625.711.3
PR14
V.2.c.

STATE HIGHWAY NO. 1 - PRINCES HIGHWAY

TOMERONG BY-PASS



Working Papers

[V.2]

Prepared for:

RTA

Roads and Traffic Authority

By:
Mitchell McCotter
Rosylyn Muston & Associates

625.711.3
PR.14
V.2.C

WORKING PAPERS

TABLE OF CONTENTS

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8.0 APPENDICES

8.1 DIRECTORS REQUIREMENTS AND AUTHORITY RESPONSES

8.1.1 Requirements of Director of Planning

8.1.2 Responses from Authority Consultations

8.2 VISUAL

8.2.1 Excerpts from Illawarra Region Landscape and Environment Study (DEP 1986)

8.2.2 Visual and Landscape Study by Land Systems EBC

8.3 FLORA AND FAUNA

Survey Report by Roslyn Muston and Associates

8.4 ARCHAEOLOGY

8.4.1 Archaeological Survey by Margrit Koettig

8.4.2 Report on Test Excavations by Rex Silcox

8.4.3 Archaeological Assessment by Kerry Navin

8.5 NOISE

Impact Assessment by Renzo Tonin and Associates

8.6 STUDY TEAM

ROADS & TRAFFIC AUTHORITY
HEAD OFFICE
LIBRARY
NOV 90

8.1 DIRECTORS REQUIREMENTS AND AUTHORITY RESPONSES

8.1.1 Requirements of Director of Planning

New South Wales Government

Department of Planning

Remington Centre
175 Liverpool Street, Sydney 2000
Box 3927 G.P.O. Sydney 2001
D.X. 15 Sydney

Telephone: (02) 266 7111 Ext 7260
Fax No (02) 266 7599

Contact: M Vincent

Our reference 89/2905

Your reference SEP/404.1397

RTA
PO Box K198
HAYMARKET NSW 2000 200

Dear Sir,

Proposed Tomerong Bypass, Princes Highway
City of Shoalhaven

Thank you for your letter of 8 February, 1990 indicating that you are consulting with the Director with regard to the preparation of an environmental impact statement (EIS) for the above development.

2. It is apparent from your letter that part of the development would affect lands outside of existing road reservations and that Shoalhaven City Council has indicated support for rezoning of such lands. It would appear that that component of the proposal which would be located outside the road reservation would require development consent, but would not be designated pursuant to Schedule 3 of the Environmental Planning and Assessment Regulation, 1980.

3. On the basis of your consultation, an EIS is required to be prepared where the proposal is an activity referred to in Section 112(1) of the Environmental Planning and Assessment Act, 1979. The EIS shall bear a certificate required by clause 59 of the Regulation (see Attachment No 1).

4. In addition, pursuant to clause 58 of the Regulation, the Director requires that the following matters be specifically addressed in the EIS:

(i) Consideration of environmental pollution potential having particular regard to noise, water and air pollution and visual impact. Safeguards to minimise such impacts should be quantified when assessing the merits of their application.

(ii) Assessment of the proposal in relation to Illawarra Regional Environmental Plan No. 1, clause 18 - Landscape and Environment Study.

(iii) In preparing your EIS you should consult with the following Authorities and include in the EIS copies of any comment or advice received in respect of this proposal:

- Department of Agriculture and Fisheries
- Forestry Commission of NSW
- Soil Conservation Service
- State Pollution Control Commission

5. Attachment No 2 is a guide to the type of information most likely to be relevant to the development you propose; not all of the matters raised therein may be appropriate for consideration in the EIS for your proposal; equally, the guide is not exhaustive.

6. When an adequate EIS has been prepared for the subject proposal, as nominated determining authority, you should then proceed with the matter in accordance with Sections 112 and 113 of the Act, and place the document on public exhibition. The procedures for public display that are to be followed by the proponent and/or determining authority are as in clauses 60 to 64 of the Environmental Planning and Assessment Regulation, 1980.

7. When the EIS is completed, four (4) copies should be forwarded to the Secretary, Attention: Manager, Assessment Branch pursuant to Section 112(2) of the Act, as well as details of the exhibition period and public display locations.

8. The nominated determining authority should also note that section 113 of the Environmental Planning and Assessments Act, 1979, and clause 61 of the associated Regulation, requires that the EIS be made available for inspection at the same time in the offices of the determining authority and the Department as well as any other agencies nominated by them. To ensure that simultaneous exhibition occurs, you should forward the necessary documents to the Department prior to the commencement of the public display period. This will enable concurrent exhibition in the Department's head office and the relevant regional office where appropriate.

9. Should any submissions be made during the period of public exhibition, it is advised that such submissions should be forwarded to the Secretary in accordance with Section 113(3) of the Act.

10. If the determining authority has not received a reply within 21 days of sending submissions to the Secretary, it should proceed to determine the matter. The Department will only contact the determining authority after the receipt of submissions if an issue of major significance is involved.

11. If there is no objection to the proposed development as a result of the exhibition, the determining authority may determine the matter at any time after the last day upon which submissions are accepted.

12. It would be appreciated if a copy of the determination could be forwarded to the Department for our information.

13. Should you require any further information regarding this matter please do not hesitate to contact us again.

Yours faithfully

B Adams 23/2/90

B Adams
Manager, ASSESSMENTS BRANCH
As Delegate for the Director

DEPARTMENT OF PLANNING
ATTACHMENT NO. 1

STATUTORY REQUIREMENTS FOR ENVIRONMENTAL IMPACT STATEMENTS.

In accordance with Part V of the Environmental Planning and Assessment Act, 1979, an environmental impact statement (EIS) must meet the following requirements.

Pursuant to clause 57 of the Environmental Planning and Assessment Regulation, 1980, as amended:

(1) An environmental impact statement referred to in section 112 (1) of the Act shall be prepared in written form and shall be signed by the person who has prepared it.

(2) The contents on an environmental impact statement referred to in subclause (1) shall include the following matters:-

(a) a full description of the proposed activity;

(b) statement of the objectives of the proposed activity;

(c) a full description of the existing environment likely to be affected by the proposed activity, if carried out;

(d) identification and analysis of the likely environmental interactions between the proposed activity and the environment;

(e) analysis of the likely environmental impacts or consequences of carrying out the proposed activity (including implications for use and conservation of energy);

(f) justification of the proposed activity in terms of environmental, economic and social considerations;

(g) measures to be taken in conjunction with the proposed activity to protect the environment and an assessment of the likely effectiveness of those measures;

(g1) details of energy requirements of the proposed development and measures to be taken to conserve energy;

(h) any feasible alternatives to the carrying out of the proposed activity and the reasons for choosing the latter;

(i) consequences of not carrying out the proposed activity.

The EIS must also take into account any matters required by the Director of Planning pursuant to clause 58 of the Regulation, which may be included in the attached letter.

The EIS must bear a certificate as required by clause 59 of the Regulation.

1. Description of the proposal.

The description of the proposal should provide general background information on the location of the proposed road works, particularly in relation to, and compatibility with, the arterial and local road network and any traffic management schemes in force or proposed and including the criteria used for route selection. It should provide an indication of adjacent developments, and land use activities, as well as details of the site, land tenure, zonings and relevant forward planning proposals, and any other land use constraints including natural environmental features sensitive to the impact of the proposal.

It may also be appropriate for the EIS to describe statutory procedures for implementing the proposal.

This section should provide specific information on the nature, intent and form of the development. Particular details that may generally be relevant include:

- The form and physical dimensions of the proposed roadworks, including locations and dimensions of bridge structures and associated facilities.
- Earthworks involved including details of cut and fill and balancing of volumes proposed.
- Presence of median strips, barriers to pedestrians, and grade separation proposals at intersecting roads.
- Provision of facilities for faunal corridors.
- Flood prevention measures.
- Alterations to access to adjoining properties.
- Resumptions required of existing development to accommodate the proposed road.
- Construction problems envisaged including staging of works, source and transport and assembly of plant and materials, employment details, construction camps, access arrangements, alternative routes and traffic management proposals for local and through traffic, and hours of operation for demolition/construction works etc.
- rehabilitation proposals on completion.

2. Description of the Environment.

This section should provide details of the environment in the vicinity of the development area and also of aspects of the environment likely to be affected by any facet of the proposal. In this regard, physical, natural, social and economic aspects of the environment should be described to the extent necessary for assessment of the environmental impact of the proposed development. In particular:

- Geography, topography, geology and geotechnical data, meteorology, hydrology etc.
- Noise and air quality where appropriate for impact consideration.

- Aesthetics.
- Flora and fauna with particular regard for sensitive environments such as wetlands.
- Agricultural and mining activities that may be affected by the proposed works.
- Utilities and communications.
- Buildings or items having architectural/heritage significance.
- Existing traffic levels and traffic flow patterns.
- Socio economic aspects including local commercial activities.

3. Assessment of Alternative Routes.

The EIS should include a proper assessment of the alternative routes considered in the feasibility study for the proposal including the key physical and engineering constraints as well as the environmental and economic factors pertinent to same including clear reasons for rejecting such alternatives in favour of the recommended proposal.

4. Analysis of Environmental impacts.

Environmental impacts usually associated with a major road development in a rural/suburban environment and related activities are listed below. Where relevant to the specific proposal, these should be addressed in the EIS, taking into account the adequacy of safeguards proposed to minimise them both during construction and when in use after completion:

- Likely noise disturbance caused by the construction of the road, and by traffic operating on the completed roadway, on any nearby residential and commercial buildings. A map depicting anticipated noise contour levels in relation to residences and inhabitants involved may be necessary. Consideration should be given to both existing and proposed residential developments for such an analysis.
- Emission of air pollutants from vehicular traffic affected by the proposal, and their impact on the local and regional environment.
- Stormwater runoff and erosion and siltation potential.
- Impact on natural vegetation and faunal movement, flood plains, drainage patterns, (particularly sedimentation from construction activity).
- Mineral sterilization and subsidence potential.
- Visual impact, particularly on residential developments by both day and night taking into account the following effects of the proposed road:

  - Scale in relation to the natural landscape and adjacent residential and commercial development.
  - Appearance from nearby and afar.
  - Lighting effects on existing and proposed residential/ commercial buildings.

- Changes in traffic patterns.
- Impacts of traffic at entry/exist points.
- Impact on historic buildings, heritage items and matters of archaeological interest.
- Effect on commercial and agricultural operations and changes in community characteristics caused by severence.

In addition, any potential for hazard or risks to public safety and any proposal to monitor and reduce environmental impacts should be included.

5. Contact with relevant Government Authorities.

In preparing the EIS, it is suggested that authorities, such as those listed below, should be consulted and their comments taken into account in the EIS.

- The State Pollution Control Commission in regard to air, water and noise impacts and relevant pollution control legislation requirements.
- The Traffic Authority with regard to traffic and road development aspects.
- Any servicing authorities which may be required to supply water, power, etc.
- The Soil Conservation Service with regard to erosion control.
- The Department of Agriculture with regard to impact on agricultural activities.
- The Department of Mineral Resources with regard to mineral sterilisation and subsidence.
- The Heritage Council of NSW if the proposal is likely to affect any place or building having heritage significance for the State.
- The National Parks and Wildlife Service with regard to impact on known archaeological sites.
- Local Councils through whose areas the road passes.

It is the responsibility of the person preparing the EIS to determine those Departments relevant to the proposed development.

5. Supporting information.

The EIS should refer by suitable appendices to all relevant studies/investigations that have been carried out in support of the proposals. This supporting documentation should be made available during the period of public display of the EIS.

DEPARTMENT OF PLANNING
ATTACHMENT NO 2

ADVICE ON THE PREPARATION OF AN ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR A MAJOR ROAD DEVELOPMENT IN A RURAL/ SUBURBAN ENVIRONMENT

Pursuant to S112 of the Environmental Planning and Assessment Act, 1979, where a proposal is a prescribed activity or where a proposal is likely to significantly affect the environment, a determining authority must, before deciding whether to proceed with the proposal, consider an EIS prepared in respect of the proposal.

