows. No such nests or hollows were observed.

A flora survey of the corridor of interest failed to find any plant species listed as presumed extinct, endangered or vulnerable under the *Threatened Species Conservation Act 1995*. The proposal would therefore have no effect on threatened plant species.

(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.

Amendments to the *Threatened Species Conservation Act 1995* list eight endangered populations. None of these populations inhabit areas within the wider region of the proposed highway upgrade.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.

The proposed highway upgrade follows the existing alignment of the highway. No riparian vegetation or eucalypt woodland associated with the Clarence River would require clearing. Only ecologically degraded lands on the highway verge or that presently support cane production would be impacted. Therefore, no significant area of known habitat is to be modified or removed by this proposal.

(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 or ecological community.

The proposed works involves an upgrade of the existing highway along the same alignment. This area presently supports either degraded roadside vegetation or sugarcane. As such, no habitat areas would become isolated as a result of this project. Neither is the study area part of any connecting corridor between areas of significant habitat.

(e) Whether critical habitat will be affected.

This question cannot be answered directly at present because there has been no declaration of critical habitat areas under the *Threatened Species Conservation Act 1995*. However, clearing of sugar cane land and a few mature trees only would be required and therefore no areas of habitat of significant conservation value for any of the threatened species previously recorded from the wider region would be impacted by the proposed highway upgrade.

(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.

No areas that are classed as 'protected areas' occur within close proximity to the study area. However, several State Forests are nearby, namely Pine Brush State Forest, Woodford South State Forest and Southgate National Forest. These areas could potentially support those threatened species identified as occurring within the wider region, but no threatened species are likely to be found in the proposed construction area.

No threatened plant species were identified within the study area.

(g) Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.

The *Threatened Species Conservation 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.'. Therefore, habitat clearance and the introduction of weeds or feral species should receive appropriate consideration.

Only ecologically degraded lands, that presently support sugar cane or residential gardens, would be cleared to facilitate the proposed highway upgrade. This would not threaten any native fauna or flora species or populations within the region. A landscaping programme following the construction work will avoid the introduction of weeds. No feral species would be introduced to the area as a result of the proposed upgrade.

(h) Whether any threatened species, population or ecological community is at the limit of its known distribution?

The recorded geographical distribution of each of the five threatened fauna species is such that the study area is not at the limit of any of their known distributions.

No threatened flora species were recorded within or directly adjacent to the study area.

7.3.10 Socio-economic issues

The social impact of a major project such as a new highway is defined as the effect of that proposal on people. More specifically it relates to potential impacts on:

- the way people live, work and recreate
- the character, cohesion and demography of their community
- their customs and values.

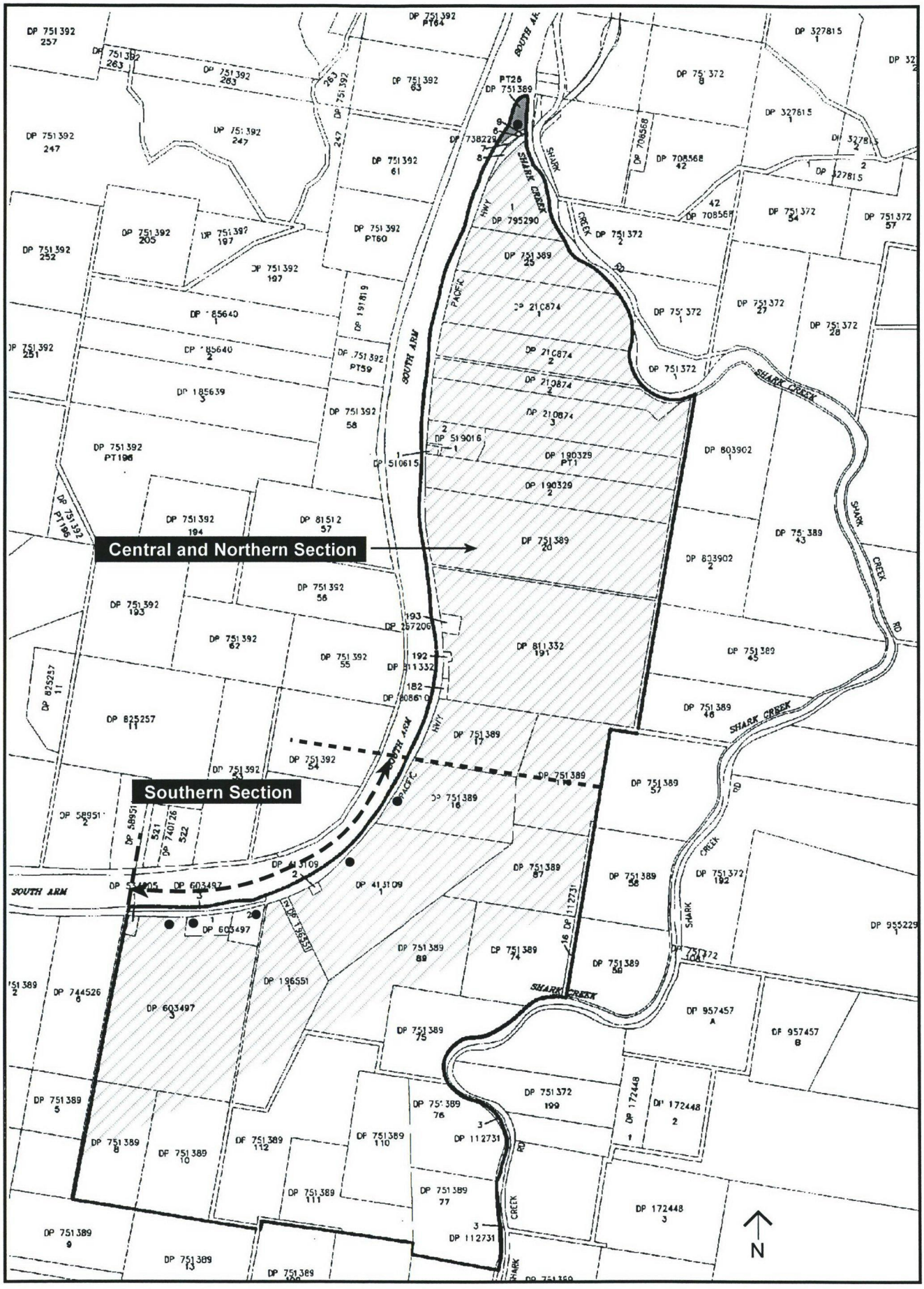
Land use

Agricultural activity is the predominant land use in the southern section of the Byrons Lane to Shark Creek project area, with sugar cane plantations widespread on the rich alluvial flood plain of the Clarence River.

Figure 7.2 illustrates current land use and improvements in the vicinity of the study area.

Community characteristics

The Byron's Lane to Shark Creek community (those residing in the immediate area) is part of the broader Tyndale Village community. This small community contains a population of approximately 30–35 residents in twelve dwellings (five of which are located within the study area for this REF and are shown on Figure 3.2). The broader Tyndale community is relatively small with a total population of 239 at the 1996 Census. The population occupied a total of eighty-six private dwellings having a dwelling density of 2.78 persons per dwelling.



● Dwelling Sugar cane Grazing

Figure 7.2
EXISTING LAND USE IN THE AREA

Appendix N contains a community profile derived from the 1991 and 1996 Census data. The main characteristics of the community compared to that of Maclean Shire and New South Wales are outlined below:

- A significantly higher proportion of the population is over 60 years old when compared to NSW but is slightly lower than that for Maclean Shire.
- The 15 to 24 age cohort is significantly under-represented being almost half that of the state.
- The area's age characteristics are reflected in the labour force status, with 42.3% of the population not in the labour force.
- There was a significantly high number of persons self employed, 21.5% of the labour force, and correspondingly a low proportion of wage or salary earners, as compared to the state as a whole.
- Average household income was $27,843, which is $10,000 lower than the state average.
- The area is dominated by detached dwellings with 10% more than the state average.
- Homes ownership is significantly higher than both NSW and Maclean Shire with 64.0% of occupied private dwellings owned and 24.4% being purchased.
- The area has a mobility rate higher than the state, however this would be countered by expected low levels of public transport available in the area.

Due to the size of the study area the figures above can only provide a broad overview of general characteristics. From contact with the community it has become evident that households are mainly made up of adults with few children being within the community. Most of the population has lived in the area for a number of generations and are part of the one or two extended families.

Community impacts

The potential effects on the community associated with the proposed upgrade would be:

- changes to vehicle, pedestrian and cycle patterns–access to individual properties would not be impacted;
- the proposed upgrade will not create any community severance or affect the ability of the community members to interact, as it closely follows the existing highway;
- the proposed upgrade would not reduce accessibility to, or require the removal of any community facilities;
- residential amenity would not be detrimentally affected, the upgrade closely follows the existing highway;
- the would be no change in the level of security within the community and safety will be improved with greater pedestrian and cycle accessibility and safety;
- the proposed upgrade would not require the relocation of any households.

Property effects

The acquisition of land to accommodate new alignments impacts significantly upon individuals. This impact is via loss of land both agricultural and residential. Figure 7.3 shows the details of property acquisitions required to implement the proposed upgrade.

The preferred route for the proposed upgrade impacts upon three residential properties. The proposal would result in their property boundaries being moved approximately 6–8 m back at the front of these properties by acquisitions of land for the road reserve. Similar acquisitions would be required from adjacent cane land.

Overall the proposed route for the upgrade would minimise severance of land and generally maintain the integrity of existing allotments. Loss of prime agricultural land would also be minimised.

Economic effects

The proposed upgrade would result in the loss of some productive agricultural land. This would be minimised by the widening the existing alignment and the impact is likely to be minimal.

Provisions for pedestrians and cyclists

Currently no provisions exist for pedestrians to cross the highway and road shoulders are narrow in places, raising safety issues. The proposed upgrade would include the widening of road shoulders, therefore improving safety for pedestrians and cyclists. Safety for pedestrians would be further improved by the provision of a bus stop and turn-around just off the highway in Byrons Lane. It is also proposed to construct a local widening at approximately chainage 33300 for a local bus stop. This will be confirmed, if accepted, in the detailed design.

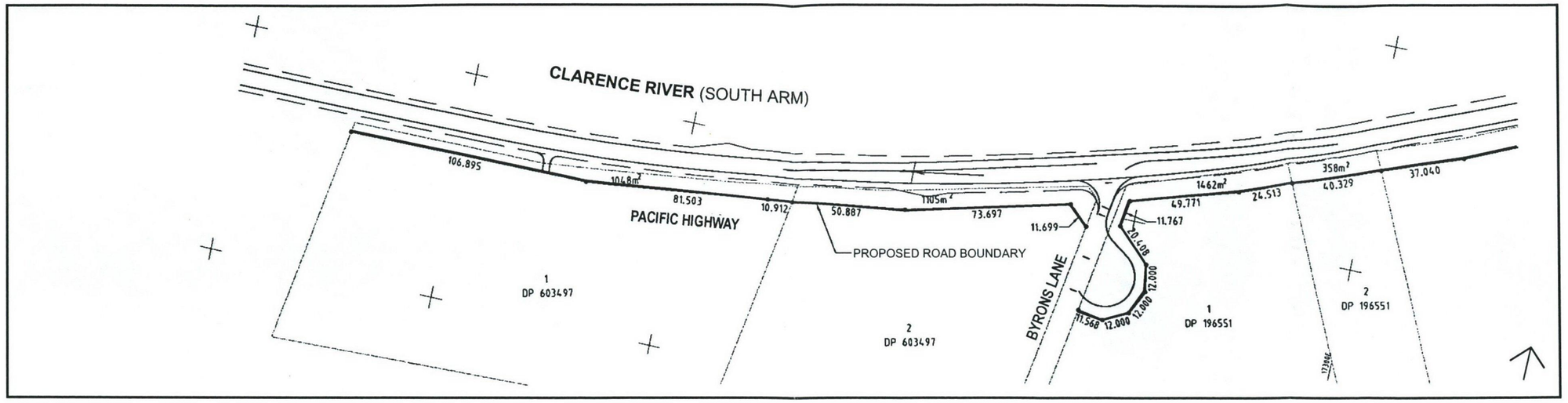
Public transport

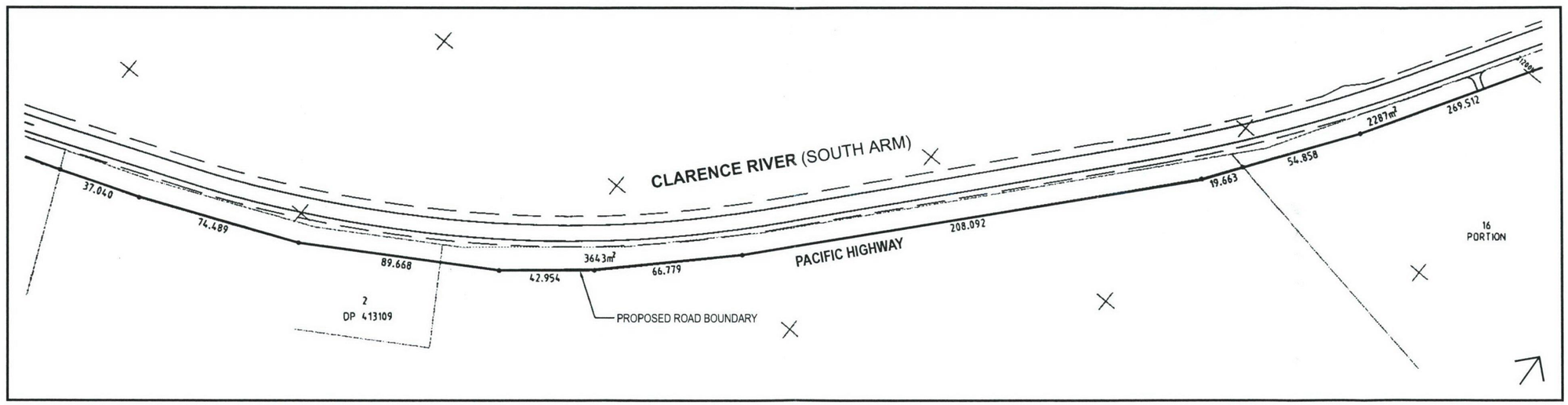
School buses currently stop at various points along the highway including Byron's Lane. The nature of bus services in the area results in buses generally stopping anywhere required to pick up passengers rather than solely at established bus stops. The proposed upgrade of the highway would provide a permanent bus stop and turn-around off the main road in Byrons Lane.

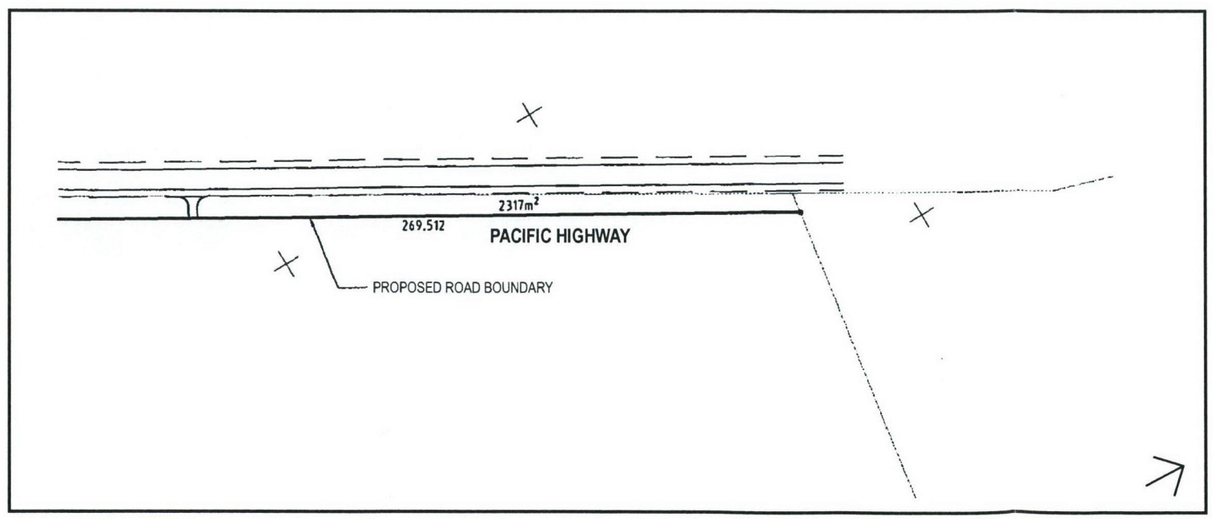
7.3.11 Indigenous cultural heritage

The Byrons Lane section of the proposed upgrade is confined to the low levee bank of the Clarence River. The original forest cover has been almost completely cleared and the land surface disturbed by road works and cane cultivation. The riparian areas are occasionally inundated by floods. An assessment was undertaken of the possible indigenous artefacts and features which could occur at the construction site.

Draft copies of the Indigenous Cultural Heritage Report (as it appears in Appendix C), were presented to the Yaegl LALC and to the RTA for review, and their preliminary comments were taken into account in preparation of this report. At the time this REF was published, a letter from the Yaegl LALC stating their views on the







LEGEND

Existing property boundary

Proposed acquisition boundary

0 50 100 m

Figure 7.3
PROPOSED PROPERTY ACQUISITIONS

BC7802.001 Rev 0
March 1998

findings of the assessment had not yet been received. However, a representative of the Yaegl LALC has provided verbal comment indicating they consider that the assessment adequately addresses cultural heritage issues. A summary of the assessment is provided below.

Stone artefact scatters

Very few sites have been reported from major rivers such as the Clarence River. None are reported for the study area, and any evidence which may have indicated that stone artefact scatters once existed there has been removed by floods, road building and cultivation.

Scarred trees

Trees in the area to be disturbed have been inspected, and no evidence of scarring was apparent.

Carved trees

Early writers reported the occurrence of carved trees in the Clarence Valley, but these do not appear to have survived, again none were apparent when inspected in the area to be disturbed.

Bora/ceremonial grounds and stone arrangements

Several bora grounds and stone arrangements are known from the Clarence Valley, but all are west of Grafton. It is extremely unlikely that these kinds of sites would be affected by the highway upgrade.

Summary

No archaeological constraints to the proposed construction works in the study area have been identified in this study. An archaeological field survey of the proposed construction site is not warranted.

7.3.12 Non-indigenous cultural heritage

A study of the area was undertaken, by Heritage Management Consultants, which involved:

- a review of historical and heritage literature;
- checking the Register of the National Estate;
- checking the national Trust Register;
- review of the Local Environment Plan status of the area with follow-up to the NSW Heritage Council;
- contact with the Maclean Shire Council.

The study identified no sites or structures of non-indigenous historic cultural significance within the southern section of the Byrons Lane to Shark Creek project area.

A full report of the detailed findings of this specialist investigation is presented in Appendix D of this report.

7.3.13 Landscape and visual issues

The existing river side verge has a guardrail separating the shoulder from the riparian vegetation, while the opposite side of the road has grassed batters. The upgrade will provide grassed batters to the side of the sealed verges on both sides of the road, and a guardrail on the river side sealed verge between chainages 32680 and the limit of the works at 33820.

The residential properties mostly have ornamental trees in the roadside gardens, though the property between chainages 32660 and 32700 has approximately twenty mature eucalypts against its front fence. Many of these trees will be removed and replaced by grassed areas within the road boundary. However, there will be very little change in the visual amenity of the Byrons Lane section following the upgrade, as the riparian vegetation will be undisturbed and the garden trees are not numerous.

7.3.14 Noise and vibration issues

Kinhill commissioned a specialist Subconsultant, Kamst and Simpson Pty Ltd, to undertake an assessment of the noise and vibration issues associated with the proposed upgrade. Their report has been included as Appendix E.

Existing noise environment

For the purposes of investigating noise and vibration impacts, the effects of the upgrade at four houses along the route have been considered. Those four houses are located at:

- chainage 32600 (Simpson residence)
- chainage 32800 (McGrath residence)
- chainage 33300 (Forrester residence)
- chainage 33600 (Moloney residence).

The firth residence at the southern end of the work, chainage 32460, will be addressed in a subsequent RTA study.

The background noise (L_{90}) levels for the subject residences within the study area are based on noise measurements carried out at representative locations within the Byrons Lane to Shark Creek area. The estimated L_{90} for the four residences is 46 dB(A).

Construction noise criteria

RTA has undertaken to comply, where possible, with the New South Wales Environmental Protection Agency (EPA) 'Environmental Noise and Control Manual' details construction noise criteria in Chapter 171.

The recommended construction noise criteria are:

- *For a construction period of four weeks or less:* The L_{10} level (i.e. the noise level exceeded 10% of the time) measured over a period of not less than fifteen minutes when the construction site is in operation, must not exceed the background level by more than 20 dB(A). (The background noise level is commonly taken to be the L_{90}—the noise level exceeded 90% of the time.)
- *For a construction period greater than four weeks and not exceeding twenty-six weeks:* The L_{10} level measured over a period of not less than fifteen minutes when the construction site is in operation, must not exceed the background level by more than 10 dB(A).

Traffic noise criteria

The RTA advised Kinhill that the Pacific Highway upgrade in the study area falls within the 'Upgraded existing Freeway/Arterial road' development type. For this classification, the EPA draft environmental criteria states the following noise limits:

Day L_{eq}(15 hour) (7.00 am to 10.00 pm) 60 dB(A)

Night L_{eq}(9 hour) (10.00 pm to 7.00 am) 55 dB(A).

For the same classification, the RTA draft criteria also state under the heading 'Where Criteria Are Already Exceeded', the following:

> It is highly desirable that there is no increase to existing noise levels in these cases.
>
> Where feasible, noise levels from existing roads should be reduced to meet the noise criteria. In many instances, this may only be achievable through long term strategies such as improved planning, design and construction for adjoining land use developments, reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles, greater use of public transport and alternate methods of freight haulage.

Vibration criterion

The RTA advise that the relevant operational vibration criterion is 2 mm/s at sensitive locations adjacent to the proposed Pacific Highway redevelopment. Ground vibrations are not considered to be of any consequence from modern highways, and have not been considered in this study.

Potential impacts

Noise and vibration issues associated with the implementation of the proposal can be considered in two distinct phases, the construction phase and the operational phase.

Construction phase

The noise levels have been estimated for the use of major construction equipment. The maximum noise level and L_{10} noise level arising from each of the modelling cases has been predicted for each of the affected residences. Blasting will not occur for the proposed upgrade, and has not been considered in this assessment.

The noise levels were calculated form an environmental noise model set up for the entire route. The noise model included attenuations associated with distance attenuation, ground effects and air absorption.

Table 7.5 Maximum noise level and estimated L_{10} noise levels due to construction noise in dB(A)

Location	Location description	Distance to highway from residence (m)	Construction noise guideline * L_{10} dB(A)	Estimated noise	
				Maximum dB(A)	L_{10} dB(A)
S1	Moloney residence	20	56	80	70
S2	Forrester residence	15	56	82	72
S3	McGrath residence	30	56	76	66
S4	Simpson residence	35	56	75	65

* *The construction noise guidelines contained in this table are based on a sixteen week construction period.*

Table 7.5 shows that the construction activity may be intrusive to the residents located close to the operations, and that the predicted noise levels from construction may exceed the recommended levels.

A comparison of the predicted construction noise levels with the predicted existing L_{10} (18 hour) road traffic noise levels at each residence, indicates that the construction noise would be similar to the noise levels at these residences, due to traffic travelling along the Pacific Highway.

As no blasting would occur during the construction phase, the activities likely to give rise to vibrations are the use of vibrating rollers and heavy equipment. None of the structures within the study area would be particularly sensitive to the level of vibration expected.

Operational phase

A three dimensional digital terrain model was used to predict the road traffic noise levels at the four sensitive locations during the operation of the proposal. Appendix E contains the detailed description and the results of the modelling. Appendix E also contains the predicted noise contours.

The predicted road traffic noise levels (are included in Table 7.6), and have been calculated for the following:

- 1999 prior to the highway upgrade
- 1999 after the highway upgrade
- 2009, ten years after the highway upgrade.

Table 7.6 also contains the following calculated differences:

- The difference in the predicted road traffic noise level for 1999 before and after roadworks.
- The differences in the predicted 2009 road traffic noise levels with the predicted 1999 levels before the roadworks.

- The difference in the predicted 2009 road traffic noise levels and the road traffic noise criteria.

The predicted road traffic noise levels for 1999, prior to the highway upgrade, at the four residences within the study area, all exceed the recommended RTA criteria of L_{eq}(15 hour)60 dB(A) and L_{eq}(9 hour) 55 dB(A), by up to 9 dB(A).

The predicted road traffic noise level for 1999, after the highway upgrade, remains the same (i.e. 0 dB(A) change) at the Moloney and Simpson residences. However, the predicted road traffic noise level at the Forrester and McGrath residences will be increased by approximately 2 dB(A). The increase in noise level at these residences is because the highway will be located approximately 6 m closer after the upgrade.

The predicted road traffic noise levels for the year 2009, ten years after the upgrade, are 10 dB(A) above the strict RTA L_{eq}(15 hour) 60 dB(A) and L_{eq}(9 hour) 55 dB(A) criteria at the Moloney, McGrath and Simpson residences, and 13 dB(A) above the criteria at the Forrester residence.

In cases where the strict RTA criteria is already exceeded, as is the case with this project, the desirable RTA criteria is to have no increase in noise levels. Thus, the predicted 2009 road traffic noise levels would be 2 dB(A) to 4 dB(A) above the 1999 road traffic noise levels prior to the upgrade.

With regard to operational phase vibration, the recommended criterion of 2 mm/s should be met at all residences adjacent to the highway redevelopment.

Mitigation measures

Construction phase

It is inherently difficult to provide effective noise attenuation measures during the construction phase, and it is therefore proposed to mitigate potential noise impacts by limiting the hours of construction and minimising the amount of noise generated. It may also be possible to construct noise attenuation barriers early in the construction phase at the affected locations.

It is recommended that the following measures are implemented during the construction phase, to minimise possible noise nuisance at adjacent noise sensitive locations:

- Hours of construction:
  - Monday to Friday—7.00 a.m. to 6.00 p.m.
  - Saturday—7.00 a.m. to 1.00 p.m. However, if construction is audible at residential premises, then recommended hours are .00 a.m. to 1.00 p.m.
  - Sunday—No construction work to take place on Sundays and public holidays.
- Road traffic noise attenuation earth mounds, and/or barriers could be built in the first stages of construction, if practical to do so, to assist in ameliorating the construction noise to these sensitive locations.
- Use of high efficiency mufflers on all construction equipment.
- Construction equipment should be well maintained.

Table 7.6 Predicted road traffic noise levels at sensitive locations for Year 1999 prior to upgrade; Year 1999 post-upgrade; and Year 2009 ten years after upgrade

Residence	1999 road traffic noise levels before roadworks dB(A)		1999 road traffic noise levels after roadworks dB(A)		2009 road traffic noise levels dB(A)		Difference in dB(A) (L_{eq} 9 and 15 hour)		
	L_{eq} (15 hour dB(A)	Leq (9 hour) dB(A)	L_{eq} (15 hour dB(A)	Leq (9 hour) dB(A)	L_{eq} (15 hour dB(A)	Leq (9 hour) dB(A)	1999 (after works)—1999 (before works)	2009 (after works)—1999 (before works)	2009 criteria
S1—Moloney	68	63	68	63	70	65	0	+2	+10
S2—Forrester	69	64	71	66	73	68	+2	+4	+13
S3—McGrath	67	62	69	64	70	65	+2	+3	+10
S4—Simpson	68	63	68	63	70	65	0	+2	+10

- The construction depot should be away from residences.

Operational phase

As discussed above, the recommended RTA road traffic noise criteria were predicted to be exceeded at all four of the noise sensitive locations adjacent to the proposed Pacific Highway upgrade.

It is unlikely to be feasible to reduce the road traffic noise levels at the residences within the study area to the RTA criteria with barriers, due to extensive size of barriers that would be required. The barriers would be high and long, and out of keeping with the environment. However, it may be more feasible to reduce the predicted road traffic noise levels for 2009, to meet the predicted road traffic noise levels for 1999, prior to the road upgrade, in line with the RTA statement—'Where Criteria are already exceeded'.

The different methods of ameliorating the predicted road traffic noise to acceptable levels are by a combination of noise barriers located between the road and residence, the application of open graded asphalt road surface, and the acoustic treatment of buildings.

For aesthetic purposes in this mainly rural environment, it may be preferable to construct barriers from earth mounding.

The road traffic noise predictions have been based on the application of dense graded asphalt. If a chip seal were to be used, the predicted road traffic noise levels may increase by another 3 dB(A). However, the use of open graded asphalt may reduce the predicted road traffic noise by approximately 3 dB(A), and therefore the barrier height and length could be reduced.

Alternatively, acoustic treatment of the residential buildings may be considered to reduce the road traffic noise to acceptable internal noise level.

For reasons other than road traffic noise, the Forrester residence may be relocated further back on their property at a greater distance from the highway. This would be effective in reducing the road traffic noise at this residence. It is recommended that the Forrester residence be relocated at least 25 m from the highway upgrade, to meet the 1999 (prior to construction) predicted noise level.

It is recommended that discussions be held with the residents of the affected properties, and a benefit cost analysis be undertaken, to determine the most acceptable methods for noise mitigation.

7.3.15 Preliminary contaminated site assessment

Agricultural chemicals have been used in the area of the upgrade; however, the potential for soil contamination within the proposed corridor is not considered to represent a significant risk to the environment or to human health and safety. The study area is considered suitable for its proposed land use, from a contaminated site perspective.

7.3.16 Road user benefit cost analysis

The benefit cost analysis evaluated the upgrading of approximately 1 km of road from 9 m seal width with poor pavement condition, to a 12 m seal width of good condition. RTA's SIMCBA process has been used for the analysis. A project yielding a benefit cost ratio of one is considered marginally satisfactory from an economic point of view. The higher the ratio, the more beneficial is the project as measured in terms of the community's economic welfare.

Construction costs of the project were assumed to be $1.5 million. RTA's traffic data indicates that daily traffic (AADT) was approximately 7200 in 1995 (taking the midpoint of AADT estimates between stations 04.023 and 04.400. The linear growth between 1986 and 1995 was 7.9% per annum. Based on these parameters, 1998 AADT of 8218 vehicles per day was assumed. The analysis uses a ratio of light to heavy vehicles of 88:12. Because the current pavement appears to be in poor condition, an allowance has been made in the base case for rehabilitation works in year 1 of $400,000. This expenditure would not be incurred in the project case, reducing project case net capital costs to $1.1 m. A 7% real discount rate and a thirty year project life have been used. Based on these assumptions, the project would yield the following results:

- Benefit cost ratio 2.3
- Net present value $1.666 million.

First year benefits of the upgrading are estimated as follows:

- User vehicle operating cost savings $0.115 million
- User travel time savings $0.0
- Accident cost savings $0.009 million.

7.4 CUMULATIVE ENVIRONMENTAL EFFECTS

Past experience has shown that a number of small environmental impacts, which individually could be considered negligible, may combine to cause a significant adverse impact. This may occur as the result of synergistic effects associated with the proposal on a local scale, or could be the result of the interaction between the proposal and other developments on a wider, regional scale. This section considers the potential for cumulative effects resulting from the proposed highway upgrade.

7.4.1 Regional issues

The proposed upgrade forms an important link in the upgrade of the Pacific Highway. The existing section of the highway in the vicinity of Byrons Lane has a significantly lower standard condition than sections of highway to the north and south, and is inadequate for current and future use by local or long distance traffic.

The proposed upgrade is compatible with both the North Coast Regional Environmental Plan and the North Coast Road Strategy. The regional cumulative effects of the upgrade would be to improve the efficiency of road transport, reduce

costs to the community from traffic accidents, and contribute to regional economic development.

The regional studies noted above have acknowledged that improving the Pacific Highway is likely to influence regional transport patterns, such as the competitiveness of road transport with other forms of transport, and development patterns through improved accessibility. The Byrons Lane upgrade proposal is located in a rural area and would only contribute to these impacts as part of the wider Pacific Highway upgrade.

7.4.2 Local issues

The community

While there would be individual effects on the local community, such as increased traffic noise at houses, the removal or relocation of some dwellings, the cumulative effects on local well being, transport and development are unlikely to be significant. There would, however, be beneficial impacts for the local community from improvements to traffic efficiency and safety.

The natural environment

The land to be taken up in the widening of the highway comprises cane land and residential blocks. The few eucalypt trees and garden ornamental trees which would be removed are not part of an extended habitat network, and their absence is unlikely to have a flow-on effect to other nearby habitats. By avoiding disturbance to the riparian zone, the upgrade would not provide additional stress to the flora and fauna communities there.

Other environmental values (such as water and air quality) are also unlikely to have effects which could contribute to an escalating impact on the local environment.

8 Summary of key issues

8.1 MAJOR BENEFITS

The major benefits which would result from the proposed upgrade of the Byrons Lane section of the Pacific Highway would be improved safety and traffic efficiency with associated benefits to the community. In addition, the proposed upgrade would be a necessary link in the Pacific Highway Upgrade, and would be compatible with the North Coast REP and North Coast Road Strategy.

More specifically, the major benefits provided by the proposed would be:

Traffic

- Improved traffic efficiency
- Reduced accident rate
- Removal of a restriction on the Pacific Highway
- Compatibility with the highway standards to the north and south.

Community

- Improved local access
- Improved pedestrian and cyclist safety
- Economic benefits during construction of the proposal.

Planning

- Compatibility with the North Coast REP and North Coast Road Strategy
- Efficient land use.

Noise

- Reduced noise associated with acceleration and deceleration of heavy vehicles.

8.2 MAJOR ADVERSE EFFECTS

It is rare that a major road widening project can be said to have as few potential adverse effects as that proposed for the southern section of the Byrons Lane to Sharks Creek project. As noted above, the proposal is unlikely to have significant impacts to flora and fauna; possible dust nuisance can be controlled by water spraying; and no water courses, culverts or drains are crossed by the proposed earthworks. The

potential adverse impacts can all be minimised, through appropriate control measures, so that the benefits significantly outweigh them. The potential adverse impacts include:

Noise

- Construction related noise effects at four residences
- Immediate increase in road traffic noise at two houses, at chainages 32800 and 33300.
- Predicted increase in road traffic noise at all four residences by 2009.

Land use

- Acquisition of a small area of residential and cane land.

Vegetation

- Removal of a small stand of Red Gums.

As discussed in another section of this report, the mitigation measures to be implemented would reduce the potential impacts described above to the point where no significant reduction of the amenity or environmental values of the Byrons Lane area would be expected.

9 Summary of proposed safeguards

This section presents a summary of mitigation measures to reduce environmental impacts to acceptable levels. It has been structured to reflect the three major stages of the proposal, which are pre-construction, construction and operation.

9.1 PRE-CONSTRUCTION PHASE

Mitigation measures to be included in the planing and design of the proposal are described below. Measures which relate to route selection and concept design have already been implemented.

Planning

- Complete and 'determine' REF
- Prepare Environmental Management Plan (EMP).

Soil and erosion control

- Designs have conservatively set most batters at 1V:4H, with a maximum slope in some locations of 1V:2H.
- Implement sediment runoff controls , such as sediment fences and grass strips.
- Refine design to avoid disturbance to riparian zone and river bank.

Climate

- Schedule major earthworks for low rainfall periods (between April and December) where possible.

Vegetation

- Design landscaping to provide erosion, water quality and fauna impact mitigation.
- Develop design to retain riparian vegetation.

Socio-economic issues

- Provide bus stop in upgrade design
- Provide for local access requirements in upgrade intersection design.

Landscape and visual considerations

- Design landscaping to address safety, visual amenity and erosion control.

Noise and vibration

- Carry out community consultation to develop road traffic noise mitigation measures.

9.2 CONSTRUCTION PHASE

Mitigation measures to be implemented during construction of the proposal follow.

Traffic

- Implement traffic management plan in accordance with RTA's Traffic Control Manual;
- Locate construction compound and stockpile areas to minimise traffic and noise impacts.

Waste management

- Reuse cleared vegetation for milling, chipping, or fire wood wherever possible and dispose of remainder by pit burning.
- Collect and dispose of all construction packaging and debris.
- Provide appropriate waste water collection and treatment systems for ablutions facilities.
- Storage of dangerous good including fuels, oils, greases etc within bunds in the construction compound, and according to Australian Standards and manufacturer's specifications.

Soil and erosion

- Minimise area of disturbance and undertake clearing/disturbance progressively in line with construction requirements.
- Strip and stockpile topsoil from areas to be disturbed for reuse in landscaping.
- Install temporary sedimentation control structures in line with construction.
- Stabilise disturbed areas progressively with rapid grass cover as soon as is practicable after construction related disturbances are completed in that area.

Air quality

- Construction related dust would be controlled by road watering, enforcing speed limits within the construction site and appropriate location of stockpile areas.

Water quality

- Refer to 'soil and erosion and 'waste management' measures.

Vegetation

- Keep topsoil from areas where weed plant species are present separate from topsoil without weeds. Reuse topsoil with weeds in the area it came from.
- Apply the above principle to vegetation chipped for mulching.
- Control weeds in stockpiled topsoil.
- Refer also to 'Waste Management'.
- Use locally endemic native species in landscaping.

Fauna

- Inspect red gums or other mature trees for fauna before felling.

Indigenous cultural heritage

- In the event that any artefacts are uncovered during construction, work would cease in the area, and the find would be reported to the NPWS and the Yaegl Aboriginal Land Council.

Landscape and visual considerations

- Refer also to 'Soil and erosion', 'Water quality', and 'Vegetation' measures
- Landscape disturbed areas progressively as soon as is practicable after construction activities are complied in that area.

Noise and vibration effects

- Limit noise generating construction activity to within the hours defined in Section 7.3.14.
- Use high efficiency mufflers on construction machinery and ensure that machinery is well maintained.
- Maintain haul roads and enforce speed limits.
- Where appropriate, road traffic noise attenuation measures would be constructed early in the construction program.
- Construct road noise attenuation measures (details finished following community consultation and detailed design).

9.3 OPERATIONAL PHASE

There would also be mitigation measures implemented during the operation of the proposal. These would primarily be maintenance requirements.

Waste management

- Routinely collect litter from road verges.

Soil and erosion

- Routinely inspect shoulders and batter slopes for signs of erosion, and effect any necessary rehabilitation promptly.

Vegetation

- Control weed species in landscaped areas by their removal or spot application of herbicide.

Noise and vibration

- Relocate the house at chainage 33300 at least 25 m from the highway upgrade
- Undertake noise reduction measures at three other residences, details to be decided following community consultation and detailed design.

Landscaping and visual considerations

- Water and maintain landscaped areas during stabilisation period
- Replace failed plants or landscaped areas as required.

Implementation process

The measures proposed to mitigate potential impacts associated with the proposal would be included in a Project Environmental Management Plan (EMP) prepared specifically for the Byrons Lane to Shark Creek Upgrade Project. This EMP is included as a subsequent section of this document.

Many of the measures proposed are already standard RTA requirements and are included in the RTA's policies and procedures, or in their standard specifications for road construction.

The RTA's Project Manager would be required to develop and implement an Environmental Control Plan (ECP) prior to commencing work on site,. This ECP would be a site specific description of how the Project Manager proposes to implement his environmental management and monitoring responsibilities within the context of the construction activities required. In this manner, the mitigation measures identified in this REF as being necessary, would be developed and would become features of the detailed design of the upgrade.

10 Clause 82 Checklist

This section contains a checklist which has been structured according to the factors listed in Clause 82 of the EP&A Regulation, 1994. It has been developed to ensure that adequate information has been provided on the likely environmental impacts of the proposal.

Each factor from Clause 82 has been presented, together with a brief summary of the impacts of the proposal.

a) Any environmental impact on a community

The most noticeable impacts on the Byrons Lane community would be increased noise during construction and operation of the widened highway. Road traffic noise during operation would increase for four residences. One house is to be relocated at a suitable distance away from the highway to mitigate the increase in traffic noise. The other three residences will have noise reduction measures following consultation and agreement on suitable methods.

The acquisition of small areas of four private properties and adjacent cane land would be required, and one residence would have changed access to the Highway during the operation of the proposal.

The community would experience a number of benefits, including improved safety when using or accessing the highway from Byrons Lane, reduced community cost from accidents, and flow on economic benefits during the construction of the proposal.

b) Any transformation of a locality

The proposed alignment follows and widens the existing Pacific Highway. No cuts or bridges would be required. The character of the upgrade would remain similar to the existing section of highway from the driver's perspective.

c) Any environmental impact on the ecosystems of the locality

The impacts on local ecosystems would be:

- loss of a small stand of mature eucalypts
- potential risk of localised increased turbidity in the Clarence River following rainfall runoff during construction and stabilisation.

d) Any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality

The construction and operation of the proposal would not have any significant impact on the environmental, scientific or recreational values of the area.

e) Any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future federations.

The proposal would not have any significant effect on any place, structure or artefact of significance to either indigenous or non-indigenous cultural heritage.

f) Any impact on the habitat of protected or endangered fauna

The proposal would not have a significant impact on the habitat of any protected or endangered fauna.

g) Any endangering of any species of animal, plant or other from of life, whether living on land, in water or in air

The implementation of the proposal would not endanger any species of plant or animal.

h) Any long term effects on the environment

There would be changes to the road traffic noise characteristics of the areas immediately adjacent to the alignment. As widening is to be undertaken only on the side of the highway away from the river, there are not expected to be any noise related impacts to fauna communities in the riparian zone. Noise impacts to four residences will be mitigated by undertaking noise reduction measures.

i) Any degradation of the quality of the environment

There would be no significant degradation of the wider area or the environment in the vicinity of the proposed upgrade.

j) Any risk to the safety of the environment

During the construction of the proposed upgrade, there would be a low risk that hazardous substances, such as fuels or oils could be accidentally spilled and enter the Clarence River. This risk would be minimised by storing and handling these substances within bunded areas.

During the operation of the upgrade, there would be a low risk of the spillage of hazardous substances from a heavy vehicle involved in an accident. The probability of this occurring, and the magnitude of impacts likely to result would be reduced when compared with the existing section of the highway. This reduction in risk would be achieved by improving the width and safety of this section of highway, and therefore reducing the probability of an accident occurring;

k) Any reduction in the range of beneficial uses of the environment

There would be no reduction in beneficial uses of the environment.

l) Any pollution of the environment

Issues associated with the potential for pollution of the environment are discussed in (j) above. Provided that the proposed mitigation measures are effectively implemented, it is unlikely that there would be any significant pollution of the environment.

m) Any environmental problems associated with the disposal of waste

No environmental problems associated with the disposal of wastes are expected, provided that the management measures described in this REF are effectively implemented.

The amount of waste vegetation to be disposed of following roadside clearing is very small and would be minimised by recovering millable timber, donating or selling non-millable timber for fire wood, chipping vegetation for mulch and disposing of the remainder by pit burning.

Construction debris and packaging would be collected in covered bins and disposed of at an approved landfill. Wastewater and sewage would be collected and treated via an approved on-site treatment and disposal system or disposed of off-site via an approved method.

n) Any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply

No demand would be placed on resources which are in short supply.

o) Any cumulative environmental effect with other existing or likely future activities

Cumulative environmental effects have been discussed in Section 7.4. No cumulative effects are expected which would have any significant adverse effect on the environmental values of the Byrons Lane area.

APPENDIX A

FAUNA ASSESSMENT

Appendix A

Fauna assessment

FAUNA AND FLORA ASSESSMENTS

Flora and fauna investigations were conducted to allow an assessment of potential impacts on threatened species, populations or ecological communities or their habitats (in accordance with Section 5A of the EP&A Act) by addressing the 'eight part test' contained therein. The assessment of the faunal values of the site was conducted by Kinhill, while the flora values were assessed by the specialist Subconsultant Landscape, Assessment, Management and Rehabilitation Pty Ltd (see Appendix B).

VERTEBRATE FAUNA AND HABITAT VALUES

Background

The highly altered and degraded nature of the environment subject to disturbance from the proposed highway upgrade, suggests that the area would not support a high diversity of fauna species. Briefly, the highway upgrade entails a widening of the existing highway and would encroach predominantly on land presently supporting intensive sugar cane production. Loss of native flora species, and therefore potential habitat for native fauna species, is thus restricted to several mature Forest Red Gums (*Eucalyptus tereticornis*). No remnant or riparian vegetation would be cleared as a result of the proposed highway upgrade.

Methodology

The methodology employed to determine the impact on native fauna species employed reviews of relevant literature and a two day site inspection by an ecologist. The review of relevant literature included information sources such as the NSW NPWS Wildlife Atlas database, Royal Australasian Ornithologists Union database and relevant scientific publications (e.g. Vertebrates of Upper North east New South Wales 1995).

The review of the vertebrate fauna species recorded on the wildlife databases encompassed an 11 x 11 km square block centred on the township of Tynedale. This review identified the presence of five threatened species (as per the Threatened Species Conservation Act 1995). The species recorded are the Black-necked Stork, Square-tailed Kite, Osprey, Brolga and Brush-tailed Phascogale. Appendix ?? lists each of the threatened and common fauna species recorded within the surveyed area.

The two day site inspection assessed the existing habitats to be disturbed by the proposal and determined the impact that the loss of this habitat may have on threatened species previously recorded from the wider region. Those mature eucalypt trees that would require felling were intensely surveyed (by means of binoculars) for raptor nest sites and hollows. Proximity to wetlands and pastoral lands that may support the Black-necked Stork and Brolga was assessed, as was the proximity to eucalypt forests that could potentially support the Brush-tailed Phascogale. Furthermore, inspections of mature trees within the immediate vicinity of the proposal (and particularly along nearby watercourse) were undertaken in an attempt to locate Osprey nests.

The heavily degraded nature of the land subject to disturbance as a result of the highway upgrade (i.e. the predominance of intense sugarcane fields), and the lack of mature, remnant or riparian vegetation to be impacted, suggested that detailed methodologies to sample fauna species was not necessary or appropriate.

Results

The degraded nature of the habitats associated with the proposed highway upgrade, the minimal clearing of vegetation to accommodate the overtaking lane, and the habitat preferences of the threatened species identified within the wider area, suggests that no threatened fauna species would be impacted as a consequence of the proposed works.

The site assessment of the area determined that sugarcane land and several isolated Forest Red Gums only, would be impacted by this proposal. Inspections of those Forest Red Gums, and nearby riparian habitats, did not reveal the presence of any raptor nests, nor hollow-bearing limbs suitable for use by common birds or insectivorous bats (no threatened bat species have previously been recorded from the wider area).

A brief background to the habitat requirements of each of the threatened species, together with an assessment of the potential impacts associated with the proposed upgrade, is provided below.

Black-necked Stork (*Ephiopiorhynchus asiaticus*)

The Black-necked Stork, or Jabiru[1], is listed as 'vulnerable' in the Threatened Species Conservation Act 1995. Recent amendments to this Act have now recognised this species as being Endangered. The geographical distribution of this species within Australia is along the north coast of Australia and along the east coast from the tip of Queensland, through NSW and almost into Victoria. Individuals of the species forage in river pools, swamps and intertidal flats where their main diet is fish, but they also eat reptiles, frogs, crabs and rodents. These are not social birds and are usually seen alone or in loose pairs.

Individuals of this species may occasionally forage within suitable habitats along the fringes of the Clarence River or within swamp land to the east of the proposed upgrade (approximately 1 km to the east). No preferred habitat for this species would be impacted by the proposed highway upgrade and individuals of this species would not be adversely impacted as a result of the proposed works.

Square-tailed Kite (*Lophoictinia isura*)

The Square-tailed Kite is scheduled as 'vulnerable' under the *Threatened Species Conservation Act 1995*. This species is sparsely distributed in open eucalypt forests, woodlands and sand plains of the coastal and subcoastal mainland. Individuals of the species predominantly prey on small birds, insects and reptiles (nestlings of honeyeaters are common prey). The birds are generally nomadic, and may be solitary or in well dispersed pairs. The habitats within the immediate vicinity of the proposed works support highly degraded cane lands with very few mature eucalypts. No preferred habitat of this species would be impacted as a result of the proposal.

Osprey (*Pandion haliaetus*)

The Osprey is scheduled as 'vulnerable' under the *Threatened Species Conservation Act 1995*. Ospreys inhabit mangroves, rivers and estuaries, inshore seas and coastal islands. Individuals of this species patrol over water before they plunge, feet-first, into the water to capture fish. The size of the nest structure of Ospreys is large and clearing a tree that contains a nest would have significant impact on those individuals. Several mature eucalypts within the township of Tynedale would be felled to accommodate the proposed highway upgrade but no clearing of any riparian vegetation associated with the Clarence River would occur. Ospreys tend to nest in very close proximity to waterbodies and the trees to be felled within the township are approximately ?? km from the nearest waterbody the Clarence River. Searches of the trees to be felled, established that no Osprey nests are present within these trees, nor were nests present within the riparian vegetation of the Clarence River in the vicinity of the proposed works. Therefore, no adverse impact would be suffered by this species.

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[1] 'Jabiru' is a commonly popularised name of this bird in the mistaken belief that it is Aboriginal. The name is actually Portuguese from a South American word, and elsewhere is given to storks in South America and Africa.

Brolga (*Grus rubicunda*)

The Brolga is scheduled as 'vulnerable' under the Threatened Species Conservation Act 1995. This species has a coastal distribution along the northern and eastern coasts of Australia. During the breeding season (September to December) the Brolga is commonly observed in pairs or small groups, whereas outside the breeding season, Brolga's may be found in flocks of several hundred individuals. They commonly utilise open, shallow swamps, wetlands and pastoral lands of coastal and subcoastal tropical Australia where they feed on plant shoots, insects and small vertebrates.

Individuals of the species are unlikely to be found within those areas that support cane growing but may be found in areas that support shallow swamps (e.g. the swamps approximately 1 km from the proposed works). The lands within the immediate vicinity of the road proposal is dominated by sugarcane and therefore this species is unlikely to suffer adverse impacts as a consequence of the proposed works. Furthermore, the behaviour of individuals of this species is such that they would not be susceptible to road deaths as a result of the highway upgrade.

Brush-tailed Phascogale (*Phascogale tapoatafa*)

The Brush-tailed Phascogale is listed as 'vulnerable' under the Threatened Species Conservation Act 1995. Individuals of this species inhabit dry sclerophyll forests and open woodlands that contain hollow-bearing trees. This species occupies relatively large home ranges (females 20-70 ha and males 40-140 ha) and individuals may use more than 20 nests in a single year. The dominance of sugarcane within the area of the proposed works would almost certainly preclude this species from the vicinity of the proposed works. Suitable forested habitat occurs approximately 1 km to the west of the proposed works in the Woodford State Forest. As such, this species would not be impacted by the proposed highway upgrade.

COMPLIANCE WITH SECTION 5A OF THE EP&A ACT (AMENDED 1995) - THE EIGHT PART TEST

It is a requirement to address the 'eight part test' for the significance of impacts under Section 5A of the EPA Act (amended 1995). This test is analogous to the now repealed 'seven point test' under Section 4A of the *Environmental Planning and Assessment Act 1979*. This section addresses that requirement.

A total of five threatened species have previously been recorded within a 20 km by 20 km square block centred on the township of Tynedale (NSW NPWS Wildlife Atlas databases). The preferred habitat of each of the five threatened species and the extent of that habitat within the subject land for each species were assessed. Following this assessment, it is noted that none of the threatened species would be directly impacted as a consequence of the proposed highway upgrade. Nevertheless, for completeness, each of these species are addressed, where relevant, within the following 8 part test.

No threatened flora species were recorded within or adjacent to the proposed works.

(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.

A brief description of the life cycle of each of the five threatened fauna species is provided in Section ?? of this report. Sugarcane land and several mature eucalypt trees only would be disturbed as a result of this proposal. Those eucalypt trees to be felled were searched thoroughly for the presence of raptor nests (for the Osprey and Square-tailed Kite) and for the presence of hollows. No such nests or hollows were observed. The proposal is not considered to impact on preferred or even suitable breeding, nesting or feeding habitat of any of the five threatened species.

A flora survey of the corridor of interest failed to find any plant species listed as endangered or vulnerable under the *Threatened Species Conservation Act 1995*. The proposal would therefore have no effect on threatened plant species.

(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.

Amendments to the *Threatened Species Conservation Act 1995*, list eight endangered populations. None of these populations inhabit areas within the wider region of the proposed highway upgrade.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.

The proposed highway upgrade follows the existing alignment of the highway. No riparian vegetation or eucalypt woodland associated with the Clarence River would require clearing. Only ecologically degraded lands on the highway verge, residential gardens or that presently support cane production would be impacted. Therefore, no significant area of known habitat is to be modified or removed by this proposal.

(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 or ecological community.

The proposed works involves an upgrade of the existing highway along the same alignment. This area presently supports either degraded roadside vegetation or sugarcane. As such, no habitat areas would become isolated as a result of this project. Neither is the study area part of any connecting corridor between areas of significant habitat.

(e) Whether critical habitat will be affected.

This question cannot be answered at present because there has been no declaration of critical habitat areas under the *Threatened Species Conservation Act 1995*. However, clearing of sugar cane land and a few mature trees only would be required and therefore no areas of habitat of significant conservation value for any of the threatened species previously recorded from the wider region would be impacted by the proposed highway upgrade.

(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.

No areas that are classed as "protected areas" occur within close proximity to the study area. However, several State Forests are nearby, namely Pine Brush State Forest, Woodford South State Forest and Southgate National Forest. These areas could potentially support those threatened species identified as occurring within the wider region, but no threatened species are likely to be found in the proposed construction area.

No threatened plant species were identified within the study area.

(g) Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.

The *Threatened Species Conservation Act 1995* defines 'threatening process' as '...a process that threatens, or may have the capacity to threaten, the survival or evolutionary development of species, populations or ecological communities. Therefore, habitat clearance and the introduction of weeds or feral species should receive appropriate consideration.

Only ecologically degraded lands, that presently support sugar cane or residential gardens, would be cleared to facilitate the proposed highway upgrade. This would not threaten any native fauna or flora species, or populations within the region. A landscaping programme following the construction work will avoid the introduction of weeds. No feral species would be introduced to the area as a result of the proposed upgrade.

(h) Whether any threatened species, population or ecological community is at the limit of its known distribution?

The recorded geographical distribution of each of the five threatened fauna species is such that the study area is not at the limit of any of their known distributions.

No threatened flora species were recorded within or directly adjacent to the study area.

APPENDIX B

FLORA ASSESSMENT

Appendix B
Flora assessment

BIOLOGICAL IMPACTS OF PROPOSED HIGHWAY WORKS

TYNEDALE NORTH

(BYRONS LANE TO SHARK CREEK)

FLORA STUDY

Landscape Assessment, Management and Rehabilitation Pty Ltd,

12/06/97

BACKGROUND

The Pacific Highway has gained a justified reputation as a highway with high accident rates resulting in considerable loss of life, injury and community cost. As a consequence, there have been a number of initiatives undertaken to address this issue. One component of the strategies developed is the assessment of a number of sites and sections of highway where road upgrading is currently being considered to alleviate some known or potentially dangerous portions of the Pacific Highway.

This study is one of four similar studies of sections of the Pacific Highway between Ballina and Grafton. This section of highway has been the scene of several highly publicised multiple fatalities in recent years. The focus of this study is to investigate the flora along the existing highway alignment and assess the likely impact of proposed highway improvement works in the designated study area.

No detailed surveys were available at the time of field inspections, but foot traverses of all remnant vegetation contiguous with the current highway and other vegetated areas were undertaken and determinations made of the flora of each site. Introduced flora dominated all sites, especially in rural/urban lands which consistently abutted the highway on at least one side.

DESCRIPTION OF STUDY SITE

The major feature of this site was the narrow riparian fringe which lay sandwiched between the current highway alignment and the major waterway of the Clarence River. Cultivated sugar cane lands with associated rural housing and other infrastructure abut the other side of the highway. The other side of this reach of the Clarence River (South Arm) is also primarily under cultivation for sugar cane with some dairying and grazing, but the regionally significant vegetation remnant of Woodford State Forest lies nearby. There is, however, no physical connectivity with this forested area.

Whilst the rural lands are dominated by introduced flora, either from deliberate plantings or weed flora established and proliferating from cultivation practices, the sliver of remnant native vegetation along the river reflects the past disturbance history. Natural disturbances such as floods were a major evolutionary influence on the substrate and the stability of the vegetation mosaic which established thereon. Artificial disturbance regimes now play a pivotal role in moulding the vegetation dynamics. A plethora of weed species occupy all regularly disturbed sites. In addition, several serious environmental weeds have invaded areas not exhibiting recent disturbance to either substrate or vegetation eg. *Anredera cordifolia.*

What is clear from even a cursory examination of the floristics of the study area (as detailed in Table B1) is the diversity of introduced flora within the area. Many of these are most abundant along the regularly maintained highway verge. This issue is dealt with in the management section below which is a proposal for alternative road verge management. Plates 1-3 clearly illustrate the problems of the remnant riparian vegetation with the dense infestations of weeds throughout the study area. These introduced species are preventing the regeneration of the remnant canopy (Plate 3), let alone allowing any natural regenerative processes to passively rehabilitate the most seriously degraded areas. Only active and on-going intervention is likely to reverse the degrading processes in this area.

NOTEWORTHY FLORA

It may have been the case that some ROTAP species may have occurred in the study area prior to it's development for sugar cane cultivation, but the restriction on the extent of the remnant vegetation has lessened the probability of their present occupancy of any of the thin vestiges of the former vegetation mosaic. Certainly, no ROTAP species were recorded during recent extensive foot traverses. As Table B1 indicates, a diversity of riparian rainforest and associated taxa remain in the area, but the degraded nature of the remnant vegetation and on-going threats diminish significantly the biotic values (for a flora perspective) of the study area. This vegetation type is now regionally rare and threatened and was never as extensive as some of the other rainforest formations of this region. Introduced flora management is the most critical issue pertaining to the long term viability and integrity of these communities.

There are some individual trees which are likely to be significant to the fauna locally and regionally. In particular, several specimens of *Ficus obliqua* and *F. macrophylla* occur along the road verges as indicated on the accompanying aerial photography. The majority of these would appear secure from acute disturbance associated with the proposed highway modification works. Two large individuals of *Ficus*

obliqua (Plate 4) may be in danger of removal for these works. Whilst there are other plants of this species in the vicinity, none of these approach the size of these trees (approx. 15 m tall and more than 20 m spread each). The impact of their potential loss will be considered subsequently.

IMPACTS OF PROPOSED WORKS

There would appear little justification on engineering, hydrological, and definitely not biotic grounds to further interfere with the riparian vegetation. Thus, it is assumed that all construction works will be placed to the landward side of the existing highway alignment. In all but a single instance will there will be no significant impact upon noteworthy native flora. Indeed, if more appropriate road verge management strategies were to be employed in the future, there exists the possibility that the weed flora's dominance of the zone between the road surface and the agricultural lands will be somewhat diminished in the intermediate time frame.

The most notable impact is that of the potential loss of the large *Ficus obliqua* as highlighted previously. These trees would, by their very size, have local cultural significance, and are a roadside landmark. The latter may be more significant than their regional biotic significance, but this is difficult to ascertain within the scope of this study. Should it be determined that their fruit resource be replaced in the landscape, then sizeable individuals need to be established to enhance the rate at which they will reach reproductive maturity and replace the fruit supply. It is also important that *Ficus obliqua* is utilised as the other common fig, *Ficus macrophylla*, has much larger fruits (Plate 5 compared to Plate 6). The frugivores which utilise the latter species require a much larger gape to consume the mature fruits. The results of the fauna studies may shed more light upon this issue.

CONCLUSIONS AND RECOMMENDATIONS

Site inspections revealed a distinct lack of natural biotic resources between the existing highway alignment and the cultivated sugar cane lands other than the two large remnant figs discussed below. Effectively, no noteworthy native flora in this area will be impacted in a detrimental manner by the proposed highway modification works.

The riparian vegetation, on the other hand, should be retained in it's entirety and it's long term viability and integrity enhanced via rehabilitation based future management strategies. This should primarily be directed towards introduced flora management undertaken conjointly with planting activities in the more seriously degraded sites.

With respect to the two large *Ficus obliqua* identified immediately adjacent to the current highway alignment, the preferred biological option would be their retention as a food resource for frugivores, particularly local avifauna. Community costs may outweigh their retention and it may be deemed necessary to instate works which would result in their removal. Transplanting is not recommended as the expense and uncertainty of such actions would be better directed to more efficacious rehabilitation of the riparian vegetation. The latter option is considered the most practical ecological outcome of the schemata assessed in this report.

ROADSIDE REMNANT VEGETATION MANAGEMENT (LAMR, 1996).

Road construction and verge management practices could be modified to further mitigate the impacts typically associated within instatement/modification of highways such as this through rural/natural landscapes. This would require a commitment to on-going monitoring and maintenance of such works. It is considered, however, that these practices will be more economically and ecologically beneficial to all sectors in the future and over the long term of relevance to natural processes and the component biota of this region.

Roads and powerlines are major linear corridors in remnant vegetation. Recent initiatives have incorporated structures to enhance the probable movement of fauna across these linear impediments to natural ecosystem function and process (Goosem, 1997; Goosem & Marsh, 1997). The facilitation of these mechanisms could be further enhanced with concurrent reduction in road verge management costs if some of the following proposals are deemed feasible in situations where such works are warranted to mitigate the impact of roads and other linear corridors.

Remnant canopy trees have obvious habitat value irregardless of their particular taxonomic status. They provide food and habitat resources to a wide range of fauna and are critical to survival and breeding success of many species. It is important to remember than they must be located in ecosystems where they are being replaced over biologically significant time frames. It is too late to plant a seedling or sapling once the canopy tree becomes moribund and collapses ecologically. There must be gradual replacement of these individuals. Thus, retention of large canopy trees is only a temporary ecological measure which will fail the biota for which it was retained if it is not replaced by similar structural and/or floristic elements in the natural landscape. Large fruit bearing trees eg. *Ficus* spp are excellent examples of important food and habitat resources which fall into this category.

Therefore, it is proposed to enhance the existing vegetation within the future road reserve by invoking environmental practices which will enable the regenerative potential of natural ecosystems to be realised in the long term. Caution during the construction phase when working in close proximity to remnant vegetation will ensure maximum vitality within these areas following completion of the roadworks. Education programs for operators of earthmoving equipment has proven highly successful in substantially larger scale engineering works associated with mining activities and major infrastructure developments in environmentally sensitive sites. Such a code of practice and environmental education program could be established uniformly for earthmoving contractors irregardless of the sensitivity of the landscapes in which they are conducting their activities.

Subsequent to construction, management activities can either threaten or enhance the viability of roadside vegetation and habitat. If extensive plantings and or community based regenerative programs are conducted concurrent with availability of scale appropriate earthmoving equipment, then reinstatement of some aspects of the former vegetation mosaic becomes a practical reality on almost a broad acre basis. It is either unlikely, or on an inappropriate time scale, that ROTAP species would establish without some form of active intervention to remove the artificial disturbance regimes and competitive effects of the introduced flora presently dominating sites and surrounding landscape. Once canopy closure is achieved and natural regeneration of the major structuring elements of the vegetation occurs, then maintenance and monitoring of weeds etc. is dramatically reduced along with other resource expensive issues.

Specifically, for current costly road verge maintenance practices, the establishment of canopy cover will reduce the requirement of predominantly herbicide based vegetation (particularly weed) management. This maintenance regime is costly in both economic and environmental terms. Bare soil surfaces which result from herbicide usage actually exacerbate the annual weed problem. Roadside verges Australia-wide bear stark testament to this fact. With a more stable, native perennial cover along road verges beneath a canopy, the weed species presently proliferating along roads would not have an available niche to occupy. Trials are urgently needed to confirm the broad scale efficacy of the few local examples of the economies produced by this ecologically based approach. The re-alignment of the Pacific Highway is a situation eminently suited to such trials and adoption of more efficient land use practices. Given the many thousands of hectares of land within road reserves, the alteration of current practices to better suited management strategies would be a highly significant outcome.

Table B1 List of taxa recorded from study area

Acacia aulacocarpa	Conyza parva *
Acacia leiocalyx	Coronopus didymus *
Acacia maidenii	Corymbia intermedia
Acacia melanoxylon	Crassocephalum crepidioides *
Acacia podalyriifolia *	Crinum pedunculatum
Acetosa sagittata *	Crotalaria lanceolata*
Adiantum aethiopicum	Crotalaria pallida *
Adiantum hispidulum	Crotalaria zanzabarica *
Ageratina adenophora *	Cryptocarya microneura
Ageratum houstonianum *	Cucumis melo *
Alphitonia excelsa	Cupaniopsis anacardioides
Ambrosia artemisiifolia *	Cynodon dactylon

Table B1 (continued)

Amyema cambagei	Cyperus gracilis
Amyema conspicuum	Cyperus iria
Anredera cordifolia *	Cyperus polystachyos
Aphananthe philippinensis	Cyperus rotundus *
Araujia hortorum *	Cyperus sesquiflorus *
Arytera divaricata	Desmodium intortum *
Asclepias curassavica *	Desmodium uncinatum *
Asparagus plumosus *	Digitaria didactyla *
Asparagus virgatus *	Dioscorea bulbifera *
Austrosteenisia blackii	Diplocyclos palmatus *
Avicennia marina	Dysoxylum mollissimum
Axonopus affinis *	Echinipogon caespitosum
Bidens pilosa *	Elaeocarpus obovatus
Brachiaria decumbens *	Eleusine indica *
Brachiaria mutica *	Eragrostis tenuifolia *
Brachychiton acerifolius	Eriobotrys japonica *
Breynia oblongifolia	Erythrina sykesii *
Callistemon viminalis	Eucalyptus microcorys
Calochlaena dubia	Eucalyptus tereticornis
Canna indica *	Euphorbia pulcherrima *
Cardiospermum halicacabum *	Ficus coronata
Castanospermum australe	Ficus macrophylla
Casuarina glauca	Galinsoga parviflora *
Cayratia eurynema	Gamochaeta spicata *
Celtis sinensis *	Geitonoplesium cymosum
Cerastium glomeratum *	Geranium solanderi
Chloris gayana *	Glochidion ferdinandi
Chloris virgata *	Glycine tabacina
Ciclospermum leptophyllum	Gomphocarpus physcocarpa *
Cinnamomum camphora *	Gomphrena celosioides *
Cirsium vulgare *	Guioa semiglauca
Citrus limonia *	Hibiscus diversifolius
Clerodendrum floribundum	Hibiscus tiliaceus
Commelina cyanea	Hippeastrum sp. (cultivated) *
Commersonia bartramia	Hypericum gramineum
Conyza bonariensis *	Hypochaeris microcephalus *
Hypochoeris radicata *	Passiflora subpeltata *
Imperata cylindrica	Pennisetum clandestinum *
Ipomoea cairica *	Pennisetum purpureum *
Ipomoea plebeia *	Phragmites australis
Ipomoea purpurea *	Phyllostachys aurea *
Jacaranda mimosifolia *	Physalis minima *
Jacksonia scoparia	Phytolacca octandra*
Jagera pseudorhus	Pittosporum undulatum
Juncus polyanthemus	Plantago lanceolata *

Table B1 (continued)

Kennedia rubicunda	Poa annua *
Lablab purpureus *	Prunus persica *
Lantana camara *	Prunus sp. *
Leersia hexandra	Psidium guajava *
Lepidium bonariense *	Pteridium esculentum
Ligustrum sinense *	Pterocaulon sphacelata
Ludwigia octovalvis *	Raphanus raphanistrum *
Macfadyena unguis-cati *	Rhodamnia rubescens
Maclura cochinchinensis	Richardia brasiliensis *
Macroptilium atropurpureum *	Ricinus communis *
Macroptilium lathyroides *	Rubiaceae red infl glossy lge opp lvs
Malaviscus arboreus *	Rubus moluccanus
Mallotus philippensis	Rumex brownii
Malvastrum americanum *	Rumex crispus *
Mangifera indica *	Saccharum officinarum *
Medicago sativa *	Salvia coccinea *
Melaleuca quinquenervia	Sanseveria trifasciata *
Melinus repens *	Senecio lautus
Monstera deliciosa *	Senna didymobotrya *
Morus alba *	Senna pendula *
Mucuna gigantea	Setaria pumila *
Musa sp. (cultivated) *	Setaria sphacelata *
Nephrolepis cordifolia *	Sida rhombifolia *
Nicandra physalodes *	Sigesbeckia orientalis *
Notothixos subaureus	Smilax australis
Ochna serrulata *	Solanum americanum*
Oenothera drummondii *	Solanum mauritianum *
Oplismenus aemulus	Solanum tuberosum *
Oxalis corniculata *	Soliva anthemifolia *
Oxalis debilis *	Soliva pterosperma *
Palmeria scandens	Sonchus oleraceus
Panicum maximum *	Sorghum bicolor *
Pararchidendron pruinosum	Sporobolus elongatus
Parsonsia straminea	Stellaria media *
Paspalidium distans	Stephania japonica
Paspalum conjugatum *	Syzygium australe
Paspalum dilatatum *	Tabernaemontana pandacaqui
Paspalum urvillei *	Tagetes minuta*
Passiflora edulis*	Thunbergia alata *
Tithonia diversifolia *	
Tradescantia albiflora *	
Trema tomentosa	
Trifolium repens *	

Table B1 (continued)

Verbena bonariensis *	
Vicia sativa *	
Wikstroemia indica	

* *indicates introduced/naturalised taxa.*

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PLATE 1
Whilst *Avicennia marina* still fringes the tidal waters of the Clarence River, *Lantana camara* and many other weed species dominate the landward margins of this narrow riparian fringe abutting the current highway alignment.