It is the responsibility of the determining authority to decide whether an EIS is required (unless the proposal is a prescribed activity). While the site characteristics largely determine the need for an EIS to be prepared, in general major road developments in rural/suburban environments have the potential to create problems for local residents and landholders due to land resumption, loss of access, severence effects on agricultural activities, sterilisation of minerals, noise generation, erosion and siltation; and impacts on flora and fauna, visual amenity, local and regional traffic flows, and local commercial interests.

The purpose of this paper is to outline various issues relevant to the preparation and consideration of an EIS for such major road developments. It is intended to assist the preparation of the EIS. It is the applicant's responsibility to identify and address, as fully as possible, the matters relevant to the specific development proposal in complying with the statutory requirements for EIS preparation (see Attachment No 1).

The matters nominated in this paper are not intended as a comprehensive identification of all issues which may arise in respect of such a major road development. Some of the issues nominated may not be relevant to a specific proposal. On the other hand, there may be other issues, not included, that are appropriate for consideration in the EIS.

Information provided should be clear, succinct and objective and, where appropriate, be supported by maps, plans, diagrams or other descriptive detail. The purpose of the EIS is to enable members of the public, the determining authority and the Department of Planning to properly understand the environmental consequences of the proposed development.

RECEIVED 1 9 MA. 1990

New South Wales Government

Department of Minerals and Energy

8-18 Bent Street
Sydney
Postal Address
GPO Box 5288
Sydney NSW 2001
Telex AA74875
Facsimile (02) [illegible]

Mitchell McCotter
PO Box 580
SPIT JUNCTION NSW 2088

Our reference: L90/198

Your reference: 90012LT9-HD3

For further information Greg MacRae

[illegible] 4776

Attention: Mr D. Snashall

Dear Sir

EIS FOR PRINCES HIGHWAY IMPROVEMENTS - TOMERONG BY-PASS

I refer to your letter of 5th March, 1990 seeking this Department's comments on possible sterilization of mineral resources, and possible subsidence affecting the proposed Tomerong By-Pass route.

The area covered by the various by-pass options contains no known mineral or extractive resources. The area is not affected by subsidence as it is not underlain by coal.

If you have any queries on this matter please contact Mr G. MacRae on 2310922 x 4776.

Yours faithfully

J N Cramsie
for Director-General

14 March 1990

GM/bp

RECEIVED 2 2 MAR 1990

SHOALHAVEN CITY COUNCIL

CITY ADMINISTRATIVE CENTRE
BOX 42, P.O. NOWRA, N.S.W., 2541

OUR REF.: 87/2106 AS/dmb
ENQUIRIES: Mr. A. Stasiukynas
YOUR REF.:

PHONE: (044) 21 6011
FAX: (044) 22 1816

Mr. Mitchell McCotter,
PO Box 580,
SPIT JUNCTION 2088

March 16, 1990

Dear Sir,

Re: Princes Highway Improvements - Tomerong Bypass

In response to your letter of 5th March, 1990 I note that you are investigating additional options for the Tomerong Bypass. It is also understood that an Environmental Impact Statement is being prepared. This will allow Council to fully assess the environmental impact of the various proposals.

As a prelude to this I offer the following comments.

Council supports the construction of a Bypass around Tomerong and believes it will result in significant improvements in safety, traffic flow and amenity for the village. However, the following matters should be addressed in the Environmental Impact Statement:-

1. Access to Sanctuary Point
   Council is currently carrying out investigations into the design of a new access route to the Sanctuary Point/St. Georges Basin area (see enclosed map). In conjunction with the proposed Currambene Creek crossing, this route will form a loop linking the coastal towns and villages with the Highway. The estimated future population of the Basin/Huskisson/Vincentia area is approximately 21,000 based on existing zonings. Estimated future traffic volumes on this route will be available when the proposed Traffic Study for the proposed Currambene Creek crossing is completed in approximately 2 months. In view of the importance of this new route it is considered essential that there be a direct link between the new access route to Sanctuary Point and Tomerong Bypass and that this be taken into consideration in the selection of the preferred option for the Bypass.

2. Intersection with Trunk Road 92/Main Road 267
   Council is actually promoting the reconstruction of Trunk Road 92, which if carried out will result in a significant increase in traffic volumes. I understand that the Roads & Traffic Authority proposals for this intersection is to construct a "T" intersection with the western leg of Trunk Road 92, with the eastern leg to be closed to vehicular traffic. As traffic volumes on the Trunk Road 92 are currently very low this will not cause major inconvenience. However, should Trunk Road 92 be reconstructed, substantial east west traffic will be generated.

8.1.2 Responses from Authority Consultations

SHOALHAVEN CITY COUNCIL

CITY ADMINISTRATIVE CENTRE

BOX 42, P.O. NOWRA, N.S.W., 2541

OUR REF.:
ENQUIRIES:
YOUR REF.:

PHONE: (044) 21 6011
FAX: (044) 22 1816

The design of the option selected should allow for a grade separated intersection at this location to provide for a direct link across the Bypass between Trunk Road 92/Main Road 267.

3. Pedestrian Access
   Pedestrian access along Trunk Road 92 between the Bypass and Tomerong will have to be maintained, this will require the retention and maintenance of the Tomerong Creek Bridge.

4. Options (f) and (h) appear to significantly affect several properties which form part of a rural residential subdivision off of Battunga Drive. These two route options need to be looked at very carefully to assess whether the benefits of such a route significantly outweigh the likely detrimental effects on lots in that subdivision (being lots in DP262346).

5. The land subject to the Bypass options is shown on the Illawarra Regional Environmental Plan No. 1 as having landscape or environmental attributes. Your liaison with the NSW Department of Planning should be able to further clarify that point.

I trust that the above comments are useful and we look forward to receiving a copy of the EIS for our more detailed comments.

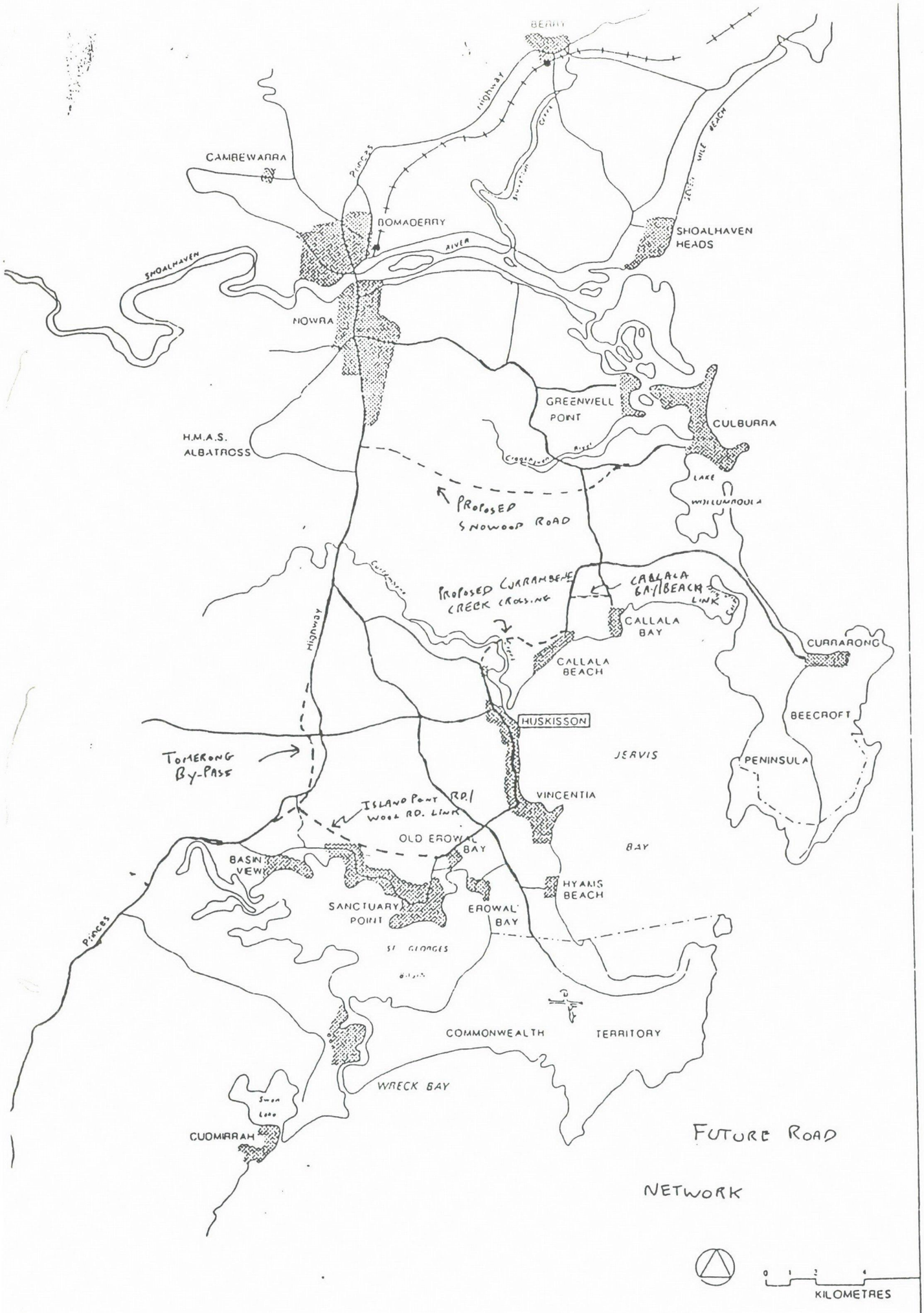
Should you require any further assistance please do not hesitate to contact the writer.

Yours Faithfully,

G. A. Napper,
TOWN CLERK

Per:

Encl. Map


BERRY
HIGHWAY
CAMBEWARRA
PRINCES
NOMADERRY
SHOALHAVEN
RIVER
SHOALHAVEN HEADS
NOWRA
GREENWELL POINT
CULBURRA
H.M.A.S. ALBATROSS
PROPOSED SNOWOOD ROAD
LAKE WOLLUMBOOLA
PROPOSED CURRAMBENE CREEK CROSSING
CALLALA BAY/BEACH LINK
CALLALA BAY
CALLALA BEACH
CURRARONG
HUSKISSON
BEECROFT PENINSULA
JERVIS BAY
TOMERONG BY-PASS
ISLAND POINT RD./ WOOD RD. LINK
VINCENTIA
OLD EROWAL BAY
BASIN VIEW
HYAMS BEACH
SANCTUARY POINT
EROWAL BAY
ST GEORGES BASIN
COMMONWEALTH TERRITORY
WRECK BAY
SWAN LAKE
CUDMIRRAH
FUTURE ROAD NETWORK
0 1 2 4
KILOMETRES

RECEIVED - 9 APR 1990

New South Wales Government

NSW Agriculture & Fisheries

Central West, South East and Illawarra Region

P.O. Box 53
ORANGE NSW 2800

Telephone: (063) 63 8250/251
Facsimile: (063) 63 8356

Mitchell McCotter,
66 Spit Road,
MOSMAN NSW 2088

Our Ref: 4E 1/4 MJN/KG
Your Ref: 90012LT4-HD3

4th April, 1990

Dear Sir,

RE: EIS for Prince Highway Improvements - Tomerong By-Pass

In confirmation of my telephone discussion with Mr David Snashall 4th April 1990, it is advised that the following matters be addressed in the Environmental Impact Study.

1. Impacts on prime crop and pasture land. These areas are specifically identified in Illawarra Rural Environmental Plan No. . Maps can obtained from our Sydney Office McKell Building, Rawson Place.

2. The hydrological impact of the alternative routes should also be considered. In this regard it is noted that Tomerong Creek will be traversed.

3. Proposed means of sedimentation and erosion control should be outlined, addressing management aspects during the construction phase.

4. Impacts on individual agricultural properties should be considered. (For example will properties be dissected? If so what arrangements can be made for stock management? What impacts will the development have on catchment for farm dams and water supplies? Will the development isolate land to the extent that it can no longer be used for agricultural purposes?)

5. Proposed methods of long term rehabilitation and stabilization should be detailed.

Yours faithfully,

for D J McDONALD
REGIONAL DIRECTOR
AGRICULTURE & FISHERIES

RECEIVED - 5 APR 1990

New South Wales Government

Forestry Commission of N.S.W.

Forestry Office
P.O. Box 25,
NOWRA. 2541.
Our reference: A99 C.COLLEY/A.W.
Your reference:
Telephone: (044) 218

Mitchell McCotter & Assoc. Pty.Ltd.
P.O. Box 580,
SPIT JUNCTION. N.S.W. 2088.

29 March, 1990.

Dear Sir,

Re; E.I.S. For Princes Highway
Improvements - Tomerong By-Pass

The delay in replying to your letter of 2 March, 1990 is regretted.

Option G and F for the Princes Highway re-alignment around Tomerong, are of particular interest to the Forestry Commission of N.S.W. Both routes traverse Compartment 204 yerriyong State Forest for approximately 0.5 km.

Both routes will pass through forest dominated by advanced regeneration of the Blackbutt and Spotted Gum forest types. The effected areas carry very small volumes of timber that would be merchantable at the present time. The primary concern to the Commission will be the loss of productive land if either proposal is shown.

The areas traversed have not been identified as having special values other than general multiple-use forestry.

Yours faithfully,

C. COLLEY
Acting District Forester

RECEIVED 2 6 APP 1990

New South Wales Government

State Pollution Control Commission

State Office Block
84 Crown Street
Wollongong 2500
P.O. Box 513 Wollongong East 2500

The Manager
Mitchell McCotter and Associates Pty Ltd
P O Box 580
SPIT JUNCTION NSW 2088
Attention: Mr David Snashall

Our Reference: 150,154 PW:DT
Your Reference:

Contact: Paul Wilkes (042) 268106
Telephone: 042 268100
268111
Facsimile: 042 268208

Dear Sir

EIS For Princes Highway Improvement
Tomerong By-pass

24 APR 1990

Thank you for your letter dated 5 March 1990 requesting the Commission's comments on the By-pass proposal.

The Commission has no concern to which option would be used for the By-pass, however, our main concern would be related to pollution caused by the construction activities. The Commission would offer the following comments:

1. Removal of trees and vegetation should be kept to a minimum. The material removed should be mulched and recycled to help re-vegetate disturbed areas.

2. Wet retention basins should be constructed to contain silt and sediments so that Tomerong Creek and its catchment remains free of pollution.

3. Silt traps and ponds should be constructed to control silt and sediments from the various stages of construction. Hay bales together with silt stop mesh should be used at the toe of cut batters to prevent silt leaving the site during periods of heavy rain and to keep large particles from the silt ponds.

4. A bunded area should be established to store fuel, oil, grease and hydraulic oils etc for the construction equipment.

5. During periods of dry weather, water carts should be used to suppress dust emission.

6. When construction activities come close to residential boundaries, time restrictions will apply. Times of operation allowed would be 7 am to 6 pm Monday to Friday and 7 am to 1 pm on Saturday. No work will be allowed on Sundays or Public Holidays. (The LA_{10} noise level measured over a period of not less than 15 minutes when construction is in operation must not exceed the background noise level by more than 10dB(A) at the nearest effected residence).

For any further information please contact the above officer.

Yours faithfully

C J WOODWARD
for Secretary

New South Wales Government

National Parks and Wildlife Service

NOWRA DISTRICT

24 Berry Street
Nowra, N.S.W. 2541

Postal Address:
P.O. Box No. 707
Nowra, N.S.W. 2541

Enquiries: RW:JH F/756

Telephone: 21 9969
Fax: 21 9971
STD: 044

The Divisional Engineer,
Roads and Transport Authority,
P.O. Box 477,
WOLLONGONG EAST. N.S.W. 2520

Dept. of Main Roads
ILLAWARRA Divn.
Received
29 NOV 1989
Acknowledged

ATTENTION: MR. LEFOE

28th November, 1989

Dear Sir,

Re: State Highway No. 1 - Prince's Highway, Tomerong Bypass
Vegetation and Fauna Survey and Impact Assessment

I refer to your meeting on 12th October, 1989, with Rod Wellington and Roslyn Muston concerning the proposed Tomerong Bypass.

The Service fully supports the environmental consultant's concerns outlined in the assessment document for the protection of the natural environment and visual amenity in the vicinity of Tomerong.

Following review of the document concerning the above matter, the Service offers the following comments:

* The Service recognises that Options F, G and H are likely to have a greater environmental effect than Options A and B, given the extensive earthworks required with construction of the bypass in the deeply dissected terrain of the two catchment areas of Tomerong Creek and Stewarts (Suffolk) Creek.

* The route of Options A and B should be selected to avoid large areas of alluvial soils and clearing large areas of riverine vegetation.

* A route to be determined where possible to avoid the stands of endangered Brush Cherry (Syzigium paniculatum).

In general the Service supports the guidelines to minimise the environmental effects outlined in the report and recommends that they be incorporated in the proposal.

I apologise for the lateness in reply. If you require any further information on that matter please contact Rod Wellington at this office.

Yours faithfully,

G. SPENCER,
Superintendent
for Director

PROJECT MANAGER

New South Wales Government

Soil Conservation Service

P.O. Box 76
Nowra 2541
Ph: 044 214860
Fax:044 221906

The Divisional Engineer
Roads & Traffic Authority
P.O. Box 477
Wollongong East
NSW 2520

Dept. of Main Roads
ILLAWARRA Divn.
Received
29 NOV 1989
Acknowledged
Replied to

28 November 1989

Contact:

Our reference:

Your reference:

Attention Mr Lefoe

RE: VEGETATION AND FAUNA SURVEY AND IMPACT ASSESSMENT - STATE HIGHWAY NO.1 - PRINCES HIGHWAY

Following recent discussions with Dr.Roslyn Muston and Mr Brian Lefoe regarding the Tomerong Bypass and Soil Conservation matters and my review of the above document, I concur with the contents of this report.

I would like to emphasise the importance of erosion and sediment control recorded in section 9 and suggest that road designers and planners pay particular attention to these guidelines. When purchasing land for the road easement, minimum batter grades of 2H:1V and associated Soil Conservation works located between the batters and the easement boundary must be allowed for.

The Soil Conservation Service has been working closely with the RTA in the design and implementation of erosion and sedimentation control works for the Mittagong Bypass. This association is producing good results in minimising the environmental effects of major road works construction. I recommend a similar arrangement between the Soil Conservation Service and the RTA be entered into in regard to the design and implementation of erosion and sedimentation control works for the Tomerong Bypass.

Yours faithfully

Noel Kesby

Noel Kesby
District Soil Conservationist
Nowra

PROJECT MANAGER

8.2 VISUAL

8.2.1 Excerpts from Illawarra Region Landscape and Environment Study (DEP 1986)

CHAPTER 11: TOMERONG-BEWONG UNIT - NO. 8

Submitted by: The National Trust.

Attributes - Environmental

* 80% of the area has native forest. The type is Wet Sclerophyll and is designated: medium-tall, medium density coastal uplands forest (4b) (see Appendix II).

* Drains into St. Georges Basin.

* Bounded on three sides by local visual horizons.

* Visual ranking mainly (and maximum of) III.

Attributes - Statutory

* The majority of the unit is privately owned - with some Crown Land and State Forest on the edges (these usually constitute individual sub-units).

* The Princes Highway, bisecting the unit, has a Non-urban 1(b) zone.

* Remainder is zoned Non-urban 1(a).

Known Potential Pressures Affecting Environmental Attributes

* Pressure associated with the Princes Highway.

* Existing major electricity transmission line running north-south through the unit.

* All of the forests in the unit have high capability for forestry.

Recommendations for Sub-Units

IIa Priority Protection

Skyline areas requiring strong protection.

IId/a Priority Protection

Skyline areas on Crown Land. Lands Department should be advised of the sub-regional importance of sub-unit and be asked to manage accordingly.

IIIa(i) Protection

Visual backdrop areas subtending a skyline. Preservation of the tree canopy is essential. Requires zoning to prohibit unsympathetic development such as large building complexes or clearing of large areas.

IIIa(ii) Protection

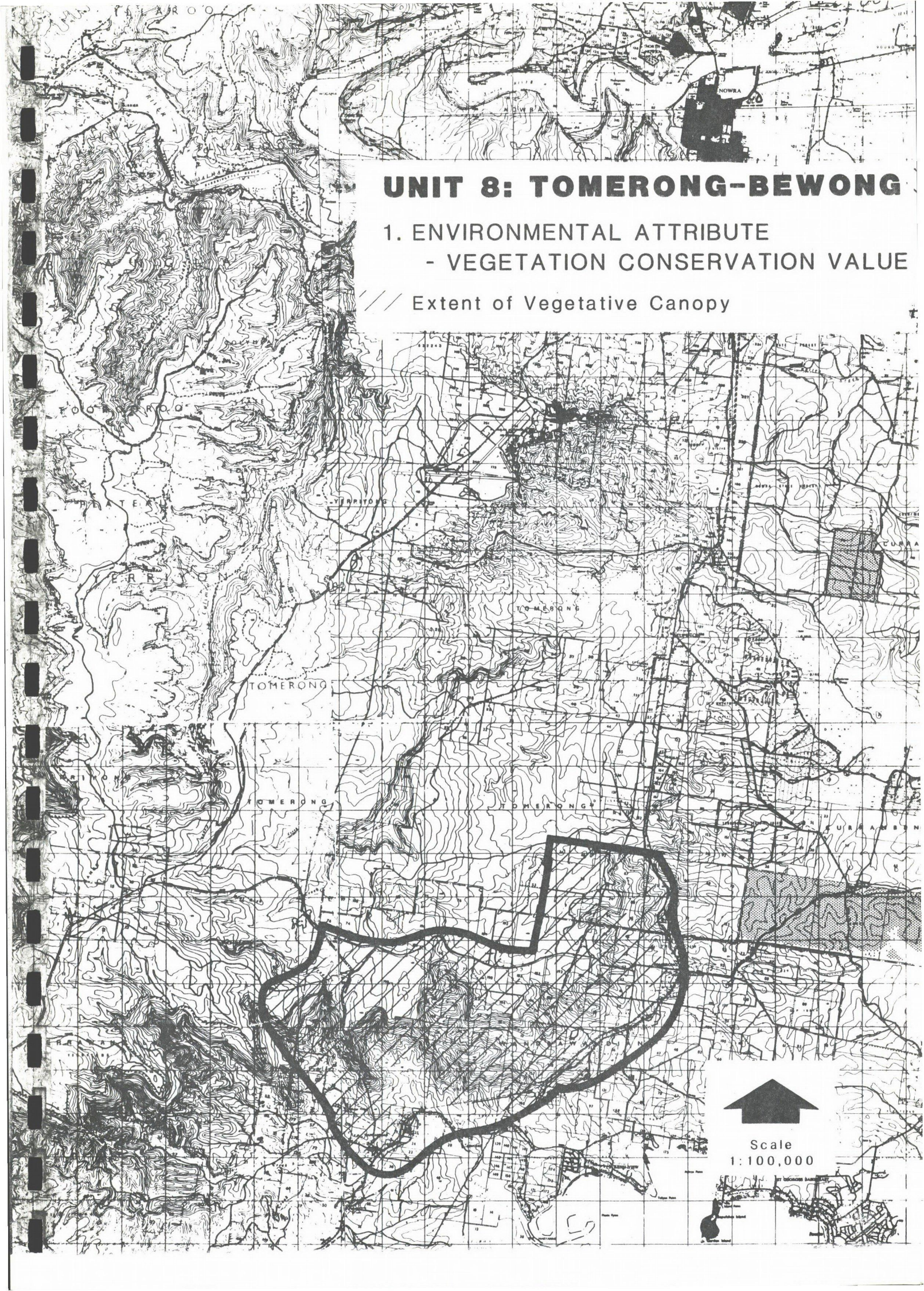
Rural zoning required to protect scenic amenity of semi-wooded lands. Moderate amounts of native vegetation should be retained, but Tree Preservation Orders are probably not appropriate.