PLATE 2
Another riparian fringe where native flora have been completely replaced by introduced weed species.

PLATE 3
Remnant *Eucalyptus tereticornis* which are not regenerating on site due to an understorey dominated by weeds such as *Lantana camara*, *Ricinus communis* and *Senna pendula*.

PLATE 4
Large remnant *Ficus obliqua* close to the existing highway.

PLATE 5
Fruit of *Ficus macrophylla* in riparian forest adjacent to the Pacific Highway.

PLATE 6
Mature fruit of *Ficus obliqua*—note smaller size compared with the fruit of *F. macrophylla* depicted by Plate 5 above.

APPENDIX C

INDIGENOUS CULTURAL HERITAGE

TYNDALE REALIGNMENTS

INDIGENOUS HERITAGE

ENVIRONMENTAL SETTING

The proposed Tyndale Village realignment crosses the footslopes of a 130 m high ridge to the east (Bondi Hill) just upslope of the junction between the hillslope and the alluvial floodplain of the south arm of the Clarence River. There are no ridges or creeklines which might have acted as a focus for Aboriginal occupation (see below). Bedrock does not crop out in this area. The original forest vegetation cover along the proposes realignment has been almost completely cleared, except for a few mature eucalyptus trees, and the land surface has been disturbed by varied land use practices, especially repeated cultivation for cane growing.

The Byrons Lane to Shark Creek reconstruction is confined to the low levee bank of the south arm of the Clarence River. The original forest vegetation cover along the route has been almost completely cleared and the land surface has been disturbed by road works and or repeated cane cultivation. A few mature eucalypt and fig trees occur, and there is a small amount of riparian vegetation. This part of the highway is occasionally inundated during floods.

PREVIOUS INVESTIGATIONS

NPWS Aboriginal Sites Database

A computer search was made of all archaeological sites in a rectangular area 23 km (east-west) by 16 km (north-south) centred on Tyndale. There were three sites listed in the NPWS Sites Register as occurring in this area, but none was within 5 km of either of the realignments:

- A burial adjacent to Everlasting Swamp near Woodford Dale to the west.
- An open camp site (artefact scatter) near Taloumbi to the east.
- A rockshelter with archaeological deposit on Woodford Island to the north.

This is a very small number of sites for such a large area and it can be inferred that this sample does not adequately reflect the actual numbers or types of sites in the area. Numerous archaeological investigations have been undertaken in the coastal hinterland of northern New South Wales, and these have provided a good indication of the kinds of archaeological sites and their environmental settings that occur in this region (see for example Collins 1991; Kinhill 1996 (the Halfway Creek report); and Navin and Officer 1990).

Stone Artefact Scatters

These are the most common type of site throughout Australia. They consist of scatters of stone artefacts on or beneath the ground surface. Numerous surface scatters have been reported from a large number of archaeological investigations undertaken in northern coastal NSW. Most of these sites were found on ridge crests, and evidence from many other parts of eastern Australia indicate that ridge crests were highly favoured locations for Aboriginal use and occupation as they provided focal points for repeated visits. Ridge crests and other areas of elevated ground adjacent to resource-rich creeks, swamps and other wetlands tend to have larger numbers of artefact scatters with higher densities of artefacts than areas away from water sources.

In contrast, on alluvial plains artefacts occur infrequently and usually in the form of a 'background scatter' of isolated artefacts rather than clusters of artefacts which can be defined as sites. This is because there are no obvious landscape features such as spatially well-defined elevated areas that would have provided a focus for repeated Aboriginal exploitation of resources and/or occupation.

Sites also commonly occur along creek banks or around the margins of swamps, but again usually only where there is elevated ground.

Very few sites have been reported from the banks of major rivers such as the Clarence River. The levee banks of such rivers would have provided a focus for Aboriginal use and occupation, but much of the evidence for such use would have been removed or dispersed during major floods, or buried beneath flood alluvium. The river banks have also been a major focus for European settlement and land use (including intensive cultivation), and this would have impacted on any surviving archaeological materials.

Other Site Types Which Might Occur

Scarred trees are trees from which sections of bark have been removed for a wide range of purposes including shields, containers or roofing for shelters. It is commonly difficult to distinguish between artificial scars and natural scars caused by limb fall or fire. It is also difficult to distinguish between scars made by Aborigines and those made by others. There are only a few remaining mature eucalyptus trees along the proposed realignments, and RTA will attempt to avoid them where possible. Some of these trees near the Tyndale Village only may be affected, depending on which alignment is adopted. Because of this, it is extremely unlikely Aboriginally scarred trees would be affected by the highway upgrade.

Carved trees are trees on which geometric and linear patterns of markings have been carved. They are often associated with ceremonial sites and the figures seem to be mythological or totemic symbols (McBryde 1974:126-131). The only places where carved trees have been recorded in the north coast region are from near Nambucca and Smoky Cape to the south of the study area. McBryde states that others were reported by early writers as occurring in the Clarence Valley, but these do not appear to have survived.

Bora/ceremonial grounds and *stone arrangements* have been reported from the region, but most have either been destroyed or their exact location is unknown. Several bora grounds and stone arrangement are known from the Clarence Valley, but they are all from west of Grafton (McBryde 1974, Chapter 2).

Carved trees, bora grounds and stone arrangements are obtrusive kinds of site and it is unlikely that any still exist which have not yet been located and reported in the literature or to NPWS. It is extremely unlikely that these kinds of site would be found along the sections of the highway to be upgraded.

ARCHAEOLOGICAL POTENTIAL OF THE SECTIONS TO BE UPGRADED

The only kinds of site which might exist in areas to be affected by the highway upgrade are stone artefact scatters along the levee bank of the southern branch of the Clarence River. However, for the reasons outlined above, such sites are likely to be uncommon, and those which have survived are likely to be heavily disturbed.

ARCHAEOLOGICAL CONSTRAINTS AND REQUIREMENTS FOR FURTHER INVESTIGATIONS

No archaeological constraints to the proposed construction works in the study area have been identified in this study. An archaeological field survey of the two areas of highway to be upgraded is not warranted.

The Yaegl Local Aboriginal Land Council is being directly involved in the community consultation process, and a representative of the Land Council has taken part in the Planning Focus Meeting which included an inspection of the study area. A copy of this report will be given to the Land Council for their consideration. Should they wish to undertake their own specific inspection of the study area in order to assess it from an Aboriginal perspective (including its Aboriginal sites potential), the RTA should facilitate such an inspection.

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APPENDIX D

NON-INDIGENOUS CULTURAL HERITAGE

PACIFIC HIGHWAY—TYNDALE REALIGNMENTS PRELIMINARY HERITAGE INVESTIGATIONS

DESK-TOP STUDIES UNDERTAKEN

The investigation has been limited to a desk-top study of the lengths of highway being considered for the realignment of a section of the Pacific Highway at Tyndale, and the reconstruction of a section from Byrons Lane to Shark Creek (hereafter 'the subject areas'), being located between Grafton and Maclean.

The study consisted of:

- review of readily available historical and heritage literature (mainly in National Library of Australia and the Australian Heritage Commission Library, Register of the National Estate and Files.)
- checking of Register of the National Estate
- checking of the National Trust Register
- checking as to Local Environment Plan status of the area, and following up with NSW Heritage Council any identified places.

The desktop nature of the study imposes some limitations on the process and conclusions. It has not, for example, been possible to confirm the exact relationship between the buildings identified as being of heritage significance and the road alignment. Nor has it been possible to identify other places that might be of significance if they have not been already assessed in the context of the Local Environment Plan.

The details of the work is included below.

HISTORICAL OVERVIEW

The National Library and AHC Library catalogues were searched for historical material relating to the Tyndale/Maclean area. The following general history is extracted from the sources found, which are listed at the end of this report.

Early settlement

The Tyndale area is associated with the earliest phase of settlement of the Clarence. Thomas Small first entered the river in 1838, being lead there by the information of one Richard Craig, an absconded convict who lived in the area with the Aborigines,

and who subsequently worked for Small. Small's party first occupied an area on the northern part of Woodford Island, and then moved to the South Arm opposite the location of Tyndale. Shortly afterwards, also in 1838, William Williams, an overseer of cedar sawyers belonging to another logging party (Girard's), occupied land at Tyndale known as Williams Flat as his headquarters (McSwan 1976: 1-2; Law 1973: 5, 35, 155). The name 'Tynedale' (later Tyndale) is believed locally to have been applied to the district because of its resemblance to the country near the river Tyne in the coal mining area in the north of England. There is also a coal seam running through the area (McSwan 1976: 8).

In 1842 the Deputy Surveyor General, Captain S.A. Perry inspected Woodford Island, and reported that: "In the bushes by which the island is margined and on the opposite bank (particularly on the south side) there was abundance of cedar, which has now been considerably thinned." (Law 1973: 148). The southern bank is the area of Tyndale and Shark Creek.

Land along the lower Clarence was sold for small farms from 1854, and the 1861 Selection Act accellerated the take-up of small holding (Heritage Office 1996: 65). The valley of Shark Creek was occupied by Somerville Station in the 1850s-60s, originally held by George Richmond Powell, who operated it in conjunction with his property at Tyndale. Powell's home during the last 30 years of his occupation was marked in the 1930s by a grove of trees spanning the Pacific Highway at Tyndale (Law 1973: 146).

Within the subject area at Byrons Lane to Shark Creek, Edward Powell is shown on the Parish map as holding lots 11, 12, and 26. These lots appear to have been gazetted in 1859 or 1860.

This brief desk-top study was not able to determine if the subject areas were used for cattle grazing, wheat farming (common on the lower Clarence until the rust wiped it out in the 1860s), or sugar cane growing.

Tyndale School, located in the Byron's Lane to Shark Creek sector, was established as a Provisional School in July 1868, and was converted to a Public School in January 1930, operating as such (with a closure for the year of 1943) until final closure in December 1963. The school's name was spelled "Tynedale" until about 1890. The changing status of the school indicates that from 1868 to 1963 the population of children in the immediate vicinity was within the following range:

- 1868 to 1880s 15 to 25
- 1880s to 1898 12 to 20
- 1898 to 1930 10 to 20
- 1930 to 1957 minimum of 20
- 1957 to 1963 minimum of 9

(Source: Department of School Education Library (NSW), 1993: 142, 17).

The Parish map (Parish Tyndale, County Clarence) indicates that the two acre Public School Reserve for Tyndale school was resumed from Lot 19, held by John Henry Monro and George Foott, and gazetted on 22/1/1884. This might suggest that from 1868 to 1884 the school was not on a gazetted reserve, a not-unusual situation in country NSW.

Other local history sources listed in the footnote failed to add any substantial information about the subject area[1]

EXISTING HERITAGE REGISTERS

Register of the National Estate

There is no place entered in the Register of the National Estate within a considerable distance of the subject area. (Register and Register maps inspected 14/4/97)

National Trust of Australia (NSW)

There is no place classified or recorded by the National Trust in the vicinity of the subject area. (reference: National Trust NSW *Jubilee Register*—all places listed by the Trust up to and including May 1995). The bridge over Shark Creek Bridge is Classified by the Trust, but this is just to the north of the subject area.

Maclean Shire Council

Maclean Shire Council has indicated that four properties in or adjacent to the subject areas which have been identified as being of heritage significance in its Local Environment Plan (15 Nov 1992). (Phone inquiry 16/4/97). These are:

- Lot 2, DP 586049, Pacific Highway, Tyndale, LEP ref. 127, being late Victoran residence (1890) set close to the highway and surrounded by bunya pines (the Powell house?)

- Lot 2, DP 573649, Pacific Highway, Tyndale, LEP ref. 128, being a very large c.1935 concrete masonry residence, which "adds enormous quality to the small village of Tyndale".

---

1 Mc Swan, E. H. 1973. The Sugar Industry of the Lower Clarence, Maclean District Historical Society, Maclean.
Clarence River Historical Society, 1974. Early Days on the Clarence, Grafton.
McSwan, E.H. 1976. Historic Buildings of Maclean, , Maclean District Historical Society, Maclean.
McSwan, E.H. 1992. Maclean—The first fifty years 1862-1912, , Maclean District Historical Society, Maclean.

- Lot 1, DP 518888 and Lot 1 DP 232031, Pacific Highway, Tyndale, LEP ref. 126, being a large weatherboard Federation house (c.1910), situated riight on the highway.

- Shark Creek bridge, on a now bypassed section of the Pacific Highway over Shark Creek. This is a reinforced concrete bow-string arch bridge with a single span of 34.1 metres, built in 1936, and the first of its kind in Australia. The bridge is identified as being of regional and state significance in the North Coast REP. (Department of Planning, 1992)

Department of Urban Affairs (NSW)

The State Heritage Inventory administered by the DUA is made up of places identified in Local and Regional Environmental Plans, and places with Conservation Orders placed on them. The places identified in the Maclean LEP and the North Coast REP fall within the jurisdiction of DUA and Heritage Office processes.

CONCLUSIONS

From the information able to be gathered in this brief desk-top study, it is clear that there are several places of historic cultural significance occuring within two subject areas. Ground verification of the potential impacts of the planned road upgrades and realignment is essential before the final planned works can be guaranteed to avoid impacting on the heritage values of the areas. Places of potential significance (such as the Tyndale School) should also be actively assessed and potential impacts determined before plans are finalised.

SOURCES

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APPENDIX E

NOISE ASSESSMENT

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NOISE AND VIBRATION REPORT, BYRONS LANE TO SHARK CREEK, SOUTHERN SECTION

Report For :	Kinhill Pty Ltd
Report No:	97030_by1.wpd
Report Date:	March 1998
Report By:	Kamst & Simpson Pty Ltd Ground Floor 15 Leichhardt Street Spring Hill QLD 4004

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1.0 INTRODUCTION

Kamst & Simpson Pty Ltd was commissioned by Kinhill Pty Ltd, on behalf of the New South Wales Roads and Traffic Authority (RTA), to carry out a noise and vibration assessment for the proposed widening of the highway between Byrons Lane and Shark Creek. This report addresses the southern section of the study area between Byrons Lane and Shark Creek.

The study section of the Pacific Highway will referred to as 'the route' within this report.

The route is a two lane section of road which is to be widened as part of an upgrade. The road widening will take the highway up to 6 m closer to existing residences.

The route is located along the eastern bank of the Clarence River South Arm and has five (5) residences located within 40 m to the east of the route.

This report addresses in detail the noise and vibration impact of the reconstruction at the adjacent noise sensitive receptors. Both the construction and the operation phases have been considered in this report.

A description of the likely noise impact of the addition of an overtaking lane, and possible amelioration measures to minimise impact on adjacent sensitive locations are included in this report.

2.0 STUDY AREA DESCRIPTION

The route is approximately 1.0 km in length and is located at the southern end of the section of highway located between Byrons Lane and Shark Creek. It has a general north-south orientation.

There are approximately five (5) noise sensitive locations (shown on Figure 1) on the eastern side of the route. However, only four (4) residences will be considered in this report as the fifth residence, located at the southern end of the study area, will be addressed in a subsequent RTA study.

Traffic on the existing Highway is clearly audible at all of these locations. From north to south the noise sensitive locations are:

- S1: The Moloney residence, a 1 storey timber residence.
- S2: The Forrester residence, a 1 storey timber residence.
- S3: The McGrath residence, a 2 storey brick residence.
- S4: The Simpson residence, a 1 storey timber residence.

3.0 CONSTRUCTION PHASE NOISE AND VIBRATION

Construction of the overtaking lane will be carried out in the study area over a 4 month period.

3.1 Construction Criteria

3.1.1 Construction Noise Criteria

RTA has undertaken to comply, where possible, with the New South Wales, Environmental Protection Agency (EPA) 'Environmental Noise and Control Manual' details construction noise criteria in Chapter 171.

The recommended construction noise criteria are:

I. For a construction period of 4 weeks or less:

The L_{10} level (ie. the noise level exceeded 10% of the time) measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 20 dB(A). (The background noise level is commonly taken to be the L_{90} - the noise level exceeded 90% of the time.)

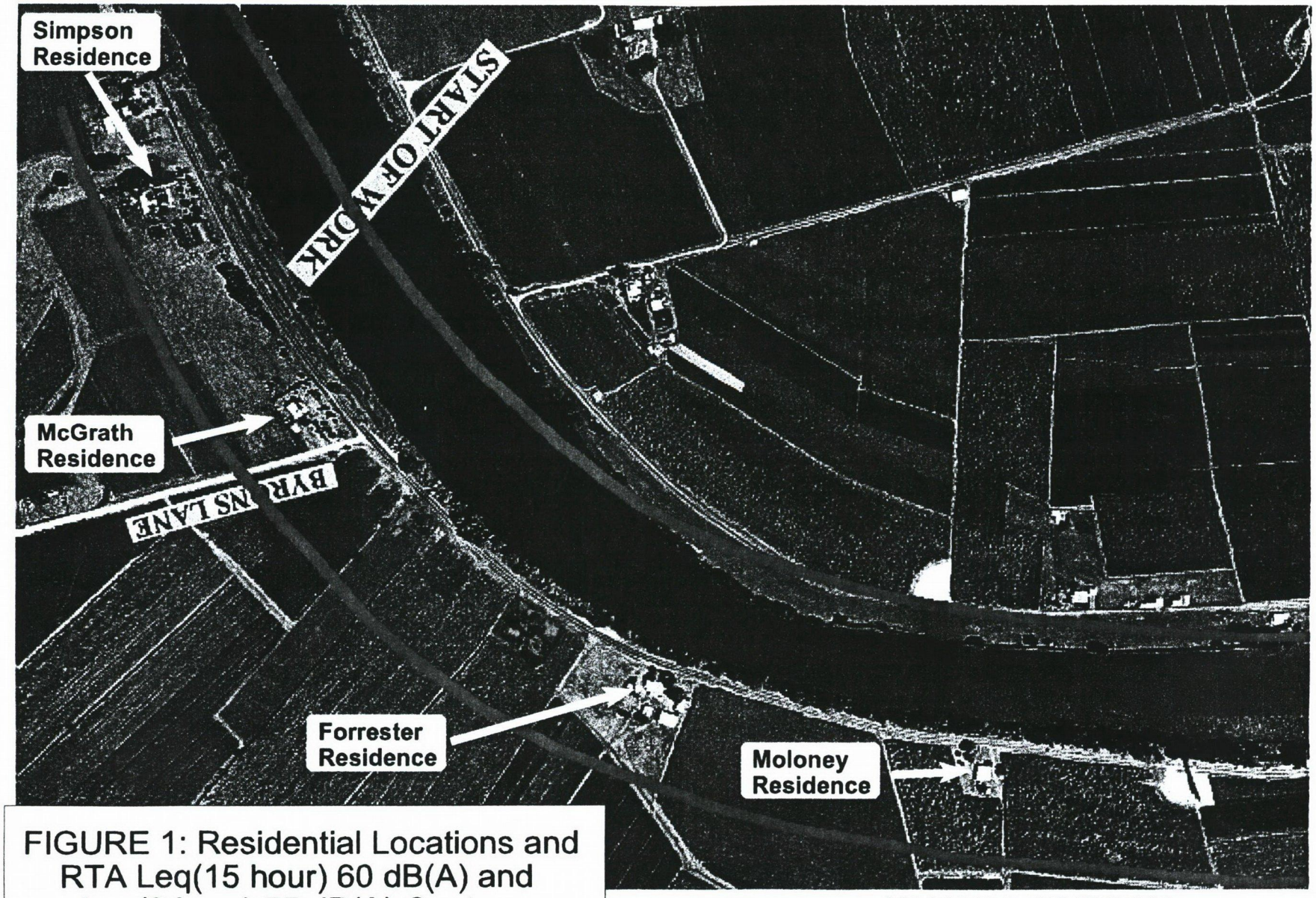

FIGURE 1: Residential Locations and RTA Leq(15 hour) 60 dB(A) and Leq(9 hour) 55 dB(A) Contour

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ENVIRONMENTAL & ACOUSTICAL CONSULTANTS

II. For a construction period greater than 4 weeks and not exceeding 26 weeks:

The L_{10} level measured over a period of not less than 15 minutes when the construction site is in operation must not exceed the background level by more than 10 dB(A).

For a construction period exceeding 26 weeks it may not be appropriate to apply the above noise levels in the case of long term constructions which may take several years. In these instance it is usual to apply the standard noise guidelines. The standard noise guideline is that the L_{10} noise level measured over a period of not less than 15 minutes when the construction site is in operation, must not exceed the background level by more than 5 dB(A) during the day.

Normal time restrictions for the hours of construction are:

Monday to Friday:	7 am to 6 pm.
Saturday:	7 am to 1 pm. However, if construction is audible at residential premises then recommended hours are 8 am to 1 pm.
Sunday:	No construction work to take place on Sundays and Public Holidays.

Variations to these conditions should be made according to local conditions.

The duration of the road construction phase is approximately 4. However, the actual location of construction activity along the 1.0 km route will vary during this period. In addition there will be periods when there will be little or no significant noise producing activities.

The background noise (L_{90}) levels for the subject residences adjacent to the study area are based on noise measurements carried out at residences immediately north of the subject study section and located within the Byrons Lane and Shark Creek area. The estimated L_{90} for the four (4) residences is 46 dB(A).

The relevant construction noise criteria at each of the noise sensitive locations adjacent to the highway redevelopment, based on the estimated background noise levels and the approximate 16 week construction time frame is 56 dB(A).

3.1.2 Blasting Criteria

It is anticipated that blasting would not be undertaken during the construction phase of the Pacific Highway redevelopment of the southern section of the study area between Byrons Lane and Shark Creek, and as a consequence would not be considered further.

3.2 Construction Noise Impacts

Table 2 shows a typical inventory of the type of plant likely to be employed during a particular construction activity and the typical noise levels associated with this equipment. The noise levels generated by the various construction activities would vary in intensity and character depending upon the combination of plant in operation at any one time and the location and duration of the individual activities.

The typical noise levels for the construction equipment in Table 2 have been extracted from the Australian Standard 2436-1981 entitled "Guide to Noise Control on Construction, Maintenance and Demolition Sites."

Table 2 Typical Sound Power Levels From Construction Equipment and Typical Number of Plant

Equipment Type	Typical Number of Plant	Sound Power Level Range Per Unit of Plant dB(A)
graders	2	114 to 118 .
water truck	1	103 to 108
15 tonne dump trucks	4	102 to 114
excavator	1	114 to 118
smooth roller	1	110 to 119
vibrating roller	1	99 to 112

The potential noise impacts associated with the respective construction activities are discussed in greater detail in the following sections. The location of the proposed construction depot has not been determined.

3.2.1 General Earthworks

The general earthwork activities are likely to generate the most significant and prolonged potential noise impacts during the reconstruction of the highway. This phase of the project should take approximately 16 weeks.

Not all operations/equipment are expected to occur simultaneously. The operations likely to lead to the highest noise levels would typically involve the following combinations of equipment working closely together:

3.2.2 Asphalt Pavement

The laying of asphalt pavement typically requires the use of a paver, vibrating rollers and trucks, as shown in Table 2. Of the plant and equipment likely to be employed in this activity the 'noisiest' piece of equipment may be the paver which generates noise levels of approximately 84 dB(A) at a distance of up to 10 m.

The asphalt laying process should take approximately 1 week.

Provided that the work activities are scheduled appropriately and the recommended management measures are employed consistently throughout the duration of the works, it is unlikely that the installation of asphalt pavements would create nuisance at nearby sensitive receptors.

3.2.3 Haul Roads

Noise levels generated by construction traffic vary depending upon the nature of the road surface, the type, speed and weight of the vehicle and existing traffic flows. It is likely that 4 trucks would be employed during the bulk earthworks phase. The haul roads and transport routes would follow the highway alignment.

The most likely sources of noise may be the loading and unloading points and depots along the haul roads where traffic is concentrated, particularly at the beginning and end of shifts. Therefore, it will be important to locate the depots at a suitable distance from any nearby sensitive land uses.

3.2.4 Construction Noise Predictions

The noise levels have been estimated for the use of major construction equipment. The maximum noise level and L_{10} noise level arising from each of the modelling cases has been predicted. The L_{10} noise level is based on combining the noise levels from the expected operations. The L_{10} would also only be representative of the operations that occur within about 300 m of the receptor site. Operations further away would result in lower maximum and L_{10} noise levels.

Since most of the significant noise sources considered in these cases are mobile sources the noise level would fluctuate as the noise source approaches or departs from the residence. In addition, constructed cuttings may assist in shielding residences while work on fill sections may tend to enhance the noise at the residences.

The noise levels were calculated from an environmental noise model set up for the entire route. The noise model included attenuations associated with distance attenuation, ground effects, air absorption and topographical shielding from cuttings and natural barriers.

The construction noise predictions relate to the position of all four (4) residences along the redevelopment.
It is assumed that best available noise control would apply and as a result noise levels equal to the minimum value of the range quoted in Table 2 have been used in this analysis.

Table 3 Maximum Noise Level and Estimated L_{10} Noise Levels Due to Construction Noise in dB(A)

Location	Location Description	Distance to Highway from Residence (m)	Construction Noise Guideline[#1] L_{10} dB(A)	Estimated Noise	
				Maximum dB(A)	L_{10} dB(A)
S1	Moloney Residence	20	56	80	70
S2	Forrester Residence	15	56	82	72
S3	McGrath Residence	30	56	76	66
S4	Simpson Residence	35	56	75	65

Note 1: The construction noise guidelines contained in this table are based on a 16 week construction period.

Table 3 shows that the construction activity is relatively intrusive to the residents located close to the operations, and that the predicted noise levels from construction may exceed the recommended levels shown in Table 3.

A comparison of the predicted construction noise levels with the predicted existing L_{10} (18 hour) road traffic noise levels at each residence, indicates that the construction noise would be similar to the noise levels at these residences due to traffic travelling along the Pacific Highway.

The predicted noise levels in Table 3 are in terms of the L_{max} and the L_{10}. The L_{max} noise would also be representative of the maximum L_{10} noise level at the times when equipment is operating at the closest approach of the route to the receptor and the noise source remains at this location for an extended time. While a maximum L_{10} noise level may not be annoying if it only occurs for a short period from time to time, any concentrated operations could be annoying for the residents particularly if it was an unforeseen event.

In general terms it is preferable to concentrate noisy activities into as short a time period as practical, even to the extent of bringing additional equipment on site to complete the task sooner. The affected residents should be consulted and suitable arrangements made to lessen the impact if necessary.

Refer to Section 5.1.1 of this report for management measures to minimise noise nuisance associated with construction works.

3.3 Construction Phase Blasting and Vibration Impacts

It is unlikely that blasting and/or drilling will be carried out during the construction phase of this project. However, the use of heavy plant and equipment in the construction of the highway redevelopment may generate discernible vibrations at those residences closest to the work sites. The level of vibrations generated as a result of these activities would vary in intensity and character depending upon the combination of plant in operation at any one time and the location and duration of the individual activities. Of the various activities conducted as part of the construction works, those likely to be associated with vibrations are the vibrating rollers and heavy construction equipment.

Vibration from construction equipment can adversely affect people in sensitive locations such as hospitals and schools, or damage old structures and buildings including structures of heritage significance if not managed correctly. However, there are no such buildings within this study area. Sensitive locations considered in this study are four (4) residences.

If blasting or other construction methods which generate high ground vibration energy are to be used near buildings or structures, consideration should be given to undertaking a pre-construction survey of them, including a photographic record of existing structural damage so that claims for compensation can be easily evaluated.

4.0 OPERATIONAL PHASE NOISE AND VIBRATION

4.1 Operational Noise and Vibration Criteria

4.1.1 Traffic Noise Criteria

The RTA advised Kinhill Pty Ltd on 18 march 1998 that the Pacific Highway upgrade in the study area falls within the "Upgraded existing Freeway/Arterial road" development type. For this classification the EPA draft environmental criteria states the following noise limits:

> *'Day L_{eq}(15 hour) (7.00 am to 10.00 pm) 60 dB(A);*
> *Night L_{eq}(9 hour) (10.00 pm to 7.00 am) 55 dB(A).'*

For the same classification the RTA draft criteria also state under the heading "Where Criteria Are Already Exceeded" the following:

> *'It is highly desirable that there is no increase to existing noise levels in these cases.*
>
> *Where feasible, noise levels from existing roads should be reduced to meet the noise criteria. In many instances this may only be achievable through long term strategies such as improved planning, design and construction for adjoining land use developments, reduced vehicle emission levels through new vehicle standards and regulation of in-service vehicles, greater use of public transport and alternate methods of freight haulage.'*

4.1.2 Vibration Criterion

The RTA advise that the relevant operational vibration criterion is 2 mm/s at sensitive locations adjacent to the proposed Pacific Highway redevelopment. Ground vibrations are not considered to be of any consequence from modern highways and will not be considered further in this study.

4.2 Road Traffic Noise Modelling

4.2.1 Traffic Noise model

A 3 dimensional (3D) digital terrain computer model was used to estimate road traffic noise levels at noise sensitive locations adjacent to the proposed Pacific Highway redevelopment at the southern end of the section of highway between Byrons Lane and Shark Creek. The predicted noise levels at the residences are in terms of the L_{eq}(15 hour) and L_{eq}(9 hour).

Noise level predictions assume a 0.5 m source height, 1.2 m receiver height for low set residences, 2.5 m height for residences raised off the ground and 4.0 m for two storey residences. The terrain data was supplied electronically in AutoCad DXF format by Kinhill Pty Ltd from their CAD model of the proposed upgrade.

The calculations used in the model have been undertaken in accordance with the United Kingdom Department of Transport (1988) procedure published as "Calculations of Road Traffic Noise" (CORTN88). The model takes into account noise attenuation due to distance, barriers, ground cover, road surface type, barrier reflections, road gradient, percentage heavy vehicles and traffic speed.

A digitised format of the local ground contours of the study area was entered into the model together with representations of the ground cover. The CORTN88 model has two ground types namely 'hard' and 'soft' ground. Hard ground is taken to be roads, and road verge, while soft ground is taken to grass, and other areas. In addition barriers were entered into the model and their heights were specified above ground level.

CORTN88 predicts road traffic noise in terms of L_{10}(1 hour) or L_{10}(18 hour). The L_{10}(1 hour) is the noise level exceeded 10% of the time. The L_{10}(18 hour) is the average of the 18 hourly L_{10} values between 6 am and midnight. To obtain the L_{eq}(15 hour) and the L_{eq} (9 hour) it was necessary to determine a suitable conversion factor.

The conversion factor was based on hourly road traffic counts with percentage heavy vehicles for the route. This data was analysed and the hourly L_{10} was calculated according to the CORTN88 method. The hourly L_{eq} was taken to be 3 dB(A) below the hourly L_{10} in accordance with normal practice. The correction between the L_{10}(18 hour) and the L_{eq}(15 hour) and between the L_{10}(18 hour) and the L_{eq}(9 hour) was then determined from the hourly traffic distribution. For the proposed upgrade the corrections which apply are :

- to convert from L_{10}(18 hour) to L_{eq}(15 hour) subtract 2.2 dB(A); and
- to convert from L_{10}(18 hour) to L_{eq}(9 hour) subtract 7.1 dB(A).

4.2.2 Traffic Data

The traffic data for the prediction years 1999 (construction year), the growth rate of 4% per annum and percentage commercial vehicles were supplied by Kinhill Pty Ltd.

It is normal procedure to adopt traffic flows for ten (10) years following the completion of construction. In the case of the road reconstruction at the southern end of Byrons Lane to Shark Creek, the prediction year is 2009.

1999 traffic data:

- AADT 8500 vpd,
- 17% heavy vehicles, and
- 100 km/h traffic speed.

2009 traffic data:

- AADT 12600 vpd,
- 17% heavy vehicles, and
- 100 km/h traffic speed.

The road traffic noise calculations were based on the application of dense graded asphalt as the proposed road pavement.

4.2.3 Validation of the Traffic Noise Model

The road traffic noise computer model was validated with the monitoring carried out for the Pacific Highway reconstruction to the north of the study area. This is detailed in the report for the northern section of highway between Byrons Lane and Shark Creek which will be prepared subsequent to this report.

In summary, all the traffic measurements used to check the prediction accuracy of the noise model are within acceptable error tolerances. It is therefore considered that the computer model is satisfactory within acceptable error tolerances.

4.2.4 Traffic Noise Predictions

The predicted road traffic noise levels have been calculated for the following and are included in Table 4:

- 1999 prior to the highway upgrade;
- 1999 after the highway upgrade; and
- 2009, 10 years after the highway upgrade.

Table 4 also contains the following calculated differences:

- The difference in the predicted road traffic noise level for 1999 before and after road works;
- The differences in the predicted 2009 road traffic noise levels with the predicted 1999 levels before the road works; and
- The difference in the predicted 2009 road traffic noise levels and the road traffic noise criteria.

Road traffic noise contours for the L_{eq}(9 hour) 55 dB(A) and L_{eq}(15 hour) 60 dB(A) are shown on Figure 1 for the year 2009.

The contour for the L_{eq}(9 hour) 55 dB(A) and L_{eq}(15 hour) 60 dB(A) are one in the same, because coincidentally, the difference in the limits is 5 dB(A), and the difference in the conversion factors 7.1 dB(A) and 2.2 dB(A) (as detailed in Section 4.2.1) is 5.1 dB(A). Therefore, the numbers in the 'Difference' column in Table 4 will be the same for the L_{eq}(9 hour) and L_{eq}(15 hour) and hence, only an overall number for both is shown.

Table 4 Predicted Road Traffic Noise Levels at Sensitive Locations for

- **Year 1999 prior to upgrade**
- **Year 1999 post upgrade**
- **Year 2009 10 years after upgrade**

Residence	1999 Road Traffic Noise Levels Before Road Works dB(A)		1999 Road Traffic Noise Levels After Road Works dB(A)		2009 Road Traffic Noise Levels dB(A)		Difference in dB(A)		
	L_{eq}(15 hour) dB(A)	L_{eq}(9 hour) dB(A)	L_{eq}(15 hour) dB(A)	L_{eq}(9 hour) dB(A)	L_{eq}(15 hour) dB(A)	L_{eq}(9 hour) dB(A)	1999(After Works) - 1999(Before Works)	2009(After Works) - 1999(Before Works)	2009 - criteria
S1 - Moloney	68	63	68	63	70	65	0	+2	+10
S2 - Forrester	69	64	71	66	73	68	+2	+4	+13
S3 - McGrath	67	62	69	64	70	65	+2	+3	+10
S4 - Simpson	68	63	68	63	70	65	0	+2	+10

4.2.5 Discussion of Road Traffic Noise Predictions

As can be seen in Table 4 the predicted road traffic noise levels for 1999, prior to the highway upgrade, at the four (4) residences within the study area all exceed the recommended RTA criteria of L_{eq}(15 hour) 60 dB(A) and L_{eq}(9 hour) 55 dB(A) by up to 9 dB(A).

The predicted road traffic noise level for 1999 after the highway upgrade remains the same (i.e. 0 dB(A) change) at two (2) residences, that is the Moloney and Simpson residences. However, the predicted road traffic noise level at the Forrester and McGrath residences will be increased by approximately 2 dB(A). The increase in noise level at the two (2) residences is because the highway will be located approximately 6 m closer after the upgrade.

The predicted road traffic noise levels for the year 2009, 10 years after the upgrade, would range from 10 dB(A) above the strict RTA L_{eq}(15 hour) 60 dB(A) and L_{eq}(9 hour) 55 dB(A) criteria at the Moloney, McGrath and Simpson residences up to 13 dB(A) above the criteria at the Forrester residence.

In cases where the strict RTA criteria is already exceeded, as is the case with this project, the desirable RTA criteria is to have no increase in noise levels. Thus the predicted 2009 road traffic noise levels would be 2 dB(A) to 4 dB(A) above the 1999 road traffic noise levels prior to the upgrade.

4.3 Operation Phase Vibration

Vibrations from road traffic are generated from the variations of contact forces between vehicle wheels and the road surface. The vibration level recorded adjacent to the roads varies as a function of the traffic flow, vehicle composition and soil conditions within the vicinity of the road. In addition, the characteristics of the particular structure likely to be affected will also influence the extent of the vibrations and therefore the susceptibility of properties to vibration caused damage.

The recommended operational vibration criterion of 2 mm/s should be met at residences adjacent to the highway redevelopment.

5.0 IMPACT MANAGEMENT

5.1 Construction Phase Management

5.1.1 Construction Noise Management

Construction noise is likely to be consistently above the construction noise guidelines. It is inherently difficult to limit construction noise due to the nature of the process. Thus for this project it is important that the affected community be consulted during all phases of construction so that a work program that minimises the impacts from the high noise level events may be developed. The contractor must demonstrate that best available work practices have been implemented during construction works. It may also be desirable to reschedule activities to increase the level of activity and reduce the exposure time. These matters should be negotiated with the affected community.

It is recommended that the following measures are implemented during the construction phase to minimise possible noise nuisance at adjacent noise sensitive locations:

- Hours of Construction:

Monday to Friday	7 am to 6 pm.
Saturday	7 am to 1 pm. However, if construction is audible at residential premises then recommended hours are 8 am to 1 pm.
Sunday	No construction work to take place on Sundays and Public Holidays;

- Road traffic noise attenuation earth mounds and/or barriers could be built in the first stages of construction, if practical to do so, to assist in ameliorating the construction noise to these sensitive locations;
- Use of high efficiency mufflers on all construction equipment;
- Construction equipment should be well-maintained;
- The construction depot should be away from residences; and
- Haul roads should be well-maintained and repaired immediately if damaged.

5.1.2 Blasting and Vibration Management

It is unlikely that blasting or drilling will be required during the construction phase. However, if blasting or drilling is required then the following recommendations should be implemented.

It is recommended that a survey of the residences adjacent to the proposed Highway reconstruction be carried out to determine the influence prior to commencement of those activities with the potential to cause excessive vibration. Such surveys should include the evaluation of the structural and architectural condition of the affected properties.

5.2 Operation Phase Management

As discussed in Section 4.2.5 of this report, the recommended RTA road traffic noise criteria were predicted to be exceeded at all four (4) of the noise sensitive locations adjacent to the proposed Pacific Highway upgrade.

The predicted road traffic noise levels for the year 2009 (10 years after the upgrade) exceed the recommended RTA L_{eq}(15 hour) 60 dB(A) and L_{eq}(9 hour) 55 dB(A) road traffic noise criteria by at least 10 dB(A) and up to 13 dB(A).

The predicted 2009 road traffic noise levels exceed the predicted 1999 levels (prior to the upgrade) by 2 dB(A) to 4 dB(A).

It is unlikely to be feasible to reduce the road traffic noise levels at the residences within the study area to the RTA L_{eq}(15 hour) 60 dB(A) and L_{eq}(9 hour) 55 dB(A) criteria with barriers due to extensive barriers required. The barriers would be high and long and out of keeping with the environment. However, it may be more feasible to reduce the predicted road traffic noise levels for 2009 to meet the predicted road traffic noise levels for 1999, prior to the road upgrade, in line with the RTA statement - 'Where Criteria are already exceeded'.

The different methods of ameliorating the predicted road traffic noise levels to acceptable levels is via a noise barrier located between the road and residence, or the application of open graded asphalt road surface, or via the acoustic treatment of buildings.

Barrier design is discussed in greater detail in Section 5.2.1 of this report. For aesthetic purposes in this mainly rural environment it may be preferable to construct the barriers from earth mounding.

The road traffic noise predictions shown in Table 4 have been based on the application of dense graded asphalt. If a chip seal were to be used the predicted road traffic noise levels may increase by another 3 dB(A). However, the use of open graded asphalt may reduce the predicted road traffic noise by approximately 3 dB(A) and therefore the barrier height and length would be reduced.

Alternatively acoustic treatment of the residential buildings may be considered to reduce the road traffic noise to acceptable internal noise level.

It is understood, for reasons other than road traffic noise, that the Forrester residence may be relocated further back on their property at a greater distance from the highway. This would also be effective in reducing the road traffic noise at this residence. The Forrester residence would be located approximately 10 m from the highway upgrade. It is recommended that the Forrester residence be relocated at least 25 m from the highway upgrade to meet the 1999 (prior to construction) predicted noise level.

It is recommended that public consultation be carried out to determine the preferred methods of road traffic noise amelioration.

5.2.1 Acoustic Barriers

A typical acoustic barrier required to achieve a 10 dB(A) reduction along the route to achieve compliance with the strict RTA criteria would be at least 5 m high and approximately 200 m in length adjacent to the road, centred on each residence.

The barrier heights and lengths, located adjacent to the highway, which would be required to reduce the predicted road traffic noise for 2009 to the 1999 (prior to upgrade) levels, the RTA desirable criterion, are shown in Table 5.

Table 5 Barrier Descriptions At Residences To Meet 1999 (Prior To Upgrade) Road Traffic Noise Levels in 2009. - Desirable Criterion

Residence	Barrier Height m	Barrier Length m
S1 - Moloney	1.2	80
S2 - Forrester	1.3	80
S3 - McGrath	1.3	100
S4 - Simpson	1.1	80

5.2.2 Open Graded Asphalt

Based on Table 4 of the Queensland Department of Main Roads (DMR) 'Interim Guidelines and Technical Notes for Road Traffic Noise Amelioration', the traffic noise difference due to surface/tyre interaction, at speeds greater than 80 km/h, between dense graded asphalt (on which the CORTN88 model is based) and open graded asphalt, is an approximate reduction of 3 dB(A) in road traffic noise.

A road traffic noise reduction of 3 dB(A), due to the application of open graded asphalt, would reduce the predicted noise levels at the two (2) residences (one being Forrester residence which is likely to be relocated) at which the road traffic noise levels are predicted to increase 2 dB(A) above 1999 levels prior to construction.

However, the application of open graded asphalt alone would not be adequate to achieve the required road traffic noise attenuation at all four (4) residences to meet the RTA L_{eq}(15 hour) 60 dB(A) and L_{eq}(9 hour) 55 dB(A) road traffic noise criteria. Further amelioration such as a barriers would be required.

It should be noted that open graded asphalt has a limited life with respect to traffic noise reduction and requires replacing more frequently than other road surfaces.

5.2.3 Building Treatments

The Roads & Traffic Authority may provide acoustical noise control treatments to the building itself in lieu or in conjunction with alternative noise control measures (low noise road surfaces or roadside noise barriers). In these instances building control treatments are provided following extensive consultation with the residents and obtaining agreement from all affected parties. The external road traffic noise criteria would not be met at these premises. However the internal noise levels due to road traffic noise would be reduced to meet acceptable internal noise level limits (eg Australian Standard AS2107 "Recommended Internal Noise Levels and Reverberation Times for Building Interiors").

Building treatments may include:

- Improving glazing in the facades exposed to the highway;
- Provision of mechanical ventilation or airconditioning;
- Upgrading the facades if the existing building materials are inadequate; and
- Upgrading the roof structure if the existing is inadequate.

6.0 CONCLUSION/EXECUTIVE SUMMARY

Four (4) noise sensitive locations on the eastern side of the proposed route have been considered in this study. They are located between 15 m and 35 m from the proposed route. The four (4) noise sensitive locations adjacent to the highway currently experience road traffic noise levels from the Pacific Highway well in excess of the strict RTA L_{eq}(15 hour) 60 dB(A) and L_{eq}(9 hour) 55 dB(A) criteria.

6.1 Construction Phase

Construction noise is likely to have an impact on the sensitive locations adjacent to the proposed route. Construction is predicted to take place over a 4 month period. Certain operations are expected to adversely affect some residences. Construction contractors should have in place an active environmental noise control programme to minimise the nuisance during this period as described in Section 5.1.1 of this report.

Drilling and blasting are unlikely to be carried out during the construction phase of this project. The construction of the proposed highway upgrade will generate minimal ground borne vibrations in the vicinity of the alignment. Therefore, the vibration impacts generated by the construction phase of the works are likely to be minimal, localised and transitory.

6.2 Road Traffic Noise

Modelling was carried out using a digital terrain model utilising ground terrain data supplied by Kinhill Pty Ltd. The road traffic noise levels following the upgrade are predicted to exceed the strict RTA L_{eq}(15 hour) 60 dB(A) and L_{eq}(9 hour) 55 dB(A) criteria at all four (4) sensitive locations.

Extensive noise control measures such as barriers, road surface treatments or treatment of the noise sensitive receptors would be required along the route to meet this strict criteria. See Section 5.2.1 for details.

A more feasible option may be to meet the desirable RTA criterion, namely no increase in traffic noise (in cases where the strict RTA criteria are already exceeded). Traffic noise levels are expected to increase up to 4 dB(A), at the adjacent noise sensitive locations.

Since the Forrester residence is to be relocated, for various reasons, it is recommended that it be relocated at least 25 m from the highway upgrade to meet the desirable RTA criterion 1999 (prior to construction) predicted noise level.

APPENDIX F

CLIMATE

R16

Katestone Scientific Pty Ltd

A.C.N. 011 052 592

INNOVATIVE INDUSTRIAL SOLUTIONS

Report from Katestone Scientific to Kinhill Cameron McNamara

Meteorological summary for Tyndale realignment projects - Pacific Highway

May 1997

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Meteorological summary for Tyndale realignment projects - Pacific Highway

Introduction

The roadworks are located a distance of 24 to 32 km to the north-east of Grafton near Tyndale village, on the Grafton to Maclean road. The roadworks are located along the flat river plain of the Clarence River approximately 25 km from the coast. They are bounded on much of the west by the river and elsewhere by cultivation.

The most comprehensive historical meteorological measurements in this region have been taken by the Bureau of Meteorology from sites at Cape Byron, Ballina, Lismore, Casino and Murwillumbah. These sites are shown on the map of Figure 1. Data from these sites (Cape Byron 1957-97 [0900 and 1500 hours data], Ballina 1992-97 [0200, 0500, 0800, 1400 hours], Lismore 1957-97 [0900 and 1500 hours], Casino 1996-97 [0200, 0500, 0800, 1100, 1400, 1700, 2000 and 2300 hours] and Murwillumbah 1972-97 [0900 and 1500 hours] have been processed for this report. The report also includes climatological data provided by the Bureau of Meteorology from sites at Alstonville, Grafton and Coffs Harbour.

The meteorological observations most representative of conditions in the area of the realignment lanes are those from the Grafton. The long term observations from Lismore and Byron Bay provide additional information on the variability of meteorology in the general area. The Lismore site is a similar distance inland and would experience similar conditions to those near the realignment project. However, the Byron Bay site is much more exposed to strong winds and coastal influences.

An interpretation of the observations in the region and their impacts on the construction and operation of the road is provided in the following sections.

Wind

The frequencies of wind speed and direction at Byron Bay, Ballina, Casino, Lismore and Murwillumbah are indicated in the wind roses of Figure 2 and in Table 1.

Table 1: Percentage occurrence of wind speeds measured at monitoring sites in the northern NSW area together with the maximum and average winds at each site.

Windspeed (m/s)	Byron Bay	Ballina	Casino	Lismore	Murwillumbah
Calm to < 05	49.15	68.4	82.13	84.43	74.88
05 to < 10	39.35	27.53	17.45	13.56	23.47
10 to < 15	9.29	3.87	0.41	1.81	1.49
15 to < 20	1.88	0.20	-	0.192	0.16
20 to < 25	0.25	-	-	0.137	0.006
25 to < 30	0.048	-	-	-	-
Maximum	26.7 m/s	18.5 m/s	13.9 m/s	23.3 m/s	20.6 m/s
Average	5.6 m/s	3.5 m/s	3.1 m/s	2.7 m/s	2.3 m/s
Observations	Daytime	Daytime	Day & Night	Daytime	Daytime
Days/year with strong winds (>14 m/s)	NA	26 (Alstonville 23 days/year)	NA	9	NA

Note: 1 m/s = 3.6 kph
1% approximates 43.8 hours of daylight events per year; 87.6 hours of day and night events per year.
The bottom row information is from climatological data tables provided by the Bureau of Meteorology.

These observations and climatological data indicate that:

- Wind directions are commonly experienced from all quadrants, due to the various combinations of the synoptic wind directions (generally south-easterly during summer and south-easterly to south-westerly during winter), the daytime onshore sea breeze components and the offshore nighttime land drainage components.

- Average wind speeds experienced at the exposed Byron Bay lighthouse are double those wind speeds experienced at the more sheltered inland sites.

- Strong winds in excess of 15 m/s (54 kph) which may cause significant dust problems during construction and impact on the stability of traffic (especially caravans) are noted to occur at Lismore on up to 0.33% of the daytime readings (i.e. 14 hours per year during the daytime hours). The frequency of strong winds at night is much reduced. Similarly gale force winds in excess of 20 m/s (72 kph) at Lismore occur on up to 0.14% of daytime observations (6 hours of daytime per year). Bureau of Meteorology climatological observations record on average 9 days per year with strong winds and 1 day per year with gales at both Lismore and Grafton. Strong wind gusts (in many cases not represented in the above data) may be also associated with thunderstorms.

- The strongest winds experienced in the area are commonly associated with strong pressure gradients (between high pressure systems to the south and low pressure systems to the north or east, producing strong winds along the coast) and also from thunderstorms producing offshore winds or southerly winds (the direction of such winds very dependent on the direction of movement of the individual storms).

- Nighttime winds are generally much lower than the daytime winds due to a combination of offshore nighttime drainage wind tendencies opposing the general onshore flow, and decreased convective mixing of faster upper-level winds to the surface. In contrast the daytime convective mixing of upper-level winds to the surface and onshore seabreeze winds reinforcing onshore synoptic combine to produce commonly stronger winds during the daytime. The existence of strong nighttime winds (in the absence of thunderstorms) would be very rare and possibly in the order of one or two hours per year.

Rain

The monthly and annual distributions of rainfall from long term monitoring sites at Byron Bay, Ballina, Alstonville and Grafton are listed in Table 2.

Table 2: Monthly and annual distribution of rainfall and number of raindays at major northern NSW sites.

Month	Mean Rainfall (mm)				No of Raindays			
	Byron Bay	Ballina	Lismore	Grafton	Byron Bay	Ballina	Lismore	Grafton
Jan	162	155	158	147	14	15	13	15
Feb	201	174	182	139	16	14	14	15
Mar	213	263	191	123	17	19	15	15
Apr	167	196	128	98	14	12	12	10
May	177	226	116	89	14	17	11	11
Jun	164	136	97	68	12	12	9	8
Jul	101	119	81	43	9	10	8	7
Aug	101	66	56	33	9	9	7	6
Sep	74	53	51	32	10	8	7	7
Oct	116	76	73	75	11	11	9	10
Nov	117	104	95	104	11	9	10	12
Dec	141	182	123	124	12	13	11	13
Annual	1734	1650	1351	1075	149	148	129	129

The rainfall and raindays experienced during the construction and operation of the realignment would be most similar to the observations of the Grafton and Lismore.

The rainfall records demonstrate:

- There is a strong seasonal variation in the rainfall.
- The highest rainfalls occur during the period December, January, February and March. (average monthly rainfall at Grafton and Lismore of between 123 mm and 191 mm occurring on an average of 11 to 15 days per month).
- The lowest rainfalls occur during the period July, August, September and October with monthly rainfall between 32 mm and 81 mm per month inland occurring on an average of 6 to 10 days per month.
- The average rainfall during the wetter period of the year is generally about 12 mm per rainday. This rainfall is largely due to convective (cumulus and thunderstorm type) cloud activity. That rainfall is relatively heavy and commonly occurs for only a short period (e.g. an hour) of the day.
- The average rainfall during the drier period of the year is generally between 7 mm and 10 mm per rainday. This rainfall is commonly due to more stratiform (low-level stratocumulus and middle-level altostratus) cloud and is relatively light and occurs for longer time periods (e.g. 12 hours).
- A maximum rainfall of approximately 96 mm over 24 hours can be expected to fall over the region once per year.

Thunderstorms

Thunderstorms which may significantly interrupt construction and traffic activities (due to heavy rainfall rates, possible strong winds and danger from hail and lightning) have been reported in the hour preceding the observations at Ballina on 0.41% of time. As the Ballina observations are taken at 3 hourly intervals throughout the day, it may be assumed that the thunderstorms will therefore be experienced within the last hour for all observations on approximately 1.23% of time (i.e. 108 hours during the year will either be experiencing thunderstorms or will have experienced thunder during the last hour). Thunderstorms commonly last one to two hours.

The mean number of days experiencing thunder per year at the various sites is given on Table 3.

Table 3: Mean number of days per year with thunder.

Site	Lismore	Ballina	Alstonville	Grafton	Coffs Harbour
Days/year with thunder	23	13	8	34	33

The low frequency of thunder days in the Ballina and Alstonville climate data is not typical of the observations at the other sites, and is thought to be most likely due to variations in the observation times and manner of data recording, as well as variations in the length of records at the different stations. The Grafton observations suggest that thunderstorms in the area of the roadworks would occur on average about 34 days per year.

Fog

One of the greatest hazards to the safe operation of roadways is the occurrence of fog when visibility is reduced to less than 1 km as listed below. Fog formation in a moist airmass is generally due to nighttime cooling, or the interception of low-level clouds with terrain. On very rare occasions (less than once per year) seafog has been observed on the northern coast (i.e. north of Byron Bay). The movement of cooler air down sloping terrain at night tends to favour the formation of fog in lower lying areas. Such fogs commonly form from about midnight and last until about 9 a.m.. Fog may occur any time of the year, especially after rain. Fogs are most significant between the hours 3 a.m. to 8 a.m. unless associated with or following heavy rain.

The mean number of days per year of fog at the various sites is indicated in Table 4.

Table 4: Mean number of days per year with fog.

Site	Lismore	Ballina	Alstonville	Grafton	Coffs Harbour
Days/year with fog	36.7	2.5	0.4	17.5	2.9

The fogs are less common closer to the coast due to the moderating effect of the sea on the prevailing onshore winds. The observations from Grafton and Lismore record that fogs occur in the general area between 17 and 37 days per year. The area in the vicinity of the realignment would experience a similar frequency of fogs.

Frosts

Frost on roadways can reduce friction and thereby cause dangers to the motorist. As for the formation of fogs, the movement of cooling nighttime air down sloping terrain favours the formation of cooler air and frosts in lower lying areas. The morning frosts will occur when the air temperature falls to 2 °C or less and the ground temperature to -1 °C.

The number of days with frost at the various sites is given in Table 5.

Table 5: Mean number of days per year with frost.

Site	Lismore	Ballina	Alstonville	Grafton	Coffs Harbour
Days/year with frost	8.9	Nil	0.6	6.9	6.9

Frosts occur in the low lying area generally from June, July and August on average about 6 times per year. The frosts are less frequent adjacent to the coast and increase with distance inland. The area in the vicinity of the realignment would experience frosts on average about 7 days per year.

Bushfires

Bushfires are a common occurrence in Australia and can cause severe interruption to traffic due to poor visibility and danger to life. Climatological data (reference Atlas of Australian Resources Third Series Volume 4 CLIMATE) indicates that large bushfires during the spring and summer period will occur in the region on approximately 5 times in 30 years (i.e. about once every 6 years).

The number of days of haze reported from the various sites is provided in Table 6.

Table 6: Mean number of days per year with haze.

Site	Lismore	Ballina	Alstonville	Grafton	Coffs Harbour
Days/year with haze	39.4	3.0	120.0	21.3	142.0

Haze which is commonly due to either dust, smoke or sea salt is reported from the different sites on between 3 and 142 days per year. The difference in the records of this phenomenom is thought to be largely due to differences at the sites in the interpretation or recording of haze.

Temperatures

Maximum and minimum dry-bulb air temperatures available for Byron Bay, Lismore, Ballina, Alstonville and Grafton are listed in Table 7.

Table 7: Maximum and minimum monthly and annual temperatures (°C).

Month	Mean Maximum					Mean Minimum				
	Byron Bay	Lis-more	Ballina	Alston-ville	Grafton	Byron Bay	Lis-more	Ballina	Alston-ville	Grafton
Jan	27.4	29.8	27.8	27.2	30.0	20.7	18.8	19.6	19.4	19.6
Feb	27.4	29.1	27.9	26.5	29.2	20.5	18.8	19.3	19.2	19.5
Mar	26.5	27.9	25.8	25.8	28.1	19.8	17.3	17.9	18.1	17.9
Apr	24.4	24.7	24.8	24.0	26.1	17.2	14.2	14.1	15.7	14.8
May	22.1	22.6	22.4	21.2	23.0	15.1	10.9	13.0	13.3	11.5
Jun	19.5	20.2	20.2	18.8	20.7	11.9	8.1	10.0	10.6	8.1
Jul	19.1	19.9	20.2	18.5	20.3	11.4	6.5	8.8	9.5	6.0
Aug	20.1	21.5	21.5	19.9	21.9	12.3	7.1	8.6	10.4	7.1
Sep	21.7	24.2	22.9	22.0	24.5	14.0	9.9	11.1	12.3	9.9
Oct	22.7	26.6	24.3	23.9	26.4	15.8	13.2	13.7	14.5	13.5
Nov	24.4	28.3	26.2	25.5	28.2	17.8	15.9	16.4	16.5	16.1
Dec	26.2	29.7	26.7	26.8	29.6	19.5	17.8	17.4	18.2	18.3
Annual	23.5	25.5	24.2	23.3	25.7	16.3	13.2	14.2	14.8	13.5
Extreme	46.5	43.0	38.0	40.7	43.8	2.0	-3.5	0.2	2.7	-2.2
Days/year >35°C		8	2	2	9	-	-	-	-	-
Days/year <2.2°C		10	2	nil	7	-	-	-	-	-

The above table and climate statistics indicate that:

- The climate of the area is quite moderate and the air temperatures should not present any problem to the construction and operation of the roadway. The occurrence of high (> 35 °C) and low (<2.2 °C) temperatures is very low.

- The warmest months occur during December, January and February with mean daily maximum temperatures between 26 °C and 30 °C, and mean daily minimum temperatures between 18 °C and 20 °C.

- The cooler months occur during June, July and August with mean daily maximum temperatures between 19 °C and 21 °C and mean daily minimum temperatures between 6 °C and 10 °C.

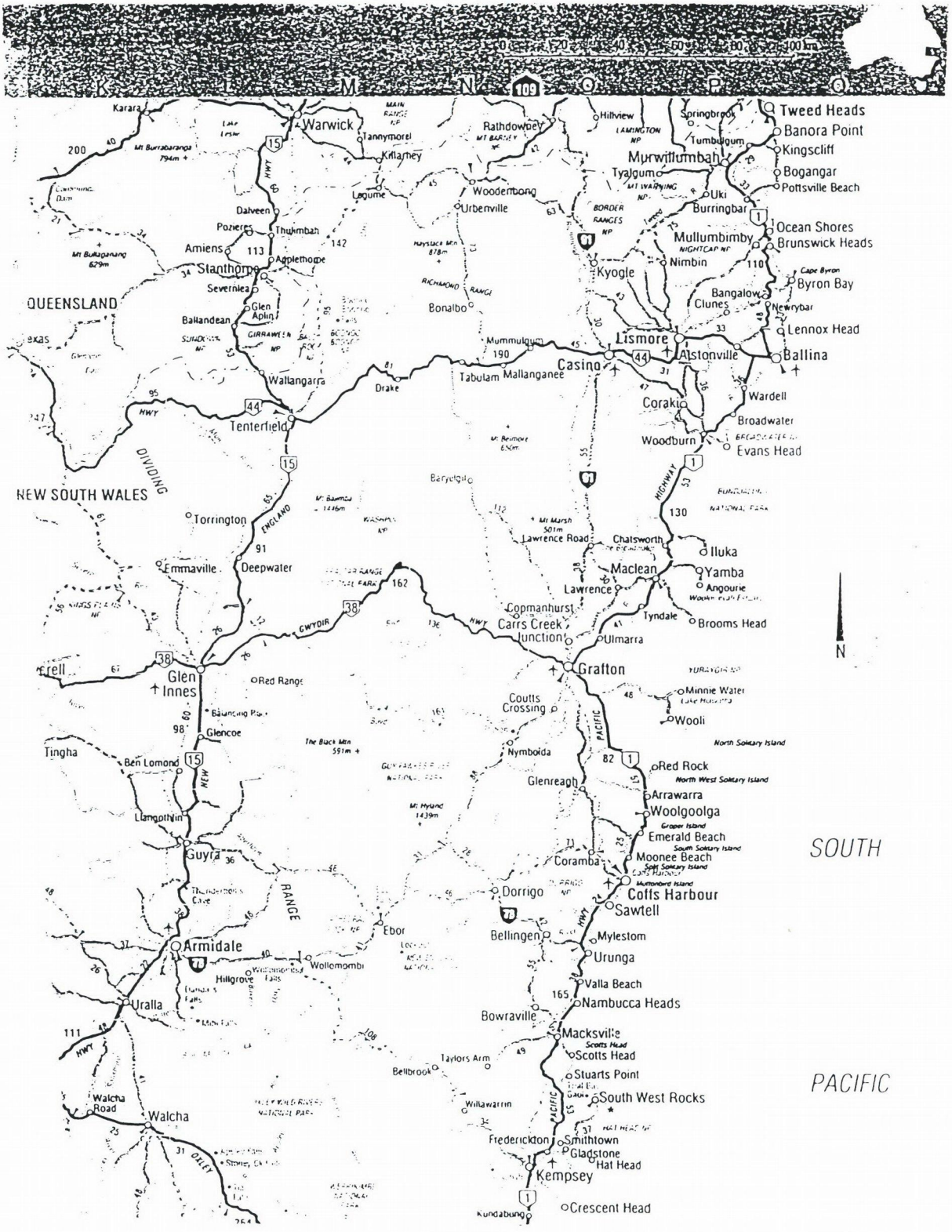
Summary

The frequencies of meteorological conditions that may affect the construction and operation of the Tyndale realignment are summarised in Table 8 below.

Table 8: Frequency of adverse climate conditions for the construction and operation for the Tyndale realignment.

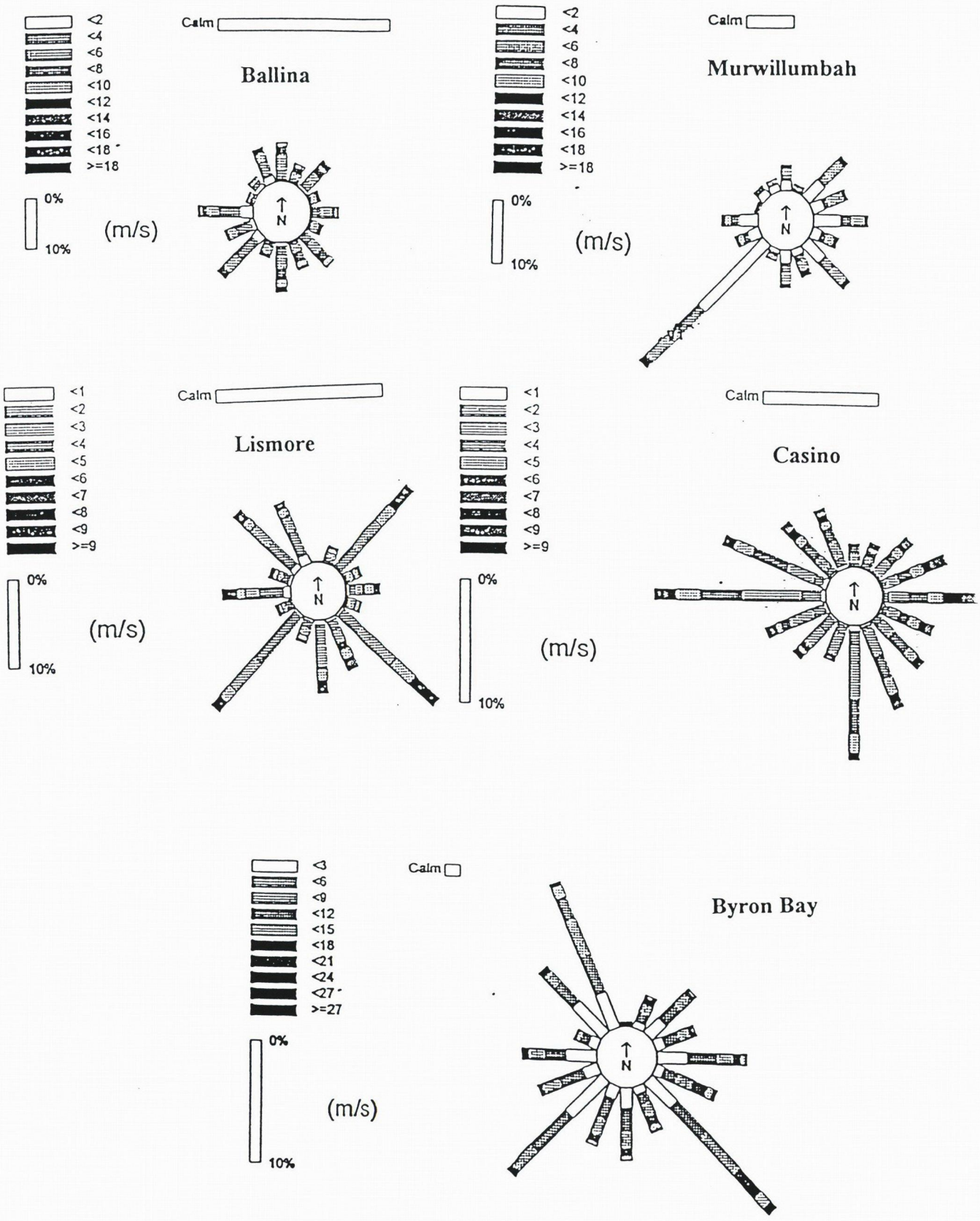
Parameter	Occurrence
Strong winds and gales	Affecting the area on approximately 9 to 10 days of the year.
Rainfall	Highest rainfall between January and March with rain occurring on average 11 to 15 days per month.
Thunderstorms	Thunderstorms will occur in the area on about 34 days per year.
Fogs	Fogs are expected to occur in the area on between 17 and 34 days per year mostly between 3 a.m. and 8 a.m.
Frosts	About 7 morning frosts per year will occur in the area.
Bushfires	Large bushfires occur in the region during spring and summer on average once in every 6 years.
Temperatures	Temperatures should not present a problem in this mild area, with extreme high or low temperatures being very infrequent.