IIId/a(i) Protection

Visual backdrop areas within State Forests. Detailed visual analysis should be carried out in these sub-units so that definite submissions for non logging and controlled logging areas can be put before the Forestry Commission.

IIId/a(iii) Protection

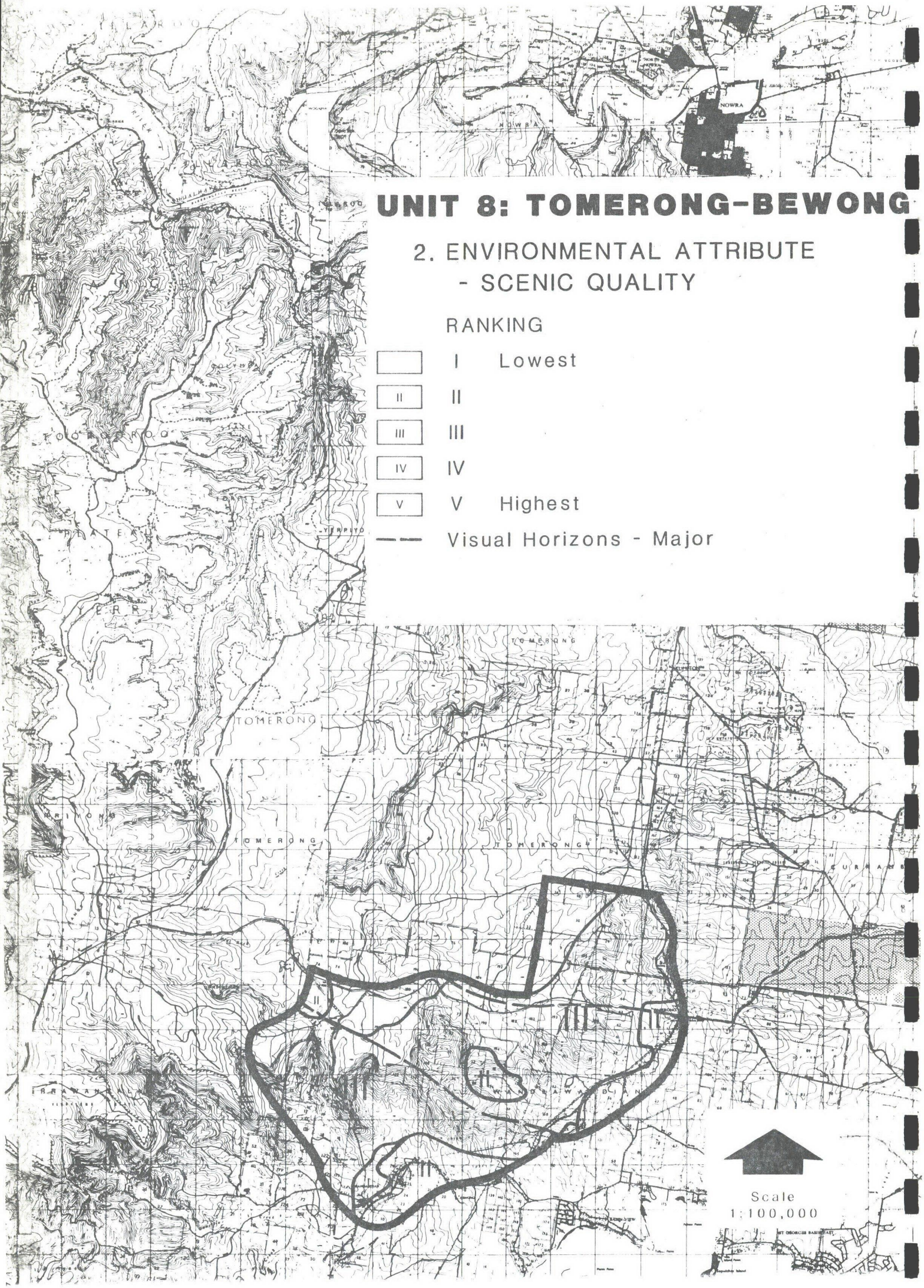
Visual backdrop areas on Crown Land. Management of these areas should have emphasis on scenic protection.

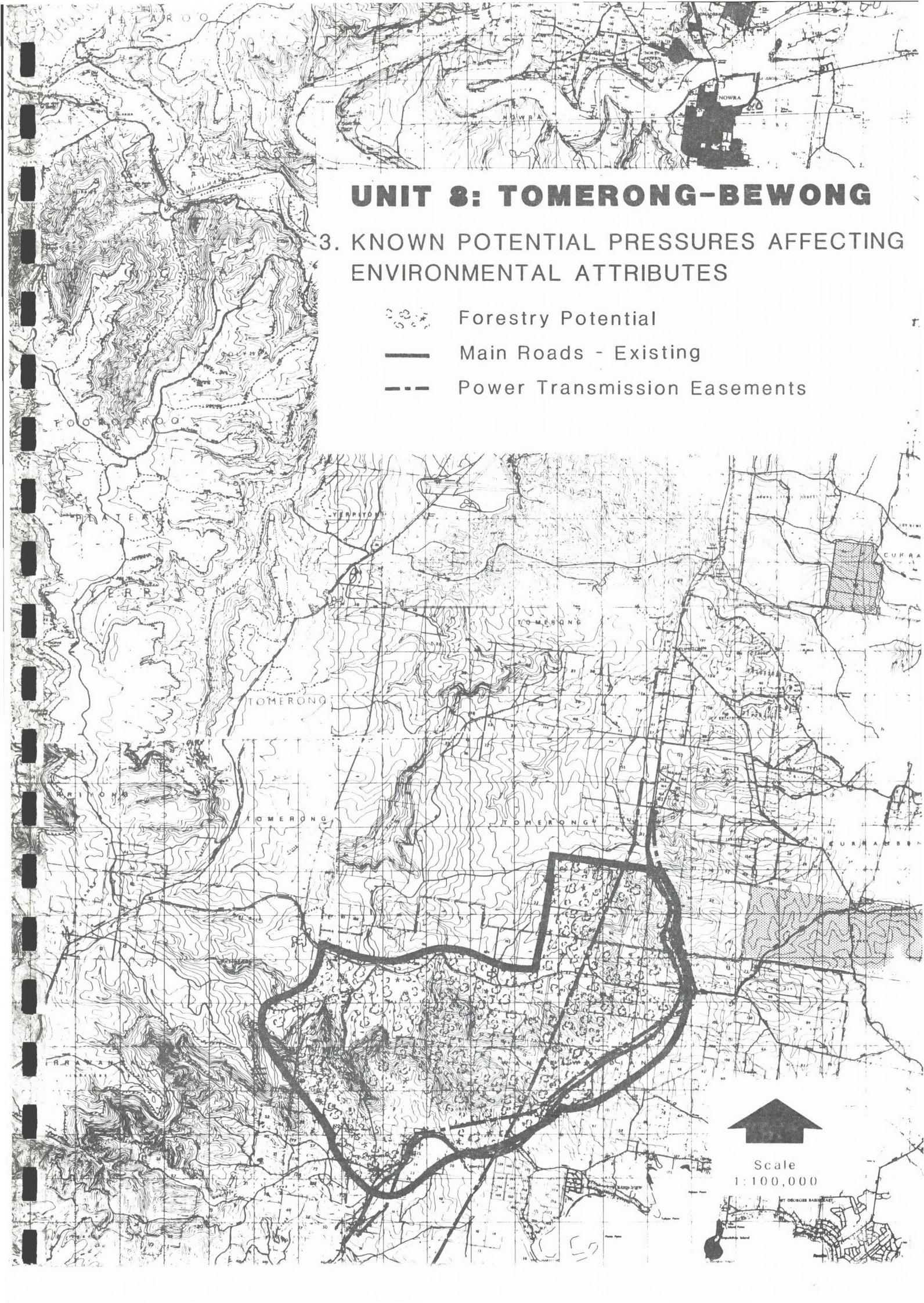


UNIT 8: TOMERONG-BEWONG

1. ENVIRONMENTAL ATTRIBUTE - VEGETATION CONSERVATION VALUE

/// Extent of Vegetative Canopy


UNIT 8: TOMERONG-BEWONG
2. ENVIRONMENTAL ATTRIBUTE
- SCENIC QUALITY
RANKING
I Lowest
II
III
IV
V Highest
Visual Horizons - Major
NOWRA
TOMERONG
Scale
1:100,000



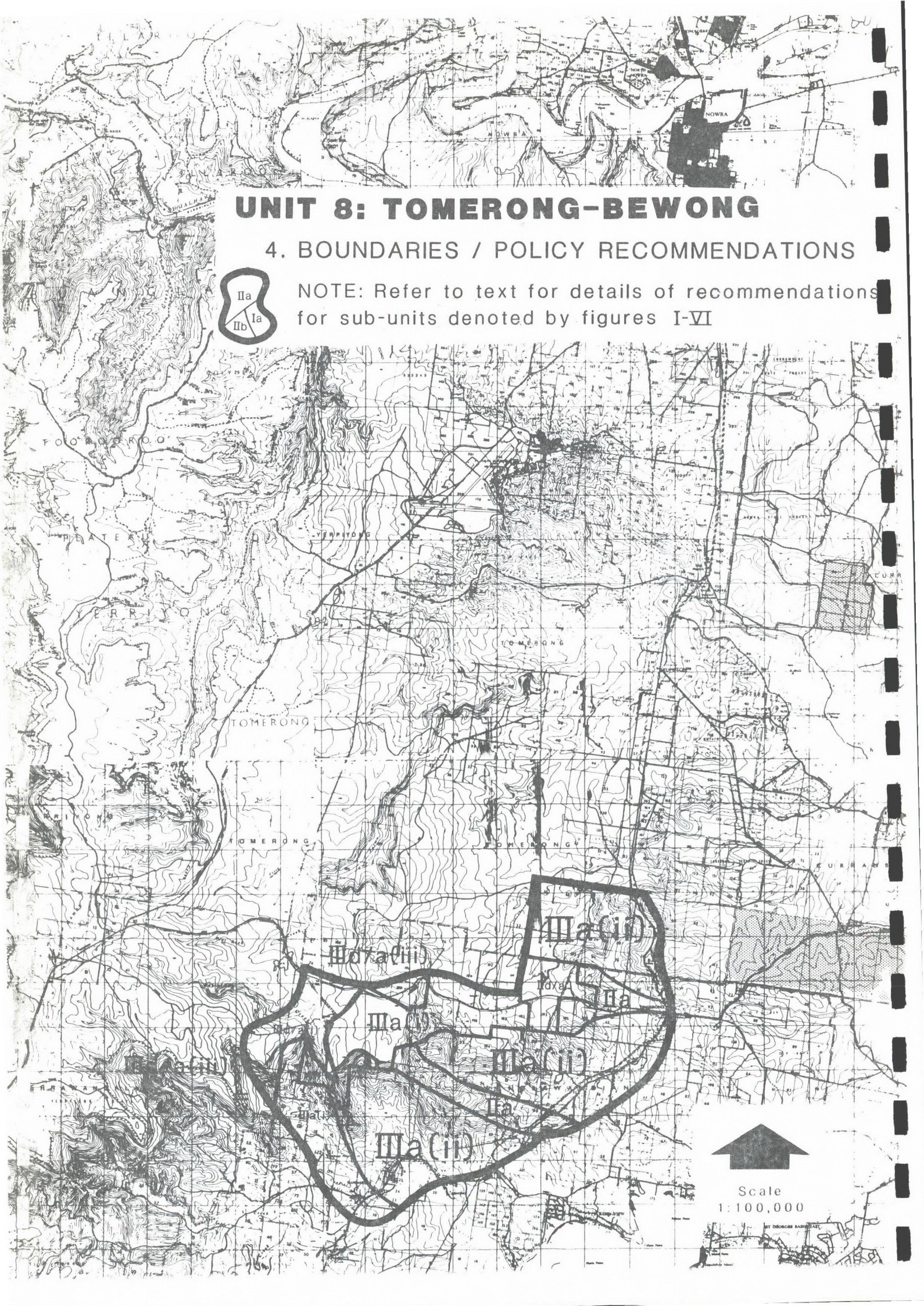
UNIT 8: TOMERONG-BEWONG

3. KNOWN POTENTIAL PRESSURES AFFECTING ENVIRONMENTAL ATTRIBUTES

Forestry Potential

Main Roads - Existing

Power Transmission Easements



UNIT 8: TOMERONG-BEWONG

4. BOUNDARIES / POLICY RECOMMENDATIONS

NOTE: Refer to text for details of recommendations for sub-units denoted by figures I-VI

8.2.2 Visual and Landscape Study by Land Systems EBC

TOMERONG BYPASS

PRINCES HIGHWAY

(STATE HIGHWAY ONE)

Visual/Landscape Study

E.I.S. Technical Report

PREPARED FOR THE

Roads and Traffic Authority

BY

Land Systems EBC Pty Ltd

JOB NO. 2456

MAY 1990

CONTENTS

		PAGE
1.	SUMMARY	1
2.	INTRODUCTION	7
3.	BACKGROUND	8
4.	OBJECTIVES	9
5.	ALTERNATIVES	10
6.	THE PROPOSAL	12
7.	EXISTING ENVIRONMENT	14
	7.1 The Study Area	14
	7.2 Physical Description	15
	7.3 Scenic Catchment	17
	. Character Units	
	. Distance Zones	
	7.4 Visual Character	19
	7.5 Scenic Quality	21
	7.6 View Points	22
	7.4 Viewer Groups	22
8.	ENVIRONMENTAL IMPACTS	25
	8.1 Evaluation of Impacts	25
	. Likely and Managed Impacts	
	. Scenic Capability	
	. View Frames	
	8.2 Macroscale Effects	27
	8.3 Microscale Effects	30
	8.4 Impact Management	43
9.	ENVIRONMENTAL CONTROLS	44
	9.1 Landscape Concept	45
	9.2 Management Guidelines	46
	9.3 Monitoring Strategy	68
	9.4 Responsible Authorities	68
GLOSSARY		
BIBLIOGRAPHY		
APPENDICES		
A1	OPTIONS ASSESSMENT	
A2	VIEWER POPULATION	
A3	SWATHE DISTURBANCE	

List of Illustrations

FIGURES

Figure 3.1 Visual Context

Figure 5.1 Corridor Options – Character Zones
Figure 5.2 Corridor Options – Character Transitions
Figure 5.3 Options Assessment

Figure 7.1 Existing Environment
Figure 7.2 Highway Sectors
Figure 7.3 Highway Viewpoints

Figure 9.1 Thematic Concept
Figure 9.2 Typical Sections – location
Figure 9.3 Typical Sections – treatment
Figure 9.4 Guideline Sketches – indicative detail
Figure 9.5a Landscape Concept – Sheet 1 North
Figure 9.5b Landscape Concept – Sheet 2 South

TABLES

7.1 Viewpoint Distribution
8.1 Impact Summary
9.1a Landscape Concept – Existing Species Groups
9.1b Plant Groups/Proposed Locations
A1.1 Corridor Options – Comparison

PHOTOSKETCHES (Before and After Views)

P.sk 1 South Tomerong Gateway – regional
P.sk 2 Barham Road Locality – residential
P.sk 3 Turpentine Road Intersection – local

PHOTOMONTAGES (Character Views)

P.mt 1 Northmost Highway
P.mt 2 North Bends at Tomerong Peak
P.mt 3 Tomerong Village Entry
P.mt 4 Tomerong Village
P.mt 5 Highway Bends at South Peak
P.mt 6 Homestead View at South Peak

1. Summary - Scenic Study

The Roads and Traffic Authority has commissioned Land Systems EBC Pty Ltd as independent consultants to prepare a visual/landscape study as a workpaper input to an EIS prepared by Mitchell McCotter and Associates Pty Ltd working in association with specialist sub-consultants in ecology and noise management, respectively Roslyn Muston and Associates and Renzon Tonin and Associates.

The following summarises the major findings of the visual/landscape study for the Tomerong Highway Bypass. In particular, consideration has been taken of the need to coordinate landscape development with ecological management.

1.1 KEY FINDINGS

- This study recognises that the Tomerong Wandandian Scenic landscape, defined by the National Trust of Australia (NSW) - 1976, is the regional landscape unit which determines the major constraints and establishes the quality context for a preferred standard of highway development.

- A "scenic motorway" standard which emphasises landscape characteristics along the highway corridor has been established and translated into management prescriptions in response to potential impacts.

- Overall a net scenic benefit will accrue along both the existing highway and future bypass where the management prescriptions are implemented.

- Environmental monitoring will be an important part of impact management and should be undertaken as part of the RTA's project development process and a long term regional programme.

1.2 SCENIC ENVIRONMENT

The Tomerong-Bewong scenic landscape unit has been recognised by the Department of Planning in the Illawarra Regional Environmental Plan (1981).

Tomerong Valley, as defined in this visual study, occurs within this regional landscape unit and contains the highway bypass together with its local environment. It is enclosed westward and north-eastward by forested ridgelines which comprise part of the regional escarpment in the hinterland behind Jervis Bay and Georges Basin.

The Valley incorporates the principal streams of Tomerong and Suffolk Creeks which geographically drain the north and south catchments of the study area. These two halves can be loosely demarcated by Turpentine Road.

The northern valley is closely confined by upland ridges almost encircling both the midland slopes and relatively low riverine floodways. The southern valley is by contrast not as distinctly enclosed. It is marked by the westward escarpment and partially contained by two low ridge spurs firstly between Tomerong and Suffolk Creeks, and secondly extending along the Grange/Island Point Roads.

Principal components of the local environment have been separated into:

- The Village – north and south
- Forest and Woodlands
- Rural Lands

Within this environment are discernible five primary landforms which comprise:

- Tomerong Peak – (twin ridge peaks) rising above the north approach to the village; it is accented by tall forest and forms the inner eastern escarpment to the valley, while its outer scarp is not visible from the present highway.

- The westward escarpment – part of the easternmost Great Dividing Range; defining the valley and its western slopes, covered by forest and woodland.

- The northern valley – an enclosed landform which remains predominantly forested.

- The southern valley – a mostly open, or partially enclosed landform which consists of mixed forest and rolling rural lands.

- South Peak – rising above the south approach to the village; it is accented by tall forest and forms the southern landmark punctuating Tomerong Valley.

A variety of cultural features have been identified which contribute to the village setting and are recognisable as landmarks by the local community. These include the village "rainforest", exotic trees, sawmill and other characteristic elements.

The major viewer population is attributable to motorists [*] which have been estimated by translating from AADT counts to comprise about 20,000 persons daily. The Tomerong locality has a population of about 3000 persons all of whom will regularly experience the scenic changes brought about by the highway bypass. However, visually only two homesteads will be marginally affected in the north valley (Bike Farm entry and a Turpentine Road rural edge) while about ten residences will be affected in the south valley within a 100 metre range. None will be demolished.

1.3 ALTERNATE CORRIDORS

Four major groups of corridor types were identified arising from the seven highway bypass options. These comprised Group 1 – The Central Corridor (Option A), Group 2 – The Perimeter Corridor (Option B), Group 3 – The Existing Corridor (Options D and E) and Group 4 – The Western Corridors (Options F, G and H).

Each of these groups were examined in terms of five major criteria:

- town–entry address – community identity
- motorway scenery – motorist outlook
- visual absorption – viewer onlook
- public sensitivity – viewer population
- linear patterns – relation to existing swathes.

After comparison, Option A – The Central Corridor was identified as the preferred scenic route which would result in the least visual disturbance and maximum benefits. This route was selected for the EIS study on the basis of a composite evaluation integrated with economic, ecological, noise and landuse planning considerations.

1.4 SCENIC IMPACTS

Two classes of potential impact have been recognised to assist in understanding the scenic environment. Macroscale and microscale effects have been respectively defined as those which occur in views address the whole picture of Tomerong Valley, and those which occur in views addressing fragmented parts of the Valley.

1.4.1 Macroscale Effects

At the macroscale, there are no effects of either significant magnitude or importance affecting any major viewer population (motorist or resident). One southern homestead would have a distant view (6.0km) to a potential thinning in the forest canopy along the Bypass beneath Tomerong Peak. This subtle change would be visually absorbed into the adjacent canopy.

The Bypass route will take major traffic away from the village centre and it is anticipated that the present highway will be declassified as a main road to become the village "mainstreet". This reassigned mainstreet will become a pleasant country road for most of its length [*] and there may be an opportunity for joint co–

operation between RTA and Shoalhaven City Council for roadscape improvement as part of the handover. This could benefit the village centre and selective locations where the mainstreet may be visible from the bypass. [*: except where it may be abandoned or reused as a highway rest area.]

1.4.2 Microscale Effects

At the microscale, scenic impacts would be restricted to those likely to occur in the foreground (600m) to mid-distance (3.0km).

Potentially, the major impacts are likely to be infrequent and have moderately adverse effects without detail management. The managed effect would result in significant improvements to potential impacts, where the degree of effect may be shifted from a moderate impact to either a low adverse condition or to a major scenic benefit enjoyable by many motorists and the local community.

Impact types have been identified and grouped into three classes, representing those occurring inn: forest lands, rural lands and highway lands [*]. [* highway lands: corridor sectors reusing the existing highway reserve or being closely parallel in relationship.]

The type of microscale impacts which have been addressed include: view sequence (lateral outlook); swathe band (site disturbance); bank construction (cut and fill); features (built and natural); intersection address (gateway); driveway address (private access) and public sensitivity (viewer onlook).

Potential major impacts **through forest lands** were identified as those likely to result from bank/rock cut and deep fill along the escarpment descent through the spurs and gullies below Tomerong Peak, and in addition from uncontrolled disturbance alongside the bridge constructions across Tomerong and Suffolk Creeks. Visual impacts would be restricted to those observable by motorists, as there are no close residences in the uncleared forest lands. Public sensitivity to management of the scenic forest environment would be relatively high as the Princes Highway bypass will be a part of the main road corridor through the South Coast region.

Major impacts likely to occur where the bypass traverses past **rural/village lands** will be restricted to the village gateway at South Tomerong – where there occurs a visual conjunction between forest, rural and village character zones. The visual outlook from about ten (10) residences along the bypass route (within 100m) will be altered and replaced with a landscaped bypass treatment in the close foreground. A quality landscape treatment will be desirable to compensate for the displaced view from these residences. At the same location, the bypass development would recapture the westward

view surrendered by these residences and make this available to motorists, which would be seen as a panorama past cottages and across open fields to the forest edge and distant escarpment. The capture of this view will result in a major scenic benefit to motorists, particularly as there are few views of rural/village scenery along the proposed bypass in comparison to the existing highway.

The potential impacts associated with highway lands [*] result where the bypass would be close to the existing highway reserve and a break in the intervening forest may occur. Where this is unavoidable the impact may be reduced with landscape rehabilitation between the two roadways. This effect occurs for about 200 metres in a 3.0km reach north of Tomerong Peak [*: defined above].

Beneath the valley's south peak, the existing highway bends will be altered with the bypass geometry through the forest. This geometry will recycle part of the existing highway swathe within the bypass route and leave one arc of the present three bends for potential re-use as a scenic rest area in the forest. This type of impact management resulting from alignment planning will minimise unnecessary disturbance through sensitive quality environments and maintain the positive scenic effect presently available in this location.