Figure 1: Map of monitoring sites in the region



(Source: The Penguin Australian Road Atlas)

Figure 2: Wind roses showing frequency of wind speeds and directions at sites in the region.



APPENDIX G

AIR QUALITY

Katestone Scientific Pty Ltd

A.C.N. 011 052 592

INNOVATIVE INDUSTRIAL SOLUTIONS

Report from Katestone Scientific to Kinhill Cameron McNamara

Air Quality Assessment of Tyndale Realignment Projects

JUNE 1997

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Air Quality Assessment of Tyndale Realignment Projects

1. Introduction

A realignment of the Pacific Highway has been proposed for two sections near Tyndale northern New South Wales. These sections are namely Byrons Lane to Shark Creek and Tyndale Village. The sections are located 24 km and 32 km north of Grafton.

Both road sections are located immediately to the east of the south arm of the Clarence River. Land to the east of the road and to the west of the river are cultivated. Further to the east of the Tyndale Village section is Bondi Hill. Further to the west of the Byrons Lane to Shark Creek section are the Woodford North and South state forests.

Likely air quality impacts have been estimated based on existing traffic volumes and detailed dispersion modelling of air quality along the Pacific Highway in northern New South Wales as part of other highway studies.

This report reviews the air quality aspects of the existing roadway.

2. Background air quality

Dominant air quality influences in both study areas will include rural activities and vehicle emissions along the Pacific Highway and low-volume residential traffic in Tyndale Village.

There are unlikely to be any major atmospheric emissions in the region apart from vehicular traffic and intermittent emissions due to farming, forestry and bushfire activity.

Results of a one-day background air quality study conducted by Katestone Scientific in a small rural village along the Pacific Highway in northern New South Wales found 1 hour average concentrations of carbon monoxide to be below 1 ppm. Emissions from the urban areas of Grafton and Ballina should not produce significant levels of pollution in the area.

Based on experience in monitoring at similar sites background air pollutant concentrations are estimated in Table 1.

Table 1: Background pollutant concentrations

Parameter	Concentration
Carbon monoxide (CO)	0.1-1.0 ppm
Nitrogen dioxide (NO_2)	10 ppb
Particulate matter (PM_{10})	30 $\mu g/m^3$
Total suspended particulates (TSP)	50 $\mu g/m^3$

Table 2 presents relevant air quality guidelines for the above pollutants recommended by national and state authorities.

Table 2: Recommended hourly equivalents of common air quality guidelines

Parameter	Recommended equivalent	Source	Derived from
CO	25 ppm	Stretton/WHO	From NH&MRC 8 hour guideline of 9 ppm.
NO_2	160 ppb	NH&MRC	1 hour
TSP	1000$\mu g/m^3$	NH&MRC	From annual average of 90 $\mu g/m^3$
PM_{10}	200 $\mu g/m^3$	USEPA	From proposed 24 hour guideline
VOC	500 $\mu g/m^3$	NH&MRC	Indoor only

3. Air quality adjacent to Pacific Highway

Estimates of ground-level concentrations of vehicle emissions have been made based on dispersion modelling studies using CALINE-4 conducted by Katestone Scientific for similar sections of the Pacific Highway. Traffic volumes travelling along the two study sections have been also used in estimating near road air quality.

CALINE-4 is a traffic dispersion model that has been used extensively in New South Wales and is currently accepted by regulatory agencies and councils in Queensland and New South Wales as being an appropriate conservative model for forecasting near field impact close to major roads.

Annual average daily traffic flows measured in 1995 at Harwood on Harwood Bridge have been used as traffic volumes for both study sections. Traffic volumes for both sections have been estimated as 9164 vehicles per day.

Estimated pollutant levels from passing vehicles at a distance of 1 m from the kerb are presented in Table 3.

Table 3: Estimated maximum hourly roadside pollutant concentrations at 1m distance from the kerb

Parameter	Concentration	Guideline
Carbon monoxide (CO)	1.6 ppm	27 ppm
Nitrogen dioxide (NO_2)	12.5 ppb	160 ppb
Total suspended particulates (TSP)	59 $\mu g/m^3$	1000 $\mu g/m^3$

Estimations of pollutant concentrations are below recommended guidelines for all pollutants at 1 m from the kerb.

Pollutant concentrations will decay rapidly with distance from the kerb. It is likely that concentrations will be at background levels within 30 m from the kerb.

4. Conclusions

This report concludes that levels of pollutants from motor vehicles predicted at the kerb for the existing highway are low and well below recommended guidelines

APPENDIX H

TRAFFIC DATA

04.150	1 KM S OF MOONEE BEACH RD	22	3080	4[illegible]0	5950	9100	9891	12314	16332
04.251	WOOLGOOLGA-N OF MR542, ARENCE ST	TOWN	3260	3[illegible]0	5070	7610	9102	12206	14722
04.252	AT ULMARRA SHIRE BDY	15	2400	2780	3750	3550	5827	6820	8109
	SHIRE OF ULMARRA								
04.168	AT HALFWAY CREEK BR	15	2710	2540	3250	3820	5064	5883	6842
*04.002	5.2KM S OF SH12,CHARLES ST	15	2350	2990	3750	4892	5725	6317	7855
	CITY OF GRAFTON								
04.254	SOUTH GRAFTON-S OF CHARLES ST	TOWN	2690	4140	3600	3630	5088	8101	9489
04.255	SOUTH GRAFTON-E OF SCHWINGHAMMER ST	TOWN	2600	4540	4330	4090	5401	7385	8339
04.256	SOUTH GRAFTON-S OF CENTENARY DR	TOWN	2890	4620	4110	3630	5133	6153	--
04.021	AT ULMARRA SHIRE BDY	15	3200	4370	4890	5190	5238	6738	8352
	SHIRE OF ULMARRA		1970	1974	1978	1982	1986	1990	1995
04.257	ULMARRA-S OF CLARENCE RIVER FERRY	15	2750	3110	3830	4350	4552	5666	--
04.023	COWPER-E OF BRUSHGROVE ISLAND RD	13	2350	3090	2940	3630	3249	5241	7311
	MACLEAN COUNCIL								*
*04.400	MACLEAN-S OF MR152,ROAD TO MACLEAN	13	2540	2650	3340	3360	5194	5640	7125
04.632	HARWOOD-S OF MR152,YAMBA RD	13	1940	3000	2740	3490	5426	5697	--
*04.001	HARWOOD-ON HARWOOD BR	13	2890	3280	4180	5664	--	6851	9164
04.124	MORORO-AT CLARENCE RIVER BR	13	2240	3140	2810	4340	5269	5870	--
04.123	MORORO-N OF ILUKA RD	13	2180	2740	2260	3510	4810	5075	6547
	SHIRE OF RICHMOND RIVER								
*04.233	AT TICK GATE-12.9KM S OF WOODBURN	13	2050	2690	3460	3664	4232	4812	6427
04.120	WOODBURN-S OF WATSON ST	TOWN	2370	3690	3890	3900	4662	5651	--
04.260	WOODBURN-N OF MR145,CORAKI RD	TOWN	3240	3330	4620	5050	5387	--	--
04.261	WOODBURN-W OF DUKE ST	TOWN	2820	3470	4400	5360	5645	7228	8511
04.119	WOODBURN-E OF NORMAN ST	TOWN	2450	2600	3580	3940	4407	5359	--
	SHIRE OF BALLINA								
04.116	AT RICHMOND RIVER SHIRE BDY	6	2570	2960	3570	4650	5424	5974	8017
04.262	WARDELL-S OF MR555,LISMORE RD	6	2750	3090	3930	6030	5525	7026	--
*04.264	BALLINA-S OF SH16,BRUXNER HWY	6	2580	3020	3690	4801	5532	6344	8505
04.039	E OF SH16,BRUXNER HWY	6	4390	4990	7690	9170	9415	12455	16990
04.040	BALLINA-E OF MR146,ELTHAM RD	6	4810	6260	8420	10400	9577	--	--
04.680	BALLINA-W OF BAGOT ST	TOWN	--	--	--	14110	13895	17141	25397
04.639	BALLINA-S OF BANGALOW RD	TOWN	1190	1690	2890	5000	6376	9104	16977
04.058	BALLINA-N OF SOUTHERN CROSS DR	TOWN	3320	2810	3760	5270	7655	10323	--
04.043	1.0KM S OF CUMBALUM	6	2130	2290	3010	3900	4730	6340	--
04.060	KNOCKROW-S OF MARTINS LANE	6	2130	2450	2850	4180	4507	5351	6742

DAILY TRAFFIC VOLUMES Year 1995

PACIFIC HWY,SH10 MACLEAN-S OF MR152,ROAD TO MACLEAN Station No. 04.400.C

Week	Beginning	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Total	Percent
1	2/01/95	7938 p	7833	7575	8082	8371	7759	6804	54362	2.0961
2	9/01/95	7839	7515	7221	7604	7657	7167	6154	51157	1.9726
3	16/01/95	7236	6694	6833	6908	7020	6102	5821	46614	1.7975
4	23/01/95	6325	6224	6814	5496 p	6144	5549	5392	41644	1.6058
5	30/01/95	6105	6186	6315	6076	6055	4834	4784	40355	1.5561
6	6/02/95	6390	6642	6439	6738	7071	5498	5353	44131	1.7017
7	13/02/95	6851	6968	6549	6219	6670	5215	5248	43750	1.6870
8	20/02/95	5902	5975	6290	6766	6774	5410	5391	42502	1.6389
9	27/02/95	5798	6035	6069	6252	6277	4880	4662	39973	1.5414
10	6/03/95	5481	5064	5406	6065	6425	4904	5241	38596	1.4883
11	13/03/95	5602	5755	5798	6161	6099	4628	4659	38702	1.4921
12	20/03/95	6263	5862	5848	6016	6238	4623	4726	39598	1.5269
13	27/03/95	5992	5839	5907	6041	6282	5021	4755	39787	1.5342
14	3/04/95	5705	5919	5851	7597	7491	6554	6432	45548	1.7564
15	10/04/95	7763	8087	8961	11539	10681 p	6378	6207	59616	2.2988
16	17/04/95	10250 p	9282	9208	9101	9137	8054	7645	62673	2.4167
17	24/04/95	7711	6480 p	6877	7526	7647	6217	5778	48238	1.8601
18	1/05/95	7184	7460	7563	7328	7311	6256	6191	49313	1.9015
19	8/05/95	6637	6529	6989	7419	6419	6090	6144	46255	1.7451
20	15/05/95	6934	6805	6787	6959	7424	5992	5667	46608	1.7972
21	22/05/95	6623	6786	6641	7118	7090	5607	5671	44536	1.7173
22	29/05/95	6555	6843	6784	7036	6858	5387	5099	44563	1.7184
23	5/06/95	6551	6511	7102	7499	8726	6542	5748	47679	1.8385
24	12/06/95	7405 p	7463	7227	7522	7388	6203	5792	48830	1.8829
25	19/06/95	6622	7054	7314	7954	7482	6188	5730	48344	1.8642
26	26/06/95	6962	7264	7141	7395	7879	7502	6835	50978	1.9657
27	3/07/95	7827	7860	7666	8062	7782	6672	6447	52336	2.0181
28	10/07/95	7337	7662	7645	7637	7645	6287	5950	50153	1.9339
29	17/07/95	6989	7261	7526	7794	7789	5998	6148	49505	1.9089
30	24/07/95	6877	7599	7443	7919	8054	5999	6075	49966	1.9267
31	31/07/95	7358	7460	7585	7650	7869	6221	6153	50396	1.9433
32	7/08/95	7456	7620	7464	8056	7499	6517	6341	50983	1.9659
33	14/08/95	7362	7429	7091	7717	8182	6378	6626	50785	1.9583
34	21/08/95	6952	7459	7419	7770	7856	6344	6302	50102	1.9320
35	28/08/95	7501	7354	7628	7982	6989	6685	6834	50973	1.9655
36	4/09/95	7368	7502	7534	7881	7935	6301	6235	50726	1.9560
37	11/09/95	7352	7336	7366	7410	8278	8163	7202	53670	2.0695
38	18/09/95	8198	7918	8151	8665	9130	9029	7823	58944	2.2729
39	25/09/95	8610	8403	8741	9618	10603	9164	7920	63061	2.4317
40	2/10/95	9506 p	8776	9036	9556	10093	9455	7592	64036	2.4693
41	9/10/95	7860	7518	7719	8097	8297	6811	6891	53193	2.0511
42	16/10/95	7857	7816	7967	8570	8879	7124	6976	55079	2.1239
43	23/10/95	7946	7779	7765	8069	8255	6295	6715	54914	2.0404
44	30/10/95	7721	7600	7971	7979	8266	7026	6762	53325	2.0562
45	6/11/95	7539	7231	7645	7910	8092	6505	6619	51540	1.9797
46	13/11/95	7451	7490	7915	7602	7839	6311	6705	51515	1.9864
47	20/11/95	6277	6892	7201	6934	7596	6122	6000	47079	1.8154
48	27/11/95	6936	7132	6919	7136	6668	5291	5170	45254	1.7450
49	4/12/95	6098	6606	6686	7068	6902	5838	5291	44489	1.7155
50	11/12/95	2295	7731	8536	10611	10984	9488	7785	57233	2.2069
51	18/12/95	8256	8220	8706	9603	11143	11075	8719	64579	2.4902
52	25/12/95	9316 p	10215 p	11984	11926	11946	11762	7237	68338	2.6351
	Annual Averages:	6908	7125	7257	7763	7801	6021	5131	47872	

AADT	AAWT	AAWE	AADH
7125	7399	6381	6043

p Indicates Public Holiday

DAILY TRAFFIC VOLUMES Year 1995

PACIFIC HWY/SH10 HARWOOD-ON HARWOOD BR Station No. 04.001.C

Week	Beginning	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Total	Percent
1	2/01/95	12658 p	12491	12090	12997	13349	11372	10450	88667	2.5987
2	9/01/95	11683	11200	10761	11333	11412	10681	9171	78241	2.2935
3	16/01/95	10599	9805	10009	10116	10282	8949	8516	68276	2.0009
4	23/01/95	9704	9508	9993	8431 p	9429	8513	8272	63887	1.8151
5	30/01/95	8603	9717	8699	8562	8533	6813	6742	56869	1.7048
6	6/02/95	8135	8456	8197	8578	9002	6959	6815	56182	1.6842
7	13/02/95	8309	8451	7942	7578	8089	6824	6434	53827	1.5905
8	20/02/95	7916	8014	8436	9067	9085	7256	7231	57005	1.7089
9	27/02/95	8206	8341	8589	8848	8884	6906	6598	56572	1.6959
10	6/03/95	7226	6676	7127	7996	8453	6365	6910	50883	1.5254
11	13/03/95	8213	8437	8500	9033	8941	6782	6830	56739	1.7002
12	20/03/95	8044	8436	8618	8662	8976	6864	6802	56597	1.7047
13	27/03/95	8371	8156	8251	8438	8705	7013	6642	55576	1.6661
14	3/04/95	8188	8493	8397	8924	8994	7256	7337	58089	1.7414
15	10/04/95	8928	9400	10212	10514	11960 p	7812	7626	69252	2.0760
16	17/04/95	11606 p	10710	10487	10039	10773	9214	8502	71631	2.1473
17	24/04/95	9047	7199 p	8438	8709	9245	7292	6792	56823	1.7034
18	1/05/95	9811	8592	8556	8710	8743	7116	7049	57655	1.7284
19	8/05/95	7902	5462	8488	8839	8813	7097	7147	53743	1.6111
20	15/05/95	8353	8043	8200	8592	8851	6923	6852	55554	1.6654
21	22/05/95	7905	7761	7750	8634	9537	6739	6717	54043	1.6201
22	29/05/95	8294	8329	8439	8777	8478	6809	6258	55094	1.6516
23	5/06/95	8037	8079	8648	9269	10465	7675	5806	57980	1.7381
24	12/06/95	8566 p	9136	8605	8817	9073	7764	6978	58979	1.7681
25	19/06/95	8166	8756	8967	9842	9707	7487	6844	59869	1.7947
26	26/06/95	8710	9260	9387	9907	10085	9007	8637	64993	1.9484
27	3/07/95	10232	9922	10228	10711	10703	9170	9084	70050	2.1000
28	10/07/95	10471	10787	10748	10751	10762	8851	8376	70746	2.1208
29	17/07/95	9121	9476	9822	10172	10165	7827	8023	64606	1.9368
30	24/07/95	8782	9703	9504	10112	10285	7660	7757	63803	1.9127
31	31/07/95	9542	9675	9966	9921	10205	8058	7980	65357	1.9593
32	7/08/95	9502	9711	9512	10305	9557	8305	8081	64973	1.9478
33	14/08/95	9009	9091	8877	9443	10012	7604	6108	62144	1.8629
34	21/08/95	8987	9642	9590	10044	10155	8200	8146	64764	1.9415
35	28/08/95	9407	9223	9567	10010	8765	8364	8570	63926	1.9164
36	4/09/95	9483	9655	9658	10143	10213	8110	8025	65287	1.9572
37	11/09/95	9463	9442	9523	10220	10655	10509	9270	69080	2.0709
38	18/09/95	10551	10191	10481	11280	12704	11125	9094	75136	2.2514
39	25/09/95	10968	11196	11162	11529	11355	9835	10032	76077	2.2906
40	2/10/95	11693 p	10512	10467	10461	10530	10459	10291	74433	2.2313
41	9/10/95	10800	10769	10441	10613	10840	9712	8503	70675	2.1187
42	16/10/95	9745	10112	9780	10475	10519	8785	8591	68011	2.0386
43	23/10/95	9906	9580	9560	10007	10317	9674	8314	66558	1.9953
44	30/10/95	9140	9080	9641	9524	10144	8610	8088	64227	1.9254
45	6/11/95	9176	9114	9436	9739	10316	8285	9403	64369	1.9296
46	13/11/95	9693	9173	9050	9655	10702	8905	8604	64882	1.9450
47	20/11/95	9621	9837	10222	9914	10844	8754	8563	67855	2.0341
48	27/11/95	9902	10179	9875	10185	9517	7851	7379	65288	1.9572
49	4/12/95	8703	9428	9543	10088	9851	8332	7551	62496	1.9035
50	11/12/95	9178	9511	8777	10762	10870	9196	8720	66724	1.9403
51	18/12/95	10257	10648	11133	11966	13624	10758	8434	75830	2.2733
52	25/12/95	10652 p	12953 p	12600	12844	14032	10476	9851	83108	2.4914
Annual Average		9149	9296	9402	9999	10047	8214	7862	84150	

AADT AAWT AAWE AADH

7704 9589 8068 1.0548

p Indicates Public Holiday

HOURLY TRAFFIC VOLUMES for Week commencing MON 14/08/95 Station No. 05.006.N

PACIFIC HWY,SH10 KARUAH-AT KARUAH RIVER BR

HOUR comm.	MON 14/08	TUE 15/08	WED 16/08	THU 17/08	FRI 18/08	SAT 19/08	SUN 20/08	WEEKDAYS TOTAL	WEEKDAYS MEAN	WEEKDAYS %	WEEKEND (+HOLIDAYS) TOTAL	WEEKEND (+HOLIDAYS) MEAN	WEEKEND (+HOLIDAYS) %	WHOLE WEEK TOTAL	WHOLE WEEK MEAN	WHOLE WEEK %
0	30	52	47	50	57	65	20	236	47	1.05	85	43	0.96	321	46	1.02
1	18	32	51	42	45	44	23	188	38	0.83	67	34	0.76	255	36	0.81
2	20	21	33	32	40	56	7	146	29	0.65	63	32	0.71	209	30	0.67
3	30	26	35	30	42	38	17	161	32	0.72	55	28	0.62	216	31	0.69
4	62	36	45	51	54	55	19	248	50	1.10	74	37	0.84	322	46	1.03
5	108	90	81	68	95	108	53	412	82	1.84	163	82	1.84	605	86	1.93
6	194	133	163	139	182	165	111	911	182	4.04	276	138	3.12	1087	155	3.47
7	224	180	181	228	222	293	149	1257	251	5.57	442	221	5.00	1479	211	4.72
8	288	238	236	264	337	346	224	1667	333	7.39	570	285	6.45	1937	277	6.18
9	333	282	273	257	372	435	350	1522	304	6.76	785	393	8.88	2307	330	7.36
10	337	276	288	291	366	444	385	1576	316	7.01	829	415	9.37	2407	344	7.68
11	365	283	296	321	370	412	361	1636	327	7.27	773	387	8.74	2409	344	7.68
12	344	281	277	281	369	325	307	1552	310	6.89	632	316	7.15	2184	312	6.96
13	346	265	266	320	394	317	297	1611	322	7.16	614	307	6.94	2225	318	7.10
14	322	256	290	337	432	345	344	1633	327	7.25	689	345	7.79	2322	332	7.40
15	277	290	278	301	448	307	372	1594	319	7.08	679	340	7.68	2273	325	7.25
16	285	264	294	285	439	240	345	1629	326	7.23	585	293	6.61	2213	316	7.06
17	239	197	201	247	460	196	230	1344	269	5.97	428	214	4.84	1772	253	5.65
18	141	123	145	158	346	124	211	915	183	4.06	335	168	3.79	1250	179	3.99
19	94	78	120	136	271	110	139	699	140	3.10	248	124	2.80	947	135	3.02
20	115	78	131	134	237	66	114	695	139	3.09	180	90	2.04	875	125	2.79
21	89	70	90	133	222	58	65	604	121	2.68	123	62	1.39	727	104	2.32
22	61	82	97	103	159	37	56	504	101	2.24	93	47	1.05	597	85	1.90
23	59	62	74	82	107	33	23	364	73	1.62	56	28	0.63	420	60	1.34
DAY TOT	4385	3715	3988	4272	6155	4621	4219	22515	4503	100.00	8844	4422	100.00	31359	4480	100.00
MAX	366	290	296	337	460	444	385	AWT =	4503		AWE =	4422		ADT =	4480	

HOURLY TRAFFIC VOLUMES for Week commencing MON 14/08/95 Station No. 05.006.S

PACIFIC HWY,SH10 KARUAH-AT KARUAH RIVER BR

HOUR comm.	MON 14/08	TUE 15/08	WED 16/08	THU 17/08	FRI 18/08	SAT 19/08	SUN 20/08	WEEKDAYS TOTAL	WEEKDAYS MEAN	WEEKDAYS %	WEEKEND (+HOLIDAYS) TOTAL	WEEKEND (+HOLIDAYS) MEAN	WEEKEND (+HOLIDAYS) %	WHOLE WEEK TOTAL	WHOLE WEEK MEAN	WHOLE WEEK %
0	41	44	34	41	45	39	16	206	41	1.03	64	32	0.63	270	39	0.89
1	27	33	39	27	33	24	22	158	32	0.79	47	24	0.46	205	29	0.68
2	29	42	41	32	42	25	13	206	41	1.03	38	19	0.37	244	35	0.81
3	49	42	53	34	47	28	21	225	45	1.13	44	22	0.43	269	38	0.89
4	42	55	27	38	79	31	21	241	48	1.21	52	26	0.51	293	42	0.97
5	49	53	67	39	48	47	20	256	51	1.28	67	34	0.66	323	46	1.07
6	111	84	85	70	90	101	28	440	88	2.20	129	65	1.27	569	81	1.89
7	165	136	154	136	147	121	91	738	148	3.69	212	106	2.08	950	136	3.15
8	231	211	198	217	239	220	145	1096	219	5.48	365	183	3.59	1461	209	4.84
9	205	249	268	297	300	205	268	1322	264	6.61	573	287	5.63	1895	271	6.28
10	295	296	312	321	330	372	321	1554	311	7.77	693	347	6.81	2247	321	7.45
11	317	289	292	300	421	430	390	1629	326	8.15	780	390	7.66	2409	344	7.98
12	308	308	325	318	265	357	395	1624	325	8.12	743	372	7.30	2367	338	7.84
13	309	271	242	278	336	329	448	1436	287	7.18	777	389	7.63	2213	316	7.33
14	280	249	267	317	307	310	503	1510	302	7.55	813	407	7.99	2323	332	7.70
15	305	276	266	310	394	297	610	1551	310	7.76	907	454	8.91	2458	351	8.15
16	275	251	258	280	350	296	537	1411	282	7.07	835	468	9.18	2349	336	7.79
17	250	221	214	253	317	261	716	1255	251	6.28	982	491	9.65	2237	320	7.41
18	173	169	187	191	254	170	542	1006	201	5.02	713	357	7.00	1717	245	5.69
19	116	92	129	117	210	131	394	694	139	3.47	479	239	4.67	1139	163	3.77
20	78	83	79	81	155	86	202	476	95	2.38	288	144	2.83	764	109	2.53
21	73	57	85	76	104	63	145	369	74	1.84	209	104	2.04	606	87	2.01
22	61	60	63	77	91	56	122	328	66	1.63	168	84	1.65	496	71	1.64
23	55	39	49	49	60	39	71	262	52	1.30	107	54	1.05	376	54	1.25
DAY TOT	3657	3630	3730	3905	4876	3092	6088	19998	4000	100.00	10180	5090	100.00	30178	4311	100.00
MAX	327	308	325	321	421	390	718	AWT =	4000		AWE =	5090		ADT =	4311	

HOURLY TRAFFIC VOLUMES for week commencing MON 14/08/95 Station No. 04.010.N

TWEED HEADS BY-PASS TERRANORA-AT TERRANORA CREEK BRIDGE

HOUR comm.	MON 14/08	TUE 15/08	* WED 16/08	THU 17/08	FRI 18/08	SAT 19/08	SUN 20/08	WEEKDAYS TOTAL	WEEKDAYS MEAN	WEEKDAYS %	WEEKEND (+HOLIDAYS) TOTAL	WEEKEND (+HOLIDAYS) MEAN	WEEKEND (+HOLIDAYS) %	WHOLE WEEK TOTAL	WHOLE WEEK MEAN	WHOLE WEEK %
0	53	61	35	56	70	67	111	275	55	0.53	178	89	0.79	453	65	0.61
1	30	31	36	41	46	53	74	184	37	0.36	127	64	0.56	311	44	0.42
2	38	45	25	29	54	48	44	199	40	0.39	92	46	0.41	291	42	0.39
3	63	56	34	76	64	42	41	293	59	0.57	83	42	0.37	376	54	0.51
4	77	79	53	77	66	62	44	352	70	0.68	106	53	0.47	458	65	0.62
5	210	226	176	222	218	138	80	1052	210	2.04	218	109	0.96	1270	181	1.71
6	592	551	503	587	571	266	204	2804	561	5.44	470	235	2.08	3274	468	4.41
7	770	847	691	761	785	427	242	3854	771	7.47	669	335	2.96	4523	646	6.10
8	879	888	789	909	887	704	450	4352	870	8.44	1154	577	5.10	5506	787	7.42
9	718	734	656	737	795	609	678	3640	728	7.06	1487	744	6.57	5127	732	6.91
10	652	638	563	623	702	766	826	3195	639	6.19	1594	797	7.05	4789	684	6.45
11	636	590	698	654	662	828	925	3240	648	6.28	1753	877	7.75	4993	713	6.73
12	568	539	543	551	666	774	995	2867	573	5.56	1769	885	7.82	4636	662	6.25
13	707	613	508	582	668	763	948	3058	612	5.93	1711	856	7.56	4769	681	6.43
14	684	663	628	659	740	753	905	3374	675	6.54	1658	829	7.33	5032	719	6.78
15	788	729	708	760	876	723	1181	3861	772	7.48	1904	952	8.42	5765	824	7.77
16	891	881	902	105	927	865	1051	3596	719	6.97	1916	958	8.47	5512	787	7.43
17	774	672	839	269	859	894	996	3411	682	6.61	1890	945	8.36	5301	757	7.14
18	509	423	525	565	715	655	684	2738	548	5.31	1339	670	5.92	4077	582	5.49
19	313	279	386	357	476	397	431	1761	352	3.41	828	414	3.66	2589	370	3.49
20	193	160	200	433	300	234	310	1086	217	2.11	544	272	2.40	1630	233	2.20
21	219	206	220	254	248	219	255	1147	229	2.22	474	237	2.10	1621	232	2.18
22	141	134	158	167	196	223	154	790	159	1.54	377	189	1.67	1173	168	1.58
23	73	60	120	91	108	206	74	452	90	0.88	280	140	1.24	732	105	0.99
DAY TOT	10578	9902	10017	9391	11699	10916	11705	51587	10317	100.00	22621	11311	100.00	74208	10601	100.00
MAX	891	888	902	909	927	894	1181	AWT =	10317		AWE =	11311		ADT =	10601	

HOURLY TRAFFIC VOLUMES for week commencing MON 14/08/95 Station No. 04.010.S

TWEED HEADS BY-PASS TERRANORA-AT TERRANORA CREEK BRIDGE

HOUR comm.	MON 14/08	TUE 15/08	WED 16/08	THU 17/08	FRI 18/08	SAT 19/08	SUN 20/08	WEEKDAYS TOTAL	WEEKDAYS MEAN	WEEKDAYS %	WEEKEND (+HOLIDAYS) TOTAL	WEEKEND (+HOLIDAYS) MEAN	WEEKEND (+HOLIDAYS) %	WHOLE WEEK TOTAL	WHOLE WEEK MEAN	WHOLE WEEK %
0	52	65	72	60	79	118	139	328	66	0.55	257	129	1.09	585	84	0.70
1	43	26	38	29	55	80	101	191	38	0.32	167	84	0.71	358	51	0.43
2	22	27	37	39	41	65	48	166	33	0.28	113	57	0.48	279	40	0.34
3	21	25	27	27	34	42	45	134	27	0.22	87	44	0.37	221	32	0.27
4	35	41	54	55	60	51	215	43	0.36	119	60	0.51	334	48	0.40	
5	142	100	116	107	147	136	129	612	122	1.03	267	134	1.14	879	126	1.06
6	477	418	421	415	501	384	231	2232	446	3.75	615	308	2.62	2847	407	3.43
7	740	710	700	704	717	524	345	3571	714	5.99	869	435	3.70	4440	634	5.34
8	975	975	943	919	938	843	524	4750	950	7.97	1367	684	5.82	6117	874	7.36
9	971	837	824	888	912	947	882	4432	886	7.44	1829	915	7.79	6261	894	7.54
	909	789	865	919	963	1028	868	4336	867	7.28	1896	948	8.07	6232	890	7.50
	821	785	714	747	834	1093	1000	3949	790	6.63	2093	1047	8.91	6042	863	7.27
12	795	706	759	731	841	969	920	3834	767	6.43	1915	958	8.15	5749	821	6.92
13	722	701	857	722	769	884	951	3745	749	6.35	1835	918	7.81	5620	803	6.76
14	779	716	719	770	848	902	723	3526	705	6.42	1626	813	6.92	5454	779	6.56
15	899	861	857	921	970	780	725	4506	902	7.56	1505	752	6.40	6011	859	7.23
16	967	896	947	961	1058	764	969	4129	826	6.93	1732	866	7.37	5861	837	7.05
17	862	987	883	974	1076	798	884	4311	862	7.24	1682	841	7.16	5994	856	7.21
18	545	628	588	670	913	612	565	3541	669	5.61	1177	589	5.01	4521	646	5.44
19	385	434	547	488	607	393	354	2258	452	3.79	746	373	3.18	3004	429	3.62
20	327	289	306	383	430	238	288	1735	347	2.91	526	263	2.24	2261	323	2.72
21	222	226	226	193	291	189	221	1298	260	2.11	410	205	1.75	1668	238	2.01
22	172	192	203	249	230	226	149	1049	210	1.76	375	188	1.60	1424	203	1.71
23	80	101	109	144	216	210	77	681	136	1.08	267	134	1.22	929	133	1.12
DAY TOT	12083	11536	11603	10953	13423	12329	11164	59526	11920	100.00	23493	11747	100.00	83091	11870	100.00
MAX	982	987	947	981	1076	1093	1000	AWT =	11920		AWE =	11747		ADT =	11870	

Daily Traffic Count by Week

Road Description - PACIFIC HIGHWAY
Roadloc Co-ordinates - R[0000010,2835,A1,14.9]
Station Description - [3044217] SH10 (Pacific Hwy), Maclean - int with MR152 (Maclean St)
Installation - [4421701] SH10 (Pacific Hwy), Maclean - S of MR152 (road to Maclean)
Direction - North and south
Lane - All lanes

Wk No	Period	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Total	Percent
1	01-Jan-96 to 07-Jan-96	0	0	0	0	0	0	0	0	0.0
2	08-Jan-96 to 14-Jan-96	0	0	0	0	0	0	0	0	0.0
3	15-Jan-96 to 21-Jan-96	0	0	0	0	0	0	0	0	0.0
4	22-Jan-96 to 28-Jan-96	0	0	0	0	0	0	0	0	0.0
5	29-Jan-96 to 04-Feb-96	0	0	0	0	0	0	0	0	0.0
6	05-Feb-96 to 11-Feb-96	0	0	0	0	7317	6123	6374	19814	2.7
7	12-Feb-96 to 18-Feb-96	7119	7368	7250	7621	7705	6138	6236	49437	6.8
8	19-Feb-96 to 25-Feb-96	7192	7143	7281	7558	7774	5951	6201	49100	6.8
9	26-Feb-96 to 03-Mar-96	6660	6752	7268	7292	7274	5769	5941	46956	6.5
10	04-Mar-96 to 10-Mar-96	6760	7015	7245	7407	7633	5713	6048	47821	6.6
11	11-Mar-96 to 17-Mar-96	6728	7038	7024	7371	7508	6104	6511	48284	6.7
12	18-Mar-96 to 24-Mar-96	6836	6938	7436	7568	7664	5814	6152	48408	6.7
13	25-Mar-96 to 31-Mar-96	6912	7094	7450	7989	7746	6878	6510	50579	7.0
14	01-Apr-96 to 07-Apr-96	8397	0	0	0	0	0	0	8397	1.2
15	08-Apr-96 to 14-Apr-96	0	0	0	0	0	0	0	0	0.0
16	15-Apr-96 to 21-Apr-96	0	0	0	0	0	0	0	0	0.0
17	22-Apr-96 to 28-Apr-96	0	0	0	0	0	0	0	0	0.0
18	29-Apr-96 to 05-May-96	0	0	0	0	0	0	0	0	0.0
19	06-May-96 to 12-May-96	0	0	0	0	0	0	0	0	0.0
20	13-May-96 to 19-May-96	0	0	0	0	0	0	0	0	0.0
21	20-May-96 to 26-May-96	0	0	0	0	0	0	0	0	0.0
22	27-May-96 to 02-Jun-96	0	0	0	0	7062	5657	5547	18266	2.5
23	03-Jun-96 to 09-Jun-96	5979	6692	6660	7352	8780	6696	4801	46960	6.5
24	10-Jun-96 to 16-Jun-96	7639	7082	6845	7096	6736	4254	0	39652	5.5
25	17-Jun-96 to 23-Jun-96	0	0	0	0	0	0	0	0	0.0
26	24-Jun-96 to 30-Jun-96	0	0	0	0	0	0	0	0	0.0
27	01-Jul-96 to 07-Jul-96	0	0	3373	8673	8947	7787	7658	36438	5.0
28	08-Jul-96 to 14-Jul-96	8688	8423	8633	8833	8918	7654	7144	58293	8.0
29	15-Jul-96 to 21-Jul-96	7367	7261	7131	7621	7784	6573	7050	50787	7.0
30	22-Jul-96 to 28-Jul-96	7768	7378	7278	8163	7750	5509	5719	49565	6.8
31	29-Jul-96 to 04-Aug-96	7282	7394	7371	7925	7952	6909	4869	49702	6.9
32	05-Aug-96 to 11-Aug-96	1472	927	595	458	527	340	187	4506	0.6
33	12-Aug-96 to 18-Aug-96	195	297	250	152	155	12	19	1080	0.1
34	19-Aug-96 to 25-Aug-96	23	56	68	61	80	23	40	351	0.0
35	26-Aug-96 to 01-Sep-96	40	32	24	28	7	24	18	173	0.0
36	02-Sep-96 to 08-Sep-96	42	22	35	28	19	4	4	154	0.0
37	09-Sep-96 to 15-Sep-96	3	7	3	2	1	0	0	16	0.0
38	16-Sep-96 to 22-Sep-96	0	146	132	23	25	0	0	326	0.0
39	23-Sep-96 to 29-Sep-96	0	0	0	0	0	0	0	0	0.0
40	30-Sep-96 to 06-Oct-96	0	0	0	0	0	0	0	0	0.0
41	07-Oct-96 to 13-Oct-96	0	0	0	0	0	0	0	0	0.0
42	14-Oct-96 to 20-Oct-96	0	0	0	0	0	0	0	0	0.0
43	21-Oct-96 to 27-Oct-96	0	0	0	0	0	0	0	0	0.0
44	28-Oct-96 to 03-Nov-96	0	0	0	0	0	0	0	0	0.0
45	04-Nov-96 to 10-Nov-96	0	0	0	0	0	0	0	0	0.0
46	11-Nov-96 to 17-Nov-96	0	0	0	0	0	0	0	0	0.0
47	18-Nov-96 to 24-Nov-96	0	0	0	0	0	0	0	0	0.0
48	25-Nov-96 to 01-Dec-96	0	0	0	0	0	0	0	0	0.0
49	02-Dec-96 to 08-Dec-96	0	0	0	0	0	0	0	0	0.0
50	09-Dec-96 to 15-Dec-96	0	0	0	0	0	0	0	0	0.0
51	16-Dec-96 to 22-Dec-96	0	0	0	0	0	0	0	0	0.0
52	23-Dec-96 to 29-Dec-96	0	0	0	0	0	0	0	0	0.0
	Averages :	1983	1828	1911	2100	2411	1922	1789		
								Total	725067	100.0

1990 A.A.D.T = 5640

05/03 '98 THU 10:56 FAX 0266401006 KIA GRAFTON +++ KINHILL BRISBANE 002

Traffic Count Sth of Ewingsdale

North Bound (South of Ewingsdale)

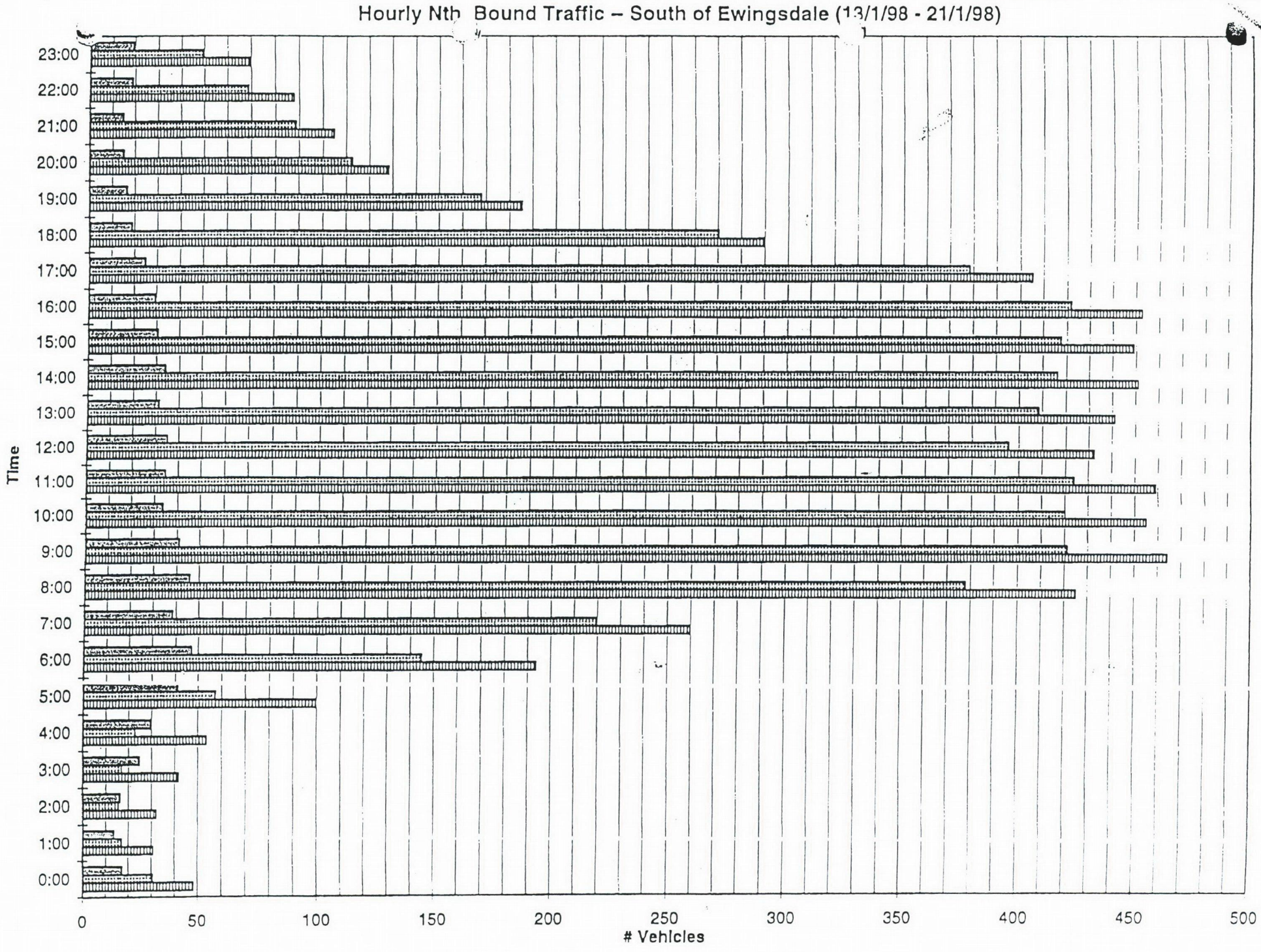
Date	Day	Total Vehicles	Light Vehicles	Heavy Vehicles	Unknown
13/01/98	Tuesday	5923	5140	743	40
14/01/98	Wednesday	6069	5236	816	17
15/01/98	Thursday	6023	5237	754	32
16/01/98	Friday	6751	5966	757	28
17/01/98	Saturday	6404	5918	465	21
18/01/98	Sunday	5927	5593	314	20
19/01/98	Monday	6033	5358	651	24
20/01/98	Tuesday	5658	4876	745	37
21/01/98	Wednesday	5737	4931	783	23
TOTAL		**54525**	**48255**	**6028**	**242**

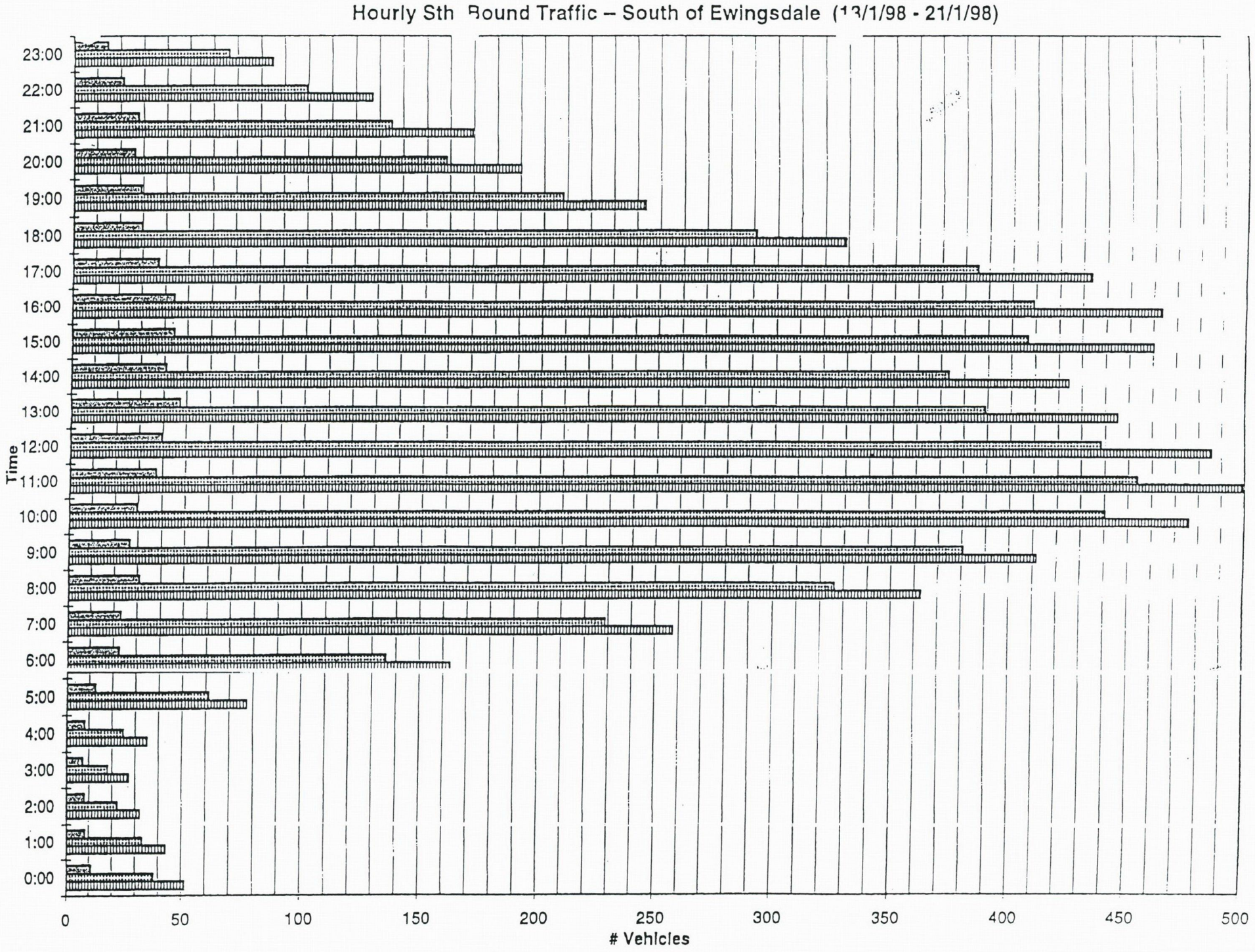
South Bound (South of Ewingsdale)

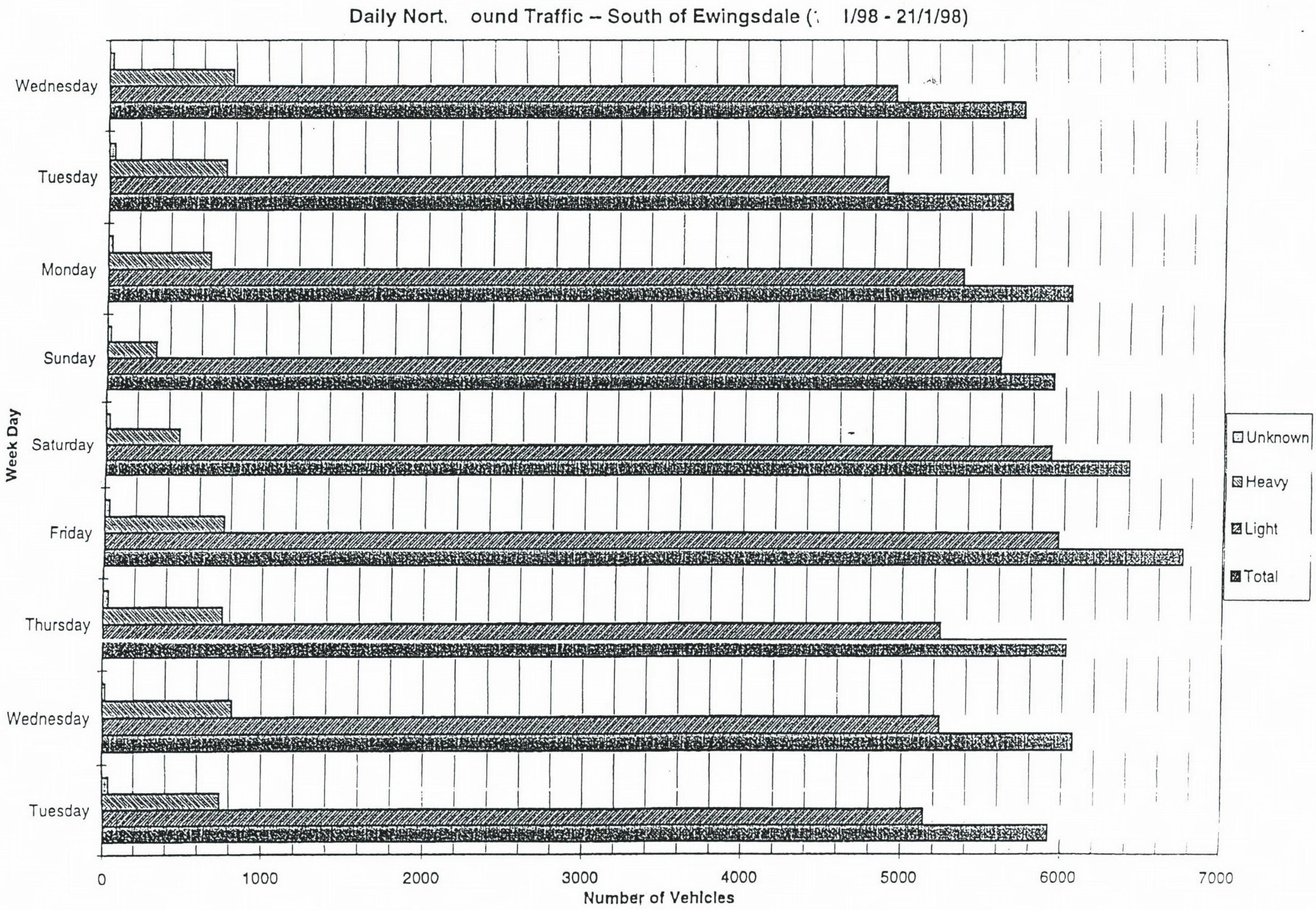
Date	Day	Total Vehicles	Light Vehicles	Heavy Vehicles	Unknown
13/01/98	Tuesday	6218	5371	747	100
14/01/98	Wednesday	6446	5573	696	177
15/01/98	Thursday	6379	5503	670	206
16/01/98	Friday	6934	6171	589	174
17/01/98	Saturday	6596	6141	378	77
18/01/98	Sunday	5969	5567	341	61
19/01/98	Monday	6225	5287	758	180
20/01/98	Tuesday	5864	4991	730	143
21/01/98	Wednesday	6000	5095	729	176
TOTAL		**56631**	**49699**	**5638**	**1294**

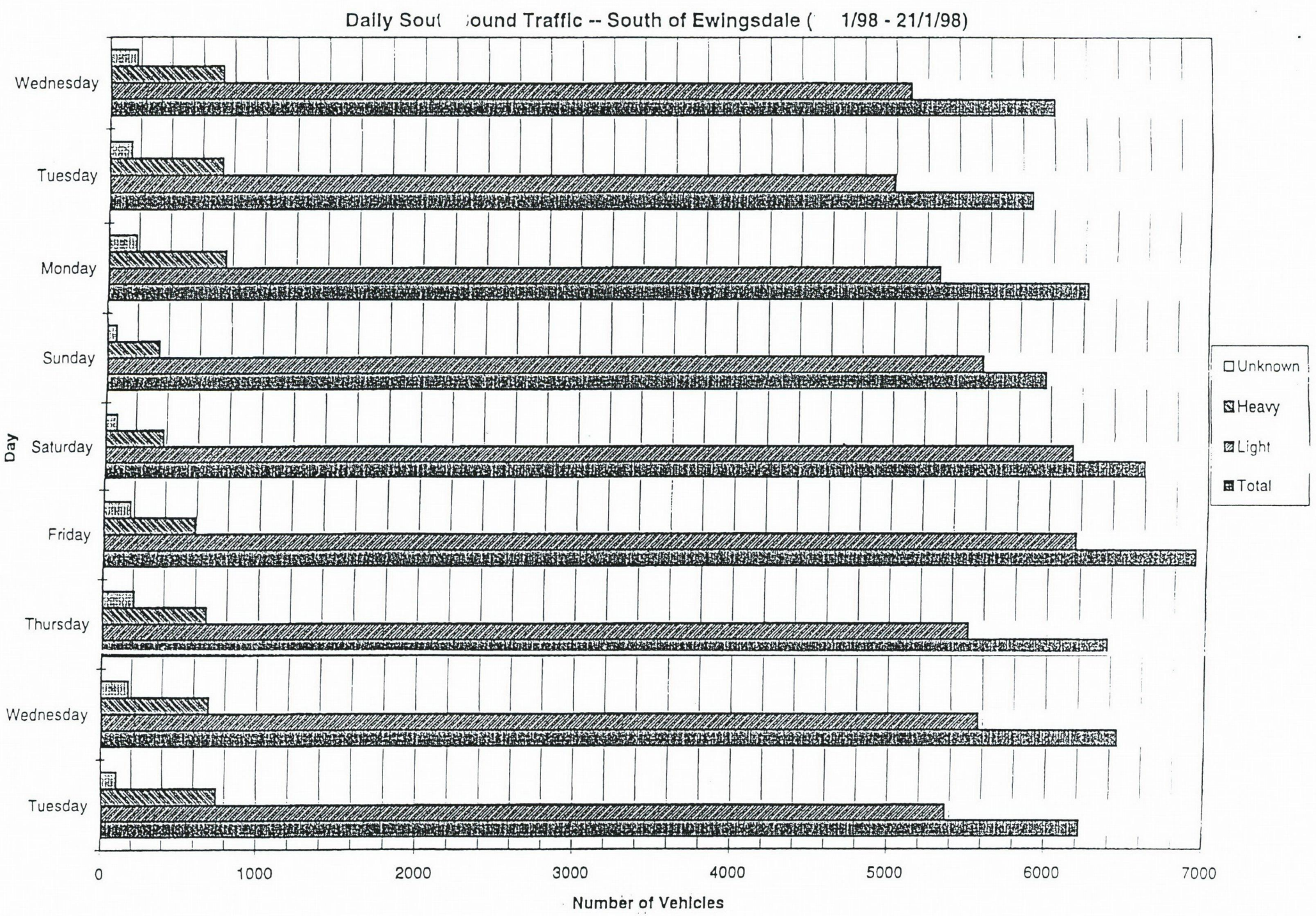
05/03 '98 THU 10:57 FAX 0266401006 RTA GRAFTON →→→ KINHILL BRISBANE 004

Hourly Nth Bound Traffic – South of Ewingsdale (13/1/98 - 21/1/98)




Hourly Sth Bound Traffic – South of Ewingsdale (13/1/98 - 21/1/98)
Time
23:00
22:00
21:00
20:00
19:00
18:00
17:00
16:00
15:00
14:00
13:00
12:00
11:00
10:00
9:00
8:00
7:00
6:00
5:00
4:00
3:00
2:00
1:00
0:00
0
50
100
150
200
250
300
350
400
450
500
Vehicles
Heavy
Light
Total


Daily Nort. ound Traffic -- South of Ewingsdale (: 1/98 - 21/1/98)
Wednesday
Tuesday
Monday
Sunday
Saturday
Friday
Thursday
Wednesday
Tuesday
Week Day
0
1000
2000
3000
4000
5000
6000
7000
Number of Vehicles
Unknown
Heavy
Light
Total


Daily Sout ound Traffic -- South of Ewingsdale (1/98 - 21/1/98)
Wednesday
Tuesday
Monday
Sunday
Saturday
Friday
Thursday
Wednesday
Tuesday
Day
0
1000
2000
3000
4000
5000
6000
7000
Number of Vehicles
Unknown
Heavy
Light
Total

APPENDIX I

HYDROLOGY

Pacific Highway Upgrade—Tynedale hydraulic investigation

1 Introduction

Kinhill has been commissioned by the NSW Roads and Traffic Authority (RTA) to undertake investigations into the proposed upgrade of two sections of the Pacific Highway, one at the village of Tynedale in the south, and the other from Byrons Lane to Shark Creek in the north. In the latter vicinity, the road runs parallel and immediately adjacent to the Clarence River - South Arm and, as such, forms a levee on the eastern bank. While it is a levee, it is relatively low level and is believed to be mainly natural. This hydraulic investigation is to determine the effects that the proposed upgrade works may have upon flooding in the area.

2 Hydraulic modelling

General

The hydraulic modelling of the Clarence River - South Arm and Shark Creek was undertaken using the MIKE-11 modelling package (Version 3.20), developed by the Danish Hydraulic Institute (DHI). MIKE-11 is a one dimensional hydrodynamic modelling system that is widely used for floodplain studies such as this project.

Background information

The catchment hydrology and design boundary conditions for this hydraulic investigation were sourced from the Lower Clarence River Flood Study report, prepared by WBM Oceanics Australia for the NSW Public Works Department in December 1988. This study used the hydraulic model ESTRY, developed in-house by WBM and focussed upon the entire lower Clarence River system from Grafton in the south, to the river mouth situated at Yamba on the northern NSW coast. The results from this report have been used to ensure that the detailed analysis undertaken in this project is consistent with the large scale flood model of the entire floodplain.

In addition to this report, there was another report prepared by WBM Oceanics Australia for RTA on the hydraulic studies for the Shark Creek Deviation immediately to the north of the area investigated in the current project. This is immediately downstream in the river system. This report was prepared in October 1993 and referred to the previous Lower Clarence River report. While it said that the basis of this report was drawn from the previous report, the results were not totally consistent. There was no explanation given in the report of the reason for this difference.

Both reports were general overview studies analysing the large scale flood behaviour of the river and provided considerably less detail on the flow patterns and hydraulic analysis than is included in this report.

The design floods adopted from the WBM 1988 report are described below. The data used in the analysis was as follows:

- Inflows to Shark Creek were taken from Table 6.2 (design flood inflows).
- Inflows in the South Arm of the Clarence River were taken as Channel 71 of the WBM model.
- The downstream water level at Node 56 was the nearest point to the detailed model used here and this was located at the junction with Shark Creek. The actual tailwater level for the MIKE-11 model was selected to be lower than the levels at Node 56 so that the level at the junction with Shark Creek matched the level at Node 56.

Hydraulic results

Three design scenarios were considered for the purpose of this study and these, including peak flows and design tailwater conditions, are listed in Table 1

Table 1 Design conditions

Design scenario		Peak Flow (m^3/s)		Tailwater Condition (mAHD)
		Clarence River	Shark Creek	
1	ARI 100 year flood event ocean spring tide	2,166	150	3.90
2	ARI 20 year flood event 5% AEP ocean storm tide	1,713	130	3.60
3	ARI 5 year flood event lower tailwater level	1,092	130	2.65

Design Scenario 1 was selected to represent approximately the ARI 100 year (or AEP 1%) event and was adopted as the Design Flood 2 from the WBM report. Design scenario 2 was selected to represent approximately the ARI 20 year (or AEP 5%) event and was adopted as the Design Flood 5 from the WBM report.

Design flood 6 from the WBM report included a 20% AEP (ARI 5 year) Clarence River inflow associated with 1% ocean storm tide and 1% lower catchment inflows. This event would obviously have a lower probability overall than AEP 20%, particularly when considering flood levels. Because of this, the flood level adopted was lower than that used in Design Flood 6. The flood which occurred in January 1968 had an observed flood level at Shark Creek bridge of 2.9 m AHD and was reported by WBM to have a 18% AEP. A flood level of 2.9 m AHD was therefore adopted at the bridge, lower than that for Design Flood 6 to provide a better estimate of the ARI 5 year flood level.

The design flood inflow for Shark Creek was also reduced to a lower discharge more representative of the smaller event, though this has only limited effect on the overall floodplain.

The design flood cases do not represent flood probabilities directly but do indicate a number of combinations of flood flows and storm surge levels for the Lower Clarence River.

A base case scenario was developed based upon the existing Pacific Highway alignment as defined by a detailed engineering survey conducted May/June 1997. A summary of peak water levels, design flows and flow velocities over the range of design scenarios at key locations throughout the study area is presented as Tables 2–4.

Table 2 Base case—design peak water levels (mAHD)

Location	Chainage (km)	Peak Water Level (mAHD)		
		Design Scenario 1*	Design Scenario 2*	Design Scenario 3*
Clarence River	2.700	6.28	5.91	5.14
	4.700	5.86	5.33	4.39
	5.800	5.65	5.08	4.00
Shark Creek	1.900	6.08	5.51	4.56
	6.100	5.89	5.34	4.16
	7.900	5.66	5.06	3.62
Overflow 1	1.100	5.86	5.33	4.40
(Clarence R -West Bank)	2.100	5.66	5.08	4.01
Overflow 2	1.250	6.09	5.51	4.49
(Clarence R - East Bank)	3.650	5.88	5.34	4.39
	4.800	5.66	5.08	4.01
Overflow 3	1.300	6.08	5.51	4.57
Shark Creek - East Bank)	5.150	5.89	5.35	4.49

** Refer Table 2.1*

Table 3 Base case—design peak flow (m^3/s)

Location	Chainage (km)	Peak Flow (m^3/s)		
		Design Scenario 1*	Design Scenario 2*	Design Scenario 3*
Clarence River	3.055	1178	1248	1092
	4.975	927	909	907
	6.125	1400	1216	1069
Shark Creek	2.375	41	29	37
	6.550	60	58	39
	8.150	144	129	86
Overflow 1	1.275	615	415	120
(Clarence Rvr -West Bank)	2.550	437	336	49
Overflow 2	1.600	448	232	38
(Clarence Rvr -	3.975	621	407	102
East Bank)	5.050	264	132	12
Overflow 3-	1.500	593	306	51
(Shark Creek- East Bank)	5.625	24	25	46

** Refer Table 2.1*

Table 4 Base case—design peak velocity (m/s)

Location	Chainage (km)	Peak Velocity (m/s)		
		Design Scenario 1*	Design Scenario 2*	Design Scenario 3*
Clarence River	2.700	2.09	1.95	1.83
	4.700	1.18	1.26	1.56
	5.800	1.63	1.70	1.89
Shark Creek	1.900	0.74	0.66	0.69
	6.100	0.22	0.27	0.60
	7.900	0.83	0.89	1.27
Overflow 1	1.100	0.21	0.20	0.19
(Clarence Rvr -West Bank)	2.100	0.23	0.21	0.16
Overflow 2	1.250	0.06	0.06	0.03
(Clarence Rvr -	3.650	0.11	0.11	0.07
East Bank)	4.800	0.33	0.29	0.22
Overflow 3	1.300	0.16	0.12	0.05
(Shark Creek - East Bank)	5.150	0.04	0.03	0.04

** Refer Table 2.1*

Flood levels were observed for four flood events at a flood warning gauge at Shark Creek bridge. These observed flood levels were different in the 1993 report by WBM from the levels provided in the earlier report. This difference was reported to be produced by an error in the datum correction in the original report. The historical flood levels at Shark Creek bridge are listed in Table 5

Table 5 Shark Creek Bridge—flood levels

Date	Observed level (m AHD)	% AEP[1]
January 1967	3.96	6
January 1968	2.90	18
March 1974	4.06	6
May 1980	2.90	14

[1] *Reference in WBM (1993) - "Historical Indication of the Frequency of Flooding at Grafton" (Clarence River County Council)*

In addition to this information, there are a number of observed spot flood heights that have been provided by local residents throughout the study area to enable some comparison with predicted levels. These include a maximum flood height of RL 3.45 m AHD (observed as floor slab level) at Lot 193 on DP 257206 in April of 1996, and a level of RL 4.10 m AHD (observed as floor slab level plus 600 mm) at Lot 191 on DP 811332 in January of 1974.

The calculated design flood levels are consistent with the observed levels listed in Table 2.5, and those noted above.

The general flow pattern in this section of the South Arm of the Clarence River can be determined from consideration of the results in these tables.

Flow into the reach at the upstream end is reasonably contained near the MIKE-11 chainage 0.450 km. Downstream of this point water breaks out of the South Arm of the Clarence River initially on the right bank (modelled as Overflow Branch 4) and then on the left bank a short distance downstream on Overflow Branch 1. The overbank flow on the right bank flows generally parallel to the river and forms a continuous inundated area between the river and Shark Creek. The flow is relatively well contained again further downstream below the junction with Shark Creek.

The Pacific Highway runs along the right bank of the river and is generally at a slightly higher level than the general floodplain level. The highway therefore acts as a "natural levee".

The highway is inundated for the complete length in Design Scenario 1 (approximately the ARI 100 year flood). For smaller floods though, only part of the highway is inundated with the downstream section being flooded before the upstream section.

The results for this analysis can be compared with the levels at the Shark Creek bridge as presented by WBM in the 1993 report (and in the 1988 report which is somewhat different). This point is represented as Node 56 in the WBM report and at chainage 7.35 km in the current report. The flood levels are listed in Table 6 for comparison.

Table 6 Flood levels—Shark Creek Bridge

	ARI 5 year	ARI 20 year	ARI 100 year	Historical
WBM (1988)	-	4.02	4.48	
WBM (1993)	-	3.9	4.3	
Current report	2.94	4.05	4.51	
June 1967				3.96
January 1968				2.90
March 1974				4.06
May 1980				2.90

This table shows that the current report has provided flood levels comparable to those in the WBM 1988 report. The WBM 1993 report has lower flood levels with no explanation given for these differences. The results indicate that the June 1967 and March 1974 flood events are approximately ARI 20 year (a little smaller) while the January 1968 and May 1980 floods are approximately ARI 5 years which is consistent with information on flooding in the region.

Three proposed Pacific Highway upgrade options were considered including the raising of the road to provide an approximate 5 year ARI flood immunity to match Design Scenario 3, the raising of the road to provide an approximate 20 year ARI immunity to match Design Scenario 2, and the raising of the road to provide an immunity against flooding approximating a 10 year ARI (road height set mid-way between a 5 year ARI immunity and a 20 year ARI immunity). These values do not strictly represent flood immunities since they are developed from the three design scenarios given in Table 1. They are however presented as approximate flood immunity levels. They are described in this report as Options A, B and C.

Modelled road levels are presented in Table 7. A summary of the potential effects upon flooding within the study area of these proposed upgrade works are presented as Appendices A (peak water levels) and B (peak flows) respectively.