1.4.3 Impact Management

Overall, the negative impacts arising from the bypass development may be successfully managed to result in a net scenic benefit to the environment for both motorists and the local community.

Ecological impacts would be closely associated with scenic disturbance and these effects would be addressed with a coordinated strategy for management of potential adverse impacts.

1.5 SCENIC MANAGEMENT

Three levels of management have been identified to control potential impacts. These comprise the following:

- a thematic/structural concept – for landscape development
- prescription guidelines – to control specific effects
- a monitoring strategy – to ensure compliance and longterm environmental care.

The thematic concept (1:25000 scale) recognises the need for the bypass to address the village entry into Tomerong and to maintain the quality of character zones through forest, rural and village areas. A secondary landscape concept (1:10000 scale) supports this structural framework and establishes a local response to conditions along the route.

Overall, this management concept advocates that a high standard be adopted in keeping with the "Tomerong-Bewong" Scenic Landscape unit which the bypass traverses through. Nominally, this standard for motorway development has been referred to as a "scenic motorway" class [*] which would signify a requirement to promote the natural and cultural imagery of the local environment as an important part of the highway experience. [* Scenic Motorway: see Glossary.] [In terms of relative hierarchy this standard would begin to approach a "scenic parkway" class without adopting all the design features attributed to this first class standard – such as independent naming, signage and coordinated road furniture and other motorway structures.]

Prescription guidelines have been developed which respond to specific aspects of macroscale and microscale effects. These would regulate the local conditions along the bypass – primarily to maintain a mature landscape and avoid all unnecessary disturbance.

In addition, finishing standards and critical dimensions have been described which address both the road construction and landscape phases of the bypass development.

Primarily these guidelines respond to requirements for regulating:

- route alignment – affecting swathe disturbance
- scenic character – within the road reserve
- construction disturbance – beyond bank formations
- earth/rock cuttings – inclusive to fauna management
- earth/boulder fill – inclusive to fauna management
- verge treatment – including fencing and drainage
- feature display – such as creeks and bridges
- intersection treatment – as part of the town gateway
- property access – rural driveway and address points.

A significant overlap between scenic and ecological landscape management occurs which has been incorporated into the guideline prescriptions. In particular these address access for native fauna across or beneath the bypass.

Monitoring will be an important part of the overall management strategy. This would be required during design development, during and after construction and at longterm intervals to assess management performance and possible remedial works.

Preferably, initial monitoring would be undertaken by the RTA Environmental Branch in conjunction with an independent consultant working together with the Divisional Office of the Project Manager. Long term monitoring should be undertaken within the framework of a regional programme for review of Divisional Works, future projects and a coordinating strategy.

2. Introduction

This report has been prepared in response to the Road and Traffic Authority (RTA) requirements for an Environmental Impact Statement (EIS) for the Proposed Highway Bypass of Tomerong Village on the South Coast. It comprises part of a series of specialist consultant reports which have contributed to the EIS prepared by Mitchell McCotter and Associates Pty Ltd.

The RTA commissioned Land Systems EBC Pty Ltd as independent consultants to prepare a visual/landscape study as a technical workpaper input to the EIS. In particular this study has been co-ordinated with the ecological study prepared by Roslyn Muston and Associates.

Specifically this report addresses the scenic environment of the study area. It assesses the potential visual impact of the Highway Bypass and identifies preferred techniques for scenic mitigation of adverse effects and enhancement of the bypass corridor.

Briefly, the objective of this study has been to describe the existing environment, determine any likely significant impact and recommend the necessary safeguards to reduce any adverse effects. The study includes:

- a qualitative landscape evaluation of the study area in terms of the regional and local context
- a photo-sketch and photographic assessment of the principal views towards the proposed bypass and character of local environment
- a recommended strategy for mitigating adverse effects and enhancing the environment wherever views have been significantly altered.

The procedure adopted for the project relies on existing baseline information and also entailed a field and photographic survey of the existing character and quality of the landscape. Existing baselines include the National Trust (NSW) "Illawarra Region Landscape Survey" (1976), Department of Planning "Illawarra Regional Environmental Plan" (1981) and the Roads and Traffic Authority "Tomerong Bypass - Review of Environmental Factors" (1989). Information about the study area was also assisted by 1:25,000 scale topographic maps, 1:10,000 aerial colour photography and RTA 1:2000 photogrammetry showing the preliminary alignment design.

3. Background

Tomerong provides a regional gateway to Jervis Bay and St Georges Basin which is visibly addressed at present from the Princes Highway, both at Parnell/Turpentine Road and the Grange Road. The Tomerong Valley has also been recognised as an important scenic landscape of the South Coast, part of the Tomerong Bewong Landscape Unit as defined by NSW Department of Planning (See Figure 3.1 - Visual Context.)

The scenic environment of Tomerong Valley is presently seen by a wide variety of travelling motorists and district residents. It is particularly visible from the present Princes Highway, as well as from a number of homesteads and residences which have key vantages

Development of the Highway Bypass will change the strategic vantage of through motorists away from the present main road to a new westward location, predominantly through forest. In addition this new route will alter the gateway address to Tomerong and the surrounding district

Scenic alteration has been an ongoing part of the history of highway and community development within NSW. However today perhaps more then ever before, the public community and planning authorities have become increasingly concerned about the need to ensure that new development will fit comfortably into the existing cultural and natural environment. Highway development should be based on a general aim of minimum disturbance to established values and a maximum endeavour to incorporate the benefits which arise to enhance the living setting.

Recognising these requirements, the opportunity has been taken in this study to advocate recommendations which will maximise the scenic benefits and aim to achieve a net environmental gain from the Bypass development

Legend

- Route Alignment – Preferred Option
- Viewshed of proposed and existing highway in the study zone
- Distance Zones:

  Foreground – to 600m
  Mid-distance – to 2.0km
  Far distance – to 4.0km
- Town Centre – Tomerong
- Town Entry
- Tomerong-Bewong, Landscape Unit
- Study Zone
- Ridge peaks and 80m contour

Figure 3.1

TOMERONG BYPASS
Visual Context

0 1 2 3KM

SCALE: 1 to 25000 (AT A1 SIZE)

LAND SYSTEMS EBC PTY LTD

DWG: 2456/..

DATE: MARCH 1990

4. Objectives and Approach

The purpose of the EIS Visual Study has been to describe the existing environment, determine any likely significant impacts and recommend the necessary safeguards to reduce any adverse effects.

The study approach recognises that the Tomerong Valley is an important regional environment which supports a variety of landuses (forestry, rural and village activity) and these are reflected by commensurate changes in visual character of the landscape setting.

Objectives of this study have been to reveal:

- the extent of available views;
- representative viewers;
- representative view points;
- sequential views;
- variants affecting scenic prominence;
- character of the landscape;
- quality of the landscape;
- capability to absorb change;
- potential impacts;
- managed impacts;
- environmental safeguards, incl. fauna management;
- monitoring proposals;
- a management structure, and
- responsibility for co-ordinated enhancement.

The Bypass proposal has been described in relation to its scenic context. Potential changes have been evaluated against the existing environment.

A baseline study describing the board visual characteristics of the Tomerong-Bewong Landscape Unit has already been established by the Department of Planning (1981). As a result, detail justification of its regional value has not been given in this report. However, the implications of the bypass have been described in response to the planning guidelines for conservation of this landscape - in particular attention to escarpment, forest and riverline protection.

Besides relying on relevant scenic criteria, recommendations for managing adverse and favourable impacts have also been made with regard to other interacting requirements affecting visual/landscape opportunities. These other aspects incorporate fauna management and the effect of downgrading the present main road through the village.

5. Alternatives

Options for location of a Highway Bypass were developed by RTA's road design engineers and these have taken into account the community's suggestions in determining alternate routes. These alternatives included the following:

Group 1:	A. The central corridor	– The Grange Way
Group 2:	B. The perimeter corridor	– West Tomerong
Group 3:	D. The existing highway	– Redevelopment
	E. The existing highway	– No Nothing
Group 4:	F. SW far alignment	– Upland/escarpment
	G. SW close alignment	– Midland/valley
	H. NS mid alignment	– Valley/escarpment

Options C and J, respectively east and furthest west of Tomerong were discarded after the review of environmental factors on the basis of engineering disturbance, travel distance and cost considerations.

A visual assessment was made of the four (4) option groups and alternate routes in conjunction with input from all other consultant disciplines involved with the EIS.

In terms of scenic evaluation, each of these options were examined by comparison of five major criteria:

. town–entry address	– community identity
. motorway scenery	– motorist outlook
. visual absorption	– viewer onlook
. public sensitivity	– viewer population
. linear patterns	– relation to existing swathes.

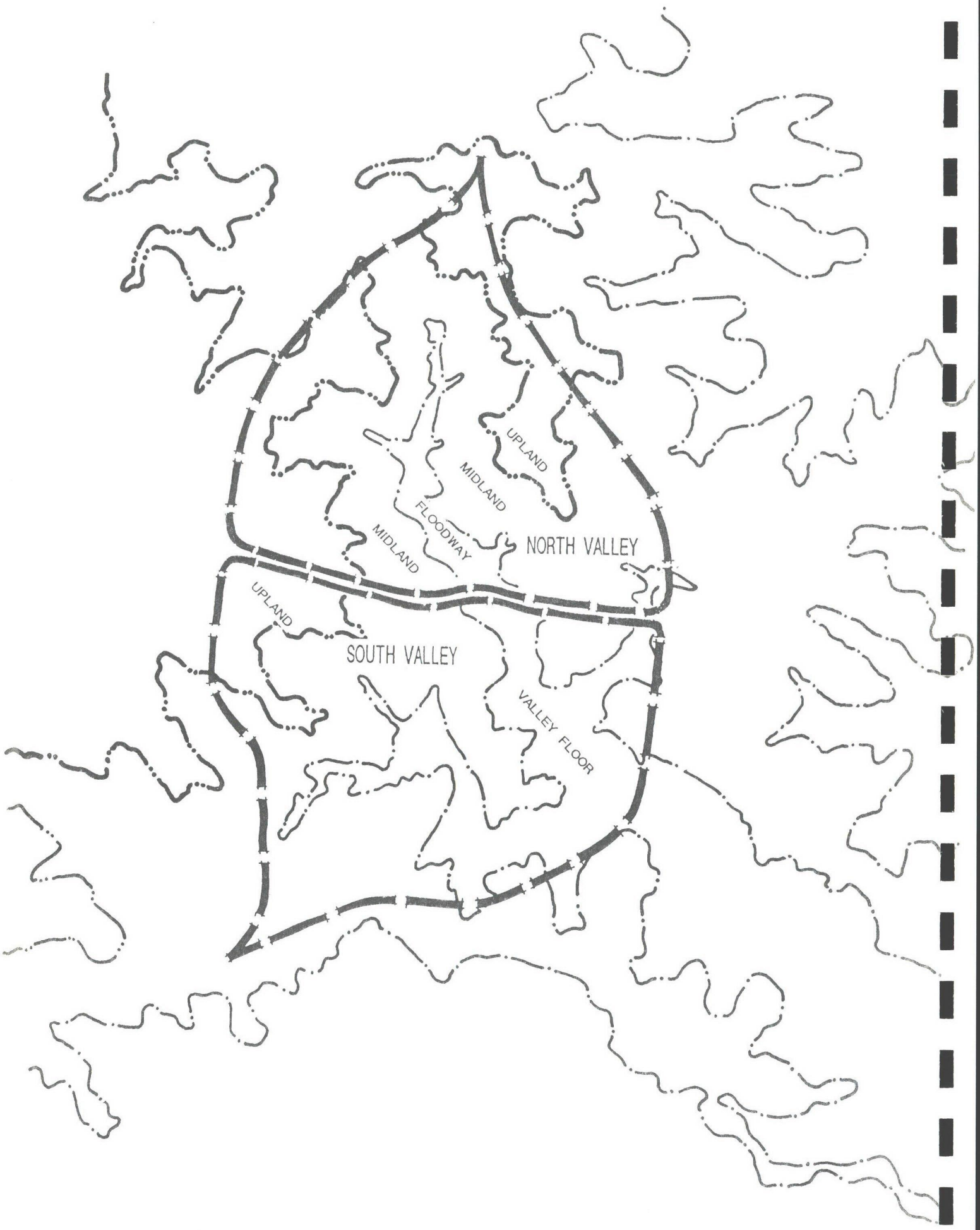
After comparison, Option A – The Central Corridor was identified as the preferred scenic route which would result in the least visual disturbance and maximum benefits. This route was selected for the EIS study on the basis of a composite evaluation integrated with economic, ecological, noise and landscape planning considerations.