These results indicate that the upgrade to the ARI 5 year flood immunity has only a relatively limited impact on flood levels and flow distribution since a significant portion of the section of highway was already above this level. The upgrade to the ARI 20 year flood immunity has a greater impact since this level of raising of the road provides a much reduced capacity for transfer of water between the main river channel and the floodplain area. While most of the length of the road is inundated by the largest flood analysed (Design Scenario 1) at an ARI 20 year immunity level, there are still some significant impacts upon flooding. The raising to the ARI 10 year event has an intermediate impact.

Table 7 Proposed Pacific Highway Upgrade raised road levels (m AHD)

	Location	Existing Road Level (mAHD)*	Proposed Minimum Road Level (mAHD)		
			Option A 5 year ARI Flood Immunity	Option B 20 year ARI Flood Immunity	Option C "10" year ARI Flood Immunity#
1	Ch 0.450km	6.00	-	7.65	6.80
2	Ch 1.050km	5.95	-	7.25	6.60
3	Ch 1.800km	5.85	-	6.90	6.35
4	Ch 2.700km	5.75	-	6.50	6.10
5	Ch 3.400km	6.00	-	6.00	6.00
6	Ch 4.100km	4.33	4.60	5.75	5.15
7	Ch 4.700km	4.38	4.50	5.60	5.05
8	Ch 5.250km	4.15	4.50	5.50	5.00
9	Ch 5.800km	3.44	4.45	5.30	4.85
10	Ch 6.450km	3.09	4.05	5.00	4.50

* *Existing highway levels presented are spot levels along modelled weir profile associated with cross-section. These levels are indicative only.*

\# *Represents a road height mid-way between a 5 year ARI flood immunity and a 20 year flood immunity*

Time of inundation

The times of inundation for the section of the Pacific Highway were calculated using the hydrograph shape observed in the 1967 flood at Shark Creek in the Clarence River–South Arm.

Since the highway does not exactly follow the shape of the flood profile, there are small differences in the exact duration of inundation along the road with the largest period of inundation for the downstream end near Shark Creek. The period of inundation of the highway is shown in Table 8.

Table 8 Period of inundation (hours)—Pacific Highway

Event	Time of Inundation (hours)			
	Existing Highway	OPTION A ARI 5Yr Immunity	OPTION B ARI 20Yr Immunity	OPTION C ARI "10" Yr Immunity#
Design Scenario 1	130	110	65	90
Design Scenario 2	100	80	0	60
Design Scenario 3	35	0	0	0

\# *Represents a road height mid-way between a 5 year ARI flood immunity and a 20 year flood immunity*

Since the inundation on the floodplain is primarily from overflow from the river and backwater along Shark Creek, and because the flood hydrographs rise and fall slowly, the upgrading of the highway will have a relatively minimal impact on the duration of inundation of overbank areas.

3 Discussion of results

Option A—Raise road to provide ARI 5 Year immunity to flooding

The raising of the road to provide an immunity to flooding approximately equivalent to a 5 year ARI design event generally results in an increase in flood levels on the eastern bank (adjacent Shark Creek) in the order of 100–200 mm for the larger design events, and a reduction in peak flood levels of up to 100 mm on the western bank.

This is due to an increase in backwater flooding effects within Shark Creek as a result of the raising of the road both reducing the volume of overspill from the Clarence River into the eastern overbank area within the reaches upstream of the Shark Creek bridge, and inhibiting the ability of the overbanks to drain excess flood waters back into the main river channel.

It is highlighted however that, though the level of inundation is somewhat increased due to the raising of the road, the slow rise and fall of the design flow hydrographs within the Clarence River suggest that the effect of the raising of the road upon the time of inundation is minimal.

Option B—Raise road to provide ARI 20 Year immunity to flooding

The raising of the road to provide an immunity to flooding approximately equivalent to a 20 year ARI design event generally results in an increase in flood levels on the western bank in the order of 200–300 mm for the ARI 20 year design event (Design Scenario 2) although some areas have greater increases in flood levels.

3.3 Option C - Raise Road to Provide ARI 10 Year Immunity to Flooding

The raising of the road to provide an immunity to flooding approximately equivalent to a 10 year ARI design event generally results in an increase in flood levels on the eastern bank (adjacent Shark Creek) in the order of 30—130 mm for the ARI 100 year event (Design Scenario 1), and an increase in peak flood levels on the western bank of approximately 10—65 mm for the ARI 20 year design event (Design Scenario 2).

Once again, the increased flooding on the eastern bank is due to an increase in backwater flooding effects within Shark Creek as a result of the raising of the road both reducing the level of overspill from the Clarence River into the eastern overbank area within the reaches upstream of the Shark Creek bridge, and inhibiting the ability of the overbanks to drain excess flood waters back into the main river channel.

APPENDIX J

GEOTECHNICAL ASSESSMENT

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REPORT ON

GEOTECHNICAL INVESTIGATION
PACIFIC HIGHWAY, BYRONS LANE TO
SHARKS CREEK, TYNDALE
NORTH COAST, NEW SOUTH WALES

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March, 1998

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1.0 INTRODUCTION

Golder Associates Pty Ltd was commissioned by Kinhill Cameron McNamara Pty Ltd to undertake geotechnical investigation for the proposed reconstruction and realignment of the Pacific Highway from Byrons Lane to Shark Creek, Tyndale (chainages 33.7 to 36.8km north of Grafton). The location of the investigation is shown on the locality plan (Drawing No. 1).

The investigation was initially oriented to providing information on that part of the alignment to be reconstructed. Benkelman Beam testing was carried out at 100 - 200m intervals along both north and south bound lanes. Test pitting and sampling with in-situ penetrometer testing was undertaken at selected intervals and laboratory testing of retrieved samples was carried out. This work was summarised in a report[1] dated October 1997.

Subsequent to the initial investigation programme, additional test pitting, sampling and in situ testing was requested and undertaken in late January to February 1998. This program involved investigating subgrades west of the existing highway (river side) on the northern 1.5km of the route and sampling of existing pavement gravels in the southern 1.5km of the route.

This report summarises all of the work completed.

2.0 SITE DESCRIPTION

The section of the Pacific Highway investigated closely follows the eastern bank of the South Arm of the Clarence River with the edge of the sealed pavement between 5m and 35m from the crest of the river bank. The ground is flat to gently sloping away from the river bank at levels ranging from RL 2 - RL 8m AHD. Most of the land to the west of the highway (between the highway and the river) is covered with vines and natural vegetation. To the east of the highway the land is mainly under cultivation for sugar cane with dwellings and associated buildings close to the highway.

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[1] Progress Factual Report on Geotechnical Investigation, State Highway No. 10, Pacific Highway, Proposed Realignment of Tyndale, North Coast, New South Wales. Golder Associates Report 97638064(D) to Kinhill Cameron McNamara Pty Ltd, October 1998.

A relatively wide zone between the highway and the river (up to 35m) is present from just south of Gallaghers Road to Shark Creek. South of Gallaghers Road this width diminishes to often less than 5m.

3.0 GEOLOGICAL SETTING

The regional geology of the area is depicted on Drawing No. 2. In brief summary, this section of the Pacific Highway is underlain by alluvium of the South Arm of the Clarence River overlying a western shallow dipping sequence of Mesozoic Rocks. It appears probable that the entire length from Byrons Lane to Shark Creek is underlain at depth by the Walloon Coal Measures comprising shale, sandstone, siltstone with some thin coal seams.

Drilling by the RTA[2] just to the south of the section investigated, indicated alluvium to be shallow, and to thin rapidly away from the river. The upper 2 - 3m on the river side of the highway was soft sandy clay or sandy clayey silt, underlain by clayey sands and sandy clays, which may be in part deeply weathered bedrock material. Definite residual rock was found at depths of 8 - 10m.

4.0 FIELD INVESTIGATIONS

4.1 Test Pitting

A John Deere 315C Backhoe using a 450mm wide bucket excavated sixteen test pits (TP20 - TP31 and TP33 - TP36) along the section of the route initially investigated. Pits were generally excavated between 5 - 10m right of the existing highway except for test pits TP33 and TP34 which were excavated on an alternate alignment section about 40m right of the existing highway.

---

[2] RTA 1996 Geotechnical Investigation of Riverbank Slope Failure at Tyndale, approximately 30km north of Grafton - RTA Scientific Services Brach - Report to Grafton Zone Office.

The test pits were logged and selected samples taken of the exposed strata. Dynamic Cone Penetrometer[3] testing was carried out adjacent to these pits.

These test pits were positioned relative to property boundaries as shown on preliminary layout plans BC7802 - SK - 012, and were not levelled. Positions are approximate only.

In early 1998, further test pitting was carried out. Test pits TP37 - TP40 were excavated, just west of the existing highway between Gallaghers Lane and Shark Creek. The test pits were logged and selected samples of the exposed strata were taken. Dynamic Cone Penetrometer testing was carried out adjacent to each pit. The pits were loosely backfilled on completion. In addition, test pits TP19, TP32 and TP52 - TP55 were excavated through the existing pavement in the south bound lane of the Pacific Highway. Sampling of basecourse, sub-basecourse and subgrade was carried out and the test pits were carefully logged.

Locations and levels of these pits were deduced from the detailed survey plans.

The results of the test pits are detailed on the test pit report sheets in Appendix A. Locations are defined by co-ordinates and chainages. It is noted that these locations are approximate only. Levels have been either deduced from the detailed survey plans provided or determined from known benchmarks.

4.2 Benkelman Beam Testing

Benkelman Beam Testing was carried out over the existing pavements between Byrons Lane and Shark Creek. Two beams were used and traffic control plan (TCP83) as approved was implemented during testing. Results are summarised and presented in Appendix B. This testing was carried out in July 1997 and locations were assessed from topographic features, property boundaries with reference to existing plans BC7802-SK-012-014. To refer to present chainages, 23700m should be added to chainages given in Appendix B.

[3] To Australian Standard AS1289.F.3.2.

5.0 LABORATORY TESTING

Soil and rock samples recovered during the investigation were delivered to Golder Associates NATA registered Brisbane Laboratory. Selected samples were tested for determination of :

- moisture condition
- liquid and plastic limit and linear shrinkage
- particle size analysis by sieve grading methods
- determination of compaction properties (RTA test T111)
- determination of 10 day soaked CBR (RTA test T117A)
- Unconfined compressive strength testing a remoulded samples with various additives (ie cement, fly ash, lime and slag)

The test results are summarised on the following tables and laboratory test certificates are presented in Appendix C. Results of the testing are discussed briefly in Section 6.0. It should be noted that UCS tasting of stabilized materials was still underway at time of report preparation. A summary of available results is given in Appendix C.

SUMMARY OF LABORATORY TESTING RESULTS

Test Pit No.	Depth (m)	Description	Moisture Content RTA - T120 (As sampled) (%)	Particle Size Distribution AS1289.3.6.1 Percent Passing						Plasticity Index AS1289.3.1.1, 3.2.1, 3.4.1			Laboratory Compaction RTA T111		Soaked CBR (Compacted at near OMC) RTA T117A	
				19.0mm	9.5mm	4.75mm	2.36mm	0.425mm	0.075mm	Liquid Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)	Maximum Dry Density (t/m^3)	Optimum Moisture Content (%)	Moulded Dry Density Ratio (%)	CBR Value (%)
TP19	0.05 - 0.15	Pale brown SILTY SANDY GRAVEL	1.9	78	59	48	42	27	9	nl	1	1.0	2.12	8.2	100.2	90
TP19	0.20 - 0.30	Brown CLAYEY GRAVELLY SAND	7.9	-	-	-	-	-	-	-	-	-	1.99	11.1	100.0	35
TP19	0.60 - 0.70	Dark grey CLAYEY SILTY SAND	14.2	-	-	-	100	96	33	23	3	2.0	1.70	16.6	100.0	20
TP20	0.00 - 0.10	Dark brown CLAYEY SILTY SAND	17.2	-	100	99	98	91	22	33	12	6	-	-	-	-
TP20	0.50 - 1.00	Brown slightly clayey SILTY SAND	16.4	-	-	100	99	94	18	25	7	2.0	1.68	16.2	100.0	12
TP21	0.50 - 1.00	Brown slightly clayey SILTY SAND	14.1	-	-	100	99	90	16	29	9	4.0	1.70	16.2	100.0	14
TP22	1.00 - 1.50	Brown SILTY SAND	7.3	-	-	-	-	-	-	-	-	-	-	-	-	-
TP23	1.00 - 1.30	Brown SANDY SILT	45.3	-	-	-	-	-	-	-	-	-	-	-	-	-
TP24	1.00 - 1.50	Brown SILTY SAND	15.0	-	-	-	-	-	-	-	-	-	-	-	-	-
TP25	0.20 - 0.50	Dark brown slightly clayey SILTY SAND	17.5	100	99	98	95	73	23	27	7	3.5	1.67	14.7	99.5	19
TP26	1.00 - 1.50	Brown clayey SILTY SAND	18.9	-	-	-	-	-	-	-	-	-	-	-	-	-
TP27	0.50 - 1.00	Brown clayey SILTY SAND	14.2	-	-	-	-	-	-	-	-	-	1.69	14.3	100.5	25
TP28	0.50 - 1.00	Brown SILTY SAND	17.3	-	-	-	-	-	-	-	-	-	1.70	15.8	99.5	11
TP29	0.50 - 1.00	Brown SILTY SAND	21.4	-	-	-	-	-	-	-	-	-	1.67	14.4	100.0	20
TP30	0.50 - 1.00	Brown SILTY SAND	24.6	-	-	100	98	82	18	30	12	6.5	1.66	17.0	100.0	12
TP31	1.00 - 1.50	Brown fine sandy CLAYEY SILT	30.4	-	-	-	-	-	-	-	-	-	-	-	-	-
TP32	0.45 - 0.55	Light brown GRAVELLY SAND	1.0	89	84	77	73	48	18	19	5	2	2.08	9.1	99.5	40
TP32	1.00 - 1.10	Light brown CLAYEY GRAVELLY SAND	3.1	-	-	-	-	-	-	-	-	-	1.93	11.4	100.5	53
TP33	0.50 - 1.00	Brown SILTY SAND	27.3	-	-	-	-	-	-	-	-	-	-	-	-	-
TP34	0.50 -	Brown SILTY	18.2	-	-	-	100	87	9	21	0	0.5	-	-	-	-

SUMMARY OF LABORATORY TESTING RESULTS (cont'd)

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Test Pit No.	Depth (m)	Description	Moisture Content RTA - T120 (As sampled) (%)	Particle Size Distribution AS1289.3.6.1 Percent Passing						Plasticity Index AS1289.3.1.1, 3.2.1, 3.4.1			Laboratory Compaction RTA T111		Soaked CBR (Compacted at near OMC) RTA T117A	
				19.0mm	9.5mm	4.75mm	2.36mm	0.425mm	0.075mm	Liquid Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)	Maximum Dry Density (t/m^3)	Optimum Moisture Content (%)	Moulded Dry Density Ratio (%)	CBR Value (%)
	1.00	SAND														
TP35	0.20 - 0.30	Brown fine to coarse SAND and SANDSTONE	5.8	100	93	87	84	45	18	23	7	3.5	1.74	9.3	100.0	45
TP35	0.70 - 0.80	Brown SILTY SAND (indurated in part)	11.7	-	100	99	99	75	12	22	3	1.0	1.87	12.7	100.0	20
TP36	0.50 - 1.00	Grey and brown CLAYEY SAND	16.0	-	-	100	99	75	19	31	12	6.0	1.71	17.3	100.0	14
TP38	0.60 - 0.70	Grey brown SILTY CLAY	33.0	-	-	-	-	100	80	50	27	11.5	-	-	-	-
TP40	0.60 - 0.80	Grey SILTY CLAY	53.1	-	-	-	100	99	79	43	20	11.0	1.45	26.5	101.0	7
TP52	0.06 - 0.12	Brown SANDY GRAVEL	3.7	76	62	53	48	33	11	nl	2	1.0	-	-	-	-
TP53	0.30 - 0.40	Red brown CLAYEY SILTY SANDY GRAVEL	7.1	-	-	-	-	-	-	-	-	-	1.98	11.7	100	40
TP52	0.70 - 0.80	Brown CLAYEY SILTY SAND	6.7	-	-	-	-	-	-	-	-	-	1.83	12.4	100	50
TP53	0.03 - 0.17	Orange brown SANDY GRAVEL	2.6	70	49	40	37	24	8	nl	2	1.0	-	-	-*	-
TP53	0.37 - 0.55	Brown clayey SANDY GRAVEL	4.6	-	-	-	-	-	-	-	-	-	2.06	8.8	100.5	50
TP53	0.55 - 0.70	Dark brown SILTY SAND	3.5	-	-	-	-	-	-	-	-	-	1.83	11.0	100.0	50
TP54	0.06 - 0.17	Orange brown SILTY GRAVELLY SAND	4.7	96	77	67	63	46	15	16	1.5	1.5	-	-	-	-
TP54	0.30 - 0.42	Brown SANDY GRAVEL	5.2	-	-	-	-	-	-	-	-	-	1.94	10.7	99.5	45
TP54	0.50 - 0.60	Brown SAND	7.6	-	-	-	-	-	-	-	-	-	1.63	16.8	100.0	30
TP55	0.08 - 0.15	Brown SANDY GRAVEL	1.3	68	54	44	37	25	8	nl	3	0.5	-	-	-	-
TP55	0.20 - 0.27	Brown GRAVELLY CLAY`	7.6	-	-	-	-	-	-	-	-	-	1.96	12.6	99.5	13.5
TP55	0.40 - 0.50	Brown CLAYEY GRAVEL	5.1	-	-	-	-	-	-	-	-	-	2.15	11.0	99.5	30

1 - Plastic Limit = 17.5% 2 = Plastic Limit = 15.5% 3 = Plastic Limit = 11.5%

6.0 ENGINEERING COMMENTS

It is understood that this section of the Pacific Highway is to be reconstructed with very minor deviations (if any), and that final detailed route selection has not yet been made.

6.1 Subgrades

Test pitting and laboratory testing indicate that subgrades beneath the existing pavement and to the east of the existing pavement consist almost entirely of silty sand, sometimes overlain by a thin organic sandy topsoil. This material is relatively uniform with the following general properties :

• Maximum Dry Density	1.63 - 1.71t/m^3	average 1.68t/m^3
• Optimum Moisture Content	14.3 - 17.3%	average 15.9%
• % Passing 0.075mm sieve	16 - 33%	average 21%
• Liquid Limit of Fines	21 - 30%	average 26.5%
• Plasticity Index of Fines	0 - 12%	average 7%
• Linear Shrinkage of Fines	0.5 - 6.0%	average 3.5%
• Soaked CBR Values	11 - 30%	average 18%

All four test pits dug to the west of the existing pavement (ie between the pavement and the river) encountered very different conditions, generally summarised as below:

GL - 0.5 to 1.0m	-	Stiff clay grading less stiff with depth
0.5 to 1.0 - 2.5 to 2.8m	-	Very soft to soft organic silty clay

Limited laboratory testing on two samples of this material indicated the following properties:

• Maximum Dry Density	1.45t/m^3
• Optimum Moisture Content	26.5%
• % Passing 0.075mm sieve	79 - 80%
• Liquid Limit of Fines	43 - 50%

- Plasticity Index 20 - 27%
- Linear Shrinkage 11 - 11.5%
- Soaked CBR Value 7%

In addition, this material is generally wet of Optimum Moisture Content and would be subject to relatively high settlement and possible stability problems. Detailed analysis of stability is beyond the scope of this investigation, as boreholes to delineate depths of strata (and underlying materials) would be required.

Penetrometer results indicate some strengthening of the material around 2 - 2.5m depth. It is possible that similar conditions are present to those found in a 1996 investigation of riverbank slope failure at Tyndale by the RTA[2]. This investigation indicated a wedge of clayey sediments thinning to almost nil thickness at the existing highway.

It is recommended that any realignment to the west be subject to more detailed investigation to include test drilling, settlement assessment and stability analysis.

6.2 Pavement Materials

Test pits TP19, TP32, TP35 - 36 and TP52 - 55 were excavated through the existing road pavement. Test pits TP35 - 36 excavated in July 1997 were dug parallel to the road centreline. The other pits were excavated at right angles to the centreline and sketches of conditions found are given in the test pit reports.

Existing Pavement Materials

Generally variable conditions were found, involving up to 450mm of asphalt at TP32 (northern tie-in); layered sealed pavement at some locations; and variable basecourse and sub-base thicknesses. Basecourse gravels were mainly composed of sandstone rock fragments in a graded matrix. General properties of basecourse gravels are set out below:

Material Property	TP19, TP32, TP52-53 and TP55	Average	TP54
Passing 19mm sieve	68 - 78%	74%	96%
Passing 2.36mm sieve	37 - 48%	42%	63%
Passing 0.075mm sieve	8 - 11%	9%	15%
Liquid Limit	non-liquid (all)		16%
Plastic Limit	non-plastic - 17.5%		14.5%
Linear Shrinkage	0.5 - 1.0%		1.5%
Maximum Dry Density	2.12t/m^3 (TP19 only)		
Optimum Moisture Content	8.2% (TP19 only)		
Soaked CBR Value	90% (TP19 only)		

Note : Basecourse gravel exposed in TP54 was significantly different to other basecourse gravels.

Sub-base gravels used in the existing pavement showed some variation from gravelly sands to sandy gravel. In all areas the materials consisted of ripped or graded sandstones. General properties are set out below.

Material Property	Based on TP19, TP32, TP52-TP55	Average
Maximum Dry Density	1.93 - 2.06t/m^3	1.98/m^3
Optimum Moisture Content	8.8 - 11.7%	11.0%
Soaked CBR Value	30 - 55%	42%

6.3 Stabilisation

The results of laboratory testing are incomplete at time of writing this report.

GOLDER ASSOCIATES PTY LTD

Cec H Shipway
Senior Engineering Geologist

Bruce White
Senior Geotechncial Engineer

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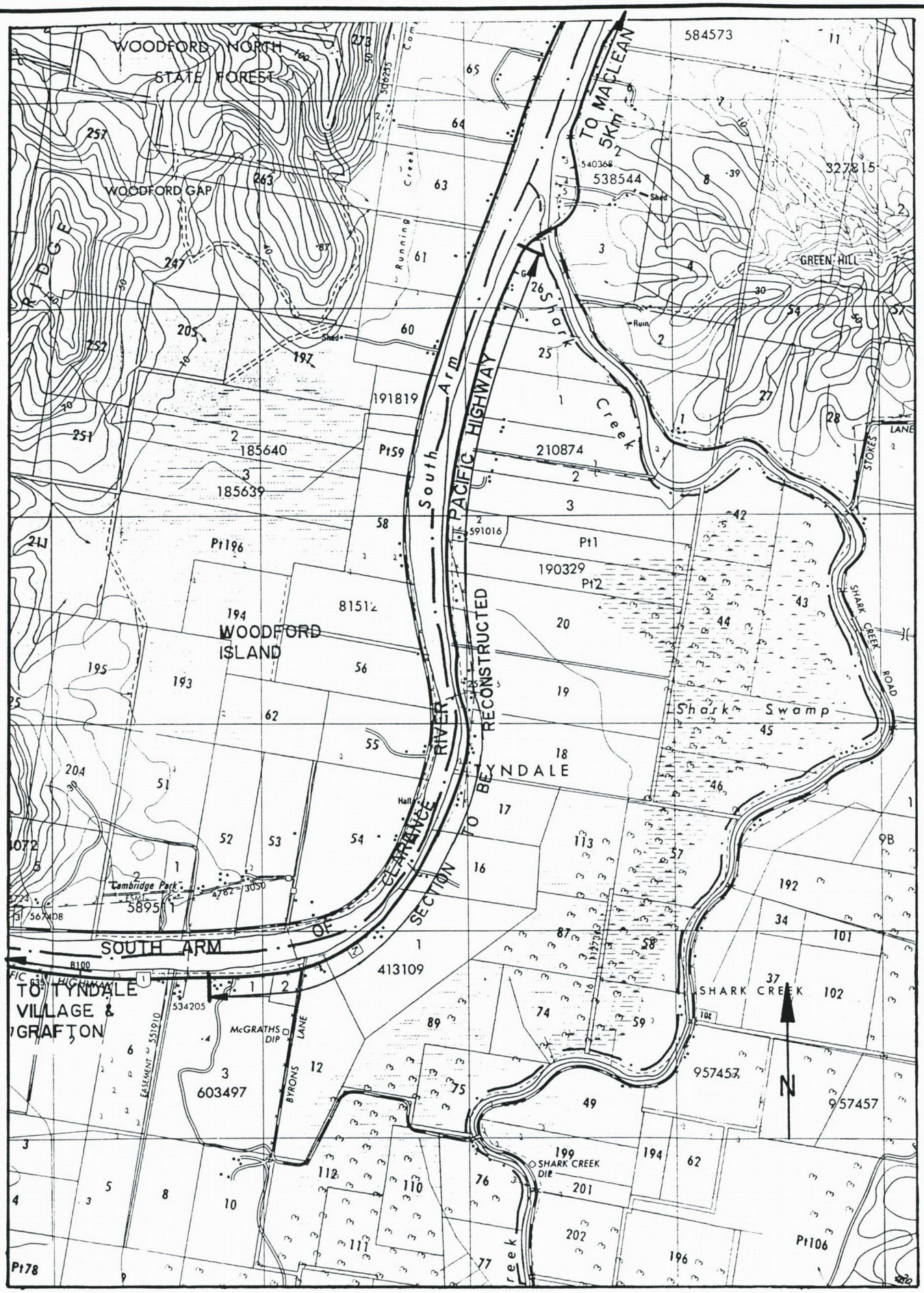
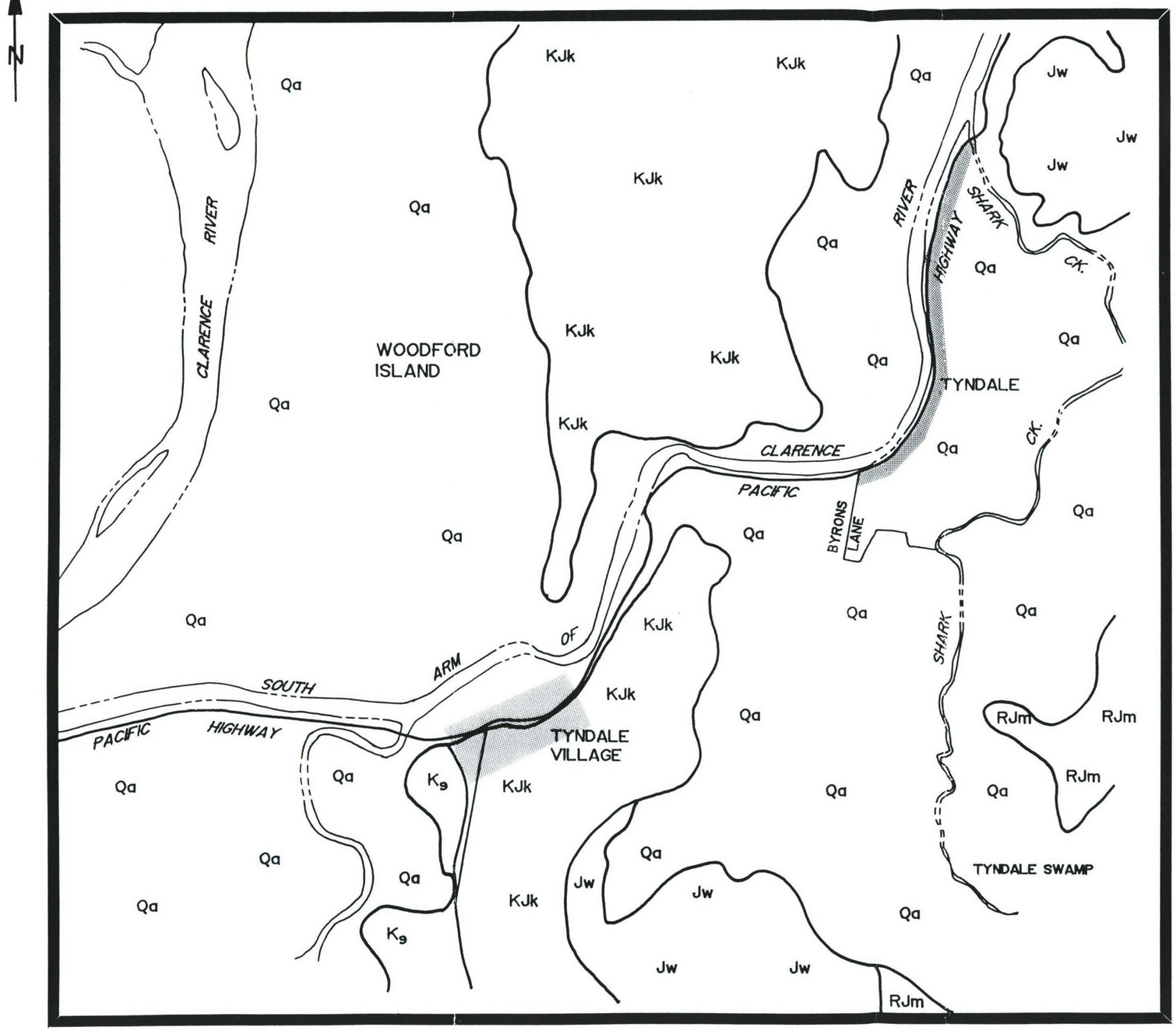
CHS:kmm

NB: Attention is drawn to the "Important Information About Your Geotechnical Engineering Report" which is appended.



Golder Associates	Drawn: T.M.D.	Date: 25-02-98	TYNDALE REALIGNMENT LOCALITY PLAN
	Checked:	Date: 6/3/98	
	Revision:	Date:	
	Scale: 1 : 25000	A4	Project No.: 97638064-7 Drg No.: 1



LEGEND

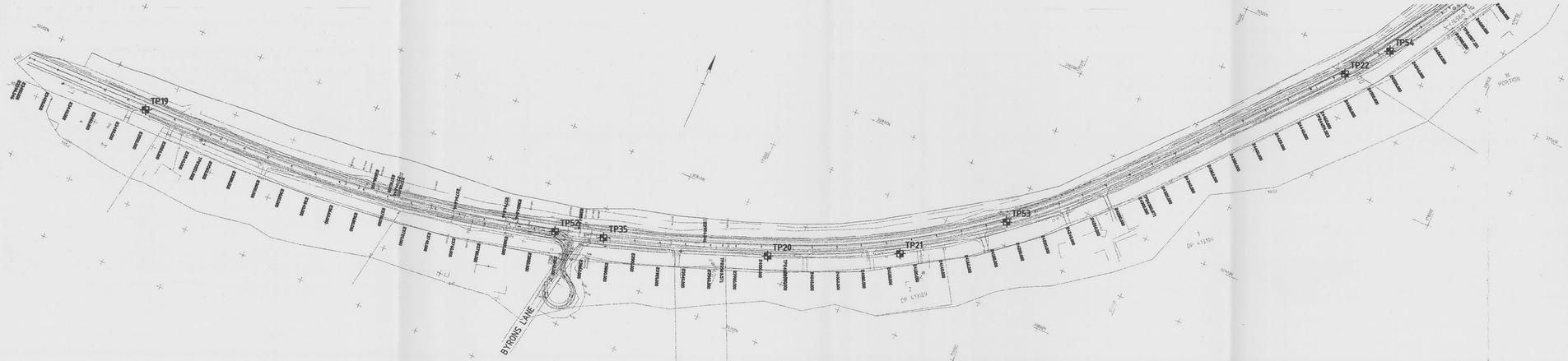
QUATERNARY	Qa	Alluvium - clay, sandy clay, sand, gravel
CRETACEOUS	K_9	Grafton Formation - sandstone, siltstone claystone, coal
CRETACEOUS JURASSIC	KJk	Kangaroo Creek Sandstone - sandstone with some conglomerate
JURASSIC	Jw	Walloon Coal Measures - shale sandstone, siltstone, some coal seams
JURASSIC - TRIASSIC	RJm	Marburg Formation - sandstone, siltstone some coal
		Geological Boundary - approximate only
		Areas Under Investigation

NOTE:

1. PLAN BASED ON MACLEAN 1:250000 GEOLOGICAL SERIES SHEET SH 56-7 - NSW DEPT. OF MINES 1970.

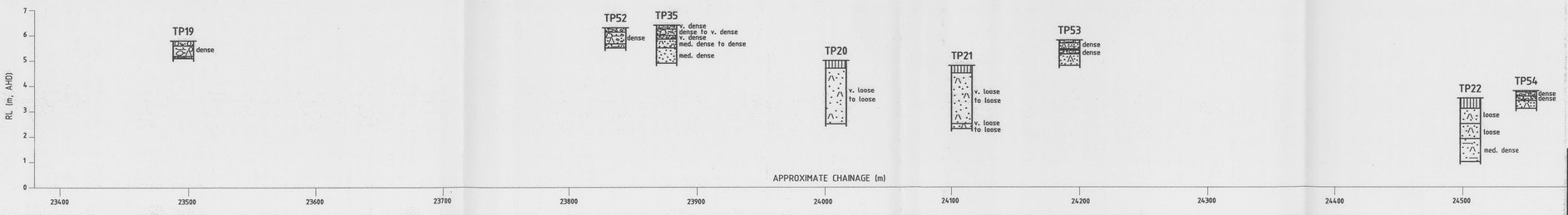
Golder Associates

Drawn: L.M.B.	Date: 30-09-97	PACIFIC HIGHWAY No. 10 PROPOSED TYNDALE REALIGNMENTS GEOLOGICAL SKETCH PLAN	
Checked:	Date: 7/10/97		
Revision:	Date:		
Scale: 1:50000	A3	Project No.: 97638064-2	Drg No. 2



LEGEND

- TP22 TEST PIT LOCATION
- ASPHALT
- TOPSOIL
- FILL
- CLAY
- ORGANIC CLAY
- SILT
- SAND
- GRAVEL
- GROUNDWATER



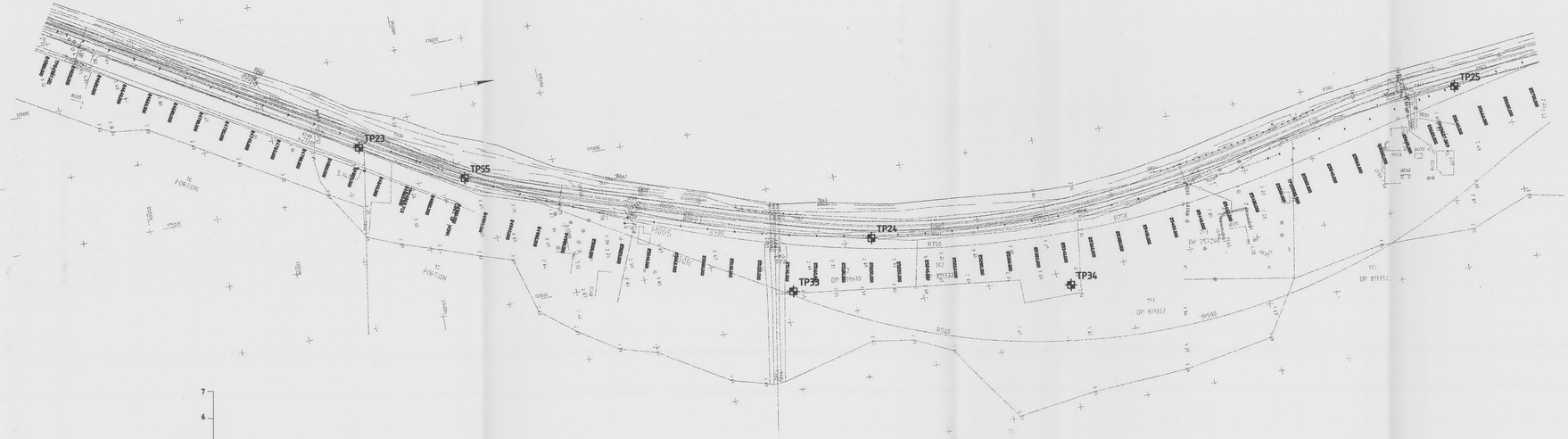
NOTES:

Test Pits were excavated while centreline was unpegged.
Chainages and levels are approximate only, determined by reference to plans and topography features.

Base plan supplied by Kinhill Cameron Mcnamara Pty Ltd.

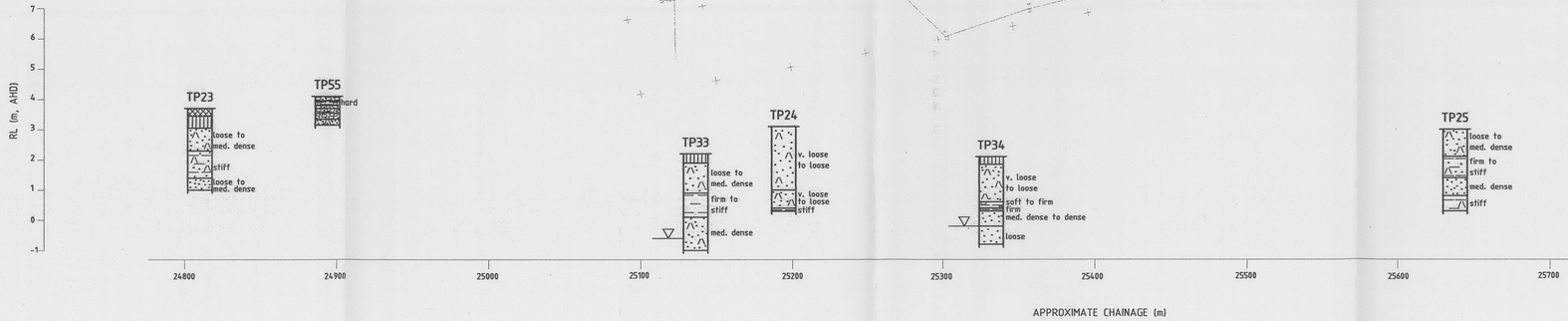
Golder Associates

Drawn: LMB	Date: 04-03-98	GEOTECHNICAL INVESTIGATION TYNDALE REALIGNMENT BYRONS LANE TO SHARK CREEK PLAN & BROKEN PROFILE SHEET 1 OF 4	
Checked:	Date: 6/3/98		
Revision:	Date:		
Scale: H 1:2000 V 1:100	A3+	Project No.: 97638064-9	Drg No: 3



LEGEND

- TP22 — TEST PIT LOCATION
- ASPHALT
- TOPSOIL
- FILL
- CLAY
- ORGANIC CLAY
- SILT
- SAND
- GRAVEL
- GROUNDWATER



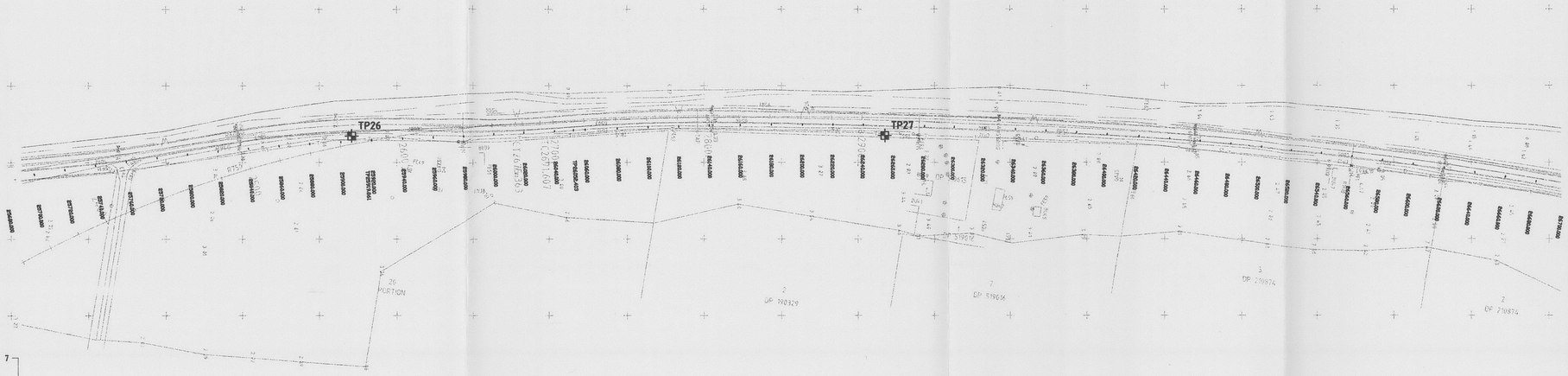
NOTES:

Test Pits were excavated while centreline was unpegged.
Chainages and levels are approximate only, determined by reference to plans and topography features.

Base plan supplied by Kinhill Cameron Mcnamara Pty Ltd.

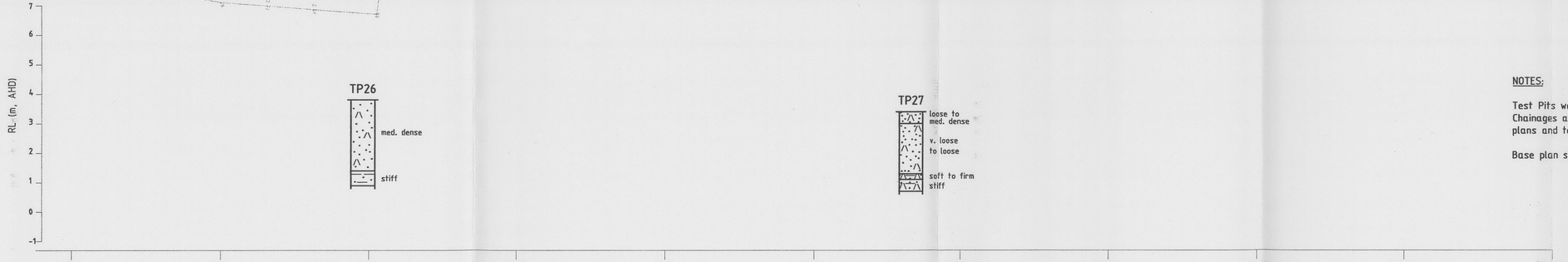
Golder Associates

Drawn: LMB	Date: 04-03-98	GEOTECHNICAL INVESTIGATION TYNDALE REALIGNMENT BYRONS LANE TO SHARK CREEK PLAN & BROKEN PROFILE SHEET 2 OF 4	
Checked:	Date: 4/3/98		
Revision:	Date:		
Scale: H 1:2000 V 1:100	A3+	Project No.: 97638064-10	Drg No: 4



LEGEND

- TP22 — TEST PIT LOCATION
- ASPHALT
- TOPSOIL
- FILL
- CLAY
- ORGANIC CLAY
- SILT
- SAND
- GRAVEL
- GROUNDWATER



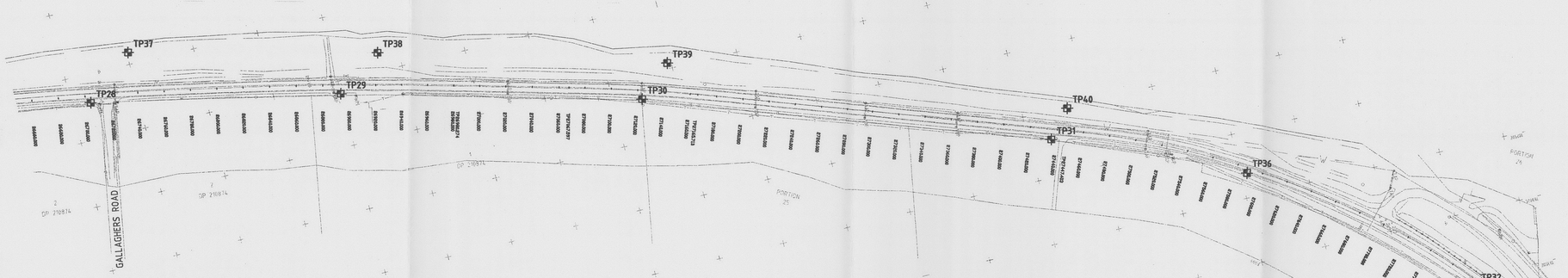
NOTES:

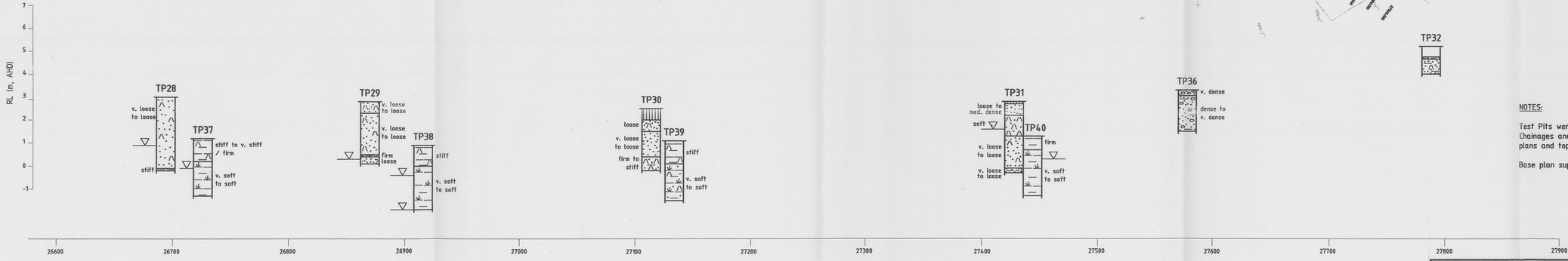
Test Pits were excavated while centreline was unpegged.
Chainages and levels are approximate only, determined by reference to plans and topography features.

Base plan supplied by Kinhill Cameron Mcnamara Pty Ltd.

Golder Associates

Drawn: LMB	Date: 04-03-98	GEOTECHNICAL INVESTIGATION TYNDALE REALIGNMENT BYRONS LANE TO SHARK CREEK PLAN & BROKEN PROFILE SHEET 3 OF 4	
Checked:	Date: 6/3/98		
Revision:	Date:		
Scale: H 1:2000 V 1:100	A3+	Project No.: 97638064-11	Drg No: 5





LEGEND

- TP22 TEST PIT LOCATION
- ASPHALT
- TOPSOIL
- FILL
- CLAY
- ORGANIC CLAY
- SILT
- SAND
- GRAVEL
- GROUNDWATER

NOTES:

Test Pits were excavated while centreline was unpegged. Chainages and levels are approximate only, determined by reference to plans and topography features.

Base plan supplied by Kinhill Cameron Mcnamara Pty Ltd.

Golder Associates

Drawn: LMB	Date: 04-03-98	GEOTECHNICAL INVESTIGATION TYNDALE REALIGNMENT BYRONS LANE TO SHARK CREEK PLAN & BROKEN PROFILE SHEET 4 OF 4	
Checked:	Date: 6/3/98		
Revisions:	Date:		
Scale: H 1:2000 V 1:100	A3+	Project No.: 97638064-12	Drg No: 6

APPENDIX A

Reports for Test Pits TP19 to TP40 and TP52 to TP55

Golder Associates

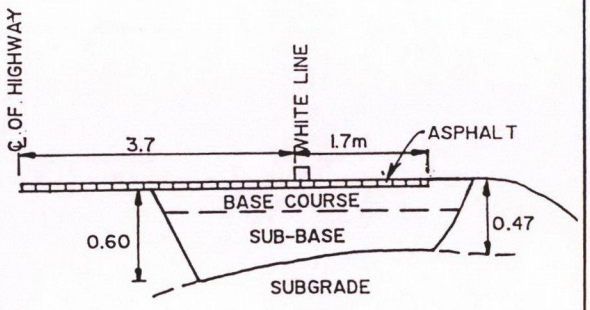
REPORT OF TEST PIT : TP19

CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 30 JANUARY 1998

TEST PIT LOCATION : 16833mE, 30675mN
ELEVATION : 5.8
DATUM : AHDD
CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315C
LOGGED : D.J. MORRISON
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING	DCP TEST Blows per 100 mm (0 5 10 15 20)
0	BACKHOE 450mm BUCKET	ASPHALT OVER SANDY GRAVEL AND COBBLES Asphalt seal (50mm) over light brown sandy gravel and small cobble size rock fragments . bitumen seal at 100mm - old road surface?		5.80 0.00		BULK 0.05 - 0.15m	
		DENSE SILTY/CLAYEY SANDY GRAVEL Dense red brown, orange brown and light grey silty/clayey sandy gravel (decomposed sandstone) . sandstone rock fragments present . becoming brown silty/clayey sandy gravel		5.60 0.20		BULK 0.2 - 0.3m	
		CLAYEY SILTY SAND Grey brown clayey silty fine grained sand . depth to this layer varied to 0.47m at the extremity of the south bound lane		5.20 0.60		BULK 0.6 - 0.7m GROUNDWATER NOT OBSERVED	
		TEST PIT DISCONTINUED AT 0.70m		5.10 0.70		CH 23496m approx Southern Tie-in Pit excavated in southbound lane	
1						BACKFILLED AND COMPACTED ON COMPLETION	
						Location and Elevation deduced from detailed survey plans and are approximate only	
2							



SCALE H 1 : 100
V 1 : 50

TP19

Golder Associates

REPORT OF TEST PIT : TP20

CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 15 JULY 1997

TEST PIT LOCATION : 17332mE 30767mN
ELEVATION : 5.0
DATUM : AHDD
CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315
LOGGED : A.B.B.
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING	DCP TEST Blows per 100 mm (0 5 10 15 20)
0	BACKHOE 450mm BUCKET	TOPSOIL Dark grey organic clayey silty sand . rootlets present		5.00 0.00		DS 0.0 - 0.1m 20.1 ES	
		VERY LOOSE TO LOOSE SILTY SAND Very loose to loose, brown, silty, fine to medium grained sand, slightly clayey		4.70 0.30		DS 0.5 - 0.6m 20.2 ES BULK 0.5 - 1.0m	
1						DS 1.0 - 1.1m 20.3 ES	
						DS 1.5 - 1.6m 20.4 ES	
2						GROUNDWATER NOT OBSERVED	
				2.50			
		TEST PIT DISCONTINUED AT 2.50m		2.50		BACKFILLED ON COMPLETION	
3						Approx location Ch 24008m 8m right	
						ES - Environmental Sample	
4						Note : These routes were unpegged. Test pits were sited on the basis of topographic features and elevations deduced from plans provided. Therefore elevations and chainages are approximate only.	
5							

Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP21

CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 15 JULY 1997

TEST PIT LOCATION : 17427mE 30811mN
ELEVATION : 4.8
DATUM : AHDD
CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315
LOGGED : A.B.B.
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING
				4.80		
0	BACKHOE 450mm BUCKET	TOPSOIL Brown silty sand . rootlets present		0.00		DS 0.0 - 0.1m 21.1 ES
				4.50		
		VERY LOOSE TO LOOSE SILTY SAND Very loose to loose, light brown, slightly clayey, silty, fine to medium grained sand		0.30		DS 0.5 - 0.6m 21.2 ES BULK 0.5 - 1.0m
1						DS 1.0 - 1.1m 21.3 ES
						DS 1.5 - 1.6m 21.4 ES
2				2.50		
		VERY LOOSE TO LOOSE SILTY SAND Very loose to loose, mottled light brown and orange brown, silty, fine to medium grained sand		2.30		GROUNDWATER NOT OBSERVED
				2.30		
		TEST PIT DISCONTINUED AT 2.50m		2.50		BACKFILLED ON COMPLETION
3						Approx location Ch 24110m, 10m right
						ES - Environmental Sample
						Note : These routes were unpegged. Test pits were sited on the basis of topographic features and elevations deduced from plans provided. Therefore elevations and chainages are approximate only.
4						
5						

DCP TEST
Blows per 100 mm
0 5 10 15 20

Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP22

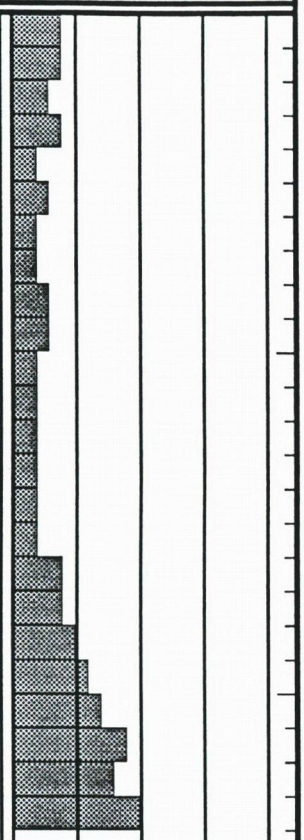
CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 15 JULY 1997

TEST PIT LOCATION : 17691mE 31084mN
ELEVATION : 3.5
DATUM : AHDD
CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315
LOGGED : A.B.B.
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING
0	BACKHOE 450mm BUCKET	TOPSOIL Black, organic sandy silt . occasional rootlets present		3.50 0.00		DS 0.0 - 0.1m 22.1 ES
				3.10 0.40		
		LOOSE SILTY SAND Loose, light brown silty fine grained sand				DS 0.5 - 0.6m 22.2 ES
1				2.50 1.00		DS 1.0 - 1.1m 22.3 ES BULK 1.0 - 1.5m
		LOOSE SILTY SAND Loose, light brown slightly clayey silty fine grained sand				DS 1.5 - 1.6m 22.4 ES
				1.90 1.60		
2		MEDIUM DENSE CLAYEY SILTY SAND Medium dense, brown mottled orange brown clayey silty fine grained sand				GROUNDWATER NOT OBSERVED
				1.00 2.50		BACKFILLED ON COMPLETION
3		TEST PIT DISCONTINUED AT 2.50m				Approx location Ch 24490m 8m right
						ES - Environmental Sample
4						Note : These routes were unpegged. Test pits were sited on the basis of topographic features and elevations deduced from plans provided. Therefore elevations and chainages are approximate only.
5						

DCP TEST
Blows per 100 mm
0 5 10 15 20



Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP23

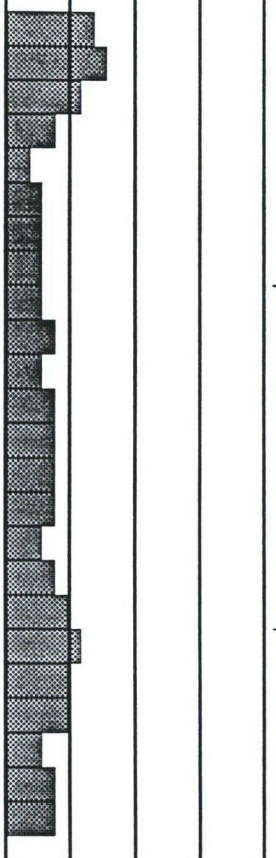
CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 16 JULY 1997

TEST PIT LOCATION : 17866mE 31362mN
ELEVATION : 3.7
DATUM : AHDD

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315
LOGGED : A.B.B.
CHECKED BY : [signature]
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING
				3.70		
0	BACKHOE 450mm BUCKET	FILL Brown gravel and cobbles in a clay matrix		0.00		DS 0.0 - 0.1m 23.1 ES
				3.45		
		TOPSOIL Black silty fine grained sand		0.25		
						DS 0.5 - 0.6m 23.2 ES
				3.05		
		LOOSE TO MEDIUM DENSE SILTY SAND Loose to medium dense, light brown mottled orange brown silty fine grained sand . grading to sandy silt with depth		0.65		
1						DS 1.0 - 1.1m 23.3 ES BULK 1.0 - 1.3m
				2.30		
		STIFF SANDY SILTY CLAY Stiff, light brown mottled orange brown sandy silty clay . fine grained sand . less sandy with depth		1.40		DS 1.5 - 1.6m 23.4 ES
						DS 1.7 - 1.8m
2						
				1.40		
		LOOSE TO MEDIUM DENSE SAND Loose to medium dense, pale brown mottled orange brown fine grained sand		2.30		
						GROUNDWATER NOT OBSERVED
				1.00		
		TEST PIT DISCONTINUED AT 2.70m		2.70		BACKFILLED ON COMPLETION
3						Approx location CH 24817m 8m right
						ES - Environmental Sample
						Note : These routes were unpegged. Test pits were sited on the basis of topographic features and elevations deduced from plans provided. Therefore elevations and chainages are approximate only.
4						
5						

DCP TEST
Blows per 100 mm
0 5 10 15 20



Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP24

CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 17 JULY 1997

TEST PIT LOCATION : 17999mE 31720mN
ELEVATION : 3.1
DATUM : AHDD
CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315
LOGGED : A.B.B.
DATE : 6/7/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING	DCP TEST Blows per 100 mm (0 5 10 15 20)
0	BACKHOE 450mm BUCKET	VERY LOOSE TO LOOSE SAND/SILTY SAND Very loose to loose, dark grey, fine grained silty sand . light brown slightly silty below 0.3m		3.10 0.00		DS 0.0 - 0.1m 24.1 ES	
						DS 0.5 - 0.6m 24.2 ES	
1						DS 1.0 - 1.1m 24.3 ES BULK 1.0 - 1.5m	
						DS 1.5 - 1.6m 24.4 ES	
2				1.00 2.10			
		VERY LOOSE TO LOOSE SILTY SAND Very loose to loose, light brown silty fine grained sand					
				0.40		GROUNDWATER NOT OBSERVED	
		STIFF CLAY Stiff, grey mottled brown clay		2.70 0.30			
		TEST PIT DISCONTINUED AT 2.80m		2.80		BACKFILLED ON COMPLETION	
3						ES - Environmental Sample	
						Approx location CH 25202m 10m right	
						Note : These routes were unpegged. Test pits were sited on the basis of topographic features and elevations deduced from plans provided. Therefore elevations and chainages are approximate only.	
4							
5							

Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP25

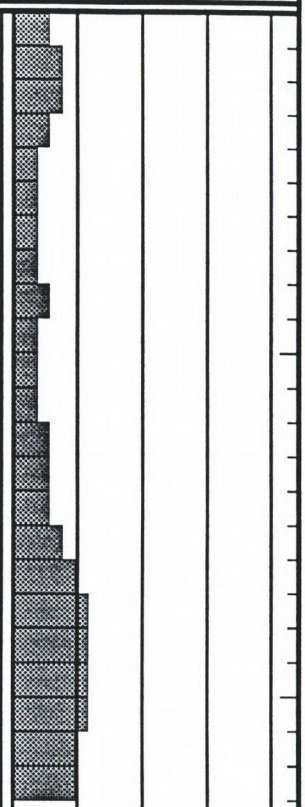
CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 17 JULY 1997

TEST PIT LOCATION : 17966mE 32163mN
ELEVATION : 3.0
DATUM : AHDD
CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315
LOGGED : A.B.B.
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING
0	BACKHOE 450mm BUCKET	**LOOSE TO MEDIUM DENSE SILTY SAND** Loose to medium dense, dark brown, slightly clayey, silty fine grained sand . rootlets down to 0.1m		3.00 0.00		DS 0.0 - 0.1m 25.1 ES BULK 0.2 - 0.5m DS 0.5 - 0.6m 25.2 ES
1		**FIRM TO STIFF SANDY SILTY CLAY** Firm to stiff, light brown mottled brown sandy silty clay		2.10 0.90		DS 1.0 - 1.1m 25.3 ES DS 1.5 - 1.6m 25.4 ES
2		**MEDIUM DENSE SAND** Medium dense, light brown fine grained sand		1.40 1.60		
		STIFF SILTY CLAY Stiff, light grey mottled brown silty clay with some fine grained sand		0.80 2.20		GROUNDWATER NOT OBSERVED
3		TEST PIT DISCONTINUED AT 2.70m		0.30 2.70		BACKFILLED ON COMPLETION Approx location CH 25645m 9m right ES - Environmental Sample Note : These routes were unpegged. Test pits were sited on the basis of topographic features and elevations deduced from plans provided. Therefore elevations and chainages are approximate only.
4						
5						

DCP TEST
Blows per 100 mm
0 5 10 15 20



Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP26

CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 17 JULY 1997

TEST PIT LOCATION : 17933mE 32421mN
ELEVATION : 3.8
DATUM : AHDD
CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315
LOGGED : A.B.B.
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING
0	BACKHOE 450mm BUCKET	MEDIUM DENSE SILTY SAND Medium dense, light grey brown clayey, silty fine grained sand		3.80 0.00		DS 0.0 - 0.1m 26.1 ES
		. rootlets present down to 0.1m . grading light brown mottled brown below 0.3m				DS 0.5 - 0.6m 26.2 ES
1						DS 1.0 - 1.1m 26.3 ES BULK 1.0 - 1.5m
						DS 1.5 - 1.6m 26.4 ES
2		. more silty below 1.9m				
		STIFF SANDY CLAY Stiff, grey mottled brown sandy clay . fine grained sand		1.40 2.40		DS 2.7 - 2.8m GROUNDWATER NOT OBSERVED
3		TEST PIT DISCONTINUED AT 2.90m		0.90 2.90		BACKFILLED ON COMPLETION ES - Environmental Sample Approx location CH 25904m 5m right Note : These routes were unpegged. Test pits were sited on the basis of topographic features and elevations deduced from plans provided. Therefore elevations and chainages are approximate only.
4						
5						

DCP TEST
Blows per 100 mm
0 5 10 15 20

Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP27

CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 17 JULY 1997

TEST PIT LOCATION : 17933mE 32767mN
ELEVATION : 3.4
DATUM : AHDD
CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315
LOGGED : A.B.B.
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING	DCP TEST Blows per 100 mm (0 5 10 15 20)
0	BACKHOE 450mm BUCKET	LOOSE TO MEDIUM DENSE SILTY SAND Loose to medium dense, brown silty fine grained sand . rootlets present to 0.15m depth		3.40 0.00		DS 0.0 - 0.1m 27.1 ES	
		VERY LOOSE TO LOOSE SILTY SAND Very loose to loose, light brown slightly clayey silty fine grained sand		3.00 0.40		BULK 0.5 - 1.0m DS 0.5 - 0.6m 27.2 ES	
1						DS 1.0 - 1.1m 27.3 ES	
						DS 1.5 - 1.6m 27.4 ES	
2				1.30			
		SOFT TO FIRM SANDY CLAYEY SILT Soft to firm, light brown mottled dark brown sandy clayey silt . fine grained sand		2.10 1.10			
		STIFF SANDY CLAYEY SILT Stiff, grey mottled orange brown sandy clayey silt with occasional cemented nodules below 2.4m		2.30		GROUNDWATER NOT OBSERVED	
		TEST PIT DISCONTINUED AT 2.70m		0.70 2.70		Approx location CH 26275m 5m right	
3						ES - Environmental Sample.	
						Note : These routes were unpegged. Test pits were sited on the basis of topographic features and elevations deduced from plans provided. Therefore elevations and chainages are approximate only.	
4							
5							

Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP28

CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 16 JULY 1997

TEST PIT LOCATION : 17972mE 33215mN
ELEVATION : 3.1
DATUM : AHDD
CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315
LOGGED : A.B.B.
DATE : 6/2/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING
0	BACKHOE 450mm BUCKET	VERY LOOSE TO LOOSE SILTY SAND Very loose to loose silty fine grained sand . rootlets present down to 0.15m		3.10 0.00		DS 0.0 - 0.1m 28.1 ES
		. grading to light brown below 0.5m				BULK 0.5 - 1.0m DS 0.5 - 0.6m 28.2 ES
1		. slightly silty below 1m				DS 1.0 - 1.1m 28.3 ES
						DS 1.5 - 1.6m 28.4 ES
2						GWO at 2.1m - Seepage
		. silty below 2.2m				
3				0.00		DS 3.1 - 3.2m
		STIFF CLAY Stiff, grey mottled brown slightly sandy clay		3.10 -0.10		
		TEST PIT DISCONTINUED AT 3.20m		3.20		BACKFILLED ON COMPLETION Approx location CH 26704m 5m right ES - Environmental Sample Note : These routes were unpegged. Test pits were sited on the basis of topographic features and elevations deduced from plans provided. Therefore elevations and chainges are approximate only.
4						
5						

DCP TEST
Blows per 100 mm
0 5 10 15 20

Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP29

CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 17 JULY 1997

TEST PIT LOCATION : 18010mE 33400mN
ELEVATION : 2.9
DATUM : AHDD
CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315
LOGGED : A.B.B.
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING	DCP TEST Blows per 100 mm (0 5 10 15 20)
0	BACKHOE 450mm BUCKET	VERY LOOSE TO LOOSE SILTY SAND/SANDY SILT Very loose to loose, brown silty fine grained sand/sandy silt . rootlets present down to 0.15m . grading to light brown with depth		2.90 0.00		DS 0.0 - 0.1m 29.1 ES	
				2.40		DS 0.5 - 0.9m 29.2 ES BULK 0.5 - 1.0m	
1		VERY LOOSE TO LOOSE SILTY SAND Very loose to loose, light brown silty fine grained sand . grading less silty with depth		0.50		DS 1.0 - 1.1m 29.3 ES	
						DS 1.5 - 1.6m 29.4 ES	
2				0.60			
		FIRM SANDY CLAYEY SILT Firm, grey mottled orange brown sandy clayey silt		2.30 0.50			
		LOOSE SAND Loose, light brown, fine grained sand		2.40		GWO at 2.5m - Seepage	
				0.20			
		TEST PIT DISCONTINUED AT 2.70m		2.70		BACKFILLED ON COMPLETION Approx location CH 26880m 5m right ES - Environmental Sample Note : These routes were unpegged. Test pits were sited on the basis of topographic features and elevations deduced from plans provided. Therefore elevations and chainages are approximate only.	
3							
4							
5							

Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP30

CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 16 JULY 1997

TEST PIT LOCATION : 18068mE 33622mN
ELEVATION : 2.6
DATUM : AHDD

CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315
LOGGED : A.B.B.
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING
0	BACKHOE 450mm BUCKET	TOPSOIL Dark grey to black sandy clay . fine to medium grained sand . rootlets present down to 0.3m		2.60 0.00		DS 0.0 - 0.1m 30.1 ES
		LOOSE SILTY SAND Loose, brown silty fine grained sand . grading light brown with depth		2.10 0.50		DS 0.5 - 0.6m 30.2 ES BULK 0.5 - 1.0m
1		VERY LOOSE TO LOOSE SAND Very loose to loose, light brown, slightly silty, fine grained sand		1.60 1.00		DS 1.0 - 1.1m 30.3 ES
						DS 1.5 - 1.6m 30.4 ES
2		FIRM TO STIFF CLAYEY SANDY SILT Firm to stiff, light brown to brown, mottled orange brown clayey sandy silt . fine grained sand		0.50 2.10		DS 2.5 - 2.6m GROUNDWATER NOT OBSERVED
		TEST PIT DISCONTINUED AT 2.70m		-0.10 2.70		BACKFILLED ON COMPLETION Approx location Ch 27123m 5m right ES - Environmental Sample Note : These routes were unpegged. Test pits were sited on the basis of topographic features and elevations deduced from plans provided. Therefore elevations and chainges are approximate only.
3						
4						
5						

DCP TEST
Blows per 100 mm
0 5 10 15 20

Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP31

CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 16 JULY 1997

TEST PIT LOCATION : 18172mE 33917mN
ELEVATION : 2.9
DATUM : AHDD
CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315
LOGGED : A.B.B.
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING	DCP TEST Blows per 100 mm (0 5 10 15 20)
0	BACKHOE 450mm BUCKET	TOPSOIL Dark grey sandy clay . rootlets present		2.90 0.00 2.80		DS 0.0 - 0.1m 31.1 ES	
		LOOSE TO MEDIUM DENSE SAND Loose to medium dense, light brown fine grained sand		0.10		DS 0.5 - 0.6m 31.2 ES	
1		SOFT CLAYEY SANDY SILT Soft, brown fine sandy clayey silt		2.30 0.60		DS 1.0 - 1.1m 31.3 ES BULK 1.0 - 1.5m GWO at 1.2m - Seepage	
		VERY LOOSE TO LOOSE SILTY SAND Very loose to loose, light brown mottled orange brown silty fine grained sand		1.40 1.50		DS 1.5 - 1.6m 31.4 ES	
2				0.00			
3		VERY LOOSE TO LOOSE CLAYEY SILTY SAND Very loose to loose, grey mottled orange brown clayey silty fine grained sand		2.90 -0.20			
		TEST PIT DISCONTINUED AT 3.10m		3.10		BACKFILLED ON COMPLETION ES - Environmental Sample Note : These routes were unpegged. Test pits were sited on the basis of topographic features and elevations deduced from plans provided. Therefore chainages and elevations are approximate only. Appox location Ch 27437m 7m right	
4							
5							

Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

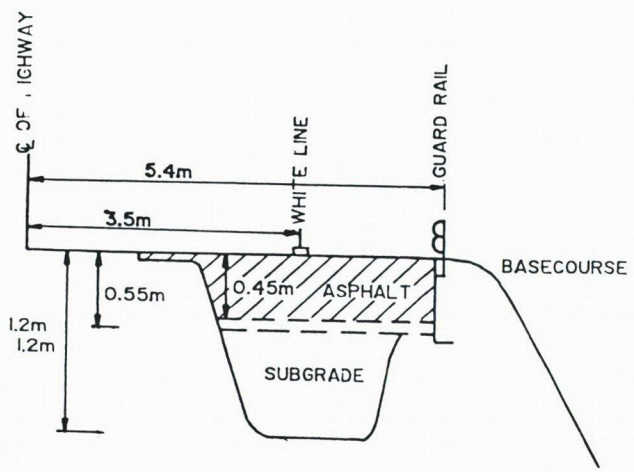
REPORT OF TEST PIT : TP32

CLIENT : KINIHLL CAMERON McNAMARA
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 17 JULY 1997

TEST PIT LOCATION : 18356mE, 34203mN
ELEVATION : 5.2
DATUM : AHDD

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315
LOGGED : A.B.B.
CHECKED BY : 6/3/98 DATE :

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING	DCP TEST Blows per 100 mm (0 5 10 15 20)
0	BACKHOE 450mm BUCKET	ASPHALT SEAL Asphalt seal (450mm) . several layers of asphalt typically 0.06 yo 0.09m . possible previous AC surface at 0.22m . stabilised		5.20 0.00		DS 0.06 - 0.065m	
		DENSE SILTY SAND AND GRAVEL/SMALL COBBLES Dense, orange brown and brown silty fine grained sand and sandstone gravel/small cobbles		4.75 0.45		BULK 0.45 - 0.55m	
		SILTY CLAYEY SAND Orange brown, silty clayey sand, some sandstone fragments of gravel size . fine sand . occasional small sandstone cobbles below 1.0m		4.65 0.55			
1						BULK 1.00 - 1.10m	
				4.00			
		TEST PIT DISCONTINUED AT 1.20m		1.20		CH 27799 approx Northern tie in pit excavated in southbound lane BACKFILLED AND COMPACTED ON COMPLETION	
2							



TP32 (Northern Tie In)

Location and detail survey elevation deduced from plans and are approximate only.

Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP33

CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 16 JULY 1997

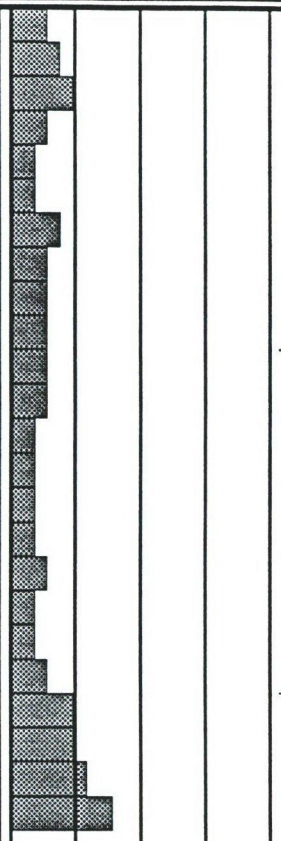
TEST PIT LOCATION : 18028mE 31657mN
ELEVATION : 2.2
DATUM : AHDD

CHECKED BY : [illegible]

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315
LOGGED : A.B.B.
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING
0	BACKHOE 450mm BUCKET	TOPSOIL Dark brown silty fine grained sand		2.20 0.00		DS 0.0 - 0.1m 33.1 ES
		LOOSE TO MEDIUM DENSE SILTY SAND Loose to medium dense, light brown mottled orange brown silty fine grained sand		1.90 0.30		DS 0.5 - 0.6m 33.2 ES BULK 0.5 - 1.0m
1						DS 1.0 - 1.1m 33.3 ES
		FIRM TO STIFF CLAY Firm to stiff, light brown mottled orange brown clay		0.90 1.30		DS 1.5 - 1.6m 33.4 ES
2		MEDIUM DENSE SILTY SAND Medium dense, light grey mottled orange brown silty fine grained sand . less silty with depth		0.10 2.10		GWO at 2.8m - Seepage
3						DS 3.0 - 3.1m 33.5 ES
		TEST PIT DISCONTINUED AT 3.20m		-1.00 3.20		BACKFILLED ON COMPLETION
4						ES - Environmental Sample. Note : These routes were unpegged. Test pits were sited on the basis of topographic features and elevations deduced from plans provided. Therefore elevations and chainages are approximate only. Approx location CH 25143 40m right
5						

DCP TEST
Blows per 100 mm
0 5 10 15 20



Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP34

CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 17 JULY 1997

TEST PIT LOCATION : 18060mE 31859mN
ELEVATION : 2.1
DATUM : AHDD
CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315
LOGGED : A.B.B.
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING
0	BACKHOE 450mm BUCKET	TOPSOIL Black silty fine grained sand . rootlets down to 0.1m		2.10 0.00		DS 0.0 - 0.1m 34.1 ES
		VERY LOOSE TO LOOSE SILTY SAND Very loose to loose, light brown and brown, silty fine grained sand		1.85 0.25		DS 0.5 - 0.6m 34.2 ES BULK 0.5 - 1.0m
1						DS 1.0 - 1.1m 34.2 ES
		SOFT TO FIRM GRAVELLY CLAY Soft to firm, dark brown grey gravelly clay . fine to medium gravel		0.60 1.50		DS 1.5 - 1.6m 34.4 ES
		FIRM CLAY Firm grey clay		0.40 1.70 0.30		
2		MEDIUM DENSE TO DENSE SAND Medium dense to dense, pale grey mottled orange brown fine to medium grained sand		1.80 -0.20		GWO at 2.3m - Seepage
		LOOSE SAND Loose, pale grey mottled orange brown fine to medium grained sand		2.30		
3		TEST PIT DISCONTINUED AT 2.90m		-0.80 2.90		GROUNDWATER NOT OBSERVED ES - Environmental Sample. Note : These routes were unpegged. Test pits were sited on the basis of topographic features and elevations deduced from plans provided. Therefore elevations and chainages are approximate only. Approx location CH 25340m 50m right
4						
5						

DCP TEST
Blows per 100 mm
0 5 10 15 20

Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP35

CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 17 JULY 1997

TEST PIT LOCATION : 17207mE 30728mN
ELEVATION : 6.4
DATUM : AHDD

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315C
LOGGED : A.B.B.
CHECKED BY : [signature]
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING	DCP TEST Blows per 100 mm (0 5 10 15 20)
0	BACKHOE 450mm BUCKET	CHIPSEAL OVER VERY DENSE SANDY GRAVEL Chipseal (30mm) over very dense grey and brown sandy gravel . occasional cobble size fragments present		6.40 0.00 6.25		BULK 0.05 - 0.15m	
		DENSE TO VERY DENSE GRAVELLY SAND Dense to very dense, light brown and orange brown fine to coarse grained sand and gravel with cobble sized sandstone fragments		0.15 6.00		BULK 0.20 - 0.30m	
		CHIPSEAL OVER VERY DENSE GRAVELLY SAND Chipseal (30mm) over very dense light brown and orange brown fine to coarse grained sand and gravel with cobble sized rock fragments		0.40 5.85		BULK 0.70 - 0.80m	
		MEDIUM DENSE TO DENSE SILTY SAND (WEAKLY INDURATED) Medium dense to dense, grey, silty fine to medium grained sand with some gravel and cobble sized rock fragments - some zones weakly indurated . grading dark brown below 0.7m		0.55 5.50		GROUNDWATER NOT OBSERVED	
1		MEDIUM DENSE SAND Medium dense, light brown fine grained sand		0.90		BULK 1.30 - 1.40m	
		TEST PIT DISCONTINUED AT 1.5m		4.90 1.50		BACKFILLED ON COMPLETION	
2						Approx location CH 23876m Middle of Northbound Lane	
3						Note : These routes were unpegged. Test pits wre sited on the basis of topographic features and elevations deduced from plans provided. Therefore elevations and chainages are approximate only.	
4							
5							

Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP36

CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 17 JULY 1997

TEST PIT LOCATION : 18231mE 34055mN
ELEVATION : 3.4
DATUM : AHDD
CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315
LOGGED : A.B.B.
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING	DCP TEST Blows per 100 mm (0 5 10 15 20)
0	BACKHOE 450mm BUCKET	CHIPSEAL OVER VERY DENSE SANDY GRAVEL Chipseal (20mm) over very dense sandy fine to coarse gravel . appeared cemented in part . occasional cobble sized rock fragments		3.40 0.00 3.15			
		DENSE TO VERY DENSE GRAVELLY CLAYEY SAND - FILL Dense to very dense, fine to medium grained clayey sand and gravel to cobble sized sandstone rock fragments		0.25		BULK 0.5 - 1.0m	
1		. grey brown below 1.7m (possibly natural material)		1.60		GROUNDWATER NOT OBSERVED	
		TEST PIT DISCONTINUED AT 1.80m		1.80		BACKFILLED ON COMPLETION Approx location CH 27587m - middle Southbound Lane	
2							
3							
4							
5							

Note : These routes were unpegged. Test pits were sited on the basis of topographic features and elevations deduced from plans provided. Therefore elevations and chainages are approximate only.

Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP37

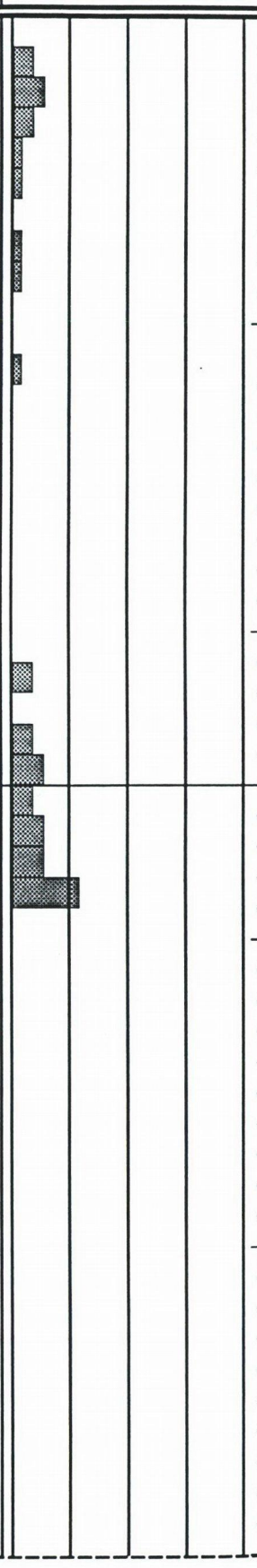
CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 29 JANUARY 1998

TEST PIT LOCATION : 17941mE 33251mN
ELEVATION : 1.2
DATUM : AHDD
CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315C
LOGGED : D.J. MORRISON
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING
0	BACKHOE 450mm BUCKET	STIFF TO VERY STIFF/FIRM SILTY CLAY Stiff to very stiff brown mottled orange brown silty clay . roots throughout . some fine sand . strength decreases to firm with depth with an increase in moisture content		1.20 0.00		0.3m Spp = 120 - 195kPa DS 0.4m
						0.5m Spp = 50kPa
		. grading firm below 0.6m				BULK 0.6 - 0.8m
						0.75m Spp = 40kPa
1		VERY SOFT TO SOFT ORGANIC SILTY CLAY Very soft to soft grey mottled brown organic silty clay . roots throughout . some sand . less silt and sand with depth		0.20 1.00		GWO at 1.3m
						U50 1.5 - 2.0m Slightly stronger seepage at 1.5m
2				-1.30		
		TEST PIT DISCONTINUED AT 2.5m		2.50		Approx Ch 26734m 20m left approx
3						Location deduced from detailed survey plans and is approximate only
4						
5						

DCP TEST
Blows per 100 mm
0 5 10 15 20



Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP38

CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 29 JANUARY 1998

TEST PIT LOCATION : 17986mE 33434mN
ELEVATION : 0.9
DATUM : AHDD
CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315C
LOGGED : D.J. MORRISON
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING	DCP TEST Blows per 100 mm (0 5 10 15 20)
0	BACKHOE 450mm BUCKET	STIFF SILTY CLAY Stiff grey brown silty clay . frequent roots to 0.25m . grading moist grey mottled brown silty clay below 0.25m . some fine sand		0.90 0.00		DS 0.1 - 0.2m 0.6m Spp = 100 - 120kPa U50 0.6 - 1.1m BULK 0.6 - 0.7m	
1		VERY SOFT TO SOFT ORGANIC CLAY Very soft to soft grey organic clay . strong organic odour . frequent roots . occasional fine sand lens		0.00 0.90		U50 1.0m - 1.45m PP at 1.0m Spp = 15 - 30kPa (variable strength) GWO at 1.3m	
2						Strong groundwater inflow at 2.8m	
3		TEST PIT DISCONTINUED AT 2.80m		-1.90 2.80		Approx CH 26924m 21m left Location deduced from detailed survey plans and is approximate only	
4							
5							

Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP39

CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 29 JANUARY 1998

TEST PIT LOCATION : 18046mE 33647mN
ELEVATION : 1.1
DATUM : AHDD
CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315C
LOGGED : D.J. MORRISON
DATE :

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING	DCP TEST Blows per 100 mm (0 5 10 15 20)
0	BACKHOE 450mm BUCKET	STIFF SILTY CLAY Stiff grey, mottled brown silty clay . some fine sand . roots throughout		1.10 0.00		0.5m Spp = 75 - 100kPa BULK 0.6 - 0.8m	
1		VERY SOFT TO SOFT ORGANIC SANDY SILTY CLAY Very soft to soft grey mottled orange brown organic sandy silty clay . fine sand lens present between 1.0 - 1.3m (50 to 100mm)		0.10 1.00		DS (sand lens) 1.0 - 1.1m U50 1.4 - 1.9m	
2		. less silty and sandy with depth below 2.0m		-1.50		GROUNDWATER NOT OBSERVED	
		TEST PIT DISCONTINUED AT 2.60m		2.60		Approx CH 27143m 20m left approx	
3						BACKFILLED ON COMPLETION	
4						Location deduced from detailed survey plans and is approximate only	
5							

Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP40

CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 29 JANUARY 1998

TEST PIT LOCATION : 15151mE, 33934mN
ELEVATION : 1.3
DATUM : AHDD

CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315C
LOGGED : D.J. MORRISON
DATE : 6/2/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING
0	BACKHOE 450mm BUCKET	FIRM CLAY Firm grey brown clay . frequent roots to 0.3m . grading stiff grey mottled red brown silty clay below 0.25m with some fine sand		1.30 0.00		0.35m Spp = 100kPa DS 0.4m 0.5m Spp = 50kPa
		VERY SOFT TO SOFT ORGANIC CLAY Very soft to soft grey organic clay . trace of fine sand . roots present throughout		0.70 0.60		BULK 0.6 - 0.8m U50 0.8 - 1.3m
1						GWO at 1.0m (seepage on road side of pit)
2						DS 2.0m
				-1.30		
		TEST PIT DISCONTINUED AT 2.60m		2.60		Approx CH 27452m 13m left approx BACKFILLED ON COMPLETION
3						Location deduced from detailed survey plans and is approximate only
4						
5						

DCP TEST
Blows per 100 mm
0 5 10 15 20

Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

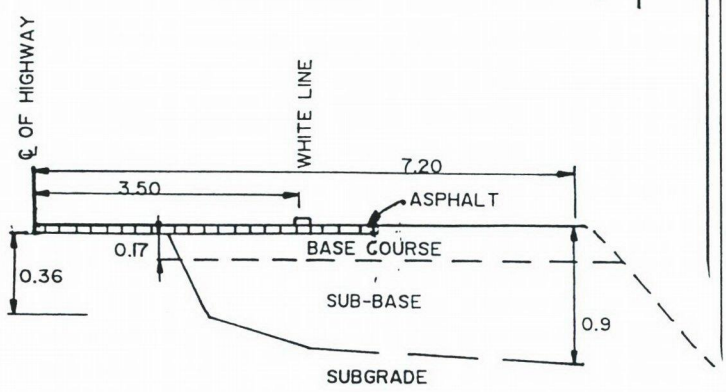
REPORT OF TEST PIT : TP52

CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 30 JANUARY 1998

TEST PIT LOCATION : 17170mE, 30717mN
ELEVATION : 6.6
DATUM : AHDD
CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315C
LOGGED : D.J. MORRISON
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING	DCP TEST Blows per 100 mm (0 5 10 15 20)
0	BACKHOE 450mm BUCKET	ASPHALT OVER SANDY GRAVEL AND COBBLES Asphalt seal (30mm) over brown sandy gravel of sandstone rock cobbles . thin discontinuous micaceous lens noted at 0.1m depth at road centreline end of pit		6.60 0.00		BULK 0.06 - 0.12m	
		DENSE CLAYEY/SILTY SANDY GRAVEL AND COBBLES Dense red brown mottled orange brown and light grey (in part) clayey/silty sandy gravel (decomposed sandstone) and cobbles . brown in colour below 0.45m		6.43 0.17		BULK 0.3 - 0.4m	
		CLAYEY SILTY SAND Grey brown clayey silty fine grained sand . mottled orange brown in part		5.96 0.64		BULK 0.7 - 0.8m GROUNDWATER NOT OBSERVED	
1		TEST PIT DISCONTINUED AT 0.80m		5.80 0.80		Approx CH 23836 Approximately 20m south of Byrons Lane Pit excavated in south bound lane BACKFILLED AND COMPACTED ON COMPLETION Location and elevation deduced from detailed survey plans and are approximate only	
2							



TP52

SCALE H 1 : 100
V 1 : 50

Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

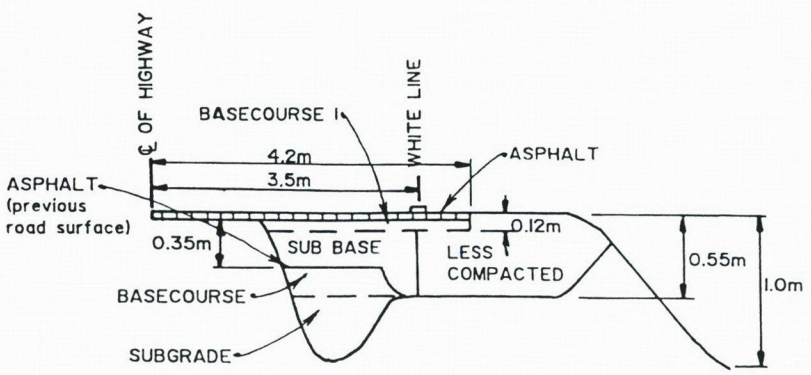
REPORT OF TEST PIT : TP53

CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 4 FEBRUARY 1998

TEST PIT LOCATION : 17494mE, 30868mN
ELEVATION : 5.8
DATUM : AHDD
CHECKED BY : B

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315C
LOGGED : D.J. MORRISON
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING	DCP TEST (Blows per 100 mm)
0	BACKHOE 450mm BUCKET	**ASPHALT SEAL OVER CLAYEY SANDY GRAVEL** Asphalt seal (30mm) over orange brown clayey sandy gravel and rock fragments to cobble size		5.80 0.00		BULK 0.03 - 0.10m	
				5.68		BULK 0.12 - 0.17m	
		DENSE CLAYEY SILTY SAND AND SANDSTONE ROCK FRAGMENTS Dense red brown stained orange brown and light gre clayey silty sand and sandstone rock gravel fragments		0.12			
				5.45			
		ASPHALT SEAL - Asphalt seal (35mm)		0.35 0.38		BULK 0.37 - 0.55m	
		DENSE SILTY SANDY GRAVEL Dense silty sandy gravel with purplish rock fragments		5.25		BULK 0.55 - 0.70	
		SILTY SAND Brown silty medium grained sand		0.55		GROUNDWATER NOT OBSERVED	
1				4.80			
		TEST PIT DISCONTINUED AT 1.0m		1.00		Approx CH 24191m Excavated in southbound lane BACKFILLED AND COMPACTED ON COMPLETION Location and elevation deduced from detailed survey plans and are approximate only.	
2							



TP53

Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP54

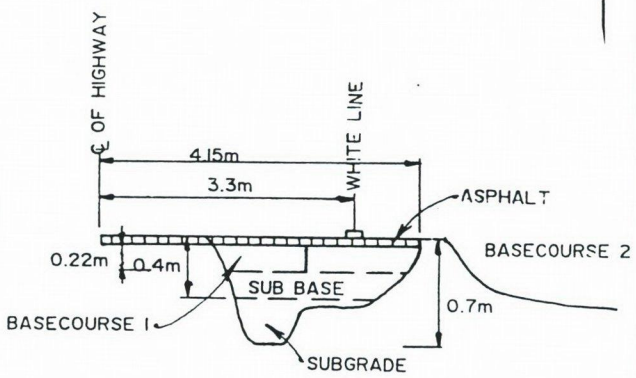
CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 4 FEBRUARY 1998

TEST PIT LOCATION : 17724mE, 31133mN
ELEVATION : 4.6
DATUM : AHDD

CHECKED BY : LD

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315C
LOGGED : D.J. MORRISON
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING	DCP TEST Blows per 100 mm (0 5 10 15 20)
0	BACKHOE 450mm BUCKET	ASPHALT SEAL Asphal seal (30mm) over thin brown sandy gravel layer (30mm) thin asphalt (30mm)		4.60 0.00 4.54		BULK 0.06 - 0.17m	
		DENSE SILTY SAND, GRAVEL SIZE ROCK FRAGMENTS Dense orange brown silty sand and gravel size rock fragments		0.06		BULK 0.10 - 0.19m	
		DENSE SANDY GRAVEL AND SANDSTONE COBBLES Dense brown sandy gravel and light grey sandstone cobbles		4.38 0.22		BULK 0.30 - 0.42m	
		SILTY SAND Brown silty medium grained sand		4.20 0.40		BULK 0.5 - 0.6m GROUNDWATER NOT OBSERVED	
		TEST PIT DISCONTINUED AT 0.70m		3.90 0.70		Approx CH 24503m Pit excavated in southbound lane BACKFILLED AND COMPACTED ON COMPLETION Location and elevation deduced from detailed survey plans and are approximate only.	
1							
2							



TP54

Report of test pit must be read in conjunction with accompanying notes and abbreviations

Golder Associates

REPORT OF TEST PIT : TP55

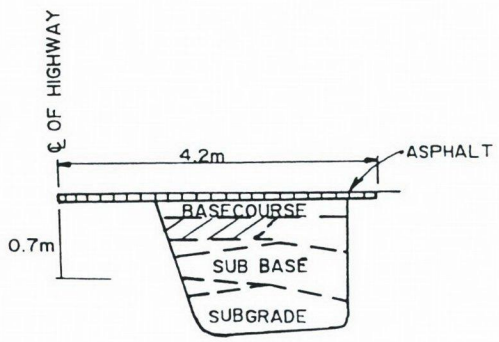
CLIENT : KINHILL CAMERON McNAMARA PTY LTD
PROJECT : TYNDALE REALIGNMENT
JOB NUMBER : 97638064
DATE STARTED : 4 FEBRUARY 1998

TEST PIT LOCATION : 17902mE, 31434mN
ELEVATION : 4.1
DATUM : AHDD

CHECKED BY :

SHEET : 1 OF 1
MACHINE : JOHN DEERE 315C
LOGGED : D.J. MORRISON
DATE : 6/3/98

DEPTH (metres)	EXCAVATION METHOD	INFERRED STRATIGRAPHY	GRAPHIC LOG	RL / Depth (m)	Recovered / Lost	SAMPLING AND TESTING	DCP TEST (Blows per 100 mm)
0	BACKHOE 450mm BUCKET	ASPHALT SEAL OVER SANDY GRAVEL Asphalt seal (30mm) over brown sandy gravel		4.10 0.00 3.95		BULK 0.08 - 0.15m	
		HARD GRAVELLY CLAY Hard red brown and brown gravelly clay		0.15 3.80		BULK 0.20 - 0.27m DS 0.30 - 0.40m	
		SILTY SAND Grey brown speckled orange brown slity sand		0.30 3.70		BULK 0.40 - 0.50m	
		CLAYEY/SILTY SAND GRAVEL Red brown and brown clayey/silty fine to medium grained sand and gravel		0.40 3.55			
		SANDY GRAVEL AND COBBLES Dark grey brown sandy gravel and cobbles		0.55 3.35		BULK 0.60 - 0.70m BULK 0.75 - 0.95m	
		SILTY SAND Grey brown silty sand		0.75 3.15		GROUNDWATER NOT OBSERVED	
1		TEST PIT DISCONTINUED AT 0.95m		0.95		Approx CH 24900m Pit excavated in southbound lane BACKFILLED AND COMPACTED ON COMPLETION	
2						Location and elevation deduced from detailed survey plans and are approximate only.	



TP55

Report of test pit must be read in conjunction with accompanying notes and abbreviations

APPENDIX B

Benkelman Beam Results

DESCRIPTION AND CLASSIFICATION OF SOIL

GENERAL

Description and classification of soil and rock are based on definitions and systems outlined in Australian Standard AS1726-1993, Geotechnical site investigations, published by Standards Australia. Description of rock fracturing is based on a system set out by the Sydney Group of the Australian Geomechanics Society, 1975.

DESCRIPTION AND CLASSIFICATION OF SOIL

Soils are classified on the basis of predominating grain size, modified by other significant grain size or sizes present (e.g. CLAYEY SAND) on the following basis:

Classification	Particle Size
CLAY	less than 0.002mm
SILT	0.002 - 0.06mm
SAND	
fine sand	0.06- 0.2mm
medium sand	0.2 - 0.6mm
coarse sand	0.6 - 2.0mm
GRAVEL	
fine gravel	2 - 6mm
medium gravel	6 - 20mm
coarse gravel	20 - 60mm
COBBLES	60 - 200mm
BOULDERS	greater than 200mm

COHESIVE SOILS are described in terms of consistency, colour and structure with comments on minor constituents or apparent special features. Consistency is based on the shear strength of the soil, and is generally estimated from experience, measured by hand penetrometer or determined by laboratory testing. Terms used in describing consistency are set out below:

Term	Shear Strength
VERY SOFT	less than 12kPa
SOFT	12 - 25kPa
FIRM	25 - 50kPa
STIFF	50 - 100kPa
VERY STIFF	100 - 200kPa
HARD	greater than 200kPa

NON-COHESIVE SOILS are described in terms of relative density, colour, with comments on minor constituents or apparent special features. Relative density or density index is generally based on standard penetration testing (AS1289.0-1991, Method 1289.6.3.1), or other forms of penetration testing. Terms used in describing relative density are set out below:

Term	Relative Density	SPT "N" Values blows/300mm
VERY LOOSE	less than 15%	less than 5 blows
LOOSE	15 - 35%	5 - 10 blows
MEDIUM DENSE	35 - 65%	10 - 30 blows
DENSE	65 - 85%	30 - 50 blows

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NOTES AND ABBREVIATIONS USED ON LOGS

DRILLING METHOD

AUGER	Continuous Flight Augering
ROTARY	Rotary Drilling with flushing of cuttings from hole using water circulation.
ROTARY/AIR	Rotary Drilling with flushing of cuttings from hole using air circulation.
ROTARY/MUD	Rotary Drilling with flushing of cuttings from hole using bentonite or polymer mud circulation.
DTHH	Down Hole Hammer drilling using air or foam circulation.
D	Diatube Diamond Core Drilling.
NMLC	NMLC 52mm Triple Tube Core Drilling.
NQ	NQ 47mm Triple Tube Core Drilling.

FIELD SAMPLING AND TESTING

Recovery	Recovered soil sample or length of recovered rock core
Lost	Lost soil sample or length of lost rock core
SPT	Standard Penetration Test to AS 1289 6.3.1. 1993 N = penetration resistance (blows for 300mm penetration following 150mm seating drive). Result reported according to penetration (P) achieved: . P=450mm blows for each 150mm of penetration, and N Value . 150<P<450 blows for seating drive, plus subsequent blows and penetration . P<150mm total blows and penetration RW = Rod weight only caused full penetration HW = Hammer and Rod weight only caused full penetration HB = Hammer bouncing
U50	Thin wall tube sample advanced by hydraulic pressure from drill rig. . number indicates nominal sample diameter in mm.
UP	Piston sample.
UA	Pneumatic sample
FV	Field vane shear test (result expressed as shear strength s_v)
PP	Pocket penetrometer test (result expressed as nominal shear strength s_{pp}) (instrument reading/2)
DS	Disturbed sample.
BULK	Bulk disturbed sample.
RQD	Rock Quality Designation (expressed as a percent) for core retrieved from borehole defined as : $\frac{\text{sum of sound core pieces} > 100\text{mm in length}}{\text{total length of section cored (run)}}$
TV	Torvane Shear Test (result expressed as shear strength S_v)

OTHER

GROUNDWATER :	
GWO	Groundwater level first observed while drilling.
GWL	Observed Groundwater level at time or date shown.
GROUNDWATER NOT OBSERVED	The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage, rain, etc, caving of borehole or test pit or where borehole or test pit was backfilled soon after completion.
FP	Field Rising or Falling Head Permeability test over section noted.
CP	Field Constant Head Permeability Test (k = hydraulic conductivity)
PM	Pressuremeter test over section noted. (E = Young's Modulus) (s_u = undrained shear strength)
WP	Water Pressure Packer test over section noted. (UL = Lugeon Units)

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PROJECT No.97638064
CLIENT: Kinhill Engineers Pty Ltd

BENKELMAN BEAM TEST RESULTS
PACIFIC HIGHWAY - TYNDALE

LOCATION Chainage	Lane	Rebound Deflection D0(mm)	D200 (mm)	D600 (mm)	D900 (mm)	D2700 (mm)	COMMENTS
CH 835 *	South	0.56	0.40	0.15	0.08	0.00	Beam 1 - External wheel path
CH 985 *	South	0.38	0.35	0.20	0.07	0.01	Beam 1 - External wheel path
CH 1135 *	South	1.33	0.91	0.40	0.27	0.05	Beam 1 - External wheel path
		1.21	1.10	0.33	0.11	0.00	Beam 2 - Internal wheel path
CH 1285 *	South	0.52	0.38	0.18	0.14	0.06	Beam 1 - External wheel path
		0.40	0.36	0.15	0.10	0.00	Beam 2 - Internal wheel path
CH 1435 *	South	0.66	0.48	0.25	0.20	0.07	Beam 1 - External wheel path
		0.33	0.18	0.05	0.03	0.02	Beam 2 - Internal wheel path
CH 1585 *	South	1.08	0.88	0.41	0.24	0.04	Beam 1 - External wheel path
		1.11	0.69	0.19	0.08	0.00	Beam 2 - Internal wheel path
CH 1735	South	0.53	0.45	0.23	0.16	0.02	Beam 1 - Internal wheel path
		0.67	0.58	0.23	0.09	0.00	Beam 2 - External wheel path
CH 1885	South	0.58	0.42	0.18	0.12	0.01	Beam 1 - Internal wheel path
		0.82	0.60	0.23	0.09	0.00	Beam 2 - External wheel path
CH 2035	South	0.28	0.22	0.07	0.05	0.02	Beam 1 - Internal wheel path
		0.25	0.19	0.03	0.01	0.00	Beam 2 - External wheel path
CH 2185	South	0.60	0.32	0.09	0.05	0.01	Beam 1 - Internal wheel path
		0.36	0.15	0.03	0.01	0.00	Beam 2 - External wheel path
CH 2335	South	0.12	0.11	0.09	0.06	0.01	Beam 1 - Internal wheel path
		0.30	0.19	0.05	0.03	0.00	Beam 2 - External wheel path
CH 2485	South	0.34	0.26	0.16	0.13	0.07	Beam 1 - Internal wheel path
		0.70	0.46	0.24	0.10	0.00	Beam 2 - External wheel path
CH 2635	South	0.74	0.59	0.25	0.10	0.00	Beam 1 - Internal wheel path
		0.72	0.51	0.23	0.09	0.00	Beam 2 - External wheel path
CH 2785	South	1.02	0.92	0.42	0.26	0.06	Beam 1 - Internal wheel path
		1.11	0.84	0.41	0.25	0.00	Beam 2 - External wheel path
CH 2935	South	0.87	0.79	0.41	0.23	0.03	Beam 1 - Internal wheel path
		0.47	0.47	0.41	0.23	0.01	Beam 2 - External wheel path
CH 3085	South	0.73	0.69	0.38	0.28	0.02	Beam 1 - Internal wheel path
		0.28	0.18	0.08	0.05	0.00	Beam 2 - External wheel path
CH 3185	South	1.21	0.88	0.50	0.34	0.09	Beam 1 - Internal wheel path
		0.82	0.75	0.43	0.24	0.03	Beam 2 - External wheel path
CH 3285	South	0.40	0.38	0.32	0.28	0.04	Beam 1 - Internal wheel path
			INVALID TEST				Beam 2 - External wheel path
CH 3485	South	0.34	0.33	0.29	0.23	0.00	Beam 1 - Internal wheel path
		0.92	0.66	0.36	0.17	0.03	Beam 2 - External wheel path
CH 3585	South	0.65	0.48	0.30	0.22	0.02	Beam 1 - Internal wheel path
		1.46	1.02	0.41	0.20	0.03	Beam 2 - External wheel path
CH 3685	South	1.14	0.93	0.50	0.27	0.00	Beam 1 - Internal wheel path
		1.02	0.87	0.35	0.21	0.00	Beam 2 - External wheel path
CH 3785	South	0.80	0.74	0.34	0.22	0.07	Beam 1 - Internal wheel path
		1.01	0.86	0.40	0.20	0.01	Beam 2 - External wheel path
CH 3885	South	1.33	1.07	0.50	0.33	0.10	Beam 1 - Internal wheel path
		1.41	1.00	0.40	0.16	0.00	Beam 2 - External wheel path
CH 3985	South	1.06	0.80	0.38	0.14	0.03	Beam 1 - Internal wheel path
		1.18	0.88	0.40	0.21	0.01	Beam 2 - External wheel path
CH 4085	South	0.39	0.39	0.28	0.19	0.05	Beam 1 - Internal wheel path
		0.54	0.44	0.18	0.09	0.00	Beam 2 - External wheel path
CH 4185	South		INVALID TEST				Beam 1 - Internal wheel path
Notes:							Beam 2 - External wheel path

1) Rear axle load 8.9 t
2) * Indicates tests undertaken in opposite direction to traffic flow
3) Chainages with reference to plan BC 7802-SK-012-014. To refer to present chainages add 23700m to these chainages.

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PROJECT No.97638064
CLIENT: Kinhill Engineers Pty Ltd

BENKELMAN BEAM TEST RESULTS
PACIFIC HIGHWAY - TYNDALE

LOCATION Chainage	Lane	Rebound Deflection D0(mm)	D200 (mm)	D600 (mm)	D900 (mm)	D2700 (mm)	COMMENTS
CH 485	North	0.62	0.52	0.30	0.22	0.04	Beam 1 - Internal wheel path
		0.43	0.26	0.12	0.07	0.00	Beam 2 - External wheel path
CH 635	North	0.67	0.46	0.29	0.23	0.07	Beam 1 - Internal wheel path
		0.41	0.26	0.11	0.06	0.00	Beam 2 - External wheel path
CH 760	North	0.31	0.29	0.17	0.14	0.03	Beam 1 - Internal wheel path
		0.33	0.30	0.15	0.10	0.00	Beam 2 - External wheel path
CH 910	North	0.27	0.21	0.09	0.06	0.00	Beam 1 - Internal wheel path
				NO TEST			Beam 2 - External wheel path
CH 1060	North	0.39	0.26	0.10	0.05	0.01	Beam 1 - Internal wheel path
				NO TEST			Beam 2 - External wheel path
CH 1210	North	1.46	1.32	0.70	0.48	0.00	Beam 1 - Internal wheel path
		1.36	1.32	0.62	0.38	0.00	Beam 2 - External wheel path
CH 1360	North	1.08	0.61	0.27	0.15	0.05	Beam 1 - Internal wheel path
		0.65	0.48	0.12	0.09	0.05	Beam 2 - External wheel path
CH 1510	North	0.76	0.72	0.36	0.26	0.02	Beam 1 - Internal wheel path
		0.58	0.43	0.21	0.12	0.00	Beam 2 - External wheel path
CH 1660	North	1.88	1.59	0.66	0.43	0.10	Beam 1 - Internal wheel path
		1.23	0.75	0.36	0.23	0.02	Beam 2 - External wheel path
CH 1810	North	1.59	1.20	0.52	0.32	0.02	Beam 1 - Internal wheel path
		1.07	0.96	0.36	0.21	0.00	Beam 2 - External wheel path
CH 1960	North	0.35	0.17	0.08	0.05	0.02	Beam 1 - Internal wheel path
		0.52	0.26	0.11	0.06	0.01	Beam 2 - External wheel path
CH 2110	North	1.26	0.80	0.38	0.24	0.08	Beam 1 - Internal wheel path
		1.76	1.00	0.39	0.17	0.00	Beam 2 - External wheel path
CH 2260	North	0.58	0.36	0.14	0.06	0.02	Beam 1 - Internal wheel path
		0.28	0.25	0.04	0.01	0.00	Beam 2 - External wheel path
CH 2410	North	0.48	0.39	0.22	0.16	0.01	Beam 1 - Internal wheel path
				INVALID TEST			Beam 2 - External wheel path
CH 2560	North	1.50	0.55	0.25	0.13	0.00	Beam 1 - Internal wheel path
		0.56	0.40	0.21	0.13	0.00	Beam 2 - External wheel path
CH 2710	North	1.04	0.90	0.49	0.35	0.03	Beam 1 - Internal wheel path
		0.69	0.59	0.31	0.22	0.01	Beam 2 - External wheel path
CH 2860	North	0.97	0.70	0.35	0.20	0.07	Beam 1 - Internal wheel path
				INVALID TEST			Beam 2 - External wheel path
CH 3010	North	1.00	0.79	0.45	0.35	0.11	Beam 1 - Internal wheel path
		0.19	0.14	0.12	0.10	0.04	Beam 2 - External wheel path
CH 3160	North	0.76	0.58	0.32	0.20	0.03	Beam 1 - Internal wheel path
		0.14	0.09	0.06	0.04	0.02	Beam 2 - External wheel path
CH 3310	North	0.81	0.60	0.31	0.19	0.01	Beam 1 - Internal wheel path
		0.05	0.01	0.00	0.00	0.00	Beam 2 - External wheel path
CH 3510	North	0.75	0.51	0.16	0.07	0.00	Beam 1 - Internal wheel path
		0.54	0.41	0.18	0.10	0.02	Beam 2 - External wheel path
CH 3710	North	1.24	1.00	0.45	0.25	0.03	Beam 1 - Internal wheel path
CH 3910	North	0.88	0.61	0.04	0.02	0.00	Beam 1 - Internal wheel path
CH 4110	North	0.16	0.14	0.04	0.01	0.00	Beam 1 - Internal wheel path

Notes:

1) Rear axle load 8.9 t
2) * Indicates tests undertaken in opposite direction to traffic flow
3) Chainages with reference to plan BC 7802-SK-012-014. To refer to present chainages add 237000m to these chainages.

APPENDIX C

Results of Laboratory Testing

RESULTS OF UNCONFINED COMPRESSIVE STRENGTH TESTING

97638064

Test Pit No	Depth (m)	Additive	Unconfined Compressive Strength Testing								
			7 Day Benchtop Cure 23°			7 Day Oven Cure 65°			28 Day Core		
			Sample A	Sample B	Average	Sample A	Sample B	Average	Sample A	Sample B	Average
TP 19	0.05 - 0.15	4% (Cement 75% (Flyash 75%	4.50	4.35	4.5	8.80	8.30	8.6			
		4% (Lime 30% (Slag 70%	2.70	2.35	2.5	6.45	7.05	6.8			
TP 52	0.06 - 0.12	4% (Cement 75% (Flyash 25%	4.30	4.50	4.4	7.85	9.00	8.4			
		4% (Lime 30% (Slag 70%	2.60	2.35	2.5	7.50	6.70	7.1			
TP 53	0.03 - 0.17	4% (Cement 75% (Flyash 70%	3.35	3.55	3.5	8.20	7.60	7.9	TO COME		
		4% (Lime 30% (Slag 70%	2.25	2.20	2.2	6.0	6.70	6.4			
TP 54	0.06 - 0.17	4% (Cement 75% (Flyash 25%	1.20	1.65	1.7	2.35	2.00	2.2			
		4% (Lime 30% (Slag 70%	0.4	0.4	0.4	0.85	0.75	0.8			
TP 55	0.08 - 0.15	4% (Cement 75% (Flyash 25%	4.5	4.00	4.0	8.80	7.50	8.2			
		4% (Lime 30% (Slag 70%	2.80	3.10	3.0	6.10	6.60	6.4			

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Golder Associates

LABORATORY C.B.R. TEST REPORT

CLIENT:	KINHILL CAMERON McNAMARA PTY LTD	PROJECT No.:	97638064
PROJECT:	HIGHWAY REALIGNMENT	REPORT No.:	B97-401
LOCATION:	TYNDALE		

Sampling Details:	Sampled by G.A.P. - Brisbane	Laboratory:	BRISBANE
Laboratory Test Procedure:	RTA - T122; T111; T117A	Date Checked:	9-9-97
		Checked by:	C Clark

Sample No.		B4352	B4353	B4357	B4359
Sample Location		TP 20 0.5 - 1.0m	TP 21 0.5 1.0m	TP 25 0.2 - 0.5m	TP 27 0.5 - 1.0m
Sample Description		Brown slightly clayey SILTY SAND	Brown slightly clayey SILTY SAND	Dark brown slight clayey SILTY SAND	Brown clayey SILTY SAND
Maximum Dry Density	t/m3	1.68	1.70	1.67	1.69
Optimum Moisture Content	%	16.2	16.2	14.7	14.3
Moulding Conditions					
Dry Density	t/m3	1.68	1.70	1.66	1.70
Density Ratio	%	100.5	100.0	99.5	100.5
Moisture Content	%	16.1	15.9	15.1	14.1
Soaked Conditions					
No. of Days		10	10	10	10
Dry Density	t/m3	1.69	1.70	1.66	1.70
Density Ratio	%	100.5	100.0	99.5	100.5
Moisture Content	%	16.7	18.3	17.6	15.8
Swell	%	-0.3	0.1	0.1	-0.0
Surcharge	kg	4.5	4.5	4.5	4.5
After Test					
Moisture Content:					
- Layer Penetrated	%	ERR	ERR	ERR	ERR
- Whole	%	16.5	18.2	17.4	15.6
C.B.R. VALUE	%	**12**	**15**	**19**	**25**
Depth of Penetration	mm	2.5	5.0	5.0	2.5

NOTE: For CBR values reported at 5mm penetration the test was not repeated.

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30-9-97

Approved Signatory & Date

Golder Associates

LABORATORY C.B.R. TEST REPORT

CLIENT:	KINHILL CAMARON McNAMARA PTY LTD	PROJECT No.:	97638064
PROJECT:	HIGHWAY REALIGNMENT	REPORT No.:	B97-402
LOCATION:	TYNDALE		

Sampling Details:	Sampled by G.A.P. - Brisbane	Laboratory:	BRISBANE
Laboratory Test Procedure:	RTA - T122; T111; T117A	Date Checked:	8.9.97
		Checked by:	C Clark

Sample No.		B4360	B4361	B4362	B4364
Sample Location		TP 28 0.5 - 1.0m	TP 29 0.5 - 1.0m	TP 30 0.5 - 1.0m	TP 33 0.5 - 1.0
Sample Description		Brown SILTY SAND	Brown SILTY SAND	Brown SILTY SAND	Brown SILTY SAND
Maximum Dry Density Standard	t/m3	1.70	1.67	1.66	1.70
Optimum Moisture Content	%	15.8	14.4	17.0	16.1
Moulding Conditions					
Dry Density	t/m3	1.69	1.67	1.67	1.70
Density Ratio	%	99.5	100.0	100.5	100.0
Moisture Content	%	16.1	14.3	16.8	15.7
Soaked Conditions					
No. of Days		10	10	10	10
Dry Density	t/m3	1.70	1.67	1.66	1.71
Density Ratio	%	100.0	100.0	100.5	100.5
Moisture Content	%	16.9	16.5	18.5	15.8
Swell	%	-0.2	0.2	0.1	-0.4
Surcharge	kg	4.5	4.5	4.5	4.5
After Test					
Moisture Content:					
- Layer Penetrated	%	ERR	ERR	ERR	ERR
- Whole	%	16.8	16.4	18.3	15.6
C.B.R. VALUE	%	**11**	**22**	**12**	**10**
Depth of Penetration	mm	2.5	5.0	5.0	2.5

NOTE: For CBR values reported at 5mm penetration the test was not repeated.

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LABORATORY C.B.R. TEST REPORT

CLIENT:	KINHILL CAMARON McNAMARA PTY LTD	PROJECT No.:	97638064
PROJECT:	HIGHWAY REALIGNMENT	REPORT No.:	B97-403
LOCATION:	TYNDALE		

Sampling Details:	Sampled by G.A.P. - Brisbane	Laboratory:	BRISBANE
Laboratory Test Procedure:	RTA - T122; T111; T117A	Date Checked:	8.9.97
		Checked by:	C Clark

Sample No.		B4365	B4366	B4367	B4368
Sample Location		TP 34 0.5 - 1.0m	TP 35 0.2 - 0.3m	TP 35 0.7 - 0.8m	TP 36 0.5 - 1.0
Sample Description		Brown SILTY SAND	Brown fine to coarse SAND & SANDSTONE FRAGMENTS	Brown SILTY SAND (Indurated)	Grey brown CLAYEY SAND
Maximum Dry Density	t/m3	1.70	1.94	1.87	1.71
Standard					
Optimum Moisture Content	%	17.2	9.3	12.7	17.2
Moulding Conditions					
Dry Density	t/m3	1.70	1.94	1.86	1.71
Density Ratio	%	100.0	100.0	99.5	100.0
Moisture Content	%	17.4	9.0	12.9	17.6
Soaked Conditions					
No. of Days		10	10	10	10
Dry Density	t/m3	1.69	1.93	1.86	1.70
Density Ratio	%	99.5	99.5	99.5	99.5
Moisture Content	%	20.2	10.8	14.8	18.9
Swell	%	0.3	0.3	0.1	0.2
Surcharge	kg	4.5	4.5	4.5	4.5
After Test					
Moisture Content:					
- Layer Penetrated	%	ERR	12.3	ERR	20.2
- Whole	%	20.0	10.6	14.8	18.8
C.B.R. VALUE	%	**8**	**45**	**20**	**14**
Depth of Penetration	mm	2.5	5.0	2.5	2.5

NOTE: For CBR values reported at 5mm penetration the test was not repeated.

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Golder Associates Pty Ltd

Particle Size Distribution & Consistency Limits Test Report

Client:	KINHILL CAMERON McNAMARA PTY LTD	**Job No.**	97638064
Project:	HIGHWAY ALIGNMENT	**Date Checked:**	30-Sep-97
Location:	TYNDALE	**Checked by:**	C Clark
		Report No.	B97-412

Lab Reference No. B4369 **Sample Identification:** TP 20 0.0 - 0.1m

Laboratory Specimen Description: Dark brown CLAYEY SILTY SAND

Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm		
75 mm		
53mm		
37.5 mm		
26.5 mm		
19.0 mm		
13.2 mm		
9.5 mm		
6.7 mm	100	
4.75 mm	99	
2.36 mm	98	
1.18 mm	97	
600 um	94	
425 um	91	
300 um	76	
150 um	30	
75 um	22	

Consistency Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	ND	
Plastic Limit	%	AS1289 3.2.1	ND	
Plasticity Index	%	AS1289 3.3.1	ND	
Linear Shrinkage	%	AS1289 3.4.1	ND	
Moisture Content	%	AS1289.2.1.1	17.2	

Sample History:	Oven Dried
Preparation Method:	Dry sieved
Crumbling / Curling of linear shrinkage:	ND
Linear shrinkage mould length:	ND

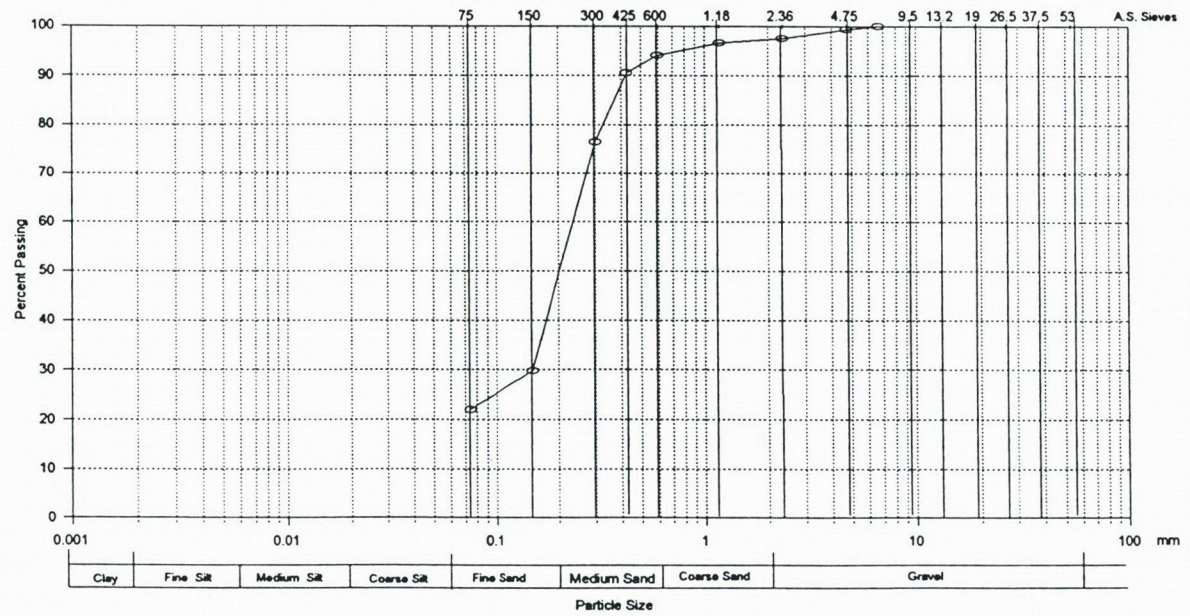
Notes

Samples supplied by: G.A.P. - Brisbane

ND = not determined

NO = not obtainable

Particle Size Distribution



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C. [signature] 30-9-97

Approved Signatory Date

Golder Associates Pty Ltd

Particle Size Distribution & Consistency Limits Test Report

Client:	KINHILL CAMERON McNAMARA PTY LTD	**Job No.**	97638064
Project:	HIGHWAY REALIGNMENT	**Date Checked:**	30-Sep-97
Location:	TYNDALE	**Checked by:**	C Clark
		Report No.	B97-413

Lab Reference No. B4352 **Sample Identification:** TP 20 0.5 - 1.0m

Laboratory Specimen Description: Brown slightly clayey SILTY SAND

Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm		
75 mm		
53mm		
37.5 mm		
26.5 mm		
19.0 mm		
13.2 mm		
9.5 mm		
6.7 mm		
4.75 mm	100	
2.36 mm	99	
1.18 mm	99	
600 um	97	
425 um	94	
300 um	78	
150 um	25	
75 um	18	

Consistency Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	ND	
Plastic Limit	%	AS1289 3.2.1	ND	
Plasticity Index	%	AS1289 3.3.1	ND	
Linear Shrinkage	%	AS1289 3.4.1	ND	
Moisture Content	%	AS1289.2.1.1	16.4	

Sample History:	Oven Dried
Preparation Method:	Dry sieved
Crumbling / Curling of linear shrinkage:	ND
Linear shrinkage mould length:	ND

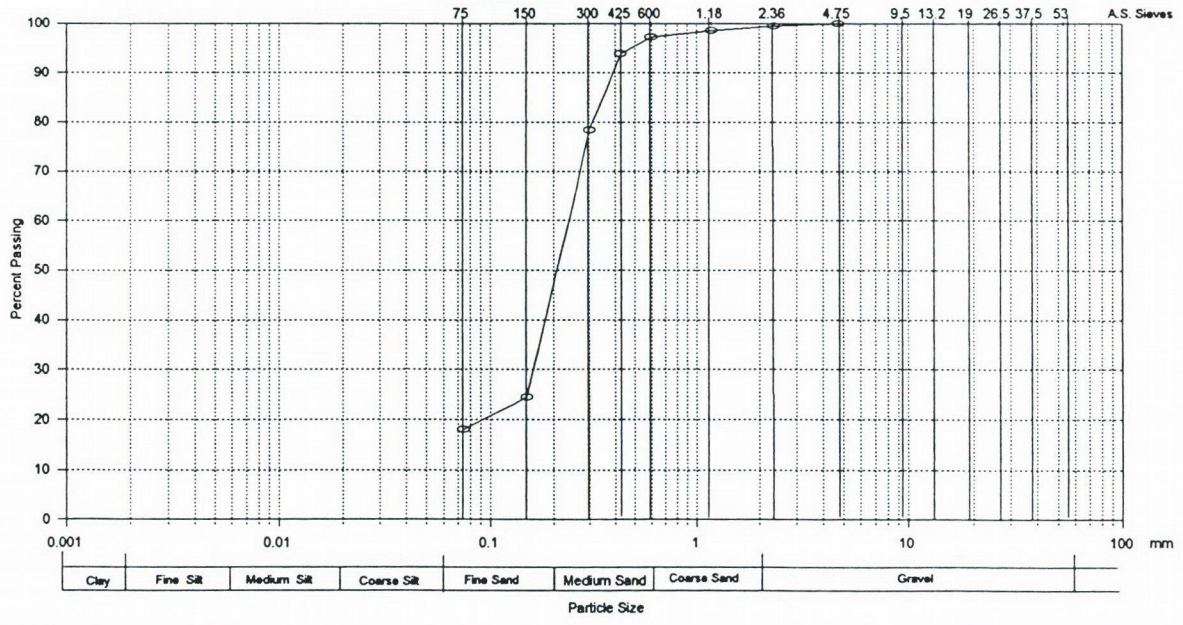
Notes

Samples supplied by: G.A.P. - Brisbane

ND = not determined

NO = not obtainable

Particle Size Distribution



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Particle Size Distribution & Consistency Limits Test Report

Client:	KINHILL CAMERON McNAMARA PTY LTD	**Job No.**	97638064
Project:	HIGHWAY REALIGNMENT	**Date Checked:**	30-Sep-97
Location:	TYNDALE	**Checked by:**	C Clark
		Report No.	B97-414

Lab Reference No.	B4353	**Sample Identification:**	TP 21 0.5 - 1.0m

Laboratory Specimen Description: Brown slightly clayey SILTY SAND

Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm		
75 mm		
53mm		
37.5 mm		
26.5 mm		
19.0 mm		
13.2 mm		
9.5 mm		
6.7 mm		
4.75 mm	100	
2.36 mm	99	
1.18 mm	97	
600 um	95	
425 um	90	
300 um	78	
150 um	26	
75 um	16	

Consistency Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	ND	
Plastic Limit	%	AS1289 3.2.1	ND	
Plasticity Index	%	AS1289 3.3.1	ND	
Linear Shrinkage	%	AS1289 3.4.1	ND	
Moisture Content	%	AS1289.2.1.1	14.1	

Sample History:	Oven Dried
Preparation Method:	Dry sieved
Crumbling / Curling of linear shrinkage:	ND
Linear shrinkage mould length:	ND

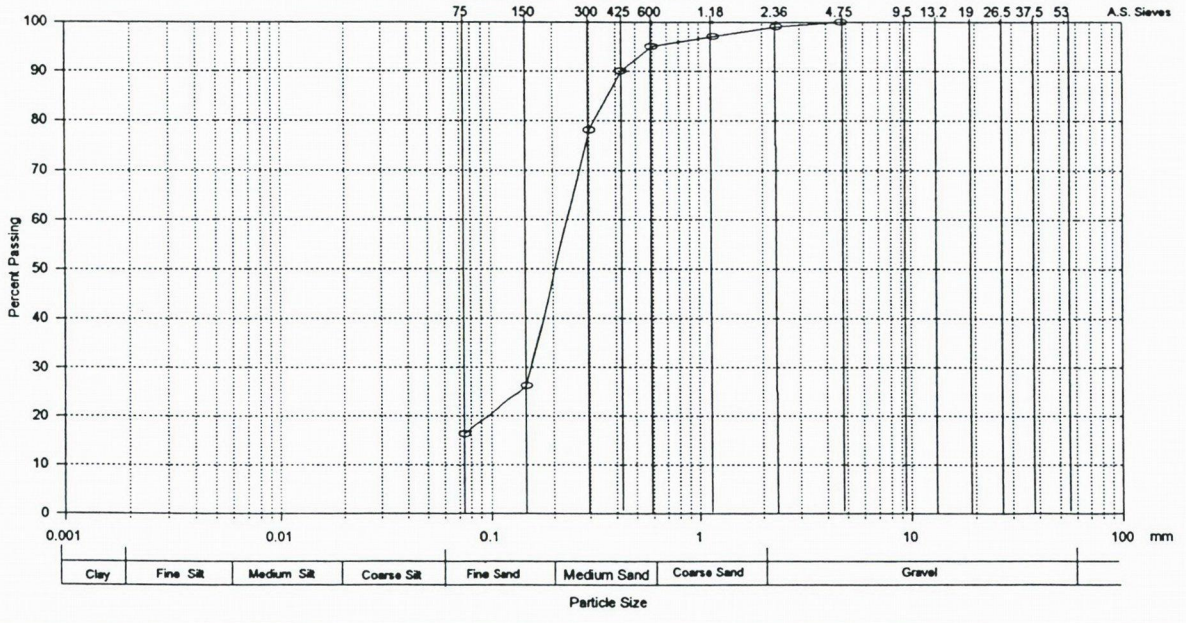
Notes

Samples supplied by: G.A.P. - Brisbane

ND = not determined

NO = not obtainable

Particle Size Distribution



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Particle Size Distribution & Consistency Limits Test Report

Client:	KINHILL CAMERON McNAMARA PTY LTD	**Job No.**	97638064
Project:	HIGHWAY REALIGNMENT	**Date Checked:**	30-Sep-97
Location:	TYNDALE	**Checked by:**	C Clark
		Report No.	B97-411

Lab Reference No. B4362 **Sample Identification:** TP 25 0.2 - 0.5m

Laboratory Specimen Description: Dark brown slightly clayey SILTY SAND

Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm		
75 mm		
53mm		
37.5 mm		
26.5 mm		
19.0 mm		
13.2 mm	100	
9.5 mm	99	
6.7 mm	99	
4.75 mm	98	
2.36 mm	95	
1.18 mm	90	
600 um	81	
425 um	73	
300 um	64	
150 um	32	
75 um	23	

Consistency Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	ND	
Plastic Limit	%	AS1289 3.2.1	ND	
Plasticity Index	%	AS1289 3.3.1	ND	
Linear Shrinkage	%	AS1289 3.4.1	ND	
Moisture Content	%	AS1289.2.1.1	17.4	

Sample History:	Oven Dried
Preparation Method:	Dry sieved
Crumbling / Curling of linear shrinkage:	ND
Linear shrinkage mould length:	ND

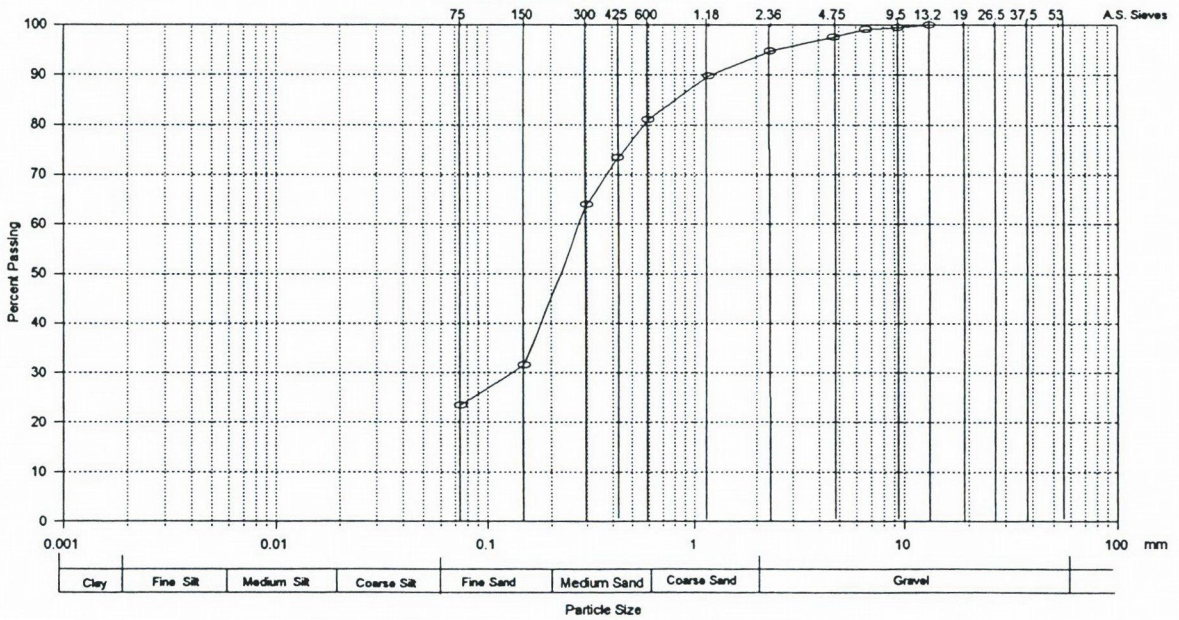
Notes

Samples supplied by: G.A.P. - Brisbane

ND = not determined

NO = not obtainable

Particle Size Distribution



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Particle Size Distribution & Consistency Limits Test Report

Client:	KINHILL CAMERON McNAMARA PTY LTD	**Job No.**	97638064
Project:	HIGHWAY REALIGNMENT	**Date Checked:**	30-Sep-97
Location:	TYNDALE	**Checked by:**	C Clark
		Report No.	B97-410

Lab Reference No.	B4362	**Sample Identification:**	TP 30 0.5 - 1.0m

Laboratory Specimen Description: Brown SILTY SAND

Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm		
75 mm		
53mm		
37.5 mm		
26.5 mm		
19.0 mm		
13.2 mm		
9.5 mm		
6.7 mm		
4.75 mm	100	
2.36 mm	98	
1.18 mm	94	
600 um	90	
425 um	82	
300 um	67	
150 um	23	
75 um	18	

Consistency Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	ND	
Plastic Limit	%	AS1289 3.2.1	ND	
Plasticity Index	%	AS1289 3.3.1	ND	
Linear Shrinkage	%	AS1289 3.4.1	ND	
Moisture Content	%	AS1289.2.1.1	24.6	

Sample History:	Oven Dried
Preparation Method:	Dry sieved
Crumbling / Curling of linear shrinkage:	ND
Linear shrinkage mould length:	ND

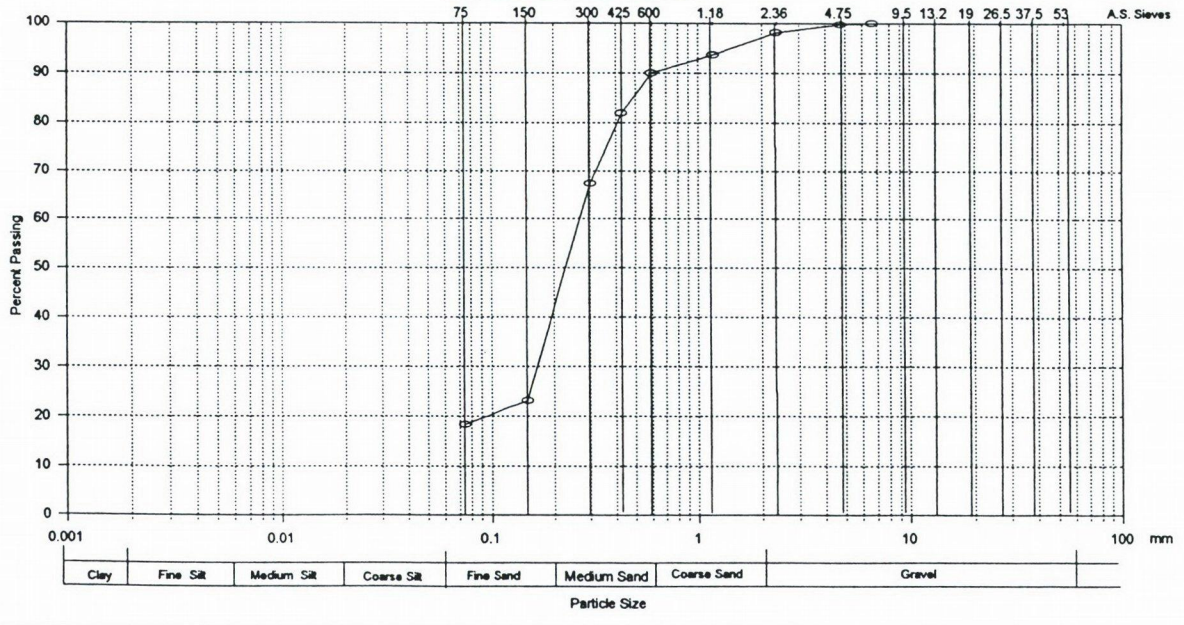
Notes

Samples supplied by: G.A.P. - Brisbane

ND = not determined

NO = not obtainable

Particle Size Distribution



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Approved Signatory Date

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Particle Size Distribution & Consistency Limits Test Report

Client:	KINHILL CAMERON McNAMARA PTY LTD	**Job No.**	97638064
Project:	HIGHWAY REALIGNMENT	**Date Checked:**	30-Sep-97
Location:	TYNDALE	**Checked by:**	C Clark
		Report No.	B97-409