(See Appendix A1 – Alternate Corridors.)

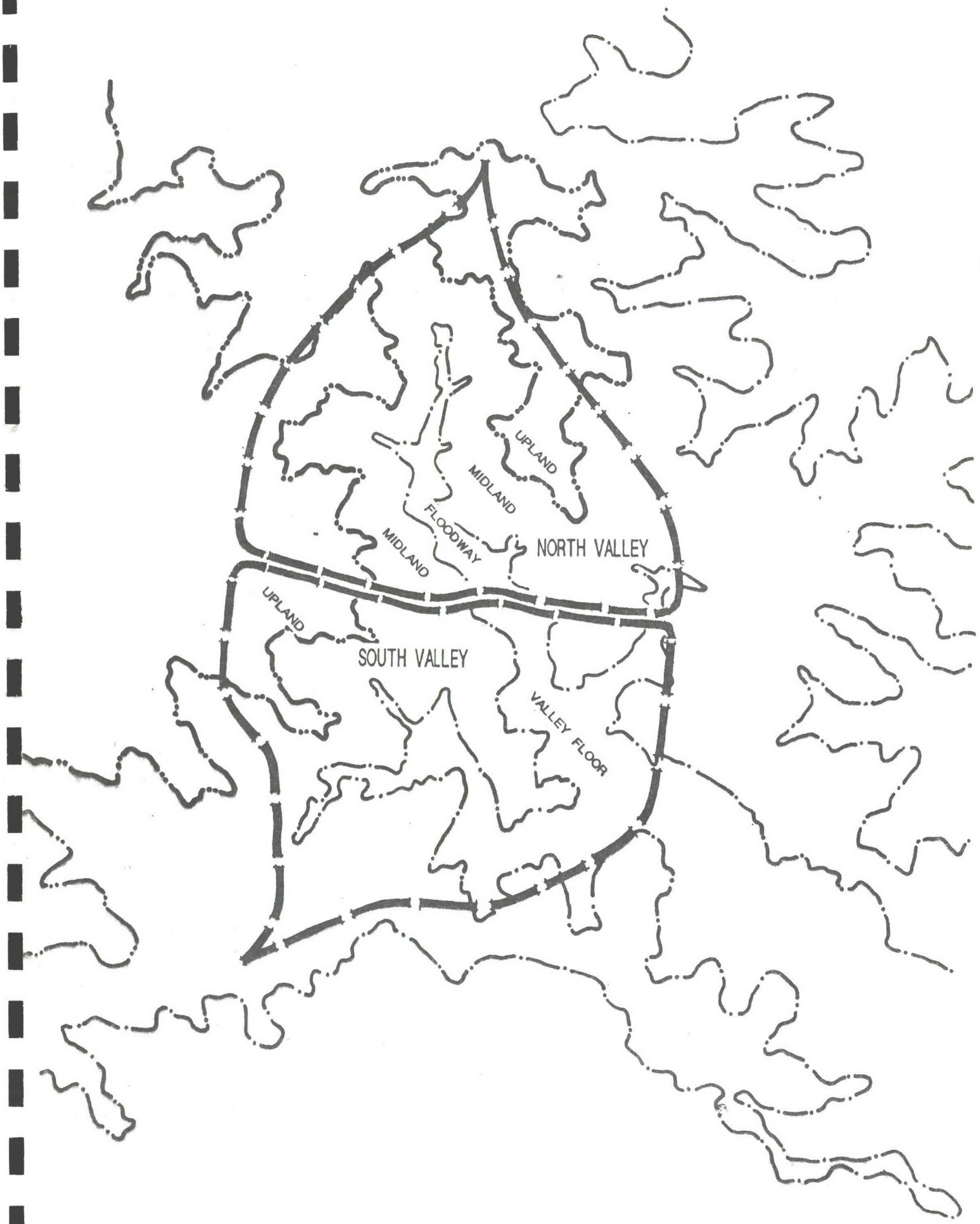
In summary, Option A offers the opportunity for a primary address to the Village at South Tomerong within a mixed scenic setting comprising urban, rural and natural landscape characteristics. This gateway would have a moderately close proximity to present town–centre crossroads in comparison with other options than that of the existing highway route. In addition, a future possible secondary gateway at the Turpentine Road t–intersection would also be relatively close to the village centre and public institutions.

Option A would have a high variety of scenic transitions through a full range of character types. Visual absorption is also high, whereby a majority (75%) of the route would be enclosed within a forest swathe or along the forest edge. Public sensitivity [*] would be low in terms of existing residential onlook. [* public sensitivity: see Glossary.]

Notably, this option avoids the western escarpment slopes although there was recognised the potential for scarring the inner east escarpment beneath Tomerong Peak where the Bypass would descend through sandstone terrain down into the North Valley above Tomerong Creek. (Detail analysis of this location has shown that an adverse impact would not occur with scenic management – See Sections 8 and 9.)



5.1/overlay
Corridor options – valley zones



5.1/overlay
Corridor options – valley zones



Figure 5.1
TOMERONG BYPASS
Corridor options - character zones

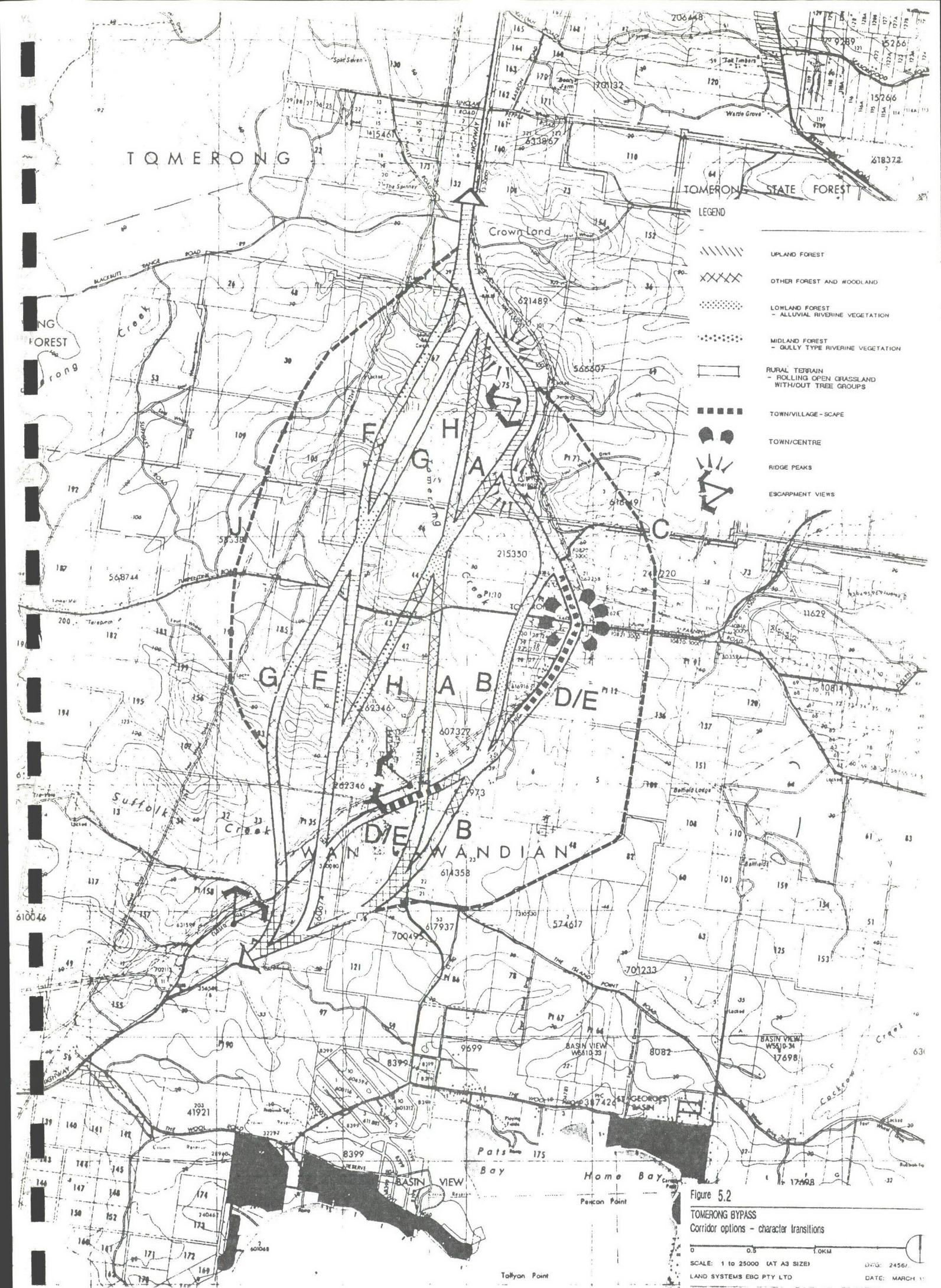


Figure 5.2

TOMERONG BYPASS

Corridor options - character transitions

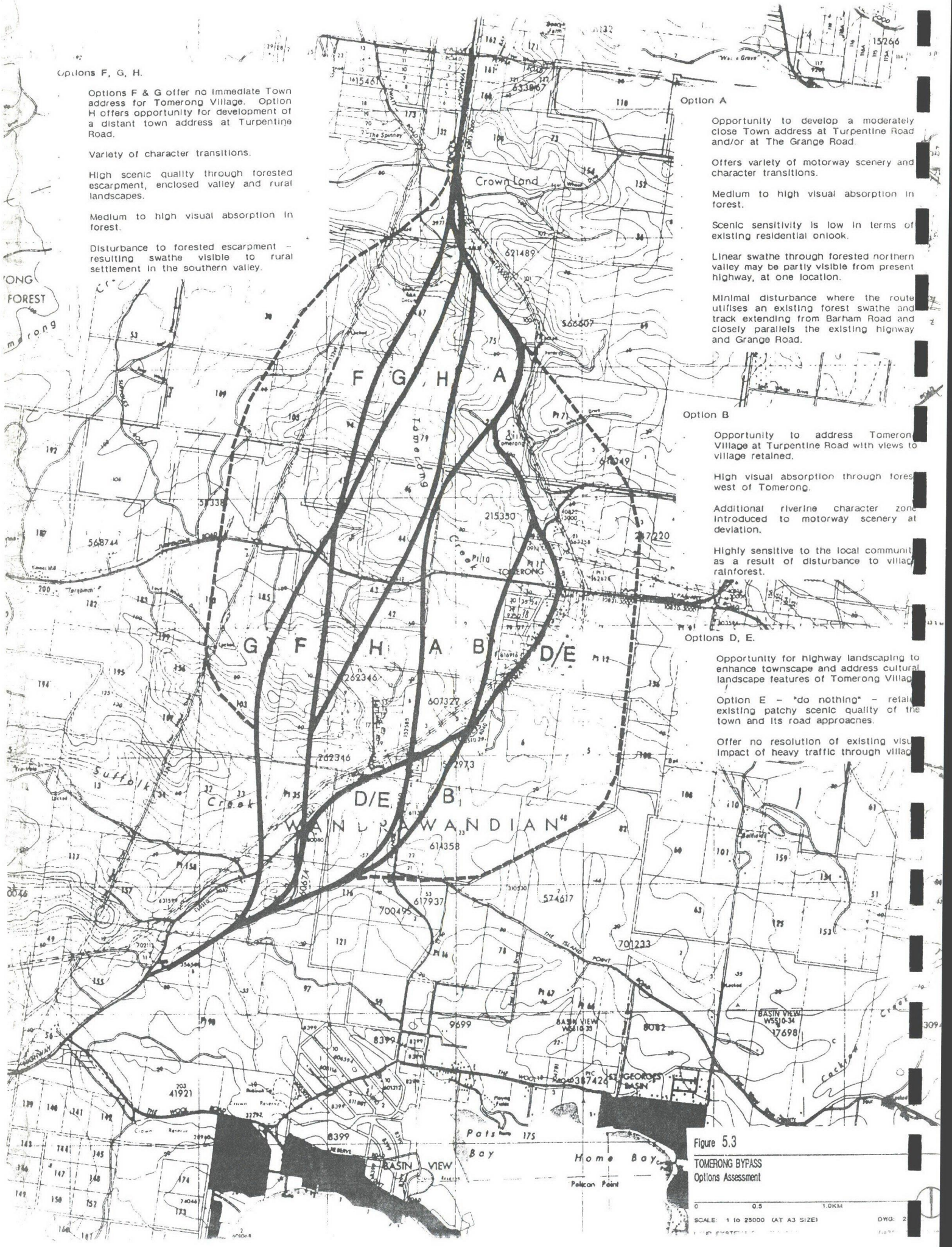
0 0.5 1.0KM

SCALE: 1 to 25000 (AT A3 SIZE)

DWG: 2456/...