Lab Reference No. B4365 **Sample Identification:** TP 34 0.5 - 1.0m

Laboratory Specimen Description: Brown SILTY SAND

Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm		
75 mm		
53mm		
37.5 mm		
26.5 mm		
19.0 mm		
13.2 mm		
9.5 mm		
6.7 mm		
4.75 mm		
2.36 mm	100	
1.18 mm	98	
600 um	94	
425 um	87	
300 um	71	
150 um	20	
75 um	9	

Consistency Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	ND	
Plastic Limit	%	AS1289 3.2.1	ND	
Plasticity Index	%	AS1289 3.3.1	ND	
Linear Shrinkage	%	AS1289 3.4.1	ND	
Moisture Content	%	AS1289.2.1.1	18.2	

Sample History:	Oven Dried
Preparation Method:	Dry sieved
Crumbling / Curling of linear shrinkage:	ND
Linear shrinkage mould length:	ND

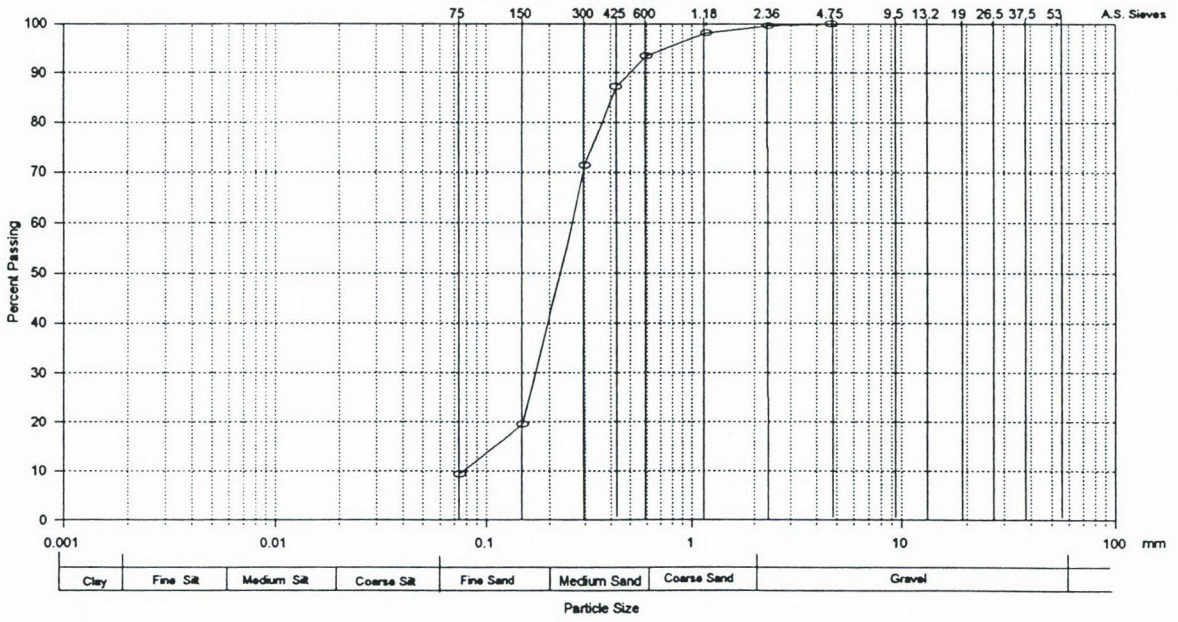
Notes

Samples supplied by: G.A.P. - Brisbane

ND = not determined

NO = not obtainable

Particle Size Distribution



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C. A. T. 30-9-97

Approved Signatory Date

Golder Associates Pty Ltd

Particle Size Distribution & Consistency Limits Test Report

Client:	KINHILL CAMERON McNAMARA PTY LTD	**Job No.**	97638064
Project:	HIGHWAY REALIGNMENT	**Date Checked:**	30-Sep-97
Location:	TYNDALE	**Checked by:**	C Clark
		Report No.	B97-404

Lab Reference No. B4366 **Sample Identification:** TP 35 0.2 - 0.3m

Laboratory Specimen Description: Brown fine to coarse SAND and SANDSTONE FRAGMENTS

Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm		
75 mm		
53mm		
37.5 mm		
26.5 mm		
19.0 mm	100	
13.2 mm	96	
9.5 mm	93	
6.7 mm	90	
4.75 mm	87	
2.36 mm	84	
1.18 mm	76	
600 um	58	
425 um	45	
300 um	36	
150 um	25	
75 um	18	

Consistency Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	ND	
Plastic Limit	%	AS1289 3.2.1	ND	
Plasticity Index	%	AS1289 3.3.1	ND	
Linear Shrinkage	%	AS1289 3.4.1	ND	
Moisture Content	%	AS1289.2.1.1	5.8	

Sample History:	Oven Dried
Preparation Method:	Dry sieved
Crumbling / Curling of linear shrinkage:	ND
Linear shrinkage mould length:	ND

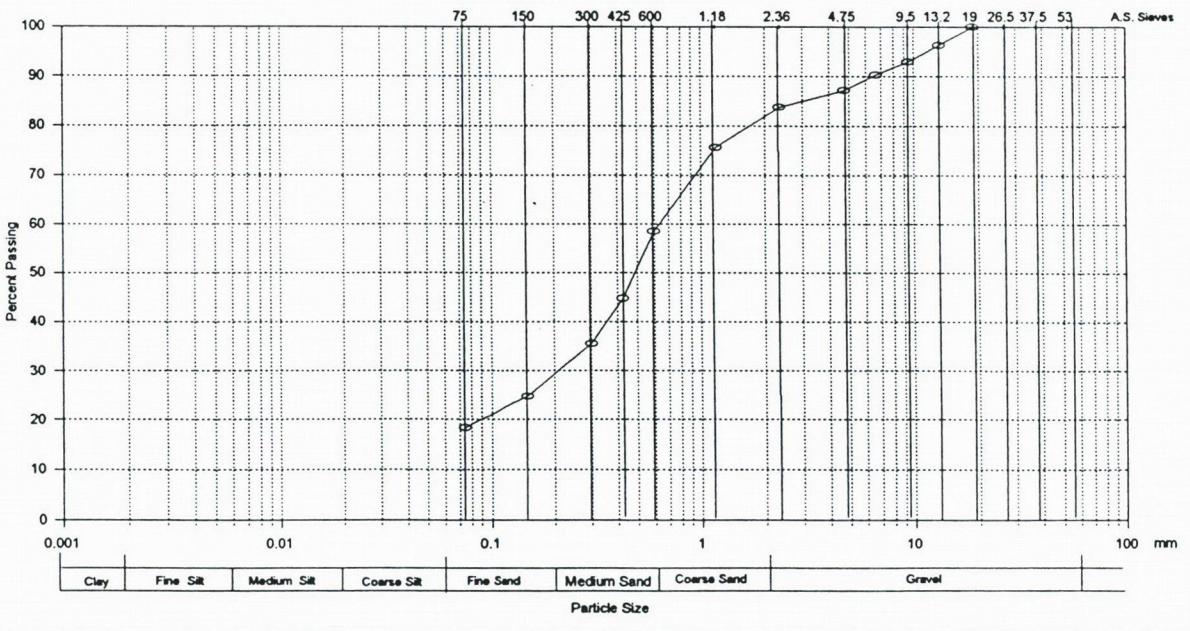
Notes

Samples supplied by: G.A.P. - Brisbane

ND = not determined

NO = not obtainable

Particle Size Distribution



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30-9-97

Approved Signatory Date

Golder Associates Pty Ltd

Particle Size Distribution & Consistency Limits Test Report

Client:	KINHILL CAMERON McNAMARA PTY LTD	**Job No.**	97638064
Project:	HIGHWAY REALIGNMENT	**Date Checked:**	30-Sep-97
Location:	TYNDALE	**Checked by:**	C Clark
		Report No.	B97-406

Lab Reference No. B4367 **Sample Identification:** TP 35 0.7 - 0.8m

Laboratory Specimen Description: Brown SILTY SAND (indurated in part)

Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm		
75 mm		
53mm		
37.5 mm		
26.5 mm		
19.0 mm		
13.2 mm		
9.5 mm		
6.7 mm	100	
4.75 mm	99	
2.36 mm	99	
1.18 mm	93	
600 um	85	
425 um	75	
300 um	59	
150 um	22	
75 um	12	

Consistency Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	ND	
Plastic Limit	%	AS1289 3.2.1	ND	
Plasticity Index	%	AS1289 3.3.1	ND	
Linear Shrinkage	%	AS1289 3.4.1	ND	
Moisture Content	%	AS1289.2.1.1	11.7	

Sample History:	Oven Dried
Preparation Method:	Dry sieved
Crumbling / Curling of linear shrinkage:	ND
Linear shrinkage mould length:	ND

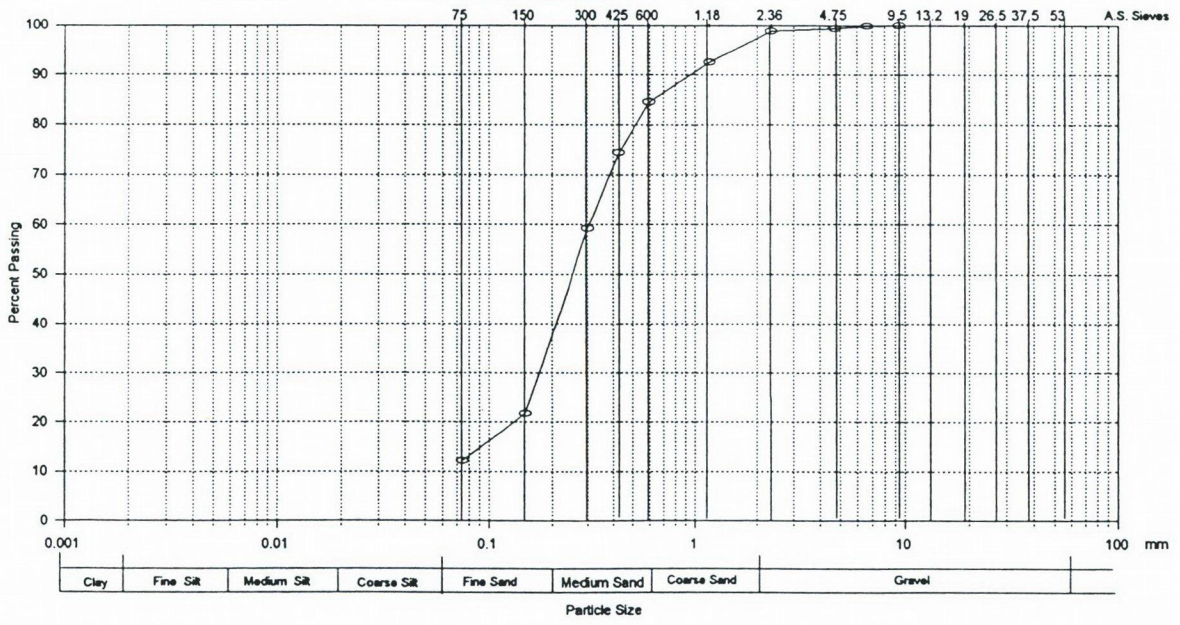
Notes

Samples supplied by: G.A.P. - Brisbane

ND = not determined

NO = not obtainable

Particle Size Distribution



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Approved Signatory Date

Golder Associates Pty Ltd

Particle Size Distribution & Consistency Limits Test Report

Client:	KINHILL CAMERON McNAMARA PTY LTD	**Job No.**	97638064
Project:	HIGHWAY REALIGNMENT	**Date Checked:**	30-Sep-97
Location:	TYNDALE	**Checked by:**	C Clark
		Report No.	B97-405

Lab Reference No. B4368 **Sample Identification:** TP 36 0.5 - 1.0m

Laboratory Specimen Description: Grey and brown CLAYEY SAND

Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm		
75 mm		
53mm		
37.5 mm		
26.5 mm		
19.0 mm		
13.2 mm		
9.5 mm		
6.7 mm		
4.75 mm	100	
2.36 mm	99	
1.18 mm	95	
600 um	86	
425 um	75	
300 um	60	
150 um	28	
75 um	19	

Consistency Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	ND	
Plastic Limit	%	AS1289 3.2.1	ND	
Plasticity Index	%	AS1289 3.3.1	ND	
Linear Shrinkage	%	AS1289 3.4.1	ND	
Moisture Content	%	AS1289.2.1.1	16.0	

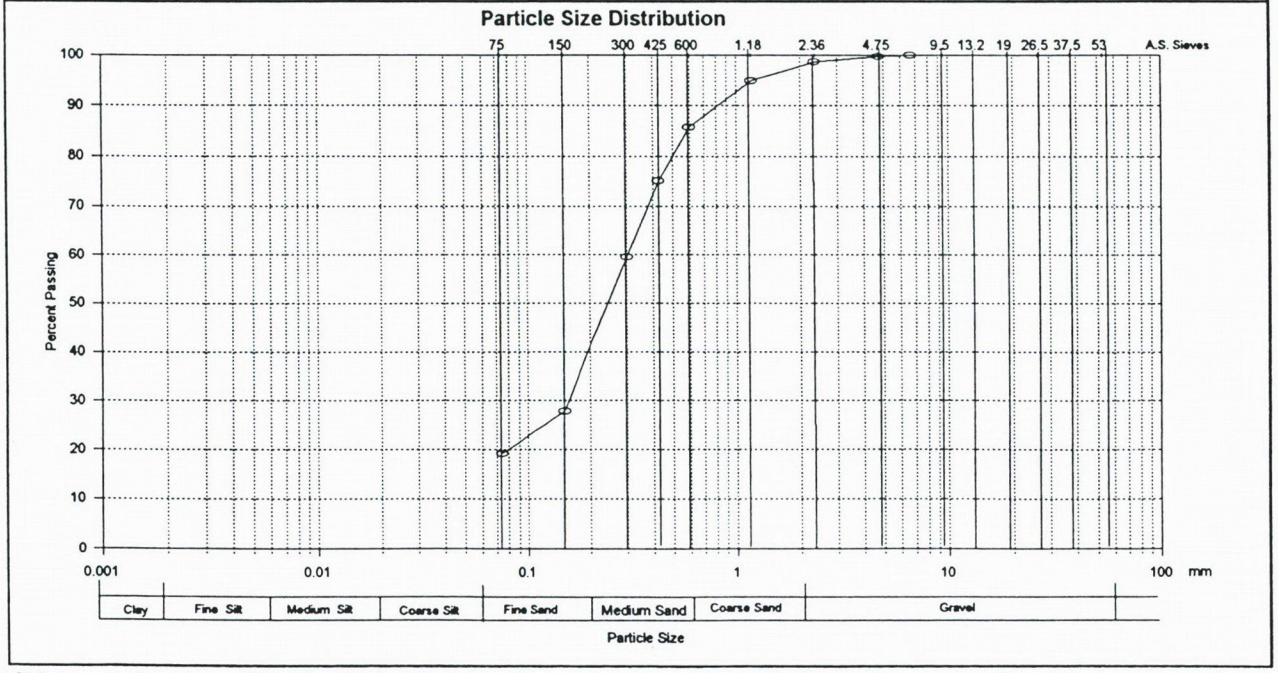
Sample History:	Oven Dried
Preparation Method:	Dry sieved
Crumbling / Curling of linear shrinkage:	ND
Linear shrinkage mould length:	ND

Notes

Samples supplied by: G.A.P. - Brisbane

ND = not determined

NO = not obtainable



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Approved Signatory Date

Golder Associates Pty Ltd
MELBOURNE LABORATORY

NATA Registration No: 1257

Golder Associates

REPORT OF CLASSIFICATION TESTS

Client :	KINHILL CAMERON McNAMARA	Job No. :	97638064
Project :	HIGHWAY REALIGN	Date :	9-Sep-97
Location :	TYNDALE		

	Test Procedures	AS1289 3.1.2	AS 1289 3.2.1	AS 1289 3.3.1	AS 1289 3.4.1	AS 1289 2.1.1	AS 1141 Sec 12
Sample No.	Sample Identification and Description	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)	Moisture Content (%)	Passing 0.075 mm (%)
B4352	TP 20 0.5 - 1.0 ML	25	18	7	2		
B4369	TP 20 0.0 - 0.1 CL	33	21	12	6		
B4362	TP 30 0.5 - 1.0 CL	30	18	12	6.5		
B4366	TP 35 0.2 - 0.3 CL	23	16	7	3.5		
B4367	TP 35 0.7 - 0.8 ML (slipping in bowl)	22	19	3	1		
B4368	TP 36 0.5 - 1.1 CL	31	19	12	6		
B4365	TP 34 0.5 - 1.0 Non Plastic (slipping in bowl)	21	21	0	0.5		
B4353	TP 21 0.5 - 1.0 CL	29	20	9	4		

Remarks:

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AUTHORISED SIGNATORY | DATE: 9/9/97

Golder Associates Pty Ltd
MELBOURNE LABORATORY

NATA Registration No: 1257

Golder Associates

REPORT OF CLASSIFICATION TESTS

Client :	KINHILL CAMERON McNAMARA	Job No. :	97638064
Project :	HIGHWAY REALIGN	Date :	9-Sep-97
Location :	TYNDALE		

Test Procedures		AS1289 3.1.2	AS 1289 3.2.1	AS 1289 3.3.1	AS 1289 3.4.1	AS 1289 2.1.1	AS 1141 Sec 12
Sample No.	Sample Identification and Description	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)	Moisture Content (%)	Passing 0.075 mm (%)
B4357	TP 25 0.2 - 0.5 CL	27	20	7	3.5		

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9/9/97
DATE

Form GAMLRS - 4/ Aug 1996

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MAROOCHYDORE OFFICE

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Telephone (07) 5443 3511
Fax (07) 5443 6645

Golder Associates

LABORATORY CBR

REPORT NO. SC 98 /263

CLIENT:KINHILL

JOB NUMBER: 97638064

PROJECT: ROAD ALIGNMENT, TYNDALE

SAMPLES SUPPLIED TO LABORATORY ON: February 4, 1998

LABORATORY TEST PROCEDURE: RTA T112 & T117A

Sample No.	98081
Sample Location	TP19,0.05 - 0.15
Sample Description	Pale Brown Silty Sandy Gravel
Maximum Density t/m^3 STD	2.12
Optimum Moisture Content %	8.2
Moulding Conditions	
Dry Density t/m^3	2.13
Density Ratio %	100.2
Moisture Content %	8.4
Soaked Conditions	
No. of days	10
Dry Density t/m^3	2.13
Density Ratio %	100.2
Moisture Content %	8.8
Swell %	0.0
Surcharge kg	4.5
After Test	
Moisture Content %	
- Layer Penetrated	8.4
- Full Depth	8.1
CBR Value % (Soaked)	90
Penetration mm	5.0

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DATE:.....12.3.98.....

Accredited Lab No. 1288

SCLABORATORY REPORT SHEET RS11.1-9/93

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Golder Associates

MATERIALS TESTING

REPORT NO. SC 98/217

CLIENT: KINHILL CAMERON M^{c}NAMARA PTY LTD.....JOB NUMBER: 97638064

PROJECT: TYNDALE VILLAGE REALIGNMENT.....

SAMPLES SUPPLIED TO LABORATORY ON :FEBRUARY 16, 1998 .....

LABORATORY TEST PROCEDURES:.....AS 1289, 3.1.1, 3.2.1, 3.3.1, 3.4.1 and 3.6.1

LAB SAMPLE NO.	98106	98107	98108	98109	98110
CLIENT REFERENCE	B4691	B4692	B4701	B4693	B4706
LOCATION	TP16 0.6 - 0.7 m	TP17 0.3 - 0.5 m	TP17 0.5 - 0.6 m	TP18 0.4 m	TP 19 0.6 - 0.7 m
LIQUID LIMIT %	44	65	50	13	23
PLASTICITY INDEX %	23	25	31	0	3
LINEAR SHRINKAGE %	12.5	11.0	14.0	1.0	2.0

LAB SAMPLE NO.	98111	98112	98113	98114	98115
CLIENT REFERENCE	B4707	B4708	B4694	B4696	B4699
LOCATION	TP38 0.6 - 0.7 m	TP40 0.6 - 0.8 m	TP50 0.05 - 0.1 m	TP50 0.54 - 0.60 m	TP 51 0.35 - 0.5 m
LIQUID LIMIT %	50	43	17	18	35
PLASTICITY INDEX %	27	20	2	6	18
LINEAR SHRINKAGE %	11.5	11.0	1.5	3.0	9.0

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Date .....23.2.98.....

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Golder Associates

MATERIALS TESTING

REPORT NO. SC 98/264

CLIENT: KINHILL PTY LTD ..... **JOB NUMBER:97638064**

PROJECT: ROAD ALIGNMENT, TYNDALE .....

SAMPLES SUPPLIED TO LABORATORY ON : FEBRUARY 4, 1998 .....

LABORATORY TEST PROCEDURES: ..... **RTA. T106,T109, T113.**

LAB SAMPLE NO.	98081	98082	98103
LOCATION	TP19, 0.05 - 0.15	TP52 0.06 - 0.12	TP53 0.03 - 0.10
DESCRIPTION OF SAMPLE	Pale Brown Silty Sandy Gravel		
MOISTURE CONTENT (as received)	1.9	3.7	2.6
LIQUID LIMIT %	ND	ND	ND
PLASTIC LIMIT %	17.5	15.5	15.5
PLASTICITY INDEX %	0	0	0
LINEAR SHRINKAGE %	1.0	1.0	1.0
PARTICLE SIZE DISTRIBUTION SIEVE SIZE (mm)	PERCENTAGE (by mass) FINER		
75.0	-	100	99
53.0	100	95	97
37.5	98	90	87
26.5	88	83	77
19.0	78	76	70
13.2	67	69	56
9.5	59	62	49
6.7	52	57	44
4.75	48	53	40
2.36	42	48	37
1.18	39	45	35
0.600	31	39	29
0.425	27	33	24
0.300	21	27	18
0.150	13	17	11
0.075	9	11	8

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Signatory J Sedercoch

Date 2.3.98

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SCLABORATORY REPORT SHEET RS26.3 - 9/93

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Golder Associates

MATERIALS TESTING

REPORT NO. SC 98/264

CLIENT: KINHILL PTY LTD ..... **JOB NUMBER:97638064**

PROJECT: ROAD ALIGNMENT, TYNDALE .....

SAMPLES SUPPLIED TO LABORATORY ON : FEBRUARY 13, 1998 .....

LABORATORY TEST PROCEDURES: ..... **RTA. T106,T109, T113.**

.....

LAB SAMPLE NO.	98104	98105	
LOCATION	TP54, 0.06 - 0.17	TP55 0.08 - 0.15	
MOISTURE CONTENT (as received)	4.7	1.3	
LIQUID LIMIT %	16.0	ND	
PLASTIC LIMIT %	14.5	16.5	
PLASTICITY INDEX %	1.5	0	
LINEAR SHRINKAGE %	1.5	0.5	
PARTICLE SIZE DISTRIBUTION SIEVE SIZE (mm)	PERCENTAGE (by mass) FINER		
75.0	100	99	
53.0	99	88	
37.5	99	81	
26.5	98	74	
19.0	96	68	
13.2	84	61	
9.5	77	54	
6.7	71	49	
4.75	67	44	
2.36	63	37	
1.18	60	34	
0.600	52	28	
0.425	46	25	
0.300	38	19	
0.150	22	12	
0.075	15	8	

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Signatory.... J. Sederach

Date..... 2-3-98.....

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SCLABORATORY REPORT SHEET RS26.3 - 9/93

QUALITY SYSTEM

Golder Associates Pty Ltd

Particle Size Distribution & Consistency Limits Test Report

Client:	KINHILL CAMERON McNAMARA PTY LTD	**Job No.**	97638064
Project:	TYNDALE REALIGNMENT	**Date Checked:**	04-Mar-98
Location:	BYRONS LANE TO SHARK CREEK	**Checked by:**	BPC
		Report No.	B98-082

Lab Reference No.	B4706	**Sample Identification:**	TP19 0.6 - 0.7m

Laboratory Specimen Description: Dark grey Clayey SAND

Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm		
75 mm		
53mm		
37.5 mm		
26.5 mm		
19.0 mm		
13.2 mm		
9.5 mm		
6.7 mm		
4.75 mm		
2.36 mm	100	
1.18 mm	99	
600 um	98	
425 um	96	
300 um	93	
150 um	59	
75 um	33	

Consistency Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	ND	
Plastic Limit	%	AS1289 3.2.1	ND	
Plasticity Index	%	AS1289 3.3.1	ND	
Linear Shrinkage	%	AS1289 3.4.1	ND	
Moisture Content	%	AS1289.2.1.1	14.2	

Sample History:	Oven dried
Preparation Method:	PSD-Wet sieved
Crumbling / Curling of linear shrinkage:	ND
Linear shrinkage mould length:	ND

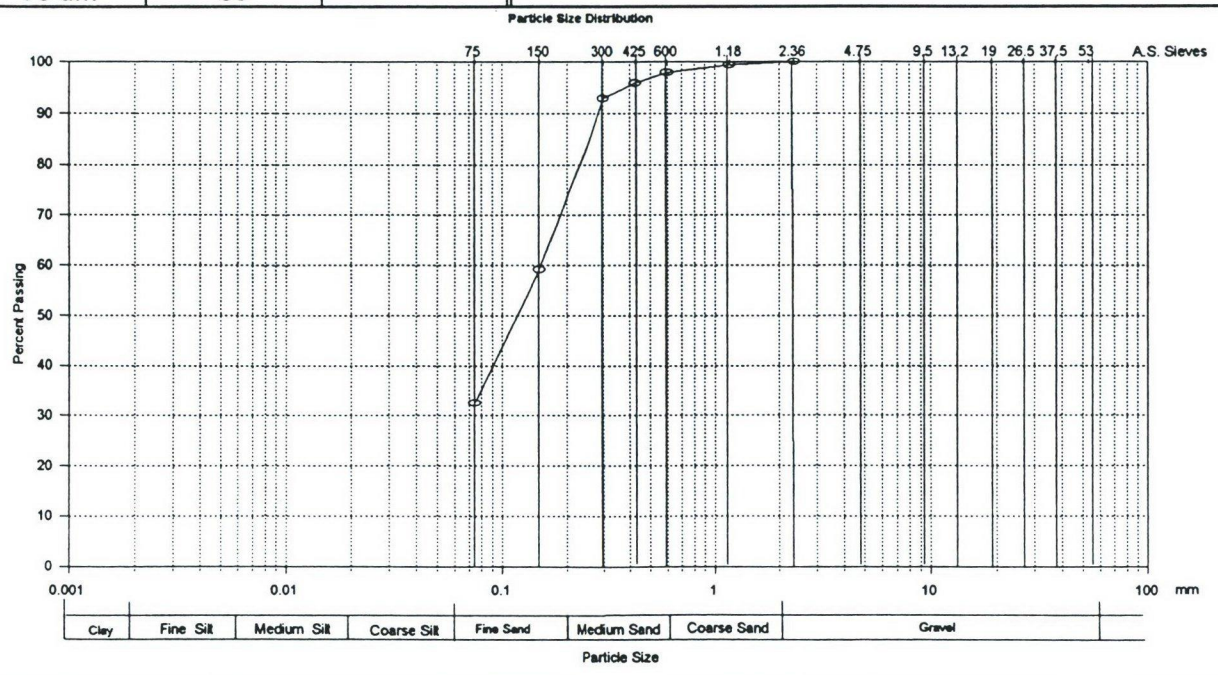
Notes

Atterberg Limits determined seperately by G.A.P.-Sunshine Coast Laboratory

Samples supplied by: G.A.P. - Brisbane

ND = not determined

NO = not obtainable



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Particle Size Distribution & Consistency Limits Test Report

Client:	KINHILL CAMERON McNAMARA PTY LTD	**Job No.**	97638064
Project:	TYNDALE REALIGNMENT	**Date Checked:**	04-Mar-98
Location:	BYRONS LANE TO SHARK CREEK	**Checked by:**	BPC
		Report No.	B98-110

Lab Reference No.	B4719	**Sample Identification:**	TP32 0.45 - 0.55m

Laboratory Specimen Description: Light brown SANDY GRAVEL

Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm		
75 mm		
53mm	100	
37.5 mm	97	
26.5 mm	92	
19.0 mm	89	
13.2 mm	88	
9.5 mm	84	
6.7 mm	80	
4.75 mm	77	
2.36 mm	73	
1.18 mm	68	
600 um	57	
425 um	48	
300 um	38	
150 um	24	
75 um	18	

Consistency Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	19	
Plastic Limit	%	AS1289 3.2.1	14	
Plasticity Index	%	AS1289 3.3.1	5	
Linear Shrinkage	%	AS1289 3.4.1	2.0	
Moisture Content	%	AS1289.2.1.1	1.0	

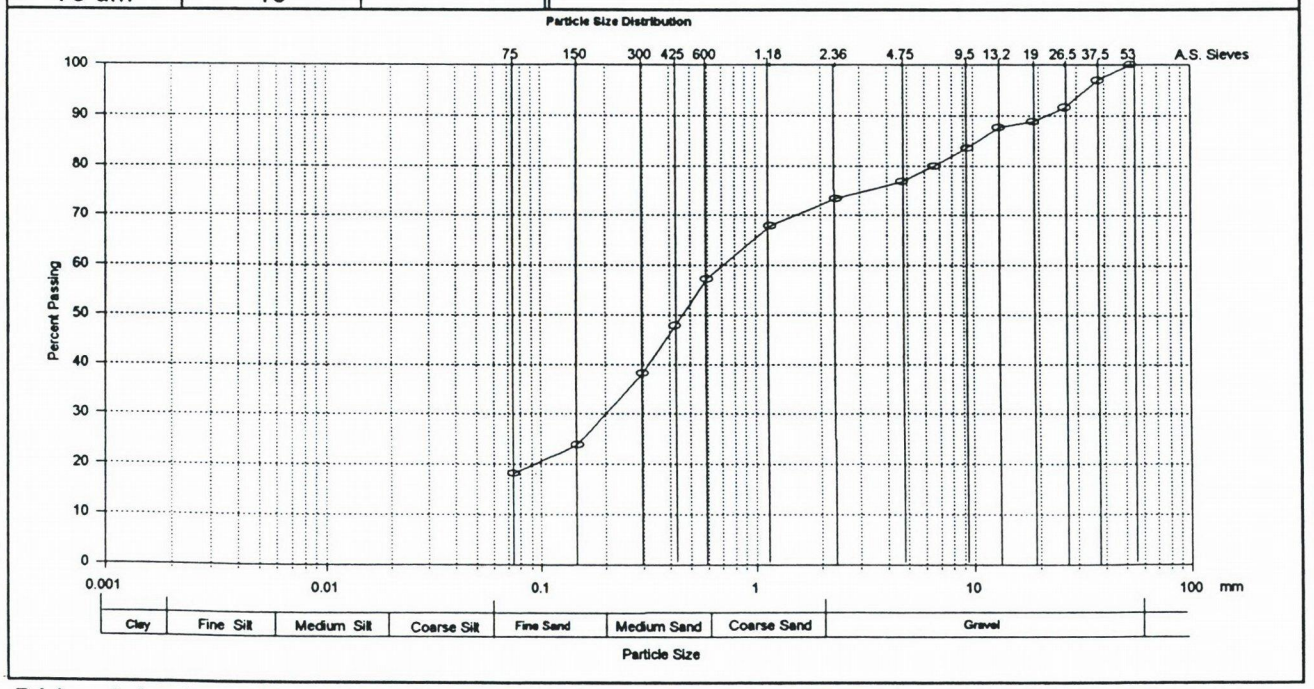
Sample History:	Oven dried
Preparation Method:	Dry sieved
Crumbling / Curling of linear shrinkage:	Nil
Linear shrinkage mould length:	250mm

Notes

Samples supplied by: G.A.P.-Brisbane

ND = not determined

NO = not obtainable



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Particle Size Distribution & Consistency Limits Test Report

Client:	KINHILL CAMERON McNAMARA PTY LTD	**Job No.**	97638064
Project:	TYNDALE REALIGNMENT	**Date Checked:**	04-Mar-98
Location:	BYRONS LANE TO SHARK CREEK	**Checked by:**	BPC
		Report No.	B98-108

Lab Reference No. B4707 **Sample Identification:** TP38 0.6 - 0.7m

Laboratory Specimen Description: Grey brown Silty CLAY

Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm		
75 mm		
53mm		
37.5 mm		
26.5 mm		
19.0 mm		
13.2 mm		
9.5 mm		
6.7 mm		
4.75 mm		
2.36 mm	100	
1.18 mm	100	
600 um	100	
425 um	100	
300 um	99	
150 um	95	
75 um	80	

Consistency Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	ND	
Plastic Limit	%	AS1289 3.2.1	ND	
Plasticity Index	%	AS1289 3.3.1	ND	
Linear Shrinkage	%	AS1289 3.4.1	ND	
Moisture Content	%	AS1289.2.1.1	33.0	

Sample History:	Oven dried
Preparation Method:	Wet sieved
Crumbling / Curling of linear shrinkage:	ND
Linear shrinkage mould length:	ND

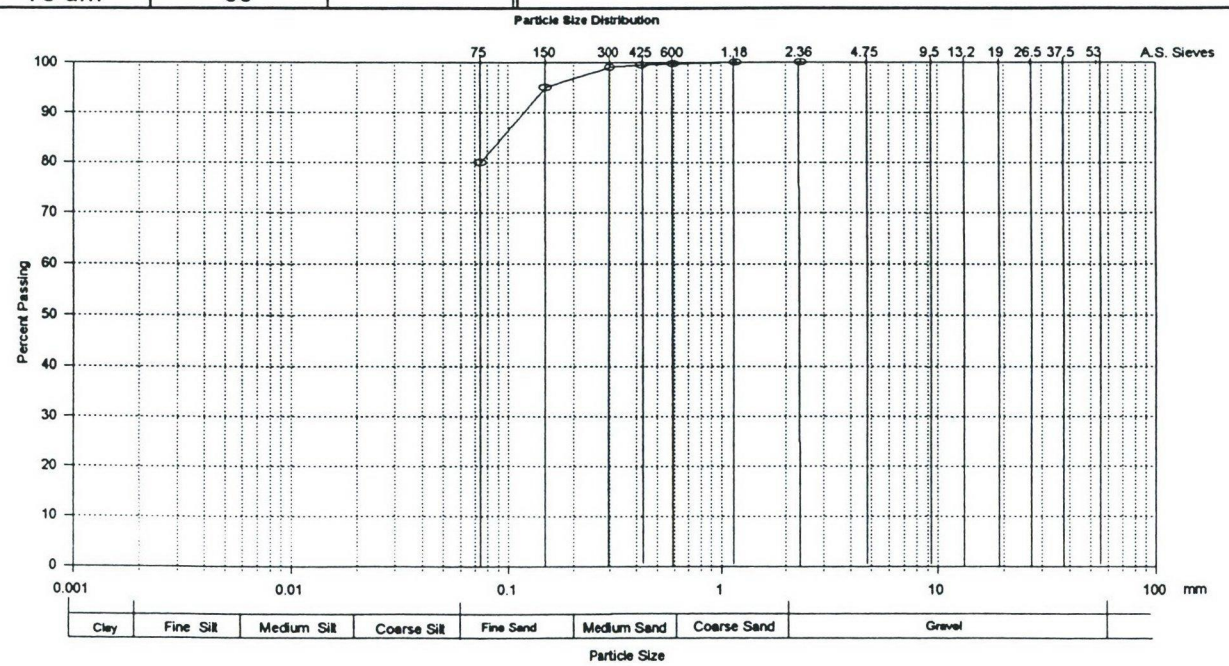
Notes

Atterberg Limits determined by G.A.P.-Sunshine Coast

Samples supplied by: G.A.P.-Brisbane

ND = not determined

NO = not obtainable



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Golder Associates Pty Ltd

Particle Size Distribution & Consistency Limits Test Report

Client:	KINHILL CAMERON McNAMARA PTY LTD	**Job No.**	97638064
Project:	TYNDALE REALIGNMENT	**Date Checked:**	04-Mar-98
Location:	BYRONS LANE TO SHARK CREEK	**Checked by:**	BPC
		Report No.	B98-085

Lab Reference No. B4708 **Sample Identification:** TP40 0.6 - 0.8m

Laboratory Specimen Description: Dark grey Silty CLAY

Particle Size Distribution AS1289 3.6.1

Sieve Size	% Passing	Specification
150 mm		
75 mm		
53mm		
37.5 mm		
26.5 mm		
19.0 mm		
13.2 mm		
9.5 mm		
6.7 mm		
4.75 mm		
2.36 mm	100	
1.18 mm	100	
600 um	100	
425 um	99	
300 um	98	
150 um	93	
75 um	79	

Consistency Limits and Moisture Content

Test		Method	Result	Spec.
Liquid Limit	%	AS1289 3.1.2	ND	
Plastic Limit	%	AS1289 3.2.1	ND	
Plasticity Index	%	AS1289 3.3.1	ND	
Linear Shrinkage	%	AS1289 3.4.1	ND	
Moisture Content	%	AS1289.2.1.1	53.1	

Sample History:	Oven dried
Preparation Method:	PSD-Wet sieved
Crumbling / Curling of linear shrinkage:	ND
Linear shrinkage mould length:	ND

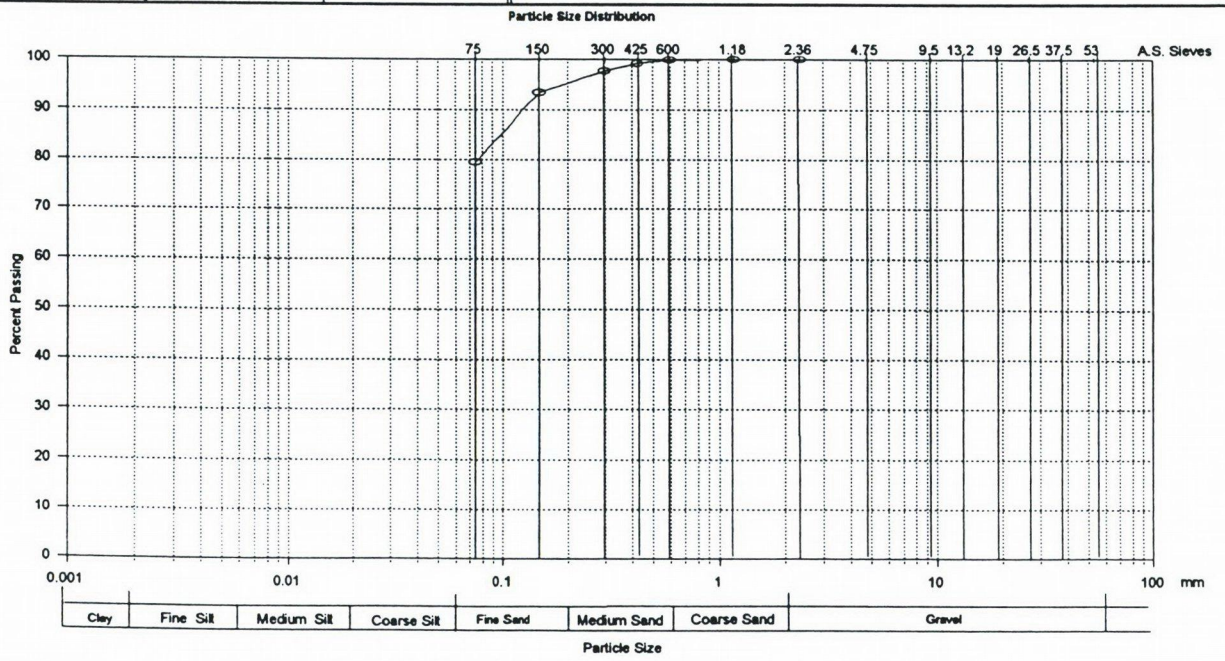
Notes

Atterberg Limits determined seperately by G.A.P.-Sunshine Coast Laboratory

Samples supplied by: G.A.P. - Brisbane

ND = not determined

NO = not obtainable



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4/3/98

Approved Signatory Date

Golder Associates

LABORATORY C.B.R. TEST REPORT

CLIENT:	KINHILL CAMERON McNAMARA PTY LTD	PROJECT No.:	97638064
PROJECT:	TYNDALE REALIGNMENT	REPORT No.:	B98-107
LOCATION:	BYRONS LANE TO SHARK CREEK		

Sampling Details:	Sampled by G.A.P.-Brisbane	Laboratory:	BRISBANE
Laboratory Test Procedure:	RTA-T117A	Date Checked:	24-2-98
		Checked by:	BPC

Sample No.		B4705	B4706	B4719	B4712	B4708
Sample Location		TP19 0.2-0.3m	TP19 0.6-0.7m	TP32 0.45-0.55m	TP32 1.0-1.1m	TP40 0.6-0.8m
Sample Description		Brown Clayey GRAVELLY SAND	Dark grey Clayey SILTY SAND	Light brown GRAVELLY SAND	Light brown Clayey GRAVELLY SAND	Brown Silty CLAY
Maximum Dry Density	t/m3	1.99	1.70	2.08	1.93	1.45
Optimum Moisture Content	%	11.1	16.6	9.1	11.4	26.5
% Oversize (+19mm)		0.0	0.0	11	0.0	0.0
Moulding Conditions						
Dry Density	t/m3	2.00	1.70	2.07	1.94	1.47
Density Ratio	%	100.0	100.0	99.5	100.5	101.0
Moisture Content	%	11.1	16.5	9.6	11.0	24.9
Soaked Conditions						
No. of Days		10	10	10	4	10
Dry Density	t/m3	2.00	1.69	2.07	1.94	1.44
Density Ratio	%	100.0	100.0	99.5	100.5	99.5
Moisture Content	%	11.8	17.9	10.4	11.8	29.3
Swell	%	0.0	0.1	-0.1	0.0	1.5
Surcharge	kg	4.5	4.5	4.5	4.5	4.5
After Test						
Moisture Content:						
- Layer Penetrated	%	11.4	17.6	10.0	11.8	29.4
- Whole	%	11.8	17.7	10.3	11.6	29.3
C.B.R. VALUE	%	**35**	**20**	**40**	**50**	**7**
Depth of Penetration	mm	5.0	5.0	5.0	5.0	2.5

NOTE: For CBR values reported at 5mm penetration the test was not repeated.

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LABORATORY C.B.R. TEST REPORT

CLIENT:	KINHILL CAMERON McNAMARA PTY LTD	PROJECT No.:	97638064
PROJECT:	TYNDALE REALIGNMENT	REPORT No.:	B98-088
LOCATION:	BYRONS LANE TO SHARK CREEK		

Sampling Details:	Sampled by G.A.P. - Brisbane	Laboratory:	BRISBANE
Laboratory Test Procedure:	RTA - T117A	Date Checked:	6-2-98
		Checked by:	BPC

Sample No.	B4709	B4710
Sample Location	TP52 0.3 - 0.4m	TP52 0.7-0.8m
Sample Description	Red brown Clayey Silty SANDY GRAVEL	Brown Clayey SILTY SAND

Maximum Dry Density (STANDARD)	t/m3	1.98	1.83
Optimum Moisture Content	%	11.7	12.4
% Oversize (+19mm)		0.0	0.0

Moulding Conditions			
Dry Density	t/m3	1.98	1.83
Density Ratio	%	100.5	100.0
Moisture Content	%	11.3	12.4
Soaked Conditions			
No. of Days		10	4
Dry Density	t/m3	1.98	1.83
Density Ratio	%	100.5	100.0
Moisture Content	%	11.7	13.5
Swell	%	0.0	0.0
Surcharge	kg	4.5	4.5
After Test			
Moisture Content:			
- Top 30mm	%	12.1	13.5
- Whole Sample	%	11.6	13.5

C.B.R. VALUE	%	**40**	**50**
Depth of Penetration	mm	5.0	5.0

NOTE: For CBR values reported at 5mm penetration the test was not repeated.

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LABORATORY C.B.R. TEST REPORT

CLIENT:	KINHILL CAMERON McNAMARA PTY LTD	PROJECT No.:	97638064
PROJECT:	TYNDALE REALIGNMENT	REPORT No.:	B98-126
LOCATION:	BYRONS LANE TO SHARK CREEK		

Sampling Details:	Sampled by G.A.P.-Brisbane	Laboratory:	BRISBANE
Laboratory Test Procedure:	RTA - T117A	Date Checked:	2/3/98
		Checked by:	BPC

Sample No.			B4713	B4715	B4717
Sample Location			TP53 0.37-0.55m	TP54 0.30-0.42m	TP55 0.20-0.27m
Sample Description			Brown Clayey SANDY GRAVEL	Brown SANDY GRAVEL	Brown GRAVELLY CLAY
Maximum Dry Density	(STANDARD)	t/m3	2.06	1.94	1.96
Optimum Moisture Content		%	8.8	10.7	12.6
% Oversize (+19mm)			0.0	0.0	0.0
Moulding Conditions					
Dry Density		t/m3	2.07	1.92	1.94
Density Ratio		%	100.5	99.5	99.5
Moisture Content		%	8.4	10.8	13.3
Soaked Conditions					
No. of Days			10	10	10
Dry Density		t/m3	2.07	1.92	1.94
Density Ratio		%	100.5	99.5	99.0
Moisture Content		%	9.5	12.1	14.7
Swell		%	-0.0	-0.1	0.2
Surcharge		kg	4.5	4.5	4.5
After Test					
Moisture Content:					
- Layer Penetrated		%	9.4	10.9	13.8
- Whole		%	9.3	11.8	14.5
C.B.R. VALUE		%	**50**	**45**	**14**
Depth of Penetration		mm	5.0	5.0	5.0

NOTE: For CBR values reported at 5mm penetration the test was not repeated.

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LABORATORY C.B.R. TEST REPORT

CLIENT:	KINHILL CAMERON McNAMARA PTY LTD	PROJECT No.:	97638064
PROJECT:	TYNDALE REALIGNMENT	REPORT No.:	B98-112
LOCATION:	BYRONS LANE TO SHARK CREEK		

Sampling Details:	Sampled by G.A.P.-Brisbane	Laboratory:	BRISBANE
Laboratory Test Procedure:	RTA-T117A	Date Checked:	24-2-98
		Checked by:	BPC

Sample No.			B4714	B4716	B4718
Sample Location			TP53 0.55-0.70m	TP54 0.5-0.6m	TP55 0.4-0.5m
Sample Description			Orange brown SILTY SAND	Brown SAND	Brown CLAYEY GRAVEL
Maximum Dry Density	(STANDARD)	t/m3	1.83	1.63	2.15
Optimum Moisture Content		%	11.0	16.8	11.1
% OVERSIZE (+19mm)			0.0	0.0	0.0
Moulding Conditions					
Dry Density		t/m3	1.82	1.64	2.14
Density Ratio		%	100.0	100.5	99.5
Moisture Content		%	10.9	16.3	11.5
Soaked Conditions					
No. of Days			4	4	4
Dry Density		t/m3	1.82	1.64	2.14
Density Ratio		%	100.0	100.5	99.5
Moisture Content		%	12.8	19.1	12.1
Swell		%	-0.0	-0.0	-0.1
Surcharge		kg	4.5	4.5	4.5
After Test					
Moisture Content:					
- Layer Penetrated		%	12.6	18.7	11.7
- Whole		%	12.7	18.8	11.9
C.B.R. VALUE		%	**50**	**30**	**30**
Depth of Penetration		mm	2.5	5.0	5.0

NOTE: For CBR values reported at 5mm penetration the test was not repeated.

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APPENDIX D

"Important Information Regarding Your Geotechnical Engineering Report"

IMPORTANT INFORMATION
ABOUT YOUR
GEOTECHNICAL ENGINEERING REPORT

More construction problems are caused by site subsurface conditions than any other factor. As troublesome as subsurface problems can be, their frequency and extent have been lessened considerably in recent years, due in large measure to programs and publications of ASFE/ The Association of Engineering Firms Practicing in the Geosciences.

The following suggestions and observations are offered to help you reduce the geotechnical-related delays, cost-overruns and other costly headaches that can occur during a construction project.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

A geotechnical engineering report is based on a subsurface exploration plan designed to incorporate a unique set of project-specific factors. These typically include: the general nature of the structure involved, its size and configuration; the location of the structure on the site and its orientation; physical concomitants such as access roads, parking lots, and underground utilities, and the level of additional risk which the client assumed by virtue of limitations imposed upon the exploratory program. To help avoid costly problems, consult the geotechnical engineer to determine how any factors which change subsequent to the date of the report may affect its recommendations.

Unless your consulting geotechnical engineer indicates otherwise, *your geotechnical engineering report should not be used*:

- When the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership, or
- for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems which may develop if they are not consulted after factors considered in their report's development have changed.

MOST GEOTECHNICAL "FINDINGS" ARE PROFESSIONAL ESTIMATES

Site exploration identifies actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing are extrapolated by geotechnical engineers who then render an opinion about overall subsurface conditions, their likely reaction to proposed construction activity, and appropriate foundation design. Even under optimal circumstances actual conditions may differ from those inferred to exist, because no geotechnical engineer, no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. *Nothing can be done to prevent the unanticipated, but steps can be taken to help minimize their impact.* For this reason, *most experienced owners retain their geotechnical consultants through the construction stage,* to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.

SUBSURFACE CONDITIONS CAN CHANGE

Subsurface conditions may be modified by constantly-changing natural forces. Because a geotechnical engineering report is based on conditions which existed at the time of subsurface exploration, *construction decisions should not be based on a geotechnical engineering report whose adequacy may have been affected by time.* Speak with the geotechnical consultant to learn if additional tests are advisable before construction starts.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Geotechnical engineers' reports are prepared to meet the specific needs of specific individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor, or even some other consulting civil engineer. Unless indicated otherwise, this report was prepared expressly for the client involved and expressly for purposes indicated by the client. Use by any other persons for any purpose, or by the client for a different purpose, may result in problems. *No individual other than the client should apply this report for its intended purpose without first conferring with the geotechnical engineer. No person should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.*

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical engineering report. To help avoid these problems, the geotechnical engineer should be retained to work with other appropriate design professionals to explain relevant geotechnical findings and to review the adequacy of their plans and specifications relative to geotechnical issues.

BORING LOGS SHOULD NOT BE SEPARATED FROM THE ENGINEERING REPORT

Final boring logs are developed by geotechnical engineers based upon their interpretation of field logs (assembled by site personnel) and laboratory evaluation of field samples. Only final boring logs customarily are included in geotechnical engineering reports. *These logs should not under any circumstances be redrawn* for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes and unanticipated costs are the all-too-frequent result.

To minimize the likelihood of boring log misinterpretation, *give contractors ready access to the complete geotechnical engineering report* prepared or authorized for their use. Those who do not provide such access may proceed under the *mistaken* impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes which aggravate them to disproportionate scale.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical Information in Construction Contracts" published by The Institution of Engineers Australia, National Headquarters, Canberra, 1987.

READ RESPONSIBILITY CLAUSES CLOSELY

Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against geotechnical consultants. To help prevent this problem, geotechnical engineers have developed model clauses for use in written transmittals. These are *not* exculpatory clauses designed to foist geotechnical engineers' liabilities onto someone else. Rather, they are definitive clauses which identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report, and you are encouraged to read them closely. Your geotechnical engineer will be pleased to give full and frank answers to your questions.

OTHER STEPS YOU CAN TAKE TO REDUCE RISK

Your consulting geotechnical engineer will be pleased to discuss other techniques which can be employed to mitigate risk. In addition, ASFE has developed a variety of materials which may be beneficial. Contact ASFE for a complimentary copy of its publications directory.

Published by

ASFE THE ASSOCIATION OF ENGINEERING FIRMS PRACTICING IN THE GEOSCIENCES

8811 Colesville Road/Suite G106/Silver Spring, Maryland 20910/(301) 565-2733

Golder Form No. GA_BQ-121. Ver.1 issued 22/4/97

KINHILL

APPENDIX K

COMMUNITY INVOLVEMENT PLAN

Appendix K

Community involvement plan

SUMMARY

This Community Involvement Plan sets out the proposed community consultation programme for the Tynedale Realignment/Reconstruction concept design and environmental studies. It details and extends the information contained in the client brief and the subsequent proposal accepted by the RTA.

A generalised work program for the Tynedale Realignment is included as Figure 1. This illustrates our general strategy and approach to involving the community in the route selection, impact assessment and design process. Like most strategies it will be necessary to make amendments throughout the course of the project—as our awareness of the local situation develops and as important community issues emerge. It is unwise to presume that a consultant or government agency can start on a project knowing what is important to the community or even how they should be involved—this can only be learned from 'inside' the project itself.

In summary, Kinhill proposes[1]:

- a half-day planning focus meeting in Week 5;
- two half-day community focus group meetings before and after the project team assesses environmental impacts—in Weeks 7 to 9 and 23 to 25 (although if the value management study has a significant community representation the second community focus group may be redundant and not carried out);
- to interview landowners and other stakeholders generally in Weeks 5 to 9 and again in Weeks 20 to 24;
- five *Community Information Sheets*—at Weeks 5, 9, 18, 29, and 56;
- two press releases to announce the preferred route (Week 18) and inform of the outcomes of the *REF* (Week 38);
- a fortnight-long public display in a local venue to present the *REF*—for the realignment of the highway at Tynedale Village only (Weeks 30 and 31);
- to consult government agencies and authorities at the Planning Focus Meeting and during the course of the project as appropriate;
- to consider all government, community and landowner submissions and input during the concept planning work and to summarise it in the *REF*;
- to properly document and report on views expressed by the community.

The remainder of this document describes the program in greater detail.

INTRODUCTION

The involvement of the community is essential to the process of selecting the route for the highway upgrade and evaluating its environmental implications.

[1] Week numbers are only approximate

The purpose of community involvement is to:

- ensure that the route selection, design, and environmental assessment process is 'transparent' and publicly accountable;
- provide all stakeholders and the general public with sufficient information to maintain an appropriate level of involvement in the proposed realignment/reconstruction;
- provide a mechanism by which stakeholders and the general public can pass on information and their concerns;
- provide a process by which issues, information and the opinions of stakeholders, once they are received, are passed on to, considered and responded to by appropriate Project Team members;
- help in the process of identifying and reconciling competing interests of various stakeholders.

This document therefore establishes a structure for meaningful community involvement.

In broad summary, the consultation program will be framed around the work flow involved in the substantive study work. It reflects the belief by both the RTA and Kinhill that structured community involvement will contribute in a positive way to the physical outcome of the project.

Public displays, Focus Group Meetings, Community Information Sheets, interviews and media releases will all be timed so as to deliver a logical flow of project information and to help all groups and individuals develop a sound understanding of the project.

Figure 1 shows a generalised work program, including consultation milestones and amendments following project familiarisation. It is intended to show the relationship between community involvement and the substantive work of route selection, impact assessment and design. The remainder of this community involvement plan describes the elements of the consultation program.

FOCUS GROUP MEETINGS

The aim of consulting via the community focus group is to obtain local and vested interest input into the project to enable all matters to be fully and properly considered and to provide the opportunity for all parties to have their interests considered.

TIMING

Kinhill proposes two half-day community focus group meetings, one before the project team assesses environmental impacts at around weeks 7 to 9 and the second after the team has assessed impacts (around weeks 23 to 25).

The first meeting would be early in the process. While some initial contact between community members and Kinhill's Project Manager (or Consultation Coordinator) would have already taken place, the first focus group is the first official meeting between community representatives and the project team. Its role would be to explain the process, identify initial concerns and issues, and to introduce the project team and the RTA representatives. Meeting the project team and the RTA in person removes some 'barriers' and makes the team more 'approachable' to community members.

The second focus group meeting should be held near the completion of the draft *REF*. This will enable effective community input prior to the finalisation of the *REF*. At the second focus group meeting all of the route selection work will have been finalised, the concept design will be substantially underway and the environmental work will have been substantially completed. (The purpose of the second focus group meeting would therefore be to provide information to focus group members direct from the managers of the major work streams of planning, environmental studies and engineering design.) We would then seek detailed input from focus group members to be reported in summary form to the RTA.

(Kinhill recommends that the final alignment (i.e. property requiring acquisition) not be released to focus group members ahead of the affected property owners.)

DRAFT LIST OF ATTENDEES

Kinhill will seek guidance from the *planning focus group* to assist in deriving an appropriate list of community focus group members. These should preferably include representatives of groups from across the full spectrum of interests relevant to the project, as well as prominent individuals considered to be community leaders in the local area. We are aiming for a total membership of between eight to ten persons from the following stakeholders:

- Affected land owners
- Tynedale progress association
- Maclean shire council (e.g. Mayor, councillors, staff)
- Local businesses
- Local environmental group(s).

LAND OWNER INTERVIEWS

We propose to undertake land owner interviews in two stages—generally from weeks 4 to weeks 8 and between Weeks 20 and 24. Less formal interaction with land owners will occur in response to them contacting us—probably following release of community information sheets.

The major objective of the land owner interviews is to obtain detailed property information for incorporation into the design process. It is expected that land owners will seek detailed information concerning the impacts on their property, the level of fill, the impact of the road on flooding, etc. However such information will not be available and is best not given at this land owner interview stage. Relevant information sought from land owners will include the location of improvements, the particular characteristics of occupation in respect of roads or farming access ways, dams, or any other influences that may affect the most logical upgrade option.

Appendix A is a proforma Interview Sheet.

COMMUNITY INFORMATION SHEETS

The purpose of the Community Information Sheets is to provide interested members of the community with relevant and up-to-date information about the project and to invite them to participate in the route selection and design process. Community Information Sheets are the primary means of communicating substantive details about the project to stakeholders.

Kinhill will prepare six Community Information Sheets. They will be worded and designed to provide a sequential description of the project and its outcomes as the study progresses. All Information Sheets will inform readers how to contact Kinhill's Project Manager and the RTA Project Manager. (Kinhill will provide a *freepost* address and a *freecall* telephone number.)

The following paragraphs detail Kinhill's proposal for each Information Sheet:

- **Project Commencement:** The first Information Sheet will be released in Week 5. It will describe the study's objectives, the areas of investigation and the study program. It will present information concerning the route and will advise people how to make a written submission[2]. The first Information Sheet will be sent to all addresses in the Tynedale Realignment locality[3]. A feature of this Information Sheet will be its invitation to return a detachable portion if they are interested in

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2 As with all Information Sheets readers will be invited to write and express their opinions.

3 The Maclean Post Office has informed Kinhill that the contractor delivers to both sides of the highway (roadside mail service and to some businesses on behalf of residents). The Post Office can also place information sheets directly into post office boxes. The combination of these two deliveries provides an extremely good coverage of the affected area. Approximately 100 information sheets would be needed to cover all Tyndale addresses.

receiving further Information Sheets. We will register all respondents on our database and include them on the mailing list for subsequent Information Sheets. Those who choose not to respond will be kept up to date via the summary information contained in later media releases and through the public display.

- **Prior to Route Selection:** A second Information Sheet will be released in Weeks 9 to 10. It will provide summary descriptions of the alternative routes, and the initial findings of the environmental and concept planning work. This information sheet will be mailed only to those on our database (i.e. owners, recognised stakeholders, and those who have returned coupons requesting information sheets).
- **Post Route Selection:** A third Information Sheet will be released in Week 18. It will summarise the findings of the route selection stage, and the initial environmental and concept planning work. It will be released in the week after the selection of the preferred alignment, i.e. after Week 18.
- **Prior to the *REF* Display:** The fourth information sheet, released in Week 29, will announce the presentation of the *REF* at a public exhibition in Weeks 29 and 30, summarise the findings of the *REF*, and summarise the outcomes of community involvement.
- **Project Conclusion:** The fifth and final information sheet will be available at the close of the project at Week 56. It will summarise the process and the conclusions from the investigations, and thank those members of the community who have contributed to the project.

MEDIA RELEASES

Schedule of media releases

We propose to prepare two press releases during the project[4]. Accordingly and as shown on Figure 1 we will prepare the following:

- a press release in Week 18 that will present the preferred alignment and outline progress (This release will coincide with Community Information Sheet 3 and alert people to issues that have arisen, advise them of the Information Sheet and offer the opportunity to make written submissions.)
- a press release in Week 37, immediately after the RTA has determined the outcome of the *REF* (i.e. the need for an *EIS*).

Protocol for media releases

The following process will apply for media releases:

- Kinhill will draft text for the proposed media releases (in the format and style required by the RTA).
- Kinhill will forward the draft with any graphics to the RTA Project Manager (4 weeks in advance of the release date).
- The RTA Project Manager will arrange for approval and release through the appropriate RTA channels.

DISPLAY OF PREFERRED ROUTE AND *REF*

Kinhill proposes a 4 week public display period. During this time we will present static exhibitions of text and graphic material to explain the route options considered, the preferred route alignment and a summary of the *REF*. Kinhill proposes one exhibition in an accessible local venue. Kinhill's Community Consultation Coordinator for the project will staff the display for up to two days at the end of the second week.

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[4] The RTA has already issued a press release announcing the commencement of the project.

We propose up to five information boards setting out the following:

- Description of objectives of the project
- Brief introduction the study team
- An outline of the issues addressed in the environmental assessment
- The outcome of the study up to the *REF* stage
- A summary of the findings of the various investigations contained within the environmental report
- A broad outline of the approval process and the determination of the need or otherwise for an *EIS*
- How to make submissions concerning the study.
- Existing highway (air photo with cadastral boundaries superimposed)
- Investigation corridor (superimposed on air photo base).

While the display will only be staffed for a total of five days, a desk and chair with a supply of comment sheets will be provided for people to record their views concerning any aspect of the project. We propose that a tender box or ballot box type facility be available adjacent to the desk in which people may place their comments or they may alternatively *freepost* comments to our Brisbane office (address will be provided).

We propose to actively solicit community views during our attendance at the display. It is usual in projects of this nature to receive a very biased response that is either wholly against it or has some problem with an aspect of it. This cannot be totally overcome—i.e. the response can not be regarded as an accurate sample of community opinion. Requesting views, however, will help to 'balance' the picture of community opinion.

Kinhill's Community Consultation Coordinator will, therefore, not only attend to members of the community who have questions about the proposed upgrade but will also interview passers-by to ascertain whether they:

- are aware of the project and at what stage it is
- understand the project
- have any views about the project that they would like to express
- would like to be on a mailing list for further information (i.e. Community Information Sheets).

The venues for the public display is a matter in which we seek the guidance of RTA's Project Manager. ('Local' venues may not be entirely suitable for the purpose of a public display.) The options include:

- service station (to the north of Tynedale village)
- Tynedale Restaurant
- Maclean Shire Information Centre
- Maclean Shire Council offices.

MANAGING SUBMISSIONS

KCM will establish a system for managing submissions from the community. This is necessary to ensure that community input is fully and properly used and that the process is guaranteed to be transparent.

We propose the following process:

- Receive the submission.
- Apply a unique sequential reference number to the submission.
- Register the submission and details of the submitter on the contacts database.
- Acknowledge receipt of submission.

- Copy submission and place original on file.
- Refer a copy of the submission to the appropriate Project Team Member and fax a copy to the RTA Project Manager for consideration or information.
- The above Project Team Member considers issues or concerns in submission.
- Consultation Coordinator will summarise issues and prepare 'profile' for the Value Management Workshop at route selection stage.
- Consultation Coordinator will prepare a summary (for inclusion in the *REF*) of how the issues and concerns raised in the public submissions were considered and used (or dismissed) during route selection and design phases.

COMMUNICATION WITH STAKEHOLDERS

General

Kinhill will consult the following stakeholders:

- Affected land owners
- Interest groups and individuals
- Government and other agencies
- Transport industry representatives.

Kinhill will send interest groups and individuals who have expressed an interest in the project copies of the Information Sheets. This group is likely to provide the majority of members of the community focus group—their involvement with the team during the two focus group meetings will be a valuable conduit for the dissemination of information on progress.

Focus group members will receive copies of Information Sheets, press releases, etc. In addition they will receive verbal briefings at each meeting with the opportunity to provide input into design and other issues. We do not propose to prepare specific briefing papers or draft reports for focus group meetings but will keep these informal and flexible.

Government and other agencies will be involved and consulted throughout the project as and when necessary.

Kinhill will discuss issues relating to the transport industry with appropriate industry representatives. Initial contact in this regard would be with the North Coast Truck and Bus Association.

Consultation with government and statutory authorities

The following government and statutory authorities will be consulted in the early stages of the project:

- Australian Heritage Commission
- Clarence River Flood Mitigation Authority.
- Department of Agriculture
- Department of Land and Water Conservation
- Department of Mineral Resources
- Department of Urban Affairs and Planning
- Lower Clarence Water Supply County Council
- Maclean Shire Council
- National Parks and Wildlife Services
- NorthPower
- NSW Environment Protection Authority

- NSW Police (in particular Grafton Highway Patrol)
- Optus Communications
- RTA (appropriate officers)
- Telstra
- Yaegl Local Aboriginal Land Council.

The involvement of Maclean Shire Council is important to the process as both elected representatives and staff are likely to have a good understanding of community issues and concerns would be able to articulate these to ensure they are properly considered. It is likely that there will be considerable contact between the Council and Kinhill during the project. Because of this Kinhill proposes that both organisations establish one point of contact—so as to improve communication and avoid unnecessary duplication or conflict. Initial contact with the Council indicates that Rob Donges (Council's Development Control Manager) and David Newby (Senior Town Planner and Consultation Coordinator) would be appropriate points of contact. All communications (phone, fax, correspondence or personal meeting) be via these two people.

General procedures

- The information and input received from the various stakeholders will be entered into a database for access by appropriate study members as necessary. (See attached database 'form'.)
- Communication between Government agencies should preferably be directed to KCM's Consultation Coordinator.
- All land owner interviews will be recorded and minuted with points raised inserted in a matrix for consideration by the concept designers.
- Focus group meetings will be minuted and recorded for consideration during the study and summarised in the *REF*.
- All issues raised in written submissions will be similarly listed and placed in a matrix for consideration.
- Any informal contact either by phone or otherwise should be recorded and entered into the matrix of community views.
- All incoming calls to the Project Manager or other team members (through *Freecall* or otherwise) should be noted and the database updated accordingly.
- All discussions (by any project team member) with stakeholders, landowners, or members of the community should be recorded and entered on the database.
- Any person or organisation requesting further information should be responded to promptly.
- Kinhill will respond in writing to all written submissions and those who make a written submission will be placed on the mailing list to receive all Information Sheets and notifications of public displays[5].
- The information received from the public and other stakeholders will be summarised and described in the social impacts section of the *REF*. Each point raised will be responded to in an appropriate manner in the review of environmental factors.

---

5 A proforma response/acknowledgment is attached.

PACIFIC HIGHWAY (TYNEDALE REALIGNMENT) UPGRADE

26.4 to 27.2 km and 32.7 to 36.7 km NORTH OF GRAFTON

PROFORMA FOR LANDOWNER INTERVIEWS

1. EXPLANATION OF PROJECT / OUTLINE OF PROPOSED CONSULTATION:

2. NAME AND ADDRESS:

3. NUMBER OF YEARS AT CURRENT ADDRESS:

4. LAND AREA:

5. LAND USE:

6. NUMBER OF RESIDENTS / EMPLOYEES BASED AT PROPERTY:

7. NATURE OF EXISTING IMPROVEMENTS:

8. DETAILS OF HIGHWAY ACCESS:

9. LIKELY IMPACT OF ROAD RESUMPTION:

10. EFFECTS ON BUSINESS / PRIVATE USE:

11. PHYSICAL EFFECTS (DRAINAGE / ACCESS):

12. SUGGESTIONS FOR ROAD UPGRADING:

13. EXPLAIN ONGOING CONSULTATION AND THANKS.

Proforma Letter—Acknowledging Receipt of Submission

BC7802.001

DHN:jw

20 March, 1998

(FirstName) (LastName)

(Organisation)

(Address1)

(Address2)

(CITY) (STATE) **(PostalCode)**

Attention: (attention)

Dear (FirstName)

RE: PACIFIC HIGHWAY UPGRADE AT TYNEDALE REALIGNMENT

Your ref: **addressee ref**

I am writing to let you know that we have received your written submission dated (date received) and will review your comments as part of our (next relevant stage) work.

We will also place your name and address on the mailing list to receive future community information sheets and notification of the public display.

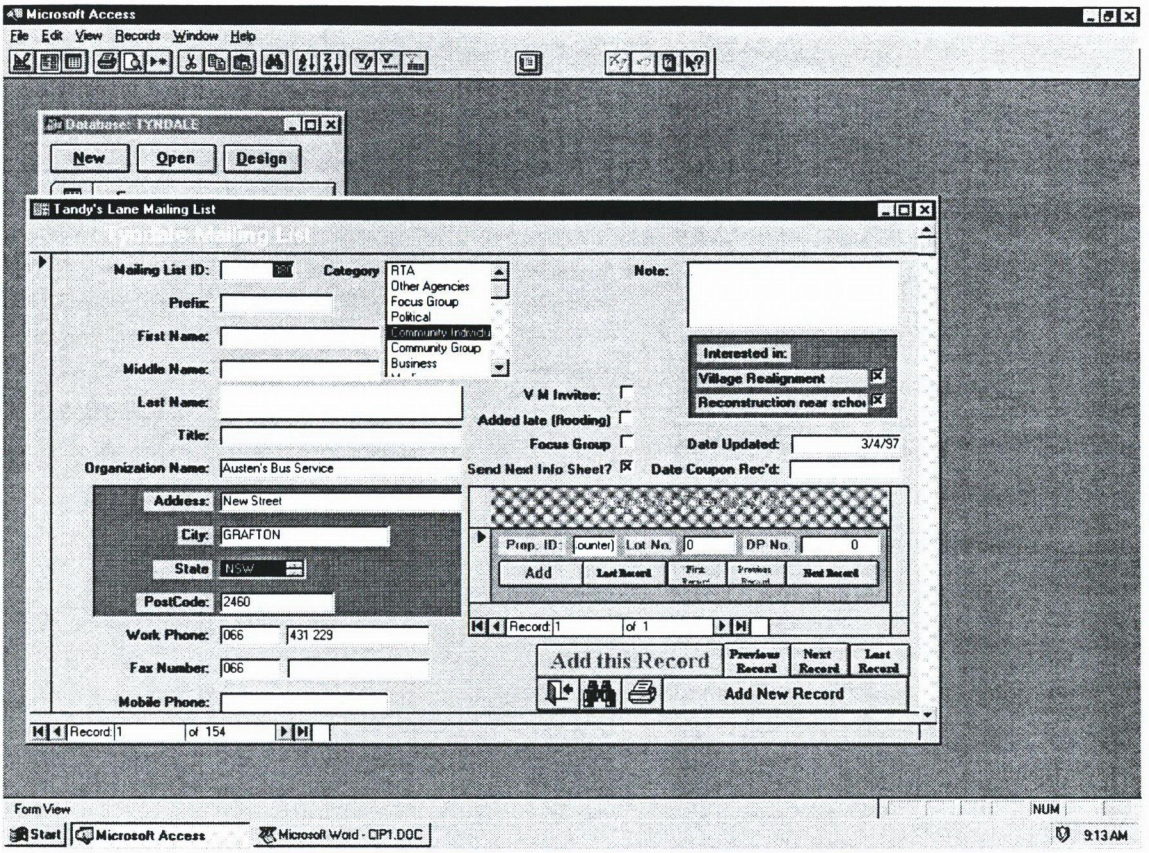
Thank you for taking the time to pass on your comments.

Yours faithfully

Alan Goodwin

Project Manager

Standard Community Involvement Database 'Form' for Tynedale Realignment



APPENDIX L

INFORMATION SHEETS

COMMUNITY INFORMATION

ISSUE 1

Improving the Pacific Highway at Tyndale

Welcome to the first in a series of information sheets published by the Roads and Traffic Authority of New South Wales (RTA). These are intended to keep the community fully informed about the status and progress of the proposed realignments to two sections of the Pacific Highway at Tyndale, north of Grafton. Your comments and input into the project are important in helping us to arrive at the best solution for this work.

The RTA invites and welcomes comments and feedback about the project. There is a freepost coupon on the other side to assist you to receive regular information.

THE PROJECTS

The RTA proposes to:

- realign a one kilometre section of the highway through the Village of Tyndale, and
- reconstruct a four kilometre section of the highway between Byrons Lane and Shark Creek, Tyndale—including a southbound overtaking lane and possible realignment near the site of the old Tyndale school.

CONSULTANTS APPOINTED

The RTA has appointed consultants to carry out the following tasks:

- manage community involvement
- select a preferred route for the Tyndale Village upgrade
- prepare a *Review of Environmental Factors* (REF) for each project
- prepare concept and final designs.

WHY WE INVOLVE COMMUNITY?

The RTA involves the community in the process because it helps create a better result. The finished 'product' needs to address the interests and concerns of the community affected by these projects—all of whom the RTA invites to take part.

Local people also have a close knowledge of local conditions and this is helpful for us in selecting the best option and designing the road.

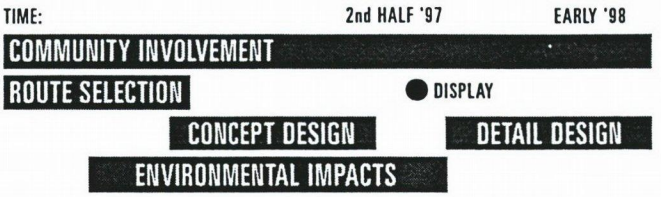
The RTA therefore wants you to be involved.

WHAT THE STUDY WILL CONSIDER

The study will investigate a wide range of potential impacts, including:

- loss of agricultural land
- air and water quality
- disruption of access to properties
- visual impacts
- socio-economic impacts (including impacts on businesses)
- implications for wildlife (flora and fauna) heritage.

WHEN WILL THE STAGES HAPPEN?



The RTA hope to complete detailed design of the overtaking lane section within the Byrons Lane to Shark Creek upgrade separately by mid 1997.

THE STUDY PROGRAM

The consultants will prepare a community involvement program that will guide consultation during stages such as:

- realignment options and selection
- concept design of the upgrading
- REF—the investigation into environmental impacts
- detailed design.

Consultation during these stages will include:

- press coverage that informs the community of progress
- information sheets (like this one) that provide basic details about findings and proposals

RTA

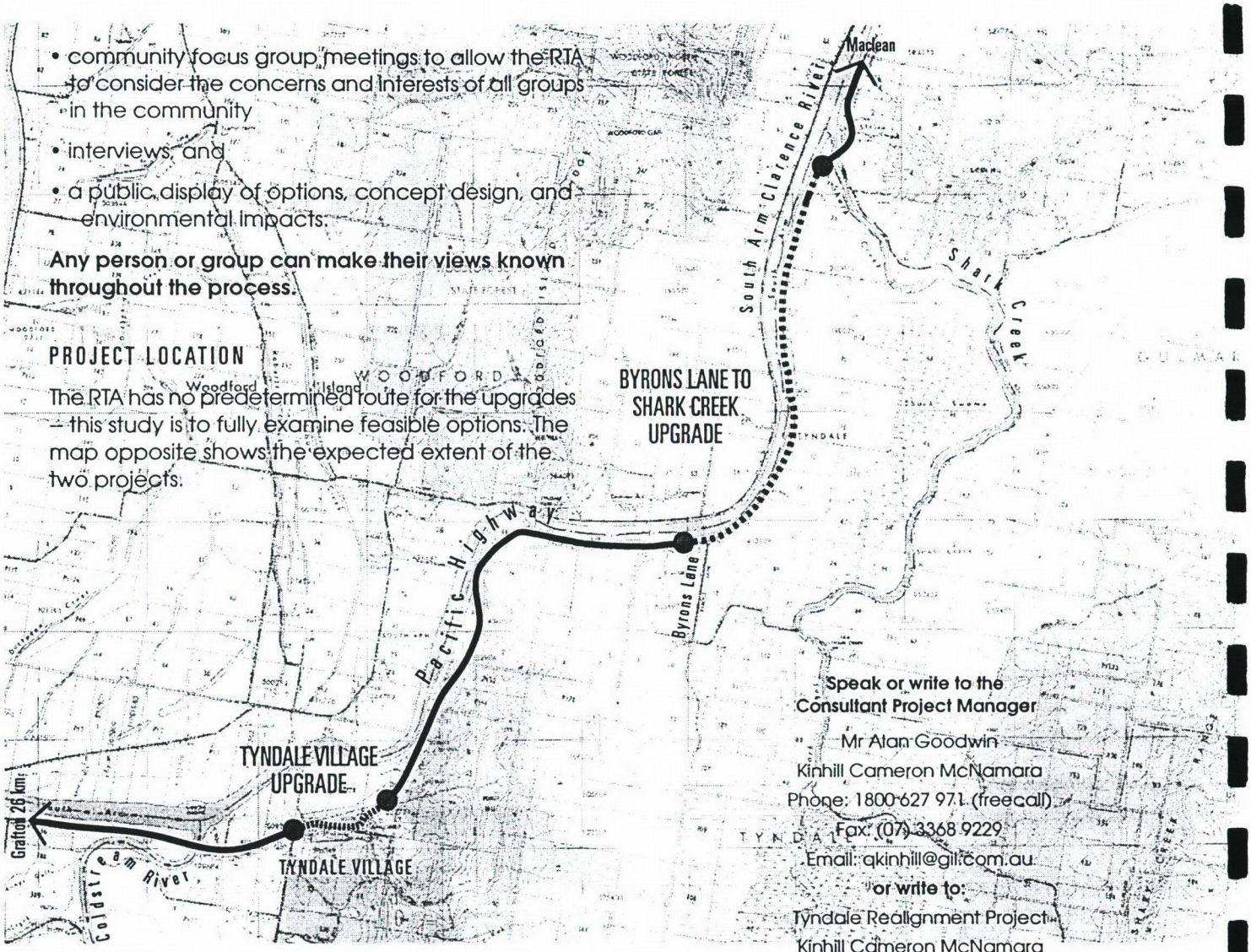
Roads and Traffic Authority
April 1997

- community focus group meetings to allow the RTA to consider the concerns and interests of all groups in the community
- interviews, and
- a public display of options, concept design, and environmental impacts.

Any person or group can make their views known throughout the process.

PROJECT LOCATION

The RTA has no predetermined route for the upgrades – this study is to fully examine feasible options. The map opposite shows the expected extent of the two projects.



Speak or write to the Consultant Project Manager

Mr Alan Goodwin
Kinhill Cameron McNamara
Phone: 1800 627 971 (freecall)
Fax: (07) 3368 9229
Email: qkinhill@gil.com.au

or write to:

Tyndale Realignment Project
Kinhill Cameron McNamara
Freepost 12
MILTON QLD 4064

The RTA Project Manager is:

Mr Colin Gould
RTA Ballina
PO Box 425
BALLINA NSW 2478
Facsimile: (07) 3368 9229

HOW TO BE INVOLVED

The RTA welcomes community input. There are several ways for you to take part or to find out more.

FURTHER INFORMATION SHEETS

If you want to receive later information sheets please phone, fax, mail, or email your contact details to the Community Consultation Coordinator. (You can use the coupon for your convenience.)

FOCUS GROUP

The study team will establish a small community focus group of people representing several local interest groups. The purpose of this group is to be a 'sounding board' on community issues and to help the study team address various ideas and concerns.

THE PUBLIC DISPLAY

The RTA will display options, preferred alignments and major REF topics at a local venue for two weeks during the second half of 1997. We will publicise details of this later.

COUPON

Please mail or fax to the Community Consultation Coordinator, Pacific Highway—Tyndale Upgrades Project, Kinhill Cameron McNamara, Freepost 13, MILTON QLD 4064
Facsimile: (07) 3368 9229

Mr/Mrs/Ms/Miss _____

Organisation _____

Phone _____

Address _____

_____

_____

ISSUE 3

Improving the Pacific Highway at Tyndale

Welcome to the third in a series of information sheets published by the Roads and Traffic Authority of New South Wales (RTA). These are intended to keep the community fully informed about the status and progress of the proposed realignments to two sections of the Pacific Highway at Tyndale, north of Grafton. The recent second issue described initial options for realignment at Tyndale Village. **In this issue we focus on the realignment and reconstruction of the highway between Byrons Lane and Shark Creek.**

We invite your comments and input as they are important in helping us to arrive at the best solution. This stage is the first major opportunity for you to pass on your views about which options for this section you favour and why.

Our **first information** sheet explained:
- the project
- why consultation is important
- what the study will consider
- the study program, and
- how you can be involved.

This information sheet describes three options identified, so far, for the realignment of the highway at the old Tyndale School site, and explains the process for selection of a preferred realignment. It invites you to give us your opinions on those options, to help us improve them and to identify other options or variations that we should consider. It also invites suggestions or comments on how access may be improved between Byrons Lane and Shark Creek .

At this stage we anticipate that works either side of the realignment options, i.e. south to Byrons Lane and north to Shark Creek will be close to the existing alignment. Assessment is underway to confirm this and the outcome will be described in future information sheets. Works may include:

- an improved intersection with Byrons Lane
- a southbound overtaking lane near Shark Creek
- shoulder widening throughout, and
- possible increase in road level to improve flood immunity.

A flood study is being carried out to assess the potential impacts of raising the highway. We invite comments or information relating to flooding impacts on the area to assist us in this assessment.

SELECTING AN ALIGNMENT

The first major objective of the overall study is to select a preferred alignment. The selection process involves the following steps:

- **review** available information, including previous studies
- **consult** with government authorities and the local community
- **assess** the environmental, economic, social and physical characteristics of the study area
- identify, assess and **adjust** possible options based on the above, and
- conduct a "Value Management Study" to compare options and **recommend** a preferred highway alignment.

Assessment of the study area is underway with studies such as:

- flooding
- flora and fauna
- geology and soils
- heritage
- planning and land use.

Any information the community can provide on these or other issues will help our assessment.

The study program encourages all community groups, individuals and government agencies to be involved in the selection of a new alignment.

All comments will be assessed before a preferred realignment option is selected. Representatives of groups affected by the options will be invited to participate in a "Value Management Study", the focus of which is a workshop run in such a way as to evaluate options through the participation of community and government organisations.

BASIS FOR SELECTING AN ALIGNMENT

The RTA is committed to achieving the best overall outcome for the community. We will judge options against objectives such as:

- safety
- value for money
- minimising land acquisition, road construction and travel costs
- minimising disturbance to existing and future land uses (farms, homes, businesses) and the people involved in them
- minimising impact on the environment.

This is not a complete list and other issues will be considered, including any identified as important to the local community. Let us know the issues you feel are important in selecting the best realignment option.

RTA

Roads and Traffic Authority
July 1997

The flood study will look at the possibility of raising this section to reduce the frequency of flooding, without causing any significant consequences, such as:

- increases in upstream flood levels
- prolonged inundation of canelands.

The RTA also welcomes your input on this subject.

HOW TO BE INVOLVED

The RTA welcomes community input so there are several ways for you to be involved.

Pass on your comments about realignment options

- You could let us know how we can improve any of the options or suggest others—we welcome your ideas.
- You could pass on to us some fact that might affect the decision about which is the preferred realignment (e.g. the presence of a habitat of a rare or endangered species of wildlife, a site of heritage or archaeological significance)
- You could let us know which realignment you think is the best one—and explain why.
- You could let us know how you think a particular option could affect you and what the RTA could do to minimise any unfavourable implications.
- Please let us know if you are not on our mailing list (and want to be) so that we can send you our future information sheets. We want to keep you up to date with what is happening on the project and you may not receive future sheets if not on our list.

We would appreciate it if you could send your comments to the consultants before Thursday 14 August1997.

Follow the project

You can follow the progress of the project through:

- press coverage
- information sheets
- the public display—during two weeks later this year we will explain the options, the preferred alignment (once it is chosen) and major topics in the *Review of Environmental Factors.*

Speak or write to the Consultant Project Manager

Mr Alan Goodwin

Kinhill Cameron McNamara

Phone: 1800 627 971 (freecall)

Fax: (07) 3368 9229

Email: tyndale@kinhill.com.au

or write to:

Tyndale Realignment Project

Kinhill Cameron McNamara

Freepost 12

MILTON QLD 4064

The RTA Project Manager is:

Mr Colin Gould

RTA Ballina

PO Box 425

BALLINA NSW 2478

COMING COMMUNITY INVOLVEMENT DATES

- Submit comments on realignment options to the Consultant by Thursday 14 August

  (Consultant reviews options—August)
- *Value Management Study*—September 1997.

R T A

Roads and Traffic Authority
July 1997

COMMUNITY INFORMATION SHEET

No. 5 Issued December 1997

Upgrading the Pacific Highway at Byrons Lane to Shark Creek

Welcome to the fifth information sheet published by the RTA to keep the community fully informed about all aspects of the proposed upgrade of the Pacific Highway between Byrons Lane and Sharks Creek, Tyndale.

This information sheet explains why a combined Option 1/1A has been chosen as the preferred route for the central section of the project. It also summarises the various advantages and disadvantages of the other options which the community asked the RTA's project team to investigate.

Your comments about how we can improve Option 1/1A, the preferred route, will be sought in the next stage of the project.

THE PREFERRED ALIGNMENT

The NSW Minister for Roads recently announced the selection of Option 1/1A as the preferred route for the cental section of the Pacific Highway upgrade between Byrons Lane and Sharks Creek. Option 1/1A is shown on the map inside this information sheet.

The selection of a preferred route is a complex task and is the result of lengthy and detailed technical and other investigations, including an analysis of potential impacts.

Community consultation has been an essential part of the study process leading up to the selection of the preferred route.

A Value Management Study workshop was held to systematically analyse the advantages and disadvantages of each of the three options outlined in Information Sheet No. 3 (July 1997). An independent facilitator assisted the project team and others who attended the Value Management Study. The workshop was attended by representatives from the community, some government agencies and the RTA.

Those attending the Value Management Study workshop listened to the views of other representatives, identified a possible additional route Option (1A), and finally evaluated all of the options put forward by the community.

The workshop recommended Option 1/1A as the preferred option. Options 1 and 1A are so close that it was difficult for the workshop to conclude which of these two was the better option. Options 1 and 1A are therefore being treated as one—the preferred route. The workshop also identified ways in which the impact of this option could be reduced, and matters that the consultants should consider in developing a road concept design.

WHAT THE COMMUNITY SAID

The consultants received eight written submissions in response to Information Sheet No. 3—and spoke to all land–owners fronting this section of the highway.

Based on our consultation, the community generally agrees that the highway needs to be upgraded. Option 1 was the most favoured, and Option 3 was the least favoured.

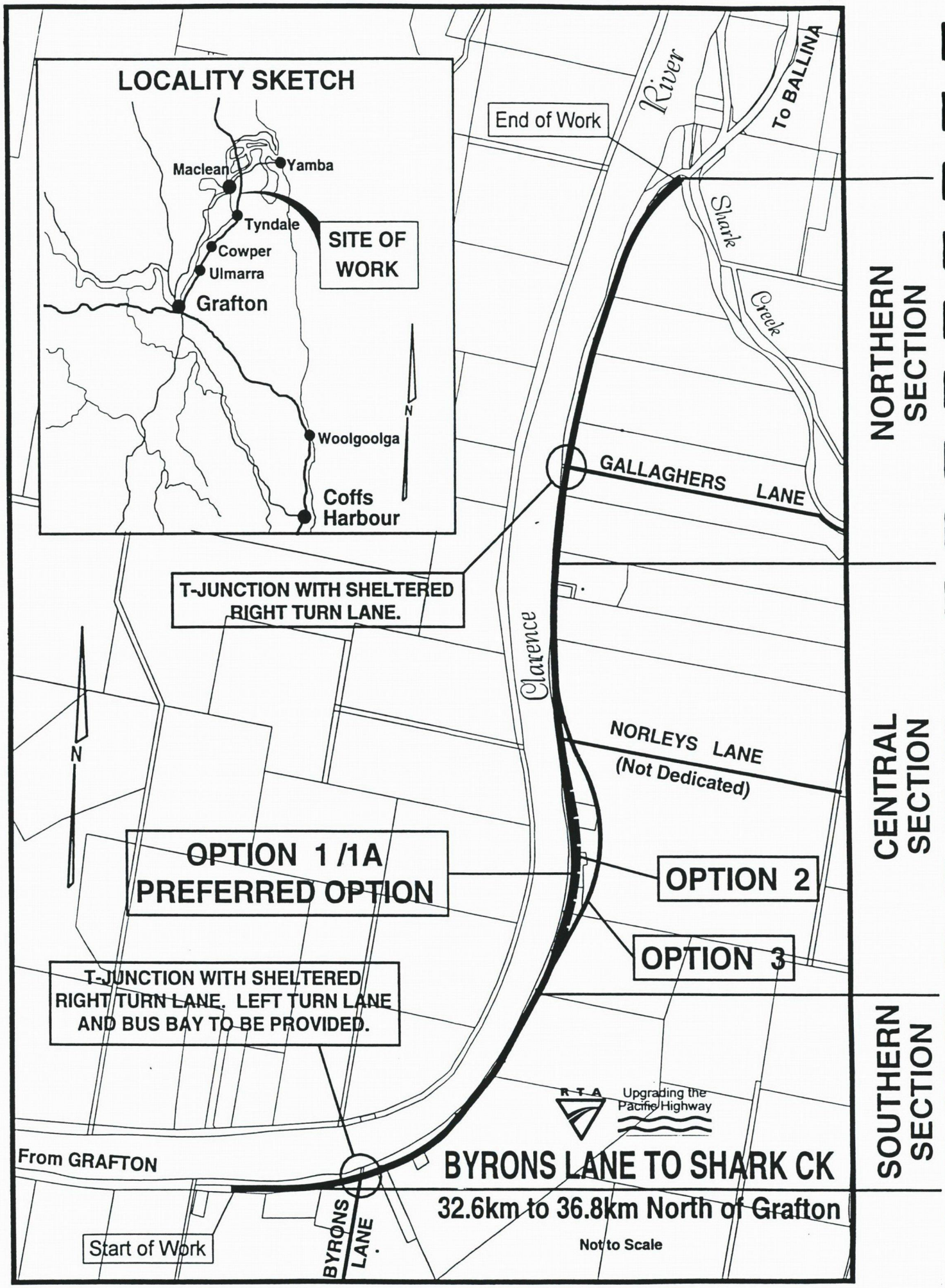
The community also stated the reasons for the various community preferences. The most common issues or concerns were:-

- property impacts, including loss and severance of agricultural land
- noise and vibration problems
- safety, including safe and convenient access and machinery access over Lees Drain
- flooding impacts (including time of inundation and scouring)
- fig trees at the site of the old Tyndale School (These were thought not to be as important as protecting cane land. Some suggested that the fig trees may be able to be transplanted.)

COMPARING THE ROUTE OPTIONS

Each route option had its advantages and disadvantages. The following is a summary based on the conclusions of the Value Management Study.

Roads and Traffic Authority
December 1997


LOCALITY SKETCH
Maclean
Yamba
Tyndale
Cowper
Ulmarra
Grafton
SITE OF WORK
Woolgoolga
Coffs Harbour
N
End of Work
River
To BALLINA
Shark
Creek
NORTHERN SECTION
GALLAGHERS LANE
T-JUNCTION WITH SHELTERED RIGHT TURN LANE.
Clarence
NORLEYS LANE
(Not Dedicated)
CENTRAL SECTION
OPTION 1 /1A
PREFERRED OPTION
OPTION 2
OPTION 3
T-JUNCTION WITH SHELTERED RIGHT TURN LANE. LEFT TURN LANE AND BUS BAY TO BE PROVIDED.
SOUTHERN SECTION
RTA
Upgrading the Pacific Highway
From GRAFTON
BYRONS LANE TO SHARK CK
32.6km to 36.8km North of Grafton
Not to Scale
Start of Work
BYRONS LANE

Options for the Central Section

Option 1/1A (the preferred route)

This route option was the one that most closely followed the existing highway while still being able to be designed for a speed of 100 kph. Of the four options, it would involve the least acquisition of land and was furthest away from residences. Although this option would mean the removal of two existing fig trees, new fig trees will be planted as part of the proposed revegetation for this project.

Option 2

This option rated poorly because it was close to houses and would involve acquiring significantly more land than Option 1/1A. It would however have less potential impact on water quality (river is further away) and on the fig trees.

Option 3

This option would require the RTA to acquire a lot more property, much of it cane land. It was also the option closest to the most residences and with the greatest flood impact. Overall it was the least favoured option. It would also be the most costly option to build.

The Value Management Study workshop concluded that Options 2 and 3 were clearly less acceptable. Options 1 or 1A rated so closely that the workshop decided to recommend them together as the preferred route, because of their minimal impacts on property. Option 1/1A would also be less expensive to build.

Options for the Northern Section

The workshop also considered options for the northern section of the proposed upgrade. The following recommendations of the workshop have been accepted:

- widening should take place as much as possible on the western side so as to minimise the loss of cane land (This is subject to further geotechnical investigations.)
- the overtaking lane should be located between Gallaghers Lane and Shark Creek
- the road should be built at a 1 in 5 year floods avoidance level.

The Southern Section

This section starts about 200 metres south of Byrons Lane and finishes about 1 kilometre north of Byrons Lane. The only practical choice for upgrading this section is to reconstruct and widen to the east of the current highway as it is close to the river at this location. This section is already relatively flood-free and does not need to be raised.

Environmental impacts relate mainly to noise and property effects. The project team will now prepare a *Review of Environmental Factors* (REF) over the next month with a decision anticipated early in 1998.

THE NEXT STAGES

the phase includes two major tasks:-

- develop road designs, including access to properties. During this process, ideas for reducing impacts of the road and improving the local environment will be examined and developed. Some of these ideas might include:-

  Retaining off-road access for farm vehicles over Lees Drain;
  Designing the road pavement to minimise traffic vibration;
  Providing a sealed level area where vehicles can wait before entering the highway;
  Byrons Lane and Gallaghers Road provided with turning and deceleration lanes (see diagram) and Norleys Lane under investigation;
  The provision of bus bays and turning areas.

  and

- assess the detailed impacts of Option 1/1A by preparing an REF

Tyndale Project Work Program:

The next information sheet will describe how you can be involved in these tasks.

HOW TO BE INVOLVED

The RTA welcomes community input. The next stage of the project will involve discussions with local land owners, especially those most directly affected by Option 1/1A. Working with

the local Tyndale community is an essential part of the road concept design phase.

There are several other ways for you to remain involved or offer comment or suggestions:-

Follow the progress of the project through this and future information sheets.

Pass on your comments:

- Let the project team know how they can reduce the impacts of Option 1/1A further and/or which features you think Option 1/1A should include.
- Let the project team know if you want to be on the mailing list for future information sheets, so they can keep you up to date with what is happening on the project.
- Contact the project team if you think that Option 1/1A will affect you (and you haven't already been contacted by them) so that you can discuss how you might take part in the road concept design phase.

Visit the REF on public display (early 1998)

The REF and associated working papers will be discussed with affected property owners early in 1998.

WRITE TO OR CONTACT THE CONSULTANT PROJECT MANAGER AT ANY TIME

The Consultant Project Manager is:

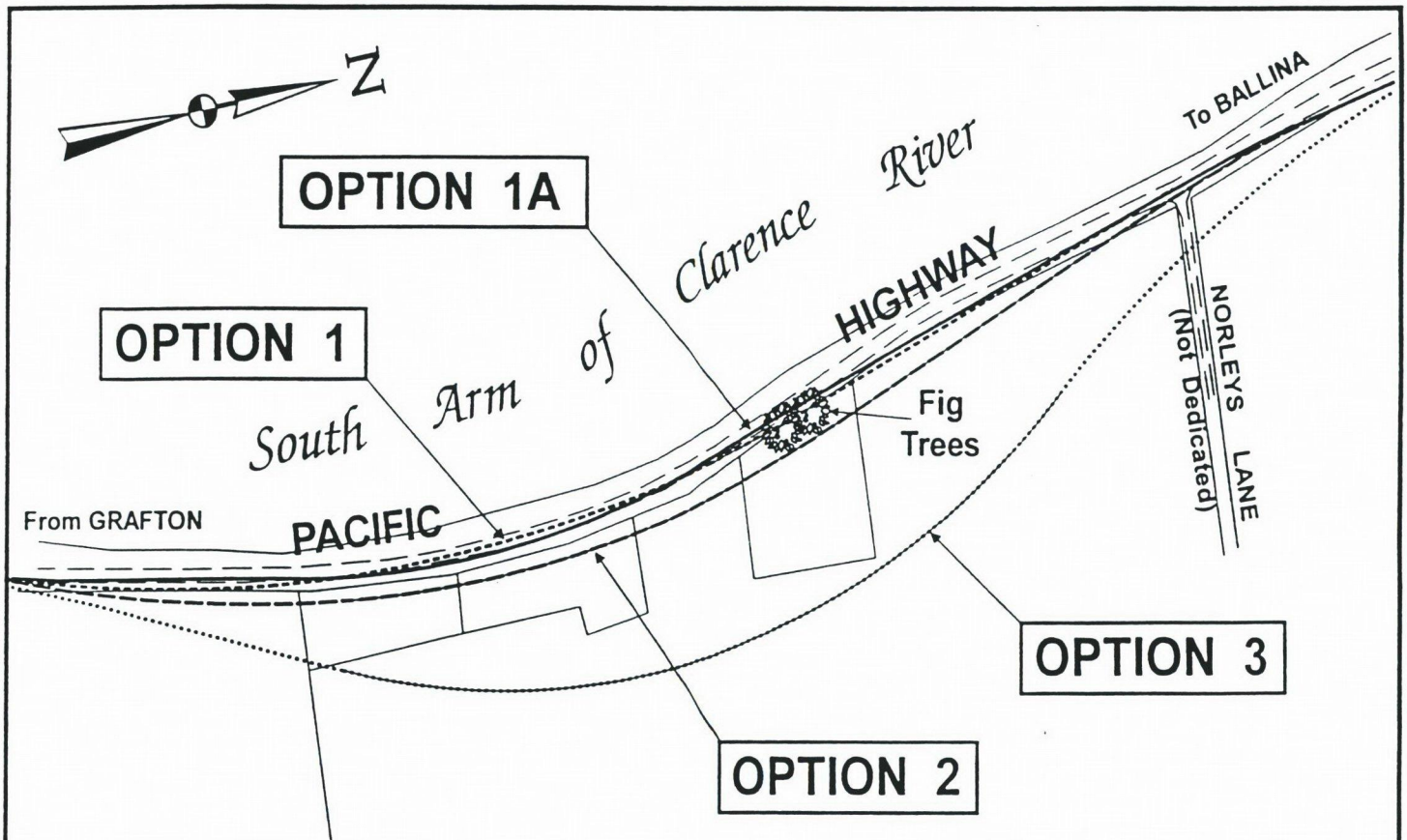
Mr Alan Goodwin
Kinhill Cameron McNamara
Phone: 1800 627 971 (freecall)
or (07) 3368 9228
Fax: (07) 3368 9229
Email: tyndale@kinhill.com.au

or write to:

Tyndale Realignment Project
Kinhill Cameron McNamara
Freepost 12
MILTON QLD 4064

The RTA Project Manager is:

Mr Colin Gould
RTA Ballina
PO Box 425
BALLINA NSW 2478



ROUTE OPTIONS FOR CENTRAL SECTION

Not to Scale

Roads and Traffic Authority
December 1997

KINHILL

APPENDIX M

SUMMARY OF COMMUNITY ISSUES

Appendix M

Summary of community issues

The following table summarises the concerns that the community has raised.

Table M1 Summary of issues and concerns raised by the community

General subject	Description
Safety	Possible car/truck collisions involving houses
	Need for safe route for farm machinery along the highway on its eastern side
	Bus stops should be located and designed so that students can access safely.
Noise & Vibration	Vibration caused by heavy vehicles leading to structural defects in buildings
	Increase in noise and vibration as a result of highway being. (Some residents, however, indicated that they had become accustomed to the noise.)
Trees and other vegetation	Loss of trees planted along the front of property reducing pleasantness
	The upgrade should preserve existing native vegetation, particularly that in close proximity to the river bank.
Cane Farming Impacts	Direct loss of prime agricultural land
	Severance of cane land resulting in decreased workability of farms
	Further reduction of cane farms reduces viability.
Flooding Impacts	Increased road levels are likely to increase flood levels and the time of inundation
	Increase road levels could increase the incidence and severity of scouring
	Adequate drainage under the highway is an important consideration.
	Providing flood-free access on this section of highway would be of little benefit.
Devaluation	Highway closer to houses will devalue properties.
Access	Widening of highway shoulders should be undertaken
	Access to houses is an important consideration.
Other matters	Stripped topsoil should be returned for use on farms.
	Should consider land swaps between surplus RTA land and cane farms.

KINHILL

APPENDIX N

SOCIO-ECONOMIC PROFILES

Appendix N

Socio-economic profiles

Table N1 Socio-economic profile of the Tyndale area

	NSW CD 1060901 (1060910*)	Maclean (S)	Mid-North Coast (SD)	New South Wales
POPULATION SUMMARY				
Total population	239	15900	261365	5979026
Population in occupied private dwellings	239	15708	255329	5841476
Occupied private dwellings	86	6462	99779	2174917
Persons per household	2.78	2.43	2.56	2.69
AGE DISTRIBUTION (% OF TOTAL POPULATION)				
0-4	5.0	6.1	6.9	7.2
5-9	6.3	6.8	7.9	7.2
10-14	5.4	6.9	8.0	7.2
15-19	5.9	4.8	6.3	6.9
20-24	2.9	3.5	4.5	7.3
25-29	3.8	4.1	4.9	7.5
30-34	6.3	5.6	6.3	7.9
35-39	6.3	6.8	7.6	8.0
40-44	6.3	6.8	7.4	7.3
45-49	7.9	6.2	6.8	7.0
50-54	7.5	5.6	5.6	5.6
55-59	8.8	6.6	5.3	4.6
60-64	6.3	7.6	5.3	4.0
65+	21.3	22.6	17.3	12.5
Total	**100.0**	**100.0**	**100.0**	**100.0**
LABOUR FORCE STATUS (% OF PERSONS AGED 15+)*				
In Labour force	57.7	44.8	52.8	62.3
Not in labour force	42.3	55.2	47.2	37.7
Total	**100.0**	**100.0**	**100.0**	**100.0**
Wage/Salary earner	53.9	52.5	59.6	73.5
Self employed	21.5	17.3	14.2	9.0
Employer	5.5	9.5	8.2	6.2
Unemployed	19.2	20.6	18.1	11.3
Total	**100.0**	**100.0**	**100.0**	**100.0**
Occupation (% of employed labour force)*				
Managers and administrators	25.6	18.8	15.9	13.0
Professionals	8.0	9.2	10.1	13.8
Para-professionals	5.1	6.1	6.0	7.0
Tradespersons	10.2	15.3	15.4	14.5

Table N1 (continued)

	NSW CD 1060901 (1060910*)	Maclean (S)	Mid-North Coast (SD)	New South Wales
Clerks	11.4	11.4	13.4	16.9
Sales and personal services	12.5	13.5	16.5	14.5
Plant and machine operators	13.1	8.3	7.3	7.4
Labourers and related workers	14.2	17.4	15.4	13.1
Total	**100.0**	**100.0**		**100.0**
Blue collar	37.5	41.1	38.1	34.9
White collar	62.5	58.9	61.9	65.1
Total	**100.0**	**100.0**	**100.0**	**100.0**
HOUSEHOLD INCOME (% OF HOUSEHOLDS)*				
$0-$25,000	56.8	64.5	59.7	41.5
$25,001-$50,000	34.9	27.6	30.2	33.0
$50001+	8.3	8.2	10.3	25.6
Total	**100.0**	**100.0**	**100.0**	**100.0**
Average (1991 $)	27843	24694	26504	37912
DWELLING STRUCTURE (% OF OCCUPIED PRIVATE DWELLINGS)				
Separate house	82.4	75.9	78.4	72.5
Semi-detached/row or terrace house etc.	13.5	5.9	6.4	8.3
Flat or apartment	0.0	7.0	9.1	17.2
Caravan etc in park	7.1	9.0	4.4	1.0
Other	7.1	2.2	1.6	1.0
Total	**100.0**	**100.0**	**100.0**	**100.0**
DWELLING TENURE (% OF OCCUPIED PRIVATE DWELLINGS)				
Owned	64.0	55.8	48.5	42.5
Being purchased	24.4	14.8	19.1	22.5
Rented	11.6	24.7	27.8	29.9
Other/Not Stated	0.0	4.7	4.6	5.1
Total	**100.0**	**100.0**	**100.0**	**100.0**
Vehicles per dwelling (% of occupied dwellings)*				
0	8.0	11.5	12.1	15.6
1	44.8	56.2	52.7	44.9
2	41.4	25.9	28.1	29.6
3	5.7	6.4	7.1	10.0
Total	**100.0**	**100.0**	**100.0**	**100.0**

* *1996 data for these variables was not available at time of writing CDATA91 figures are quoted*

APPENDIX O

ROAD USER BENEFIT COST

Appendix O

Road user benefit cost

INTRODUCTION

The benefit cost analysis evaluated the upgrading of approximately 1 km of road from 9 m seal width with poor pavement condition, to a 12 m seal width of good condition. RTAs SIMCBA process has been used for the analysis.

CBA is a formalised technique used widely in the evaluation of public sector projects. The benefits of the project - of reduced user travel time and vehicle operating costs, accident costs and maintenance costs - over a 30 year period, are compared with the project capital costs. A project yielding a benefit cost ratio of one is considered marginally satisfactory from an economic point of view. The higher the ratio, the more beneficial is the project as measured in terms of the community's economic welfare.

ASSUMPTIONS

Construction costs of the project were assumed to be $1.5 million. The current and proposed alignments are flat and a single sweeping curve.

RTAs traffic data indicates that daily traffic (AADT) was approximately 7200 in 1995 (taking the midpoint of AADT estimates between stations 04.023 and 04.400. The linear growth between 1986 and 1995 was 7.9% per annum. Based on these parameters, 1998 AADT of 8218 vehicles per day was assumed. The analysis uses a ratio of light to heavy vehicles of 88:12.

User benefits (vehicle operating cost savings, travel time savings) and accident cost savings have been calculated using the SIMCBA method.

Because the current pavement appears to be in poor condition, an allowance has been made in the base case for rehabilitation works in year 1 of $400,000. This expenditure would not be incurred in the project case, reducing project case net capital costs to $1.1 m.

A 7% real discount rate and a 30 year project life have been used.

RESULTS OF THE COST BENEFIT ANALYSIS

Based on these assumptions, the project would yield the following results:

Benefit cost ratio	2.3
Net present value	$1.666 million.

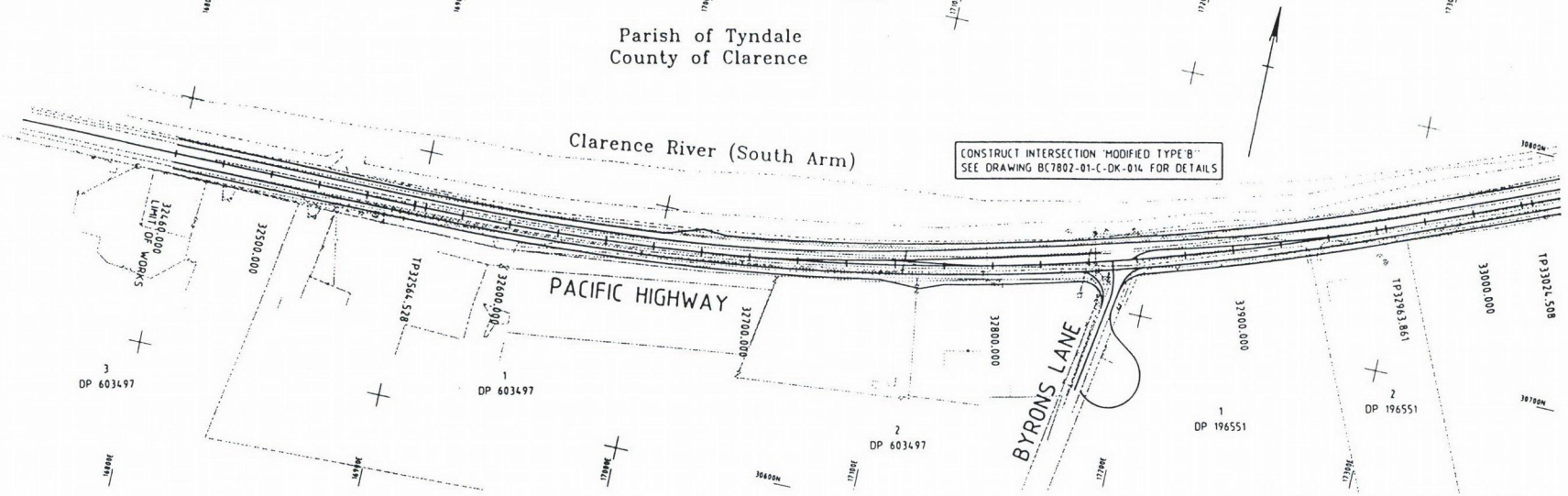
First year benefits of the upgrading are estimated as follows:

User vehicle operating cost savings	$0.115 million
User travel time savings	$0.0
Accident cost savings	$0.009 million.

APPENDIX P

CONCEPT DESIGN DRAWINGS

Parish of Tyndale
County of Clarence



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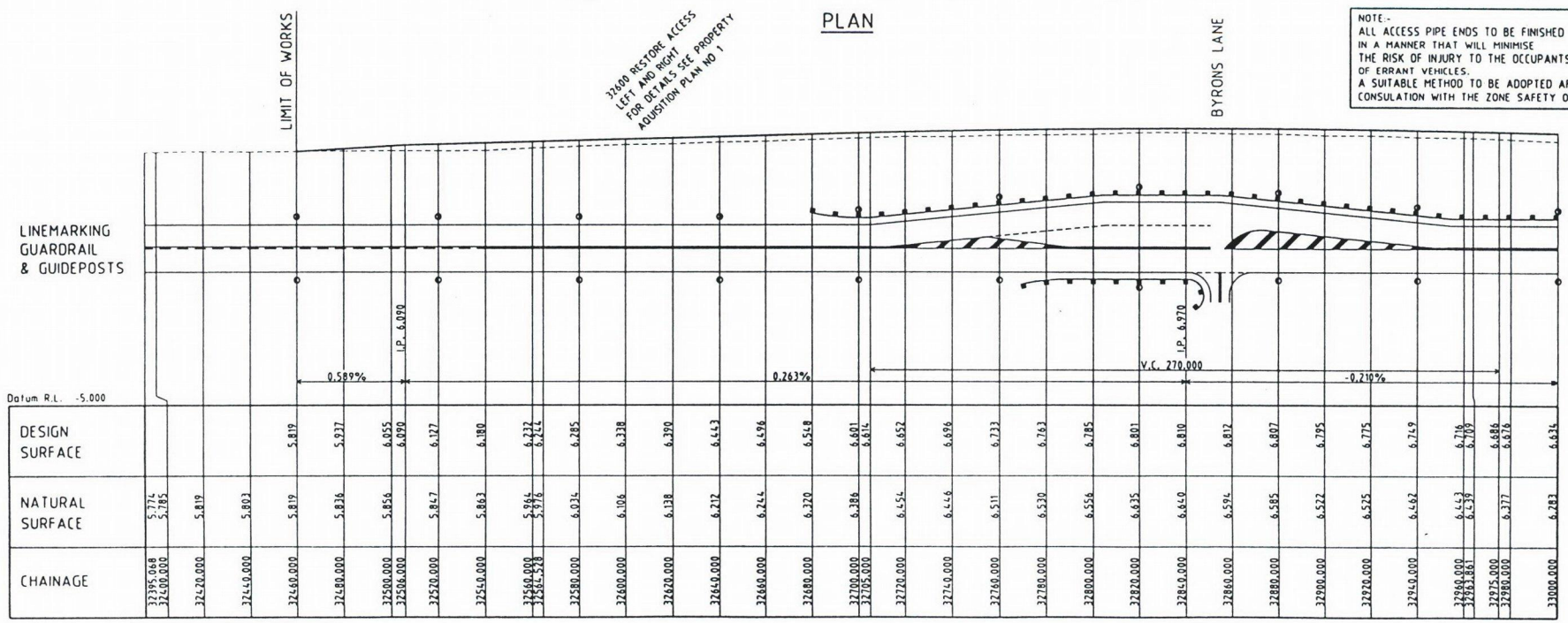

NOTE:-
ALL ACCESS PIPE ENDS TO BE FINISHED IN A MANNER THAT WILL MINIMISE THE RISK OF INJURY TO THE OCCUPANTS OF ERRANT VEHICLES.
A SUITABLE METHOD TO BE ADOPTED AFTER CONSULATION WITH THE ZONE SAFETY OFFICER.

ROAD LONGITUDINAL SECTION - PACIFIC HIGHWAY

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32.5km TO 33.9km NORTH OF GRAFTON
TYNDALE REALIGNMENT
PLAN AND LONGITUDINAL SECTION
SHEET 1 OF 3

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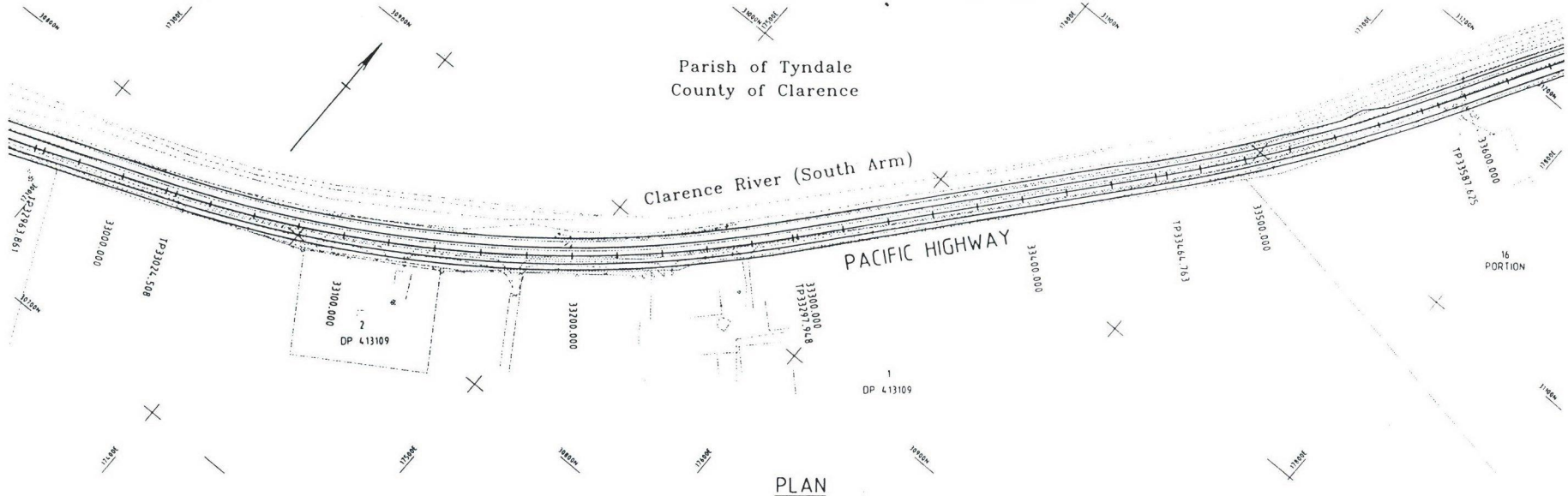

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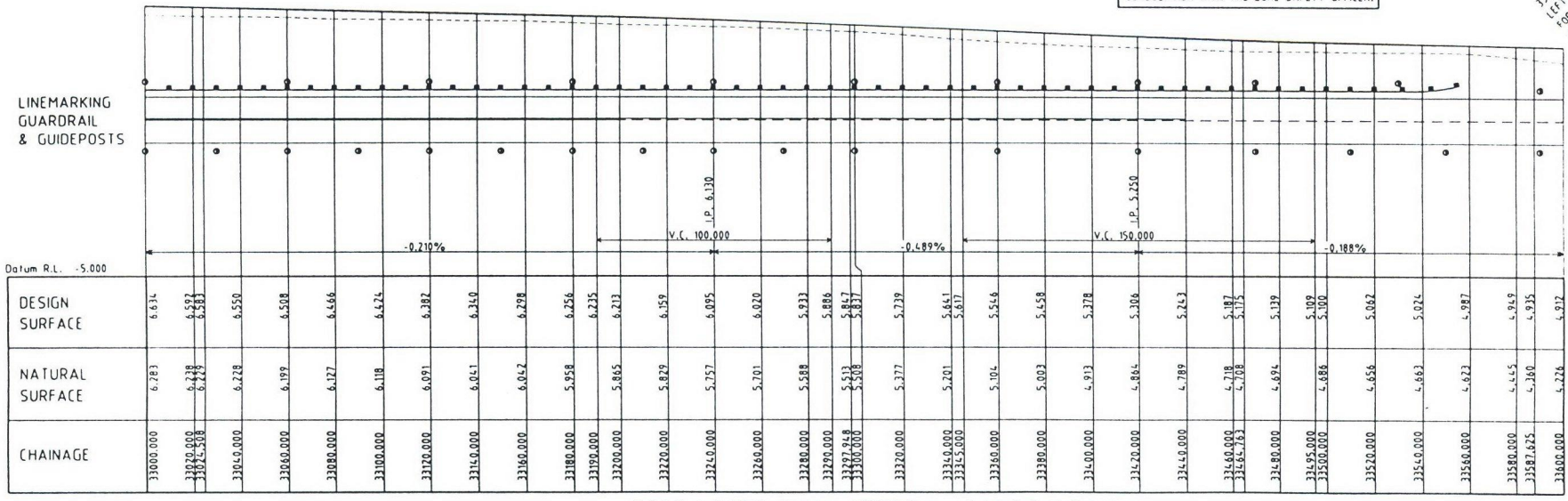
NOTE -
ALL ACCESS PIPE ENDS TO BE FINISHED IN A MANNER THAT WILL MINIMISE THE RISK OF INJURY TO THE OCCUPANTS OF ERRANT VEHICLES.
A SUITABLE METHOD TO BE ADOPTED AFTER CONSULATION WITH THE ZONE SAFETY OFFICER.

33600 RESTORE ACCESS LEFT AND RIGHT FOR DETAILS SEE PROPERTY ADQUISITION PLAN NO 1



ROAD LONGITUDINAL SECTION - PACIFIC HIGHWAY

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32.5km TO 33.9km NORTH OF GRAFTON
TYNDALE REALIGNMENT
PLAN AND LONGITUDINAL SECTION
SHEET 2 OF 3

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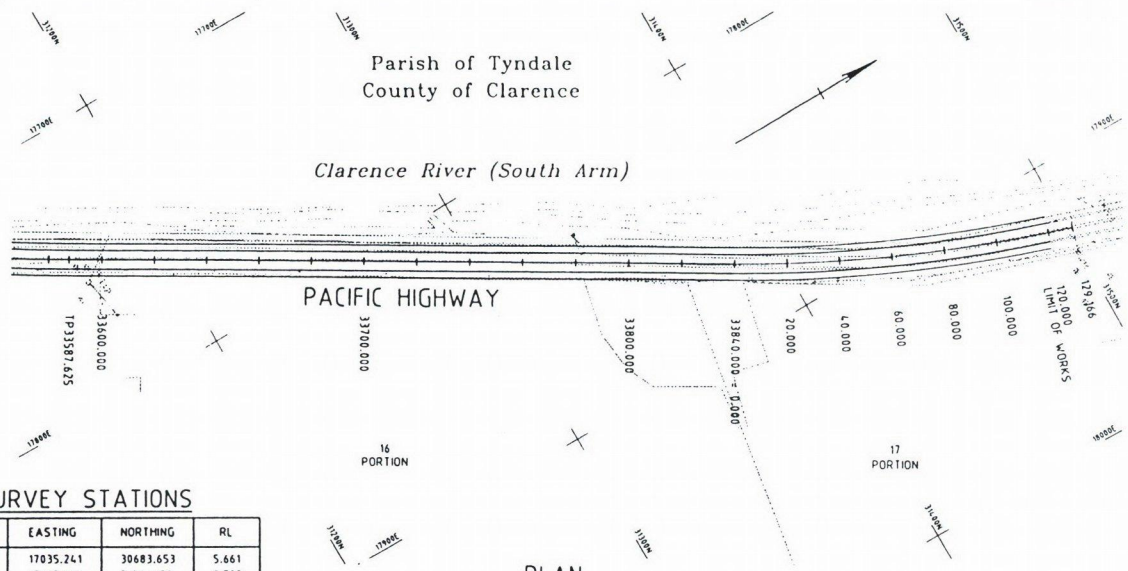


PLAN

SURVEY STATIONS

STATION	EASTING	NORTHING	RL
SSM 28982	17035.241	30683.653	5.661
SSM 28983	17662.086	31041.638	3.793
SSM 28984	17930.520	31494.808	3.943
PM 47715	17266.429	30743.539	5.402
STN 111	17801.320	31255.315	3.763
STN 112	17476.246	30848.216	5.862
STN 113	17095.244	30695.632	6.483

CONTROL LINE DETAILS

PACIFIC HIGHWAY (MOOV)

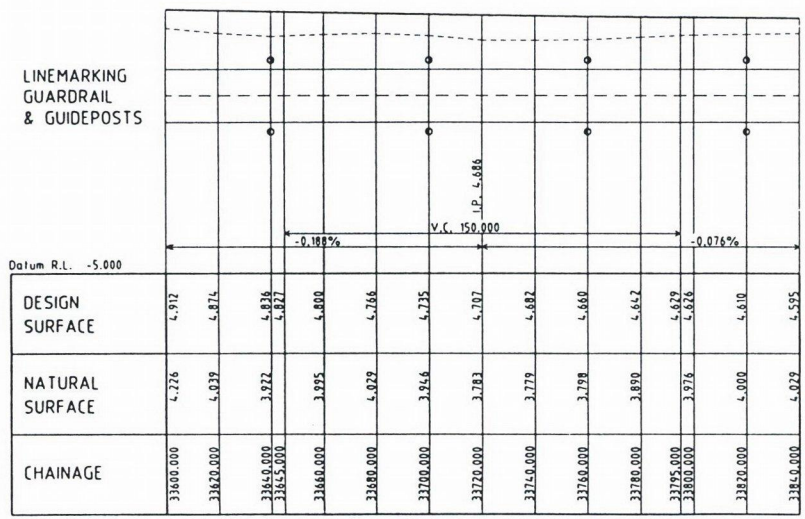
Chainage	Easting	Northing	Radius	TanLngth	Def Angle	Bearing	
32460 000	16797 997	30676 757				89°25'48"	Straight
32564 528	16902 519	30677 797				89°25'48"	Straight
			1050 000	202 109	21°47'26"		Arc
32963 861	17291 530	30756 696				67°38'22"	Straight
33024 508	17347 616	30779 769				67°38'22"	Straight
			575 000	139 356	27°14'49"		Arc
33297 948	17566 800	30938 921				40°23'33"	Straight
33464 763	17674 900	31065 971				40°23'33"	Straight
			700 000	61 589	10°03'23"		Arc
33587 625	17745 918	31166 035				30°20'10"	Straight
33840 000	17873 386	31383 854				30°20'10"	Straight

TEMPORARY CONNECTION

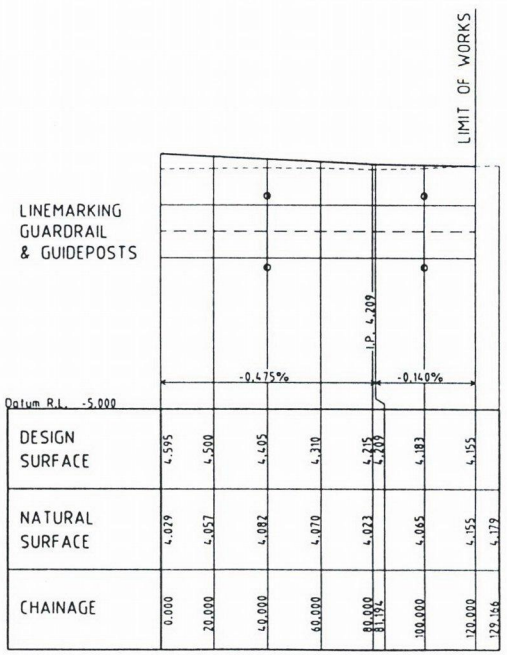
Chainage	Easting	Northing	Radius	TanLngth	Def Angle	Bearing	
0 000	17873 386	31383 854				30°20'10"	Straight
			572 690	64 858	12°55'22"		Arc
129 166	17925 554	31501 717				17°24'49"	

BYRONS LANE

Chainage	Easting	Northing	Radius	TanLngth	Def Angle	Bearing	
0 000	17184 090	30719 168				163°51'09"	Straight
5 251	17185 550	30714 124				163°51'09"	Straight
			25 000	5 638	25°25'04"		Arc
16 342	17186 210	30703 144				189°16'13"	Straight
55 508	17179 901	30664 489				189°16'13"	Straight



ROAD LONGITUDINAL SECTION
PACIFIC HIGHWAY



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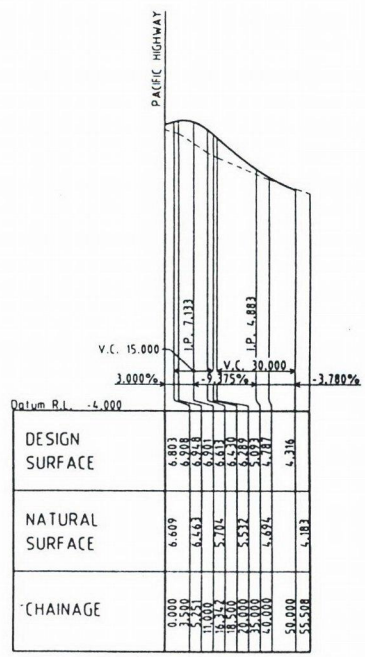
TEMPORARY CONNECTION



ROAD LONGITUDINAL SECTION
BYRONS LANE

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STATE HIGHWAY NO. 10 - PACIFIC HIGHWAY
32.5km TO 33.9km NORTH OF GRAFTON
TYNDALE REALIGNMENT
PLAN AND LONGITUDINAL SECTION
SHEET 3 OF 3

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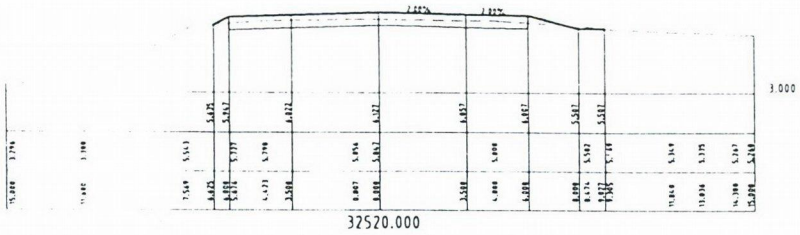

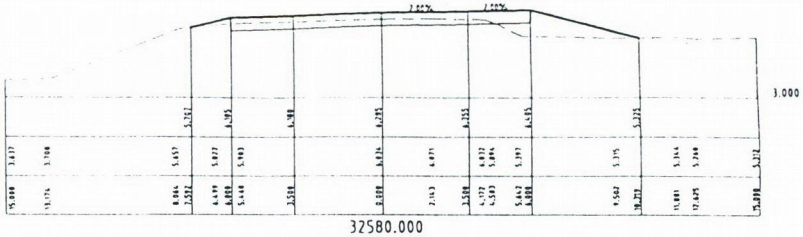

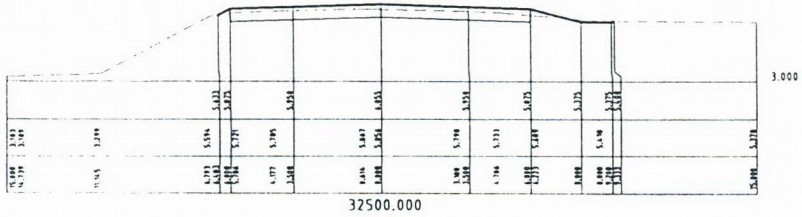

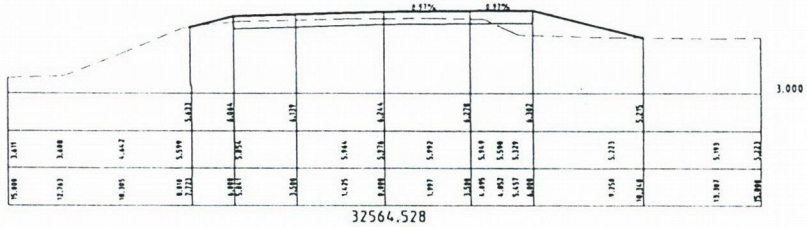

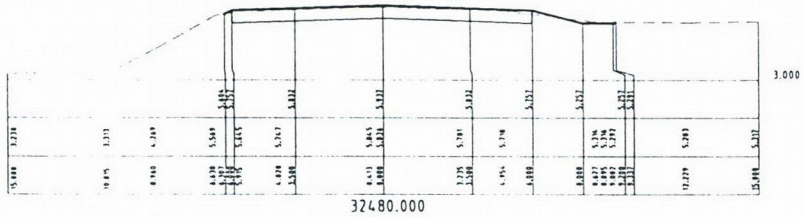

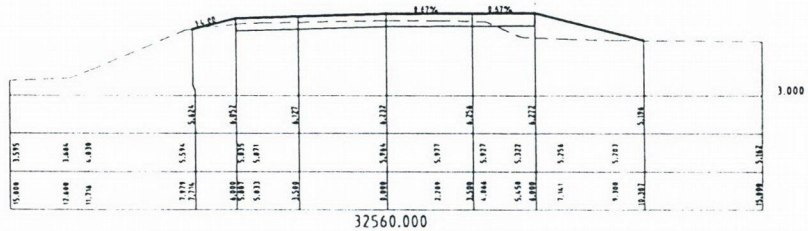

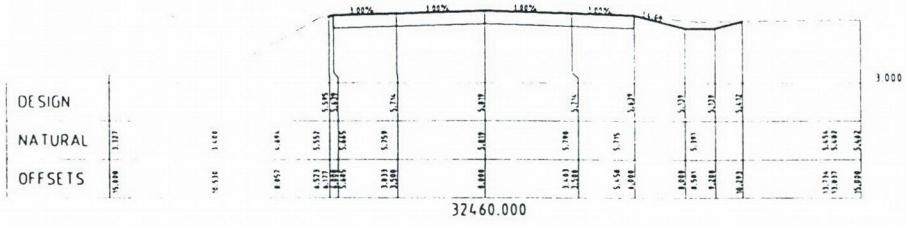

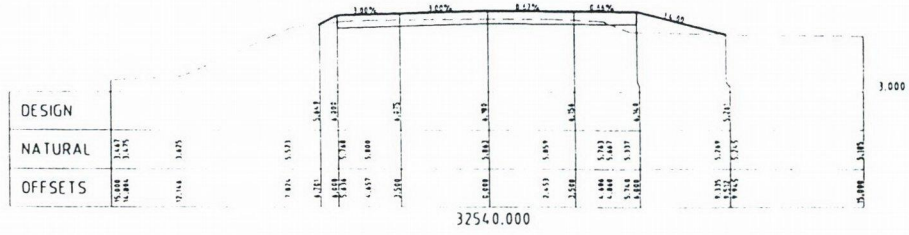

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STATE HIGHWAY NO. 10 - PACIFIC HIGHWAY
32.5km TO 33.9km NORTH OF GRAFTON
TYNDALE REALIGNMENT
ROAD CROSS SECTIONS - HIGHWAY
SHEET 1 OF 10

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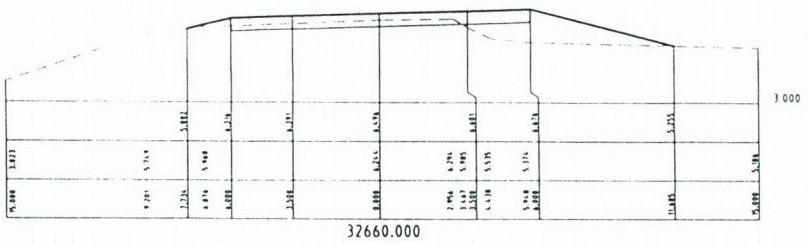

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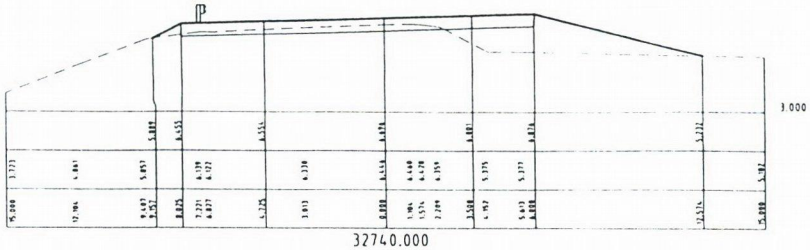

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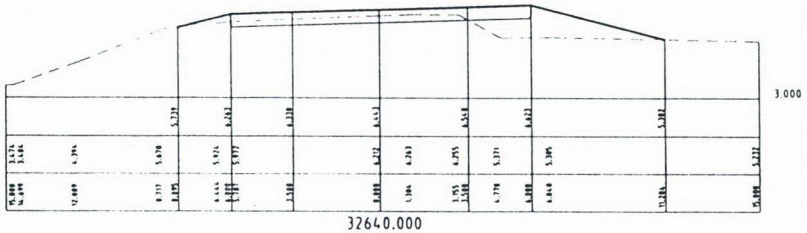

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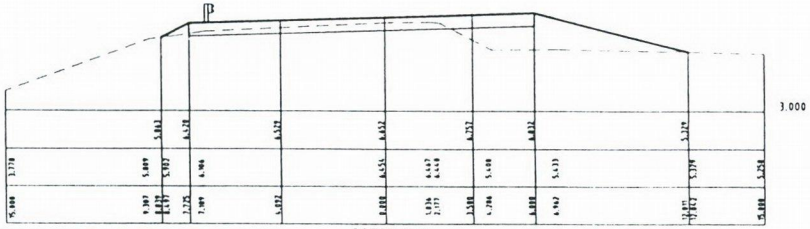

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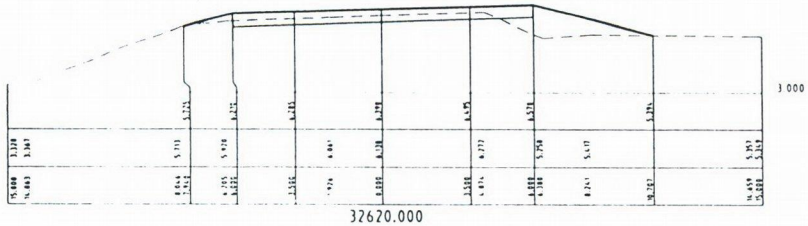

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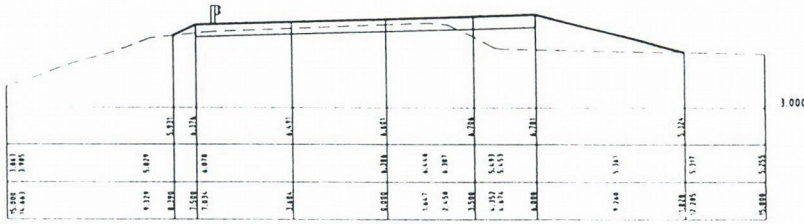

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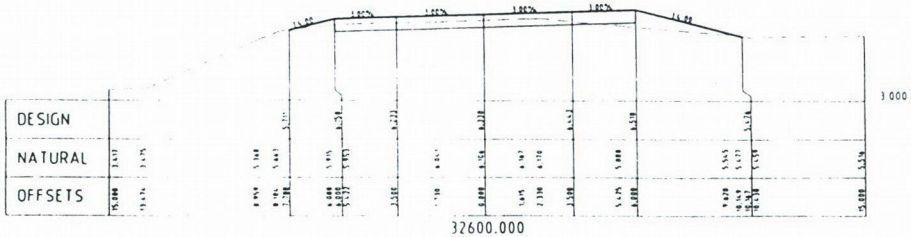

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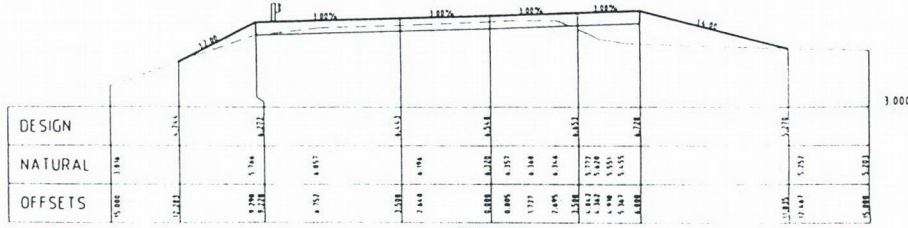

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ROAD CROSS SECTIONS - PACIFIC HIGHWAY

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ROAD CROSS SECTIONS - HIGHWAY
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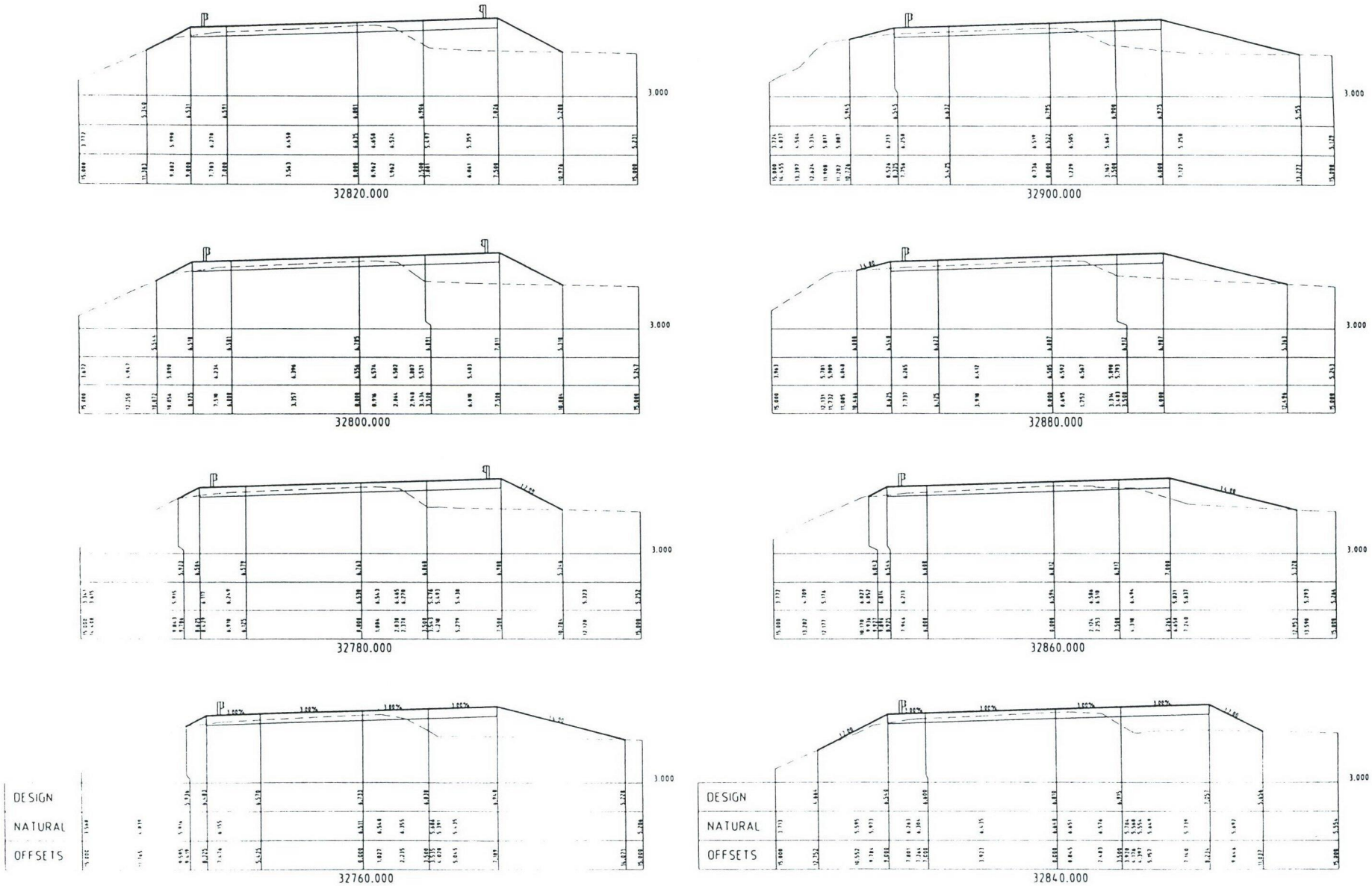


ROAD CROSS SECTIONS - PACIFIC HIGHWAY

PRELIMINARY NOT FOR CONSTRUCTION

CODE	DATE	DESCRIPTION	PROJ SUP
B	3.2.98	TO RTA	
A	24.11.97	FIRST ISSUE	

ISSUES

DRG No.	TITLE

REFERENCE DRAWINGS

2 0 2 4 6
SCALE OF METRES

CODE	DATE	DESCRIPTION	DRAFT	DES	PROJ SUP
B	3.2.98	REVISED LAYOUT & GRADING			
A	24.11.97	FIRST ISSUE			

REVISIONS AND APPROVALS

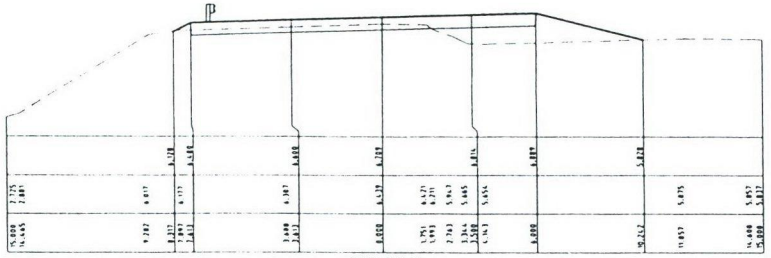
DESIGN	DATE	SCALES	AS SHOWN
DESIGN CHECK		CAD FILE	6802AF
		PLOT SCALE	1:1
DRAWN		TECHNICAL APPROVAL	DATE
DRAFTING CHECK		PROJECT APPROVAL	
CHIEF DRAFTER		CLIENT APPROVAL	

KINHILL CAMERON McNAMARA
Kinhill Pty Ltd A.C.N. 007 660 317

RTA

ROADS AND TRAFFIC AUTHORITY
STATE HIGHWAY NO. 10 - PACIFIC HIGHWAY
32.5km TO 33.9km NORTH OF GRAFTON
TYNDALE REALIGNMENT
ROAD CROSS SECTIONS - HIGHWAY
SHEET 3 OF 10

DRAWING NUMBER: BC7802-01-C-DK-006
REVISION CODE: B



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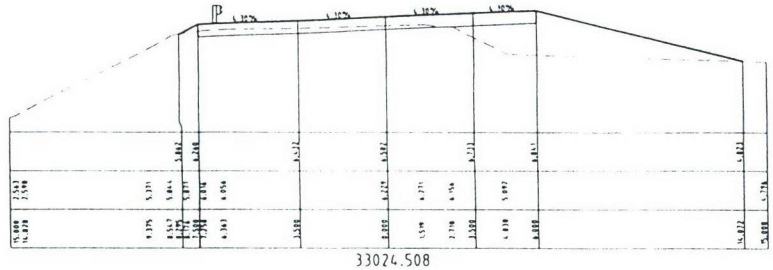

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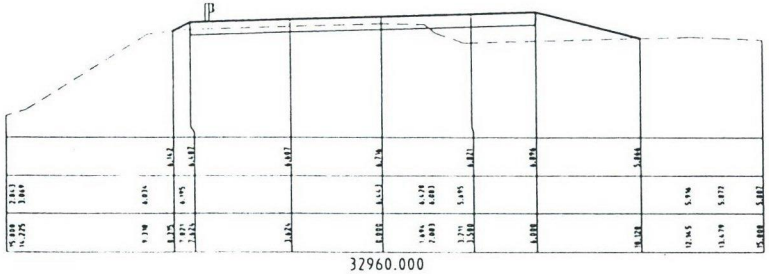

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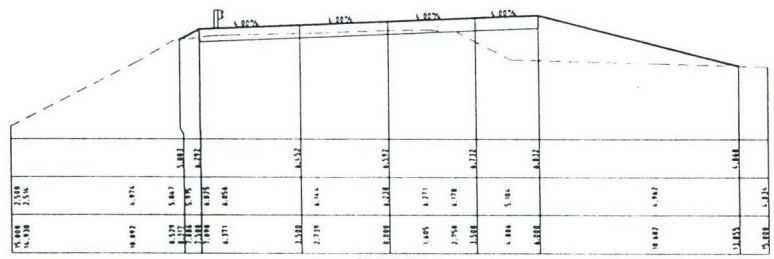

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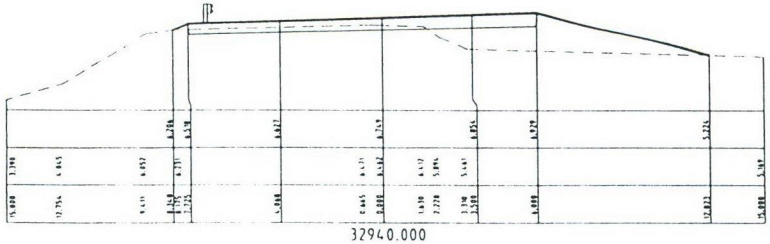

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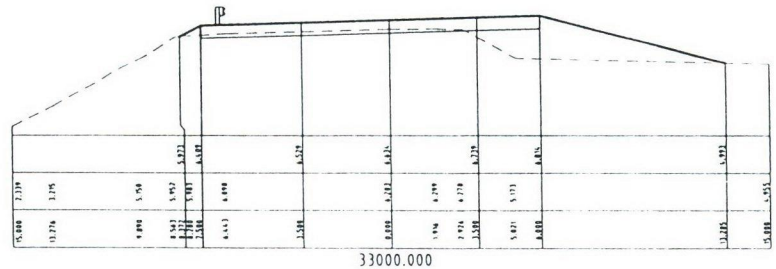

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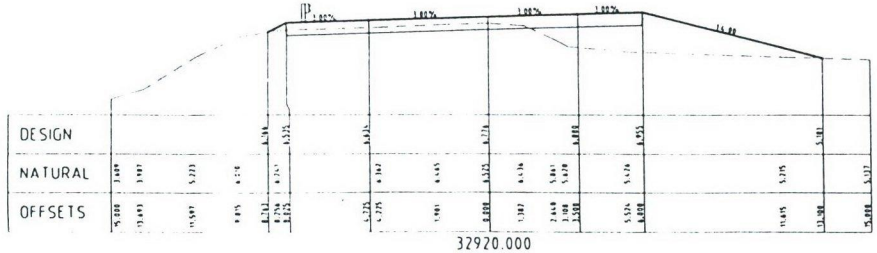

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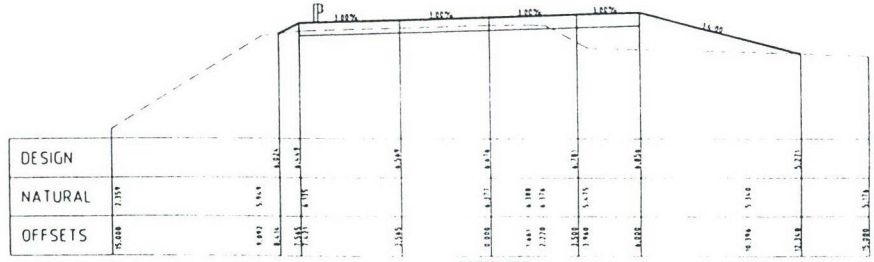

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ROAD CROSS SECTIONS - PACIFIC HIGHWAY

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PRELIMINARY NOT FOR CONSTRUCTION

CODE	DATE	DESCRIPTION	PROJ SUP
B	3.7.96	TO RTA	
A	24.11.95	FIRST ISSUE	

ISSUES

DRG No. TITLE

REFERENCE DRAWINGS

2 0 2 4 6
SCALE OF METRES

CODE	DATE	DESCRIPTION	DRAFT	DES	PROJ SUP
B	3.7.96	REVISED LAYOUT & GRADING			
A	24.11.95	FIRST ISSUE			

REVISIONS AND APPROVALS

DESIGN
DESIGN CHECK
DRAWN
DRAFTING CHECK
CHIEF DRAFTSMAN

DATE

SCALES
AS SHOWN
CAD FILE 6802AG
PLOT SCALE 11

TECHNICAL APPROVAL
PROJECT APPROVAL
CLIENT APPROVAL

DATE

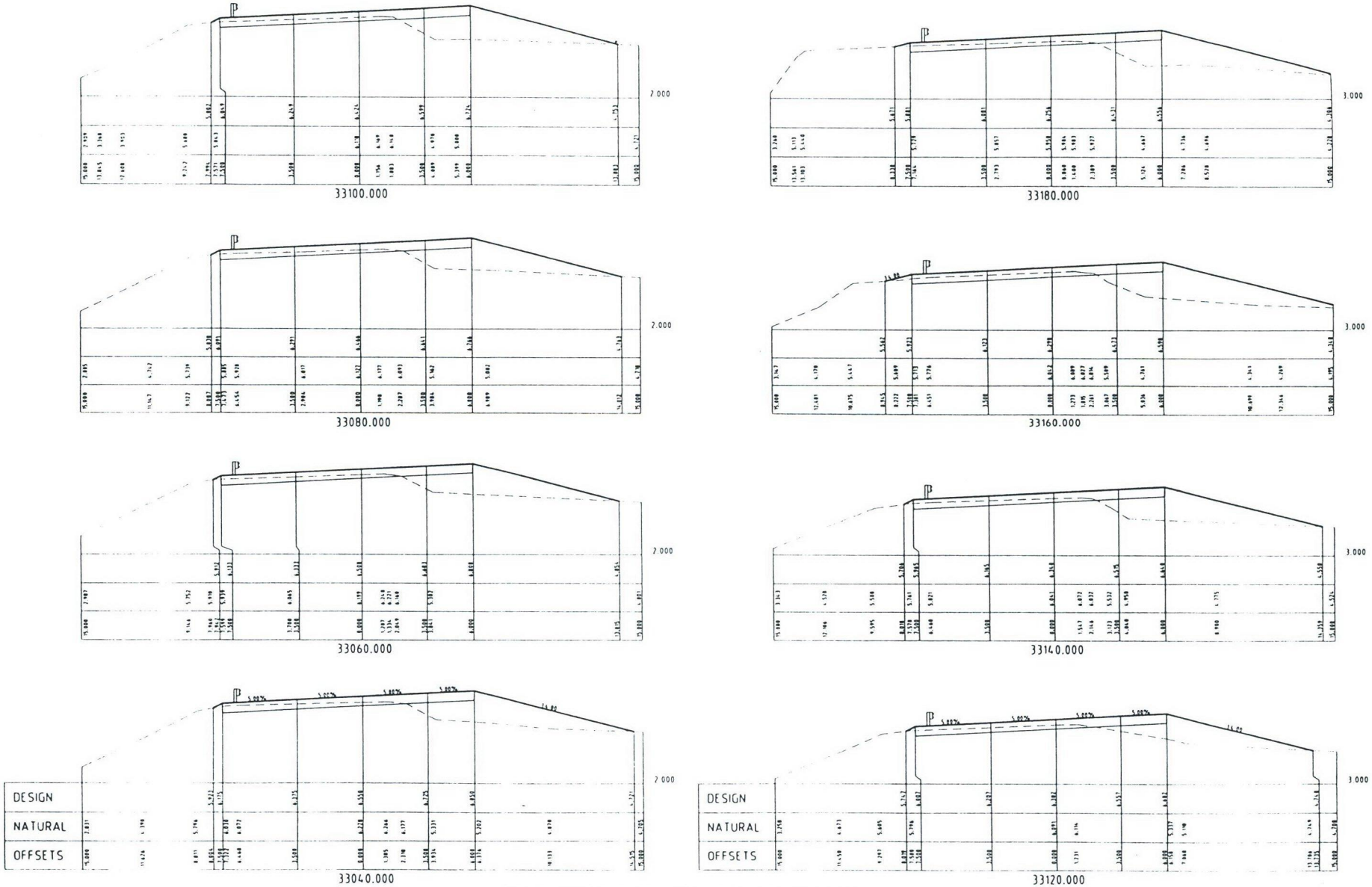
KINHILL CAMERON McNAMARA
Kinhill Pty Ltd A.C.N. 007 660 317

RTA

ROADS AND TRAFFIC AUTHORITY
STATE HIGHWAY NO. 10 - PACIFIC HIGHWAY
32.5km TO 33.9km NORTH OF GRAFTON
TYNDALE REALIGNMENT
ROAD CROSS SECTIONS - HIGHWAY
SHEET 4 OF 10

DRAWING NUMBER
BC7802-01-C-DK-007

REVISION CODE
B



ROAD CROSS SECTIONS - PACIFIC HIGHWAY

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PRELIMINARY NOT FOR CONSTRUCTION

CODE	DATE	DESCRIPTION	PROJ SUP
B	3.2.98	TO RTA	
A	24.11.97	FIRST ISSUE	

ISSUES

DRG No.	TITLE

REFERENCE DRAWINGS

SCALE OF METRES

CODE	DATE	DESCRIPTION	DRAFT	DES	PROJ SUP
B	3.2.98	REVISED LAYOUT & GRADING			
A	24.11.97	FIRST ISSUE			

REVISIONS AND APPROVALS

DESIGN	DATE	SCALES AS SHOWN	
DESIGN CHECK		CAD FILE 6802AH	
		PLOT SCALE 1:1	
DRAWN		TECHNICAL APPROVAL	DATE
DRAFTING CHECK		PROJECT APPROVAL	
CHIEF DRAFTER		CLIENT APPROVAL	

KINHILL CAMERON McNAMARA

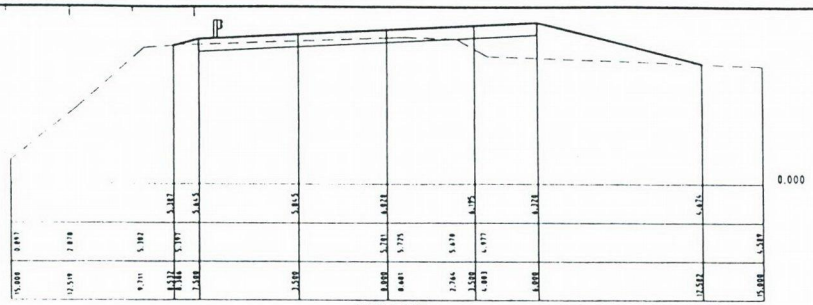
Kinhill Pty Ltd A.C.N. 007 660 317

RTA

ROADS AND TRAFFIC AUTHORITY
STATE HIGHWAY NO. 10 - PACIFIC HIGHWAY
32.5km TO 33.9km NORTH OF GRAFTON
TYNDALE REALIGNMENT
ROAD CROSS SECTIONS - HIGHWAY
SHEET 5 OF 10

DRAWING NUMBER BC7802-01-C-DK-008

REVISION CODE B



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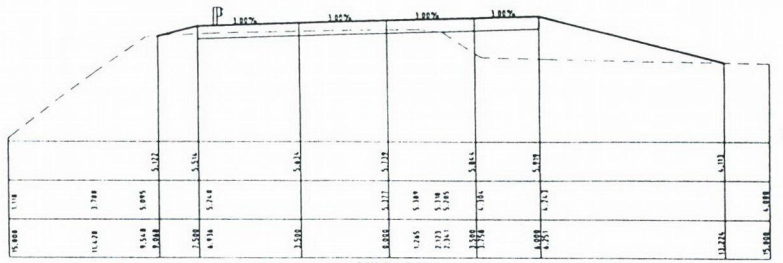

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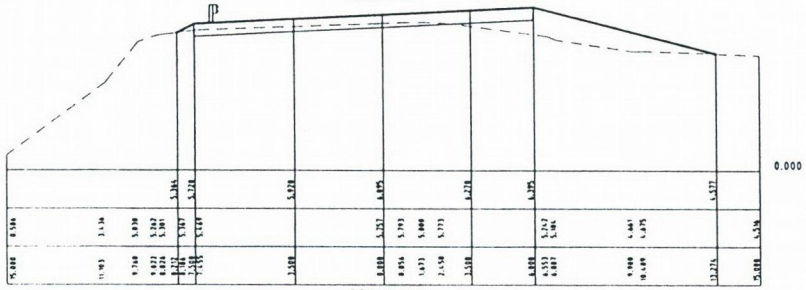

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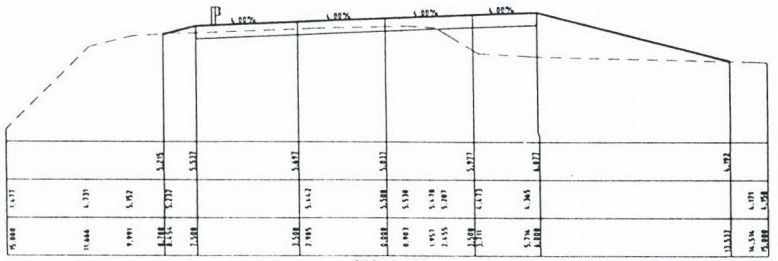

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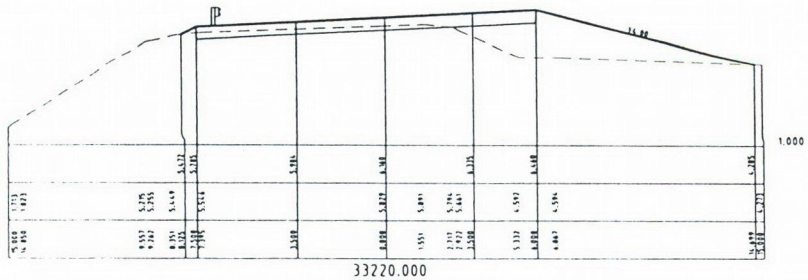

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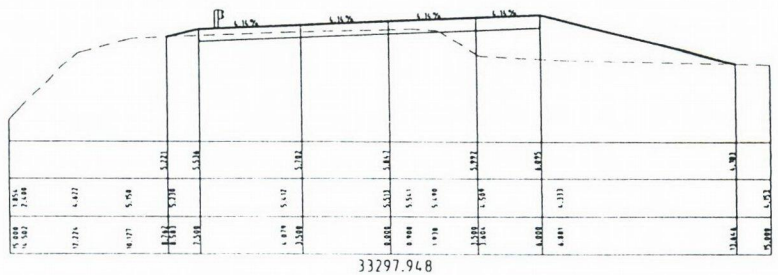

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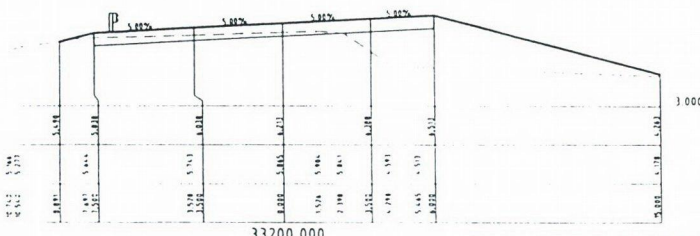

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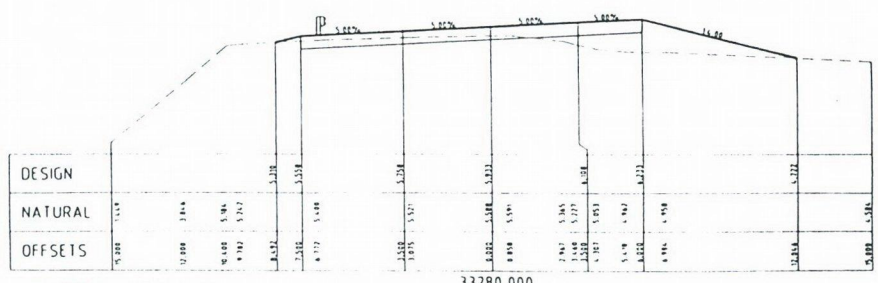

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ROAD CROSS SECTIONS - PACIFIC HIGHWAY

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PRELIMINARY NOT FOR CONSTRUCTION

CODE	DATE	DESCRIPTION	PROJ SUP
B	3 2 98	TO RTA	
A	24.11.97	FIRST ISSUE	

ISSUES

DRG No | TITLE

REFERENCE DRAWINGS

2 0 2 4 6
SCALE OF METRES

CODE	DATE	DESCRIPTION	DRAFT	DES	PROJ SUP
B	3 2 98	REVISED LAYOUT & GRADING			
A	24.11.97	FIRST ISSUE			

REVISIONS AND APPROVALS

DESIGN	DATE	SCALES AS SHOWN
DESIGN CHECK		CAD FILE 6802A1
		PLOT SCALE 1:1
DRAWN		TECHNICAL APPROVAL / DATE
DRAFTING CHECK		PROJECT APPROVAL
CHIEF DRAFTER		CLIENT APPROVAL

KINHILL CAMERON McNAMARA

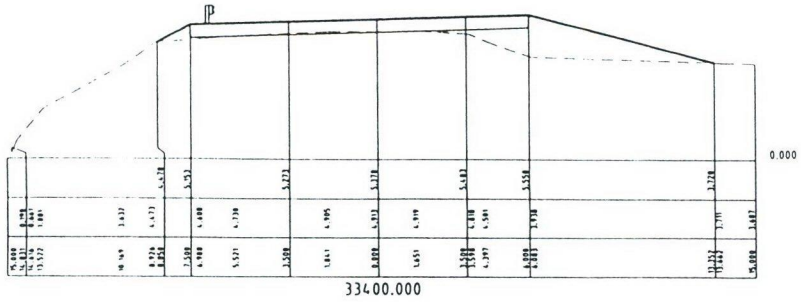
Kinhill Pty Ltd A.C.N. 007 660 317

RTA

ROADS AND TRAFFIC AUTHORITY
STATE HIGHWAY NO. 10 - PACIFIC HIGHWAY
32.5km TO 33.9km NORTH OF GRAFTON
TYNDALE REALIGNMENT
ROAD CROSS SECTIONS - HIGHWAY
SHEET 6 OF 10

DRAWING NUMBER: BC7802-01-C-DK-009

REVISION CODE: B



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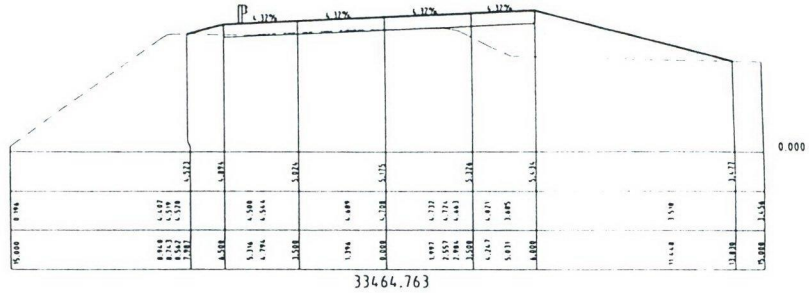

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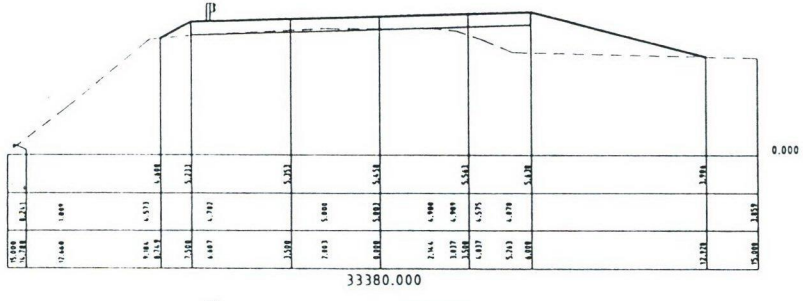

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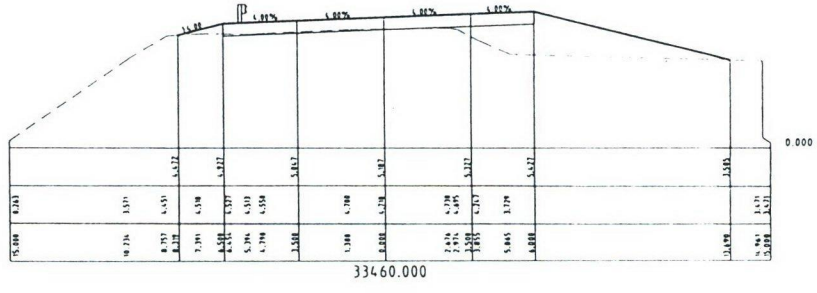

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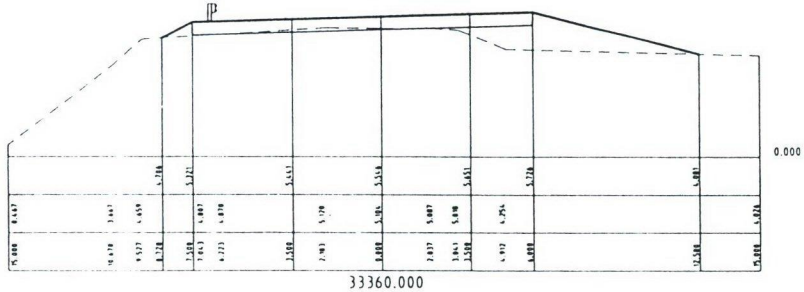

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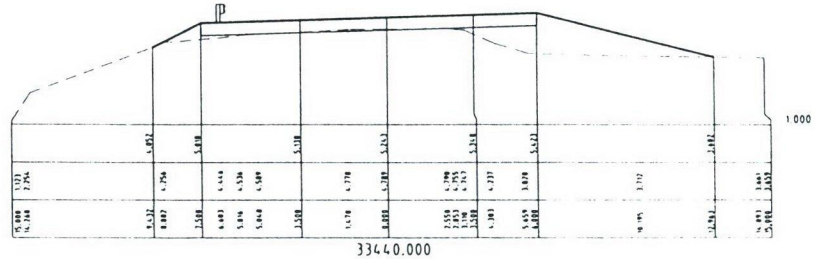

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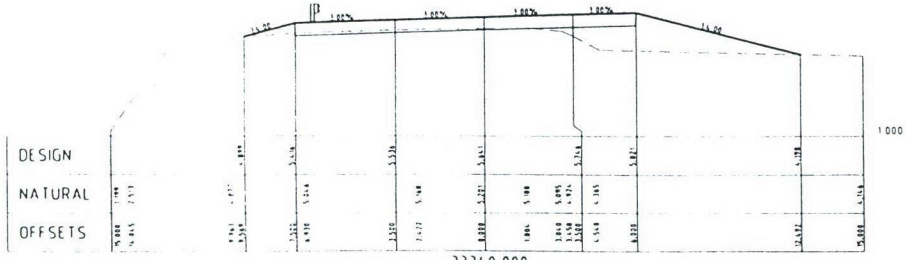

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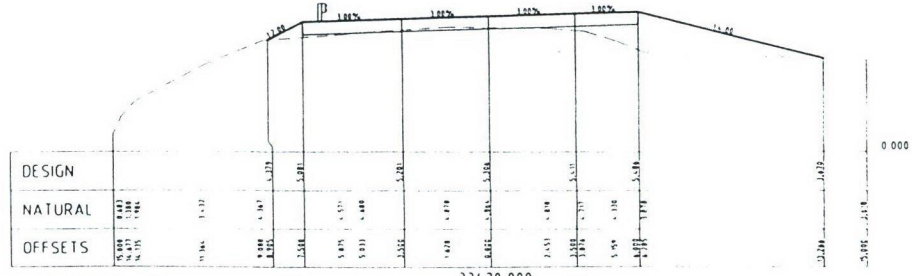

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ROAD CROSS SECTIONS - PACIFIC HIGHWAY

PRELIMINARY NOT FOR CONSTRUCTION

CODE	DATE	DESCRIPTION	PROJ SUP
B	3 2 98	TO RTA	
A	24.11.97	FIRST ISSUE	

ISSUES

REFERENCE DRAWINGS

SCALE OF METRES

CODE	DATE	DESCRIPTION	DRAFT	DES	PROJ SUP
B	3 2 98	REVISED LAYOUT & GRADING			
A	24.11.97	FIRST ISSUE			

REVISIONS AND APPROVALS

DESIGN	DATE	SCALES AS SHOWN
DESIGN CHECK		CAD FILE 6802AJ
DRAWN		PLOT SCALE 1:1
DRAFTING CHECK		TECHNICAL APPROVAL / DATE
CHIEF DRAFTER		PROJECT APPROVAL
		CLIENT APPROVAL

KINHILL CAMERON McNAMARA

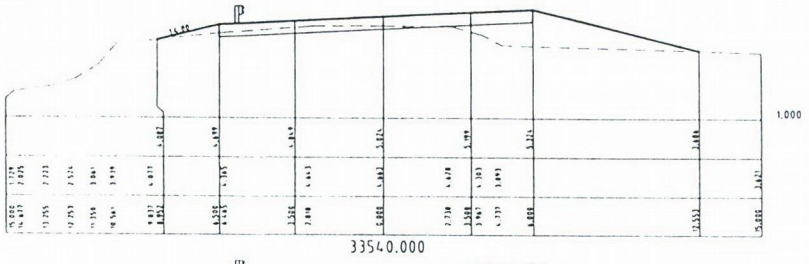
Kinhill Pty Ltd A.C.N. 007 660 317

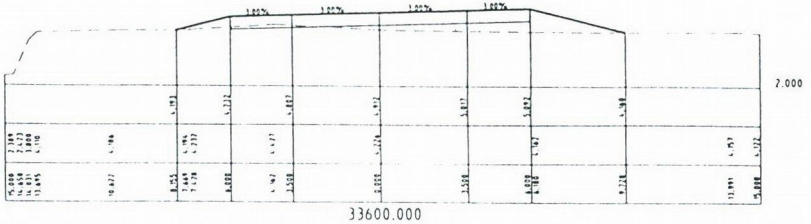
RTA

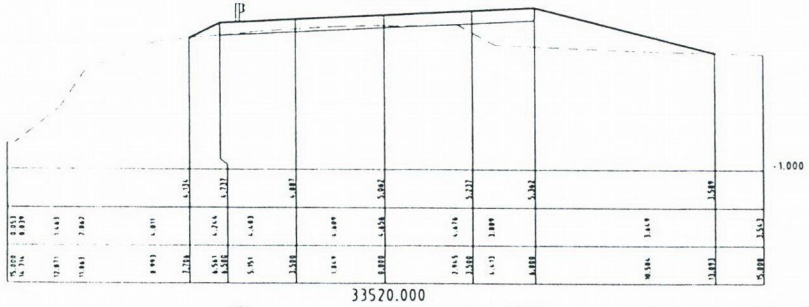
ROADS AND TRAFFIC AUTHORITY
STATE HIGHWAY NO. 10 - PACIFIC HIGHWAY
32.5km TO 33.9km NORTH OF GRAFTON
TYNDAYE REALIGNMENT
ROAD CROSS SECTIONS - HIGHWAY
SHEET 7 OF 10

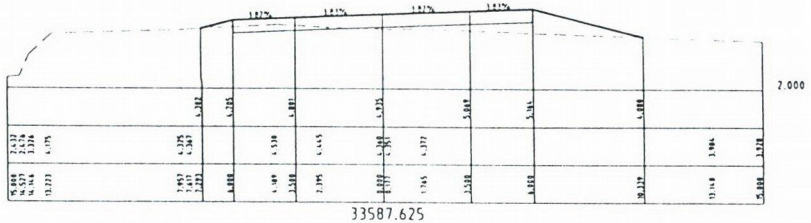
DRAWING NUMBER: BC7802-01-C-DK-010

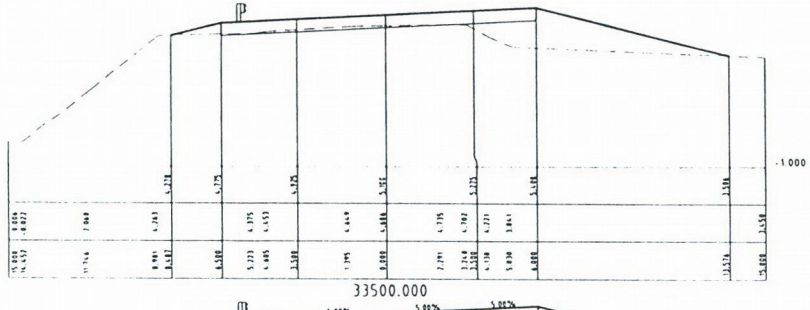
REVISION CODE: B

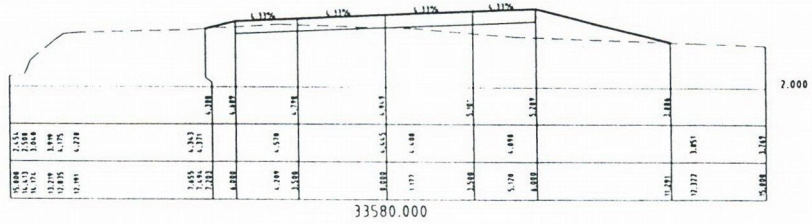


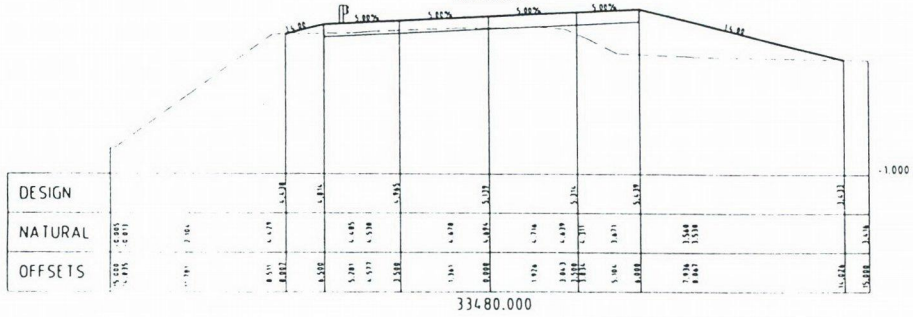


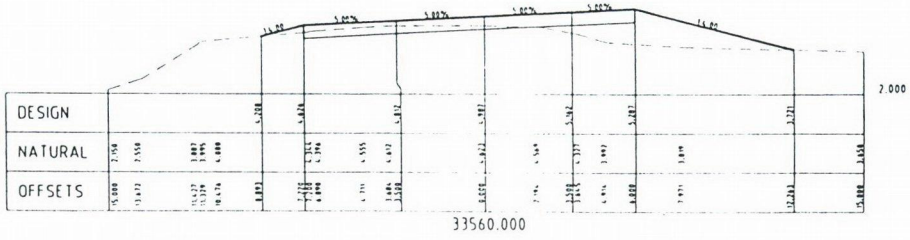












ROAD CROSS SECTIONS - PACIFIC HIGHWAY

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PRELIMINARY NOT FOR CONSTRUCTION

CODE	DATE	DESCRIPTION	PROJ SUP
B	0 2 96	TO RTA	
A	24.11.95	FIRST ISSUE	

ISSUES

DRG No. | TITLE

REFERENCE DRAWINGS

2 0 2 4 6
SCALE OF METRES

CODE	DATE	DESCRIPTION	DRAFT	DES	PROJ SUP
B	0 2 96	REVISED LAYOUT & GRADING			
A	24.11.95	FIRST ISSUE			

REVISIONS AND APPROVALS

DESIGN	DATE	SCALES AS SHOWN
DESIGN CHECK		CAD FILE 6802AK
DRAWN		PLOT SCALE 1:1
DRAFTING CHECK		TECHNICAL APPROVAL / DATE
CHIEF DRAFTER		PROJECT APPROVAL / DATE
		CLIENT APPROVAL / DATE

KINHILL CAMERON McNAMARA

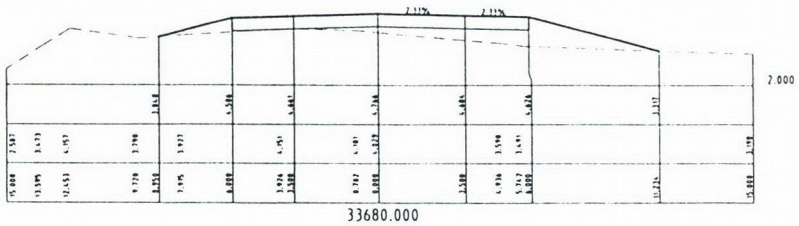
Kinhill Pty Ltd A.C.N. 007 660 317

R T A

ROADS AND TRAFFIC AUTHORITY
STATE HIGHWAY NO. 10 - PACIFIC HIGHWAY
32.5km TO 33.9km NORTH OF GRAFTON
TYNDALE REALIGNMENT
ROAD CROSS SECTIONS - HIGHWAY
SHEET 8 OF 10

DRAWING NUMBER: BC7802-01-C-DK-011

REVISION CODE: B



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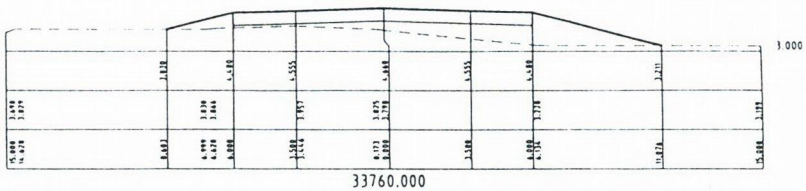

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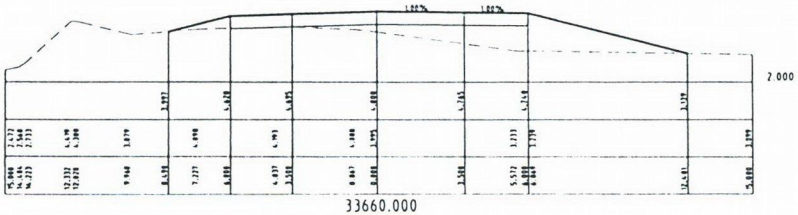

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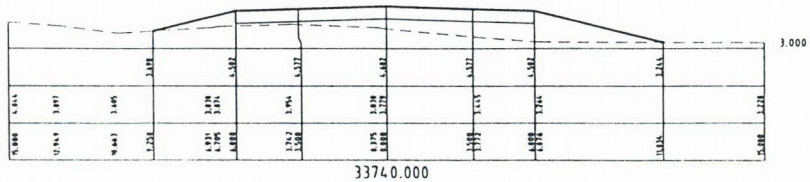

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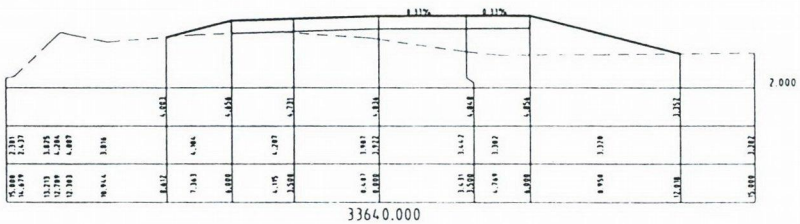

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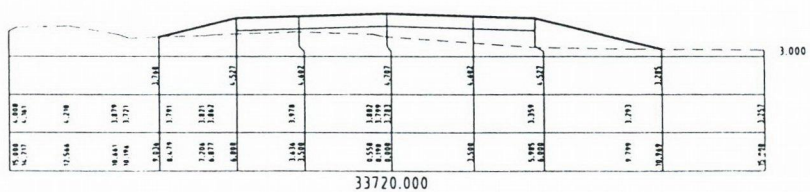

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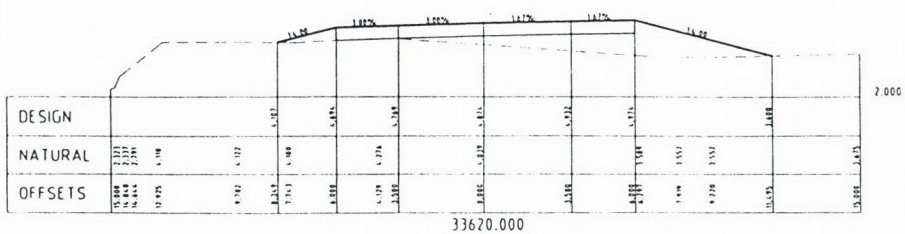

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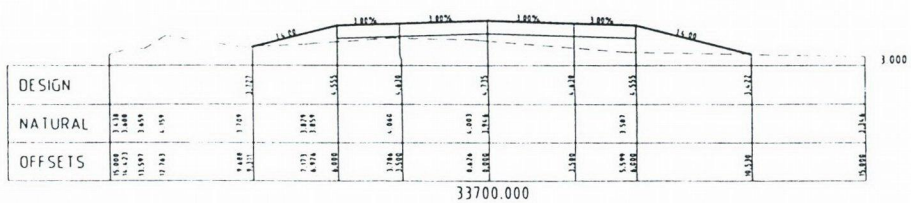

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ROAD CROSS SECTIONS - PACIFIC HIGHWAY

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KINHILL CAMERON McNAMARA

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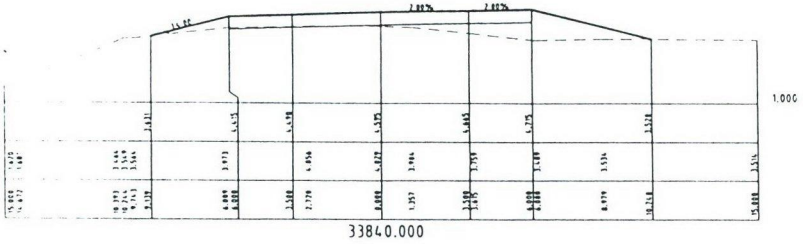
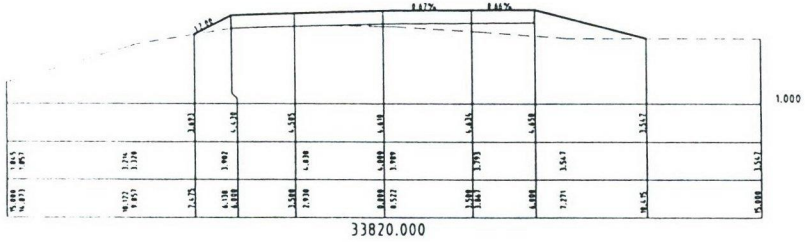
RTA

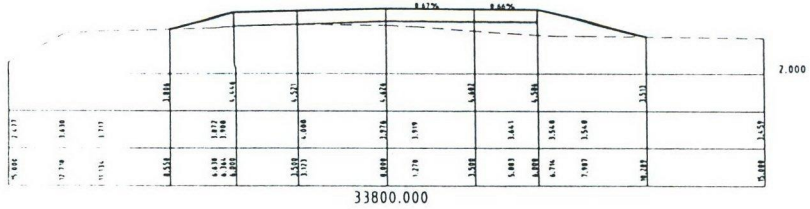
ROADS AND TRAFFIC AUTHORITY
STATE HIGHWAY NO. 10 - PACIFIC HIGHWAY
32.5km TO 33.9km NORTH OF GRAFTON
TYNDALE REALIGNMENT
ROAD CROSS SECTIONS - HIGHWAY
SHEET 9 OF 10

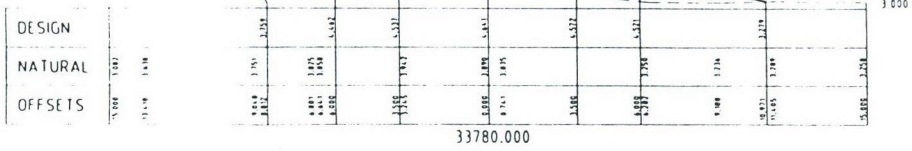
DRAWING NUMBER: BC7802-01-C-DK-012

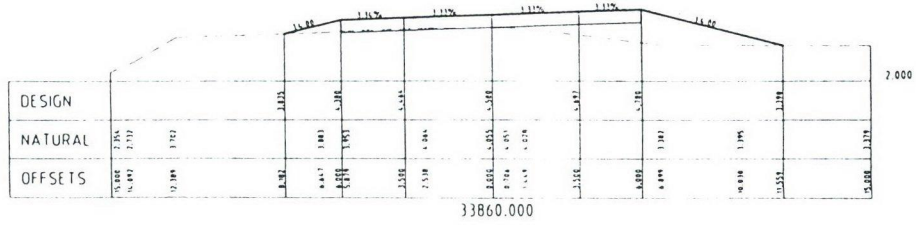
REVISION CODE: B

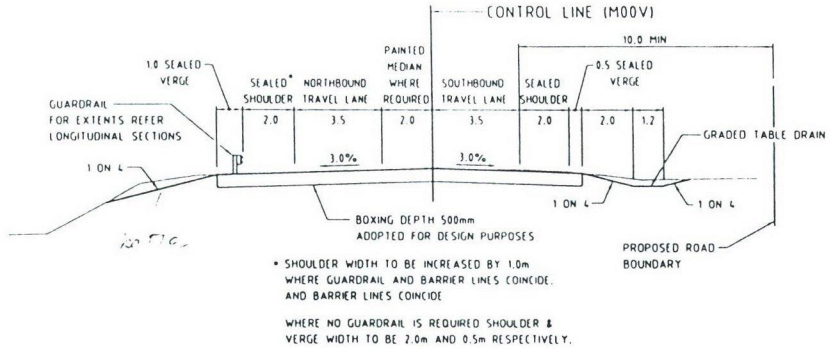












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TYPICAL CROSS SECTION

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ROAD CROSS SECTIONS - PACIFIC HIGHWAY

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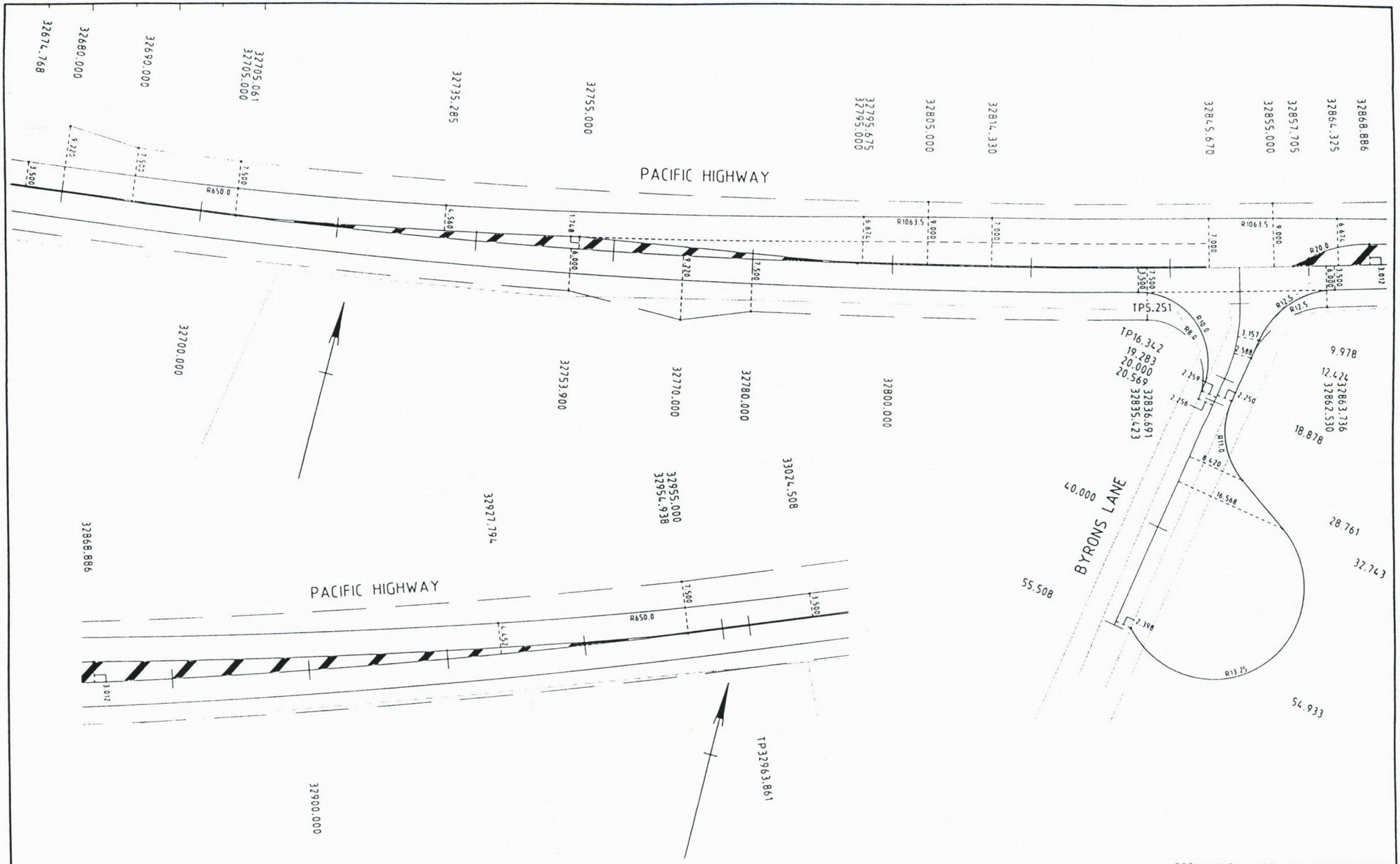
RTA

ROADS AND TRAFFIC AUTHORITY
STATE HIGHWAY NO. 10 - PACIFIC HIGHWAY
32.5km TO 33.9km NORTH OF GRAFTON
TYNDALE REALIGNMENT
ROAD CROSS SECTIONS - HIGHWAY
SHEET 10 OF 10

DRAWING NUMBER: BC7802-01-C-DK-013

REVISION CODE: B



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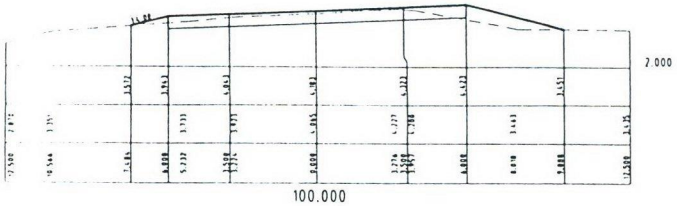
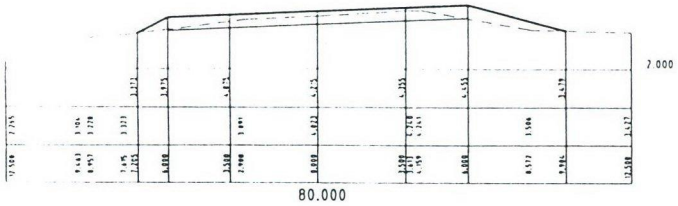
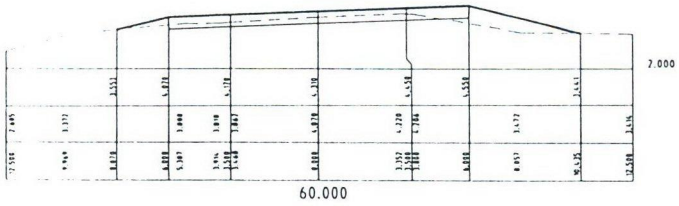
ROADS AND TRAFFIC AUTHORITY
STATE HIGHWAY NO. 10 - PACIFIC HIGHWAY
32.5km TO 33.9km NORTH OF GRAFTON
TYNDALE REALIGNMENT
INTERSECTION DETAIL

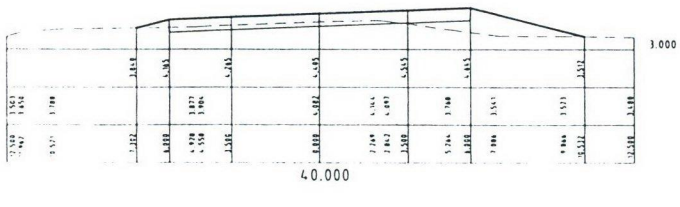
DRAWING NUMBER BC7802-01-C-DK-014

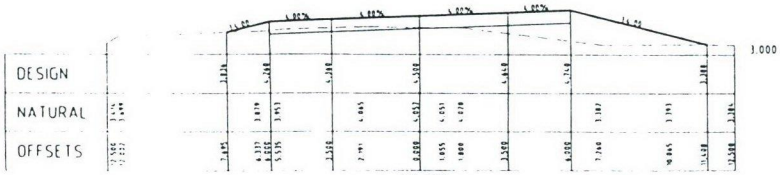
REVISION CODE B











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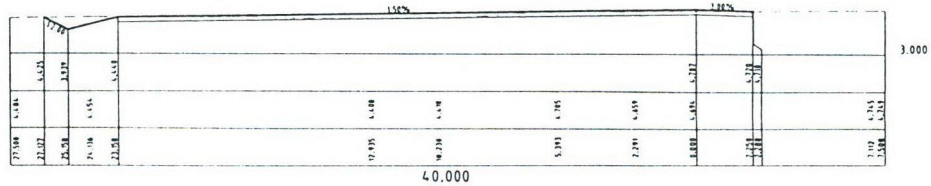

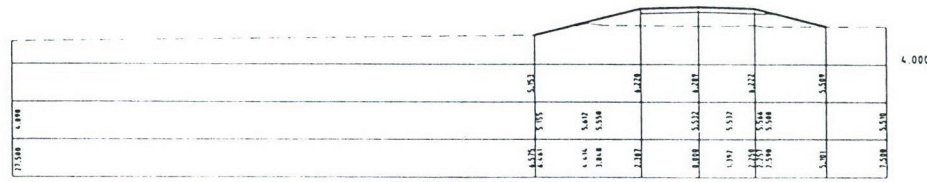

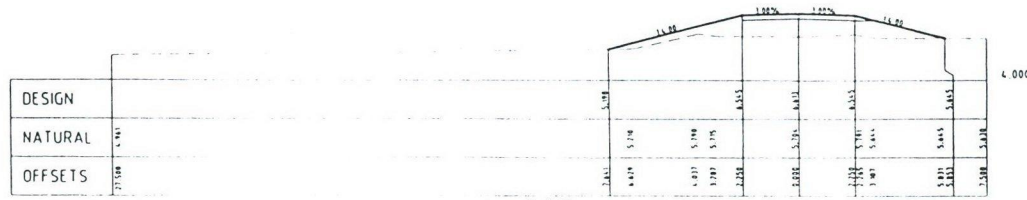

ROAD CROSS SECTIONS - BYRONS LANE

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RTA

ROADS AND TRAFFIC AUTHORITY
STATE HIGHWAY NO. 10 - PACIFIC HIGHWAY
32.5km TO 33.9km NORTH OF GRAFTON
TYNDALE REALIGNMENT
ROAD CROSS SECTIONS
SHEET 1 OF 1

DRAWING NUMBER: BC7802-C-DK-017

REVISION CODE: A

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APPENDIX Q

PRELIMINARY CONTAMINATED SITE ASSESSMENT

Appendix Q

Preliminary contaminated site assessment

INTRODUCTION

A preliminary contaminated site investigation has been conducted along a 1.3 km length of the Pacific Highway in northern New South Wales, which forms the Southern Section of the Byrons Lane to Shark Creek crossing corridor. This investigation forms part of the Review of Environmental Factors (REF) being conducted on behalf of the New South Wales Road Traffic Authority.

METHODOLOGY

Overview

The purpose of the investigation was to identify the location, nature and potential risk of possible contaminant sources along the proposed route. A sampling and analysis program was not included in the preliminary scope of works.

The assessment focussed on identifying potentially contaminating industries and activities which may reasonably be expected in the local area. This included; broadacre agriculture, cattle dips, service stations, automotive workshops, waste disposal areas, underground storage tanks, storage sheds and animal husbandry.

Current land usage

An assessment of the current land usage along the corridor was compiled from the following sources:

- A review of available mapping and aerial photography, including;

Map Type	Scale	Details	Date
Topographic	1 : 25 000	Tynedale 9538-IV-N	1983
Cadastral	1 : 25 000	Byron Shire	1991
Agricultural land use and cattle dip locations	1 : 58 000	NSW Agriculture	1997
Aerial photograph	1: 5000	NSW RTA	1996
Vegetation survey	1: 25 000		1996

- A series of field inspections and on-site investigations as follows:

Name	Organisation	Expertise
Mr Alan Goodwin	Kinhill	Water Quality Assessment
Mr Ian Smith	Kinhill	Acid Sulphate Soils Assessment
Mr Aaron Becket	Golders	Geotechnical Investigation
Mr Mike Olsen	Specialist Subconsultant	Flora Assessment
Mr Frits Kamst	Kamst and Simpson	Noise Assessment

Historical land usage

As limited documentation was available, an overview of the area's historical land usage was compiled primarily from anecdotal information. This included discussions with technical personnel with specialist knowledge of the proposed corridor, and local residents and business operators familiar with the local land use.

Personnel interviews were conducted with the following individuals:

Name	Organisation	Expertise
Mr George Natase	NSW Agriculture	Cattle dip locations
Mrs Chris Forrester	Community individual	Resident (19 years)
Mrs Margaret Moloney	Community individual	Resident (39 years)

ENVIRONMENTAL OVERVIEW

Site description

The upgrade works are proposed for an existing 1.3 km section of the Pacific Highway in northern NSW, which forms the Southern Section of the Byrons Lane to Shark Creek crossing corridor. The corridor runs parallel to the South Arm Clarence River, typically 10 - 15 m from the eastern bank. The surrounding land is relatively flat at approximately 5.0 m AHD, with a slight grading towards the river.

Historical overview

Land holdings in the Tynedale area were associated with the first phase of settlement of the Clarence around 1838, predominantly for the purpose of cedar logging. Subsequent settlement and establishment of small farm holdings occurred from 1854 through the late 1860's. These small farm holdings may have been associated with a mix of cattle grazing, wheat farming and sugar cane growing. Local residents report that the area was comprised predominantly of small dairy farms during the period 1930 to 1970 when a gradual shift to sugar cane production commenced. This has remained the dominant agricultural activity in the area to this day.

Activity description

The land to the south and east of the river and road corridor is dominated by cane farms and the associated residential properties. The properties typically comprise a main house and several moderately sized storage and utility sheds. A number of the properties may conduct limited non-commercial maintenance works for on-site vehicles and farm equipment. It is reported however, that the majority of farm equipment is maintained at the Harwood Island centre, where appropriate facilities are available. It is possible that farm properties may store limited quantities of fuel and oil on site, although no evidence of above or below ground storage tanks was identified during the preliminary survey.

It was confirmed during the preliminary survey and reported by local residents that there were no dips in the vicinity of the proposed road corridor. However, McGraths Dip, a former arsenic cattle dip, is located approximately 280m south of the existing Pacific Highway alignment, adjacent to the western side of Byrons Lane. This dip was emptied and closed in 1970 and the dip run has been filled. The fencing and infrastructure surrounding the dip are intact. The dip has not been remediated.

Current farming activities involve the application of a number of chemicals during the agricultural cycle. The following chemicals are reported by residents to be used in the area:

- Urea
- Atrazine
- Gramoxone
- Wetter or surfactants for spray application enhancement

- Amacide (2,4,D)
- Diuron.

These compounds are applied for soil conditioning and pest control purposes once annually. There is no aerial application, spraying being undertaken at ground level. Crop spraying with these compounds has been reported to have commenced only recently in 1992. The cane farms contain numerous large irrigation drains, some of which discharge either directly or indirectly to the adjacent river.

There are no other known industries or potentially contaminating activities conducted in this area.

PRELIMINARY ASSESSMENT

The following earthworks are proposed along the corridor:

- Widening the existing carriageway, including shoulder widening
- Improving the intersection with Byrons Lane.

The Byrons Lane realignment corridor is located within a rural environment, dominated by cane plantations to the east and the South Arm Clarence River to the west.

It is possible that unidentified cattle dips associated with the former dairy farms, may exist in the general area. However, no additional dip locations or additional details have been identified by this investigation which present an impact on the proposed road corridor.

The preliminary investigation did not identify the presence of any significant potential contaminant sources within the proposed road corridor. It is considered unlikely that appreciable soil contamination has occurred within the highway corridor and further investigations are not deemed necessary.

It is possible that minor contamination of the corridor has occurred through more indirect mechanisms. This may have resulted from the transport of contaminants in surface runoff from neighbouring contaminated areas. The predominant contaminant sources adjacent to the highway corridor are the broadacre agricultural areas where soil conditioning and pest control chemicals have been applied. As the large scale application of these compounds has only recently occurred, it is anticipated that the concentration of any contaminants transported by this mechanism would be very small.

The potential for soil contamination within the proposed corridor is not considered to represent a significant risk to the environment or to human health and safety. The study area is considered suitable for its proposed land use, from a contaminated site perspective.

CONTINGENCY PROCEDURES

It is considered unlikely that contaminated material is present within the proposed extent of the Byrons Lane section of the corridor. The following guidelines are provided to help ensure best practice environmental management during construction. A site specific Management Plan will be developed in the event that a significant contaminant source is identified.

- Daily visual monitoring of the excavation areas will be conducted during construction.
- Specific observations with regard to the detection of stained soil, buried waste material or unusual odours will be reported to the Site Supervisor.
- Samples of suspected contaminated material will be obtained as necessary and forwarded to a NATA registered laboratory for analysis.
- Reference will be made to the ANZECC *Guidelines for the Assessment and Management of Contaminated Sites,* in determining the severity of any identified contamination and the appropriate level of action.
- Suspected contaminated material will not be removed from the site, without prior discussions with the NSW Regional EPA