LAND SYSTEMS EBG PTY LTD

DATE: MARCH ...



Options F, G, H.

- Options F & G offer no immediate Town address for Tomerong Village. Option H offers opportunity for development of a distant town address at Turpentine Road.
- Variety of character transitions.
- High scenic quality through forested escarpment, enclosed valley and rural landscapes.
- Medium to high visual absorption in forest.
- Disturbance to forested escarpment – resulting swathe visible to rural settlement in the southern valley.

Option A

- Opportunity to develop a moderately close Town address at Turpentine Road and/or at The Grange Road.
- Offers variety of motorway scenery and character transitions.
- Medium to high visual absorption in forest.
- Scenic sensitivity is low in terms of existing residential onlook.
- Linear swathe through forested northern valley may be partly visible from present highway, at one location.
- Minimal disturbance where the route utilises an existing forest swathe and track extending from Barham Road and closely parallels the existing highway and Grange Road.

Option B

- Opportunity to address Tomerong Village at Turpentine Road with views to village retained.
- High visual absorption through forest west of Tomerong.
- Additional riverine character zone introduced to motorway scenery at deviation.
- Highly sensitive to the local community as a result of disturbance to village rainforest.

Options D, E.

- Opportunity for highway landscaping to enhance townscape and address cultural landscape features of Tomerong Village.
- Option E – "do nothing" – retains existing patchy scenic quality of the town and its road approaches.
- Offer no resolution of existing visual impact of heavy traffic through village.

Figure 5.3

TOMERONG BYPASS
Options Assessment

0 0.5 1.0KM

SCALE: 1 to 25000 (AT A3 SIZE) DWG: 2

6. The Proposal

A detailed description of the proposal has been included in the EIS document. However, a brief description has been included here with emphasis on the chief physical and scenic characteristics of the Highway Bypass.

Broadly, the proposed Tomerong Bypass would be developed as a deviation of the Princes Highway westward and away from the present Highway and the village centre. This finished development after landscape works would result in a narrow swathe approximately 10 to 15 metres wide between the road shoulders, for two to three lanes respectively.

The Bypass will establish a new motorway about 7.0 kilometres in length. North to south this would start about Blackbutt Road, traverse first along the upland ridgetops, parallel the existing road and north bends, descend the inner each escarpment below Tomerong Peak, reach through the north valley, cross Tomerong Creek and meet Turpentine Road about 1.0km west of the Village crossroads. Continuing southward it would follow an existing Crown road reserve, cross Suffolk Creek, parallel and occupy Barham road, meet the present highway about 2.0km south of the Village Crossroads. It would then proceed parallel to the Grange Road, cut through a midland forest in a wide curve and again meet the Princes Highway at the road bends beneath Tomerong's South Peak.

Landforms which would be encountered include uplands of moderate slope with minor creek headwaters, rugged gullies and short spurlines, steep escarpment, midland slopes, the valley floor, floodway and gully side slopes. As a result the earthworks will vary from a deep sandstone cutting, deep gully fill with boulder revetment (if available) and a range of cut/fill works about and below 3.0m height/depth, as well as alignments which meet existing roads at natural grade.

Vegetation transitions along the Bypass will display a range of forest types with distinctly contrasting characteristics (Turpentine Ironbark, Spotted Gum, Blue Gum, Paperbark and Cabbage Tree Palm stands of Tall Forest and Woodland). In addition, glimpses of rural lands and the village-scape will be evident alongside part of the proposed motorway.

Route alignment of the Bypass will not result in the demolition of any rural homesteads or other residences. While it would pass close alongside some homes at South Tomerong, at this location.the separation would be sufficient to permit appropriate scenic management.

The Bypass would address and develop a new gateway into the village at South Tomerong. This will incorporate closing the present highway at the Grange Road and rerouting local traffic on to and from the Bypass by a "sea-gull" intersection that would meet the future arterial development of Island Point Road by Shoalhaven City Council.

A village gateway at South Tomerong will provide the opportunity for a major scenic enhancement of this location as a feature landmark in the local district. Other natural features which will be presented by the Bypass would include the two bridge crossings of Tomerong and Suffolk Creeks. Landscaping and revegetation at these feature locations would permit the opportunity to promote both the cultural landscape of the South Coast and distinct natural vegetation of Tomerong's local riverine forest.

In the short term, during the construction of the Highway Bypass these would be significant quarrying, earthworks and material stockpiles at certain locations. Earthmoving machinery would be almost continuously active and large areas would be in an incomplete form during this period. A high standard and early completion of perimeter works at the Village Gateway and where the Bypass intersects other parts of the existing highway, will facilitate the best scenic advantage to be gained by reducing the time of disturbance to public views. Forward landscape works would contribute to the enhancement and relative invisibility the Bypass development at key locations.

Similarly, early attention to revegetation along the creeks at bridge crossings would contribute to these as features and facilitate the advanced reestablishment of strategic fauna movement corridors.

Ultimate completion of the proposed Bypass with prescribed landscape controls should result in a high quality "scenic motorway" and improvements to the close margins of adjacent country roads. With proper attention to scenic management the changes arising from the Bypass development will have a net positive benefit to the local and regional environment.

7. Existing Environment

The following refers to the proposed corridor route. This locality description and classification presents a technical overview of Tomerong's scenic landscape environment. For the purpose of establishing a baseline reference, the Highway Bypass setting has been briefly described in relation to each major parameter of the visual environment.

7.1 THE STUDY AREA

The Visual Study Area, also herein described as Tomerong Valley, has been defined to extend linearly the full length of the proposed corridor. It extends laterally to the east and west limits of the corridor options, already discussed in Section 5. This area includes the pattern of all nearby rural lands about Tomerong Village and the multiple linear swathes along roadways and transmission easements.

Tomerong is located about twenty (20) kilometres south from Nowra and eight (8) kilometres west of Huskisson on Jervis Bay. The Village provides a regional gateway to Jervis Bay and St. Georges Basin. (See Figure 3.1.)

Scenic Classification

The Tomerong–Bewong landscape unit has been recognised by the Department of Planning in the "Illawarra Regional Environmental Plan" (1981). This landscape management unit was initially identified by the National Trust of Australia (NSW) in its publication "Illawarra Region: Landscape Survey" (1976) – where it was first called the Tomerong Wandandian Scenic Landscape (No. 10).

The Illawarra Regional Environmental Plan (REP) (1981) refers to the Department of Planning technical background report "Illawarra Region: Landscape and Environmental Study" (1981). **Clause 18** of the Illawarra REP No. 1 states:

> *"A draft local environmental plan applying to land shown on the map as land with landscape or environmental attributes shall be prepared having regard to recommendations contained in the Illawarra Region Landscape and Environmental Study published by the Department of Environmental and Planning in August 1981."*

Regional Environment Plan

The Illawarra REP No. 1 makes specific reference to certain components of the region environment which have an interconnected relationship to scenic aspects of the Highway Bypass proposal.

These references include the following:

- Part II – Provisions Relating to Rural Lands.
  Division 1: Ovjectives relating to rural lands
  - Cl.11 – Objectives (b,c,d,h,i)

  Division 2: Development Applications
  - Cl.14 – Land Supporting rain forest vegetation species
  - Cl.15 – Wildlife corridors

  Division 3: Draft LEPs
  - Cl.17 – Wildlife corridors
  - Cl.18 – Valuable natural environments
  - Cl.19 – Forests
  - Cl.20 – Environmental protection
  - Cl.28 – Floodprone lands
  - Cl.29 – Wildlife corridors
  - Cl.30 – Forests
  - Cl.31 – Soil erosion

- Part VII – Provisions Relating to Living Areas
  Division 2: Draft LEPs
  - Cl.73 – Bushfire management

- Part IX – Provisions Relating to Transport Corridor
  Division 1: Objectives relating to transport
  - Cl.80 – Objectives (b, c, e)

  Division 2: Principles – transport corridors
  - Cl.86 – Wollongong Region. Programme
  - Cl.89 – Bicycles (1)

- Part XII – Provisions Relating to the Escarpment
  Division 1: Objectives relating to escarpment
  - Cl.101 – Objective
  - Cl.102 – Escarpment area

These provisions and aims have been accommodated within the EIS Visual/Landscape Study.

7.2 PHYSICAL DESCRIPTION

Tomerong Valley, as a majority of the study area may be described, is enclosed westward and north-eastward by forested ridge lines which comprise part of the regional escarpment – behind Jervis Bay and Georges Basin.

The Valley incorporates the principal streams of Tomerong and Suffolk Creeks which geographically drain the north and south catchments of the study area. These two halves can be loosely demarcated by Turpentine Road.

The northern valley is closely confined by upland ridges almost

The northern valley is closely confined by upland ridges almost encircling both the midland slopes and the relatively low riverine band. The southern valley is by contrast not as distinctly enclosed. It is marked by the westward escarpment and partially contained by two low ridge spurs firstly between Tomerong and Suffolk Creeks, and secondly extending along the Grange/Island Point Roads.

Principal components of the local environment have been separated into the following.

The Village

Tomerong consists of the village located at the town crossroads and identified by a small highway service station on a cleared knoll. The village comprises a light cluster of rural-residential and residential lots about the crossroads, and outlying fragmented ribbon development of the same type. Village fragmentation mainly occurs as a result of intersection by Tomerong and Suffolk Creeks south, whereby there is an identifiable second residential cluster occurring at The Grange Road intersection.

Forests and Woodlands

The upland ridgeline, midland slopes (north catchment) and creek floodplain remain densely forested or wooded. Three major types of vegetation have been identified in a separate report: tall forest, woodland and riverine vegetation comprising alluvial and gully subtypes. (See: RTA EIS, Ecologists Report.)

Rural Lands

The midland valley floor above the narrow floodplains has been cleared extensively wherever the terrain has permitted grazing or other permissible uses.

Broadly this has occurred in three major segmented patterns - north, east and south of the village centre. (See Figure 7.1.)

Prominent Landforms

Discernible at the local scale are four primary landforms which comprise:

- Tomerong Peak - (twin ridge peaks) rising above the north approach to the village; it is accented by tall forest and forms the inner east escarpment of the valley, while its outer scarp is not visible from the present highway.

- The westward escarpment - defining the valley and slopes; covered by forest and woodland.

- The northern valley - an enclosed landform which remains predominantly forested.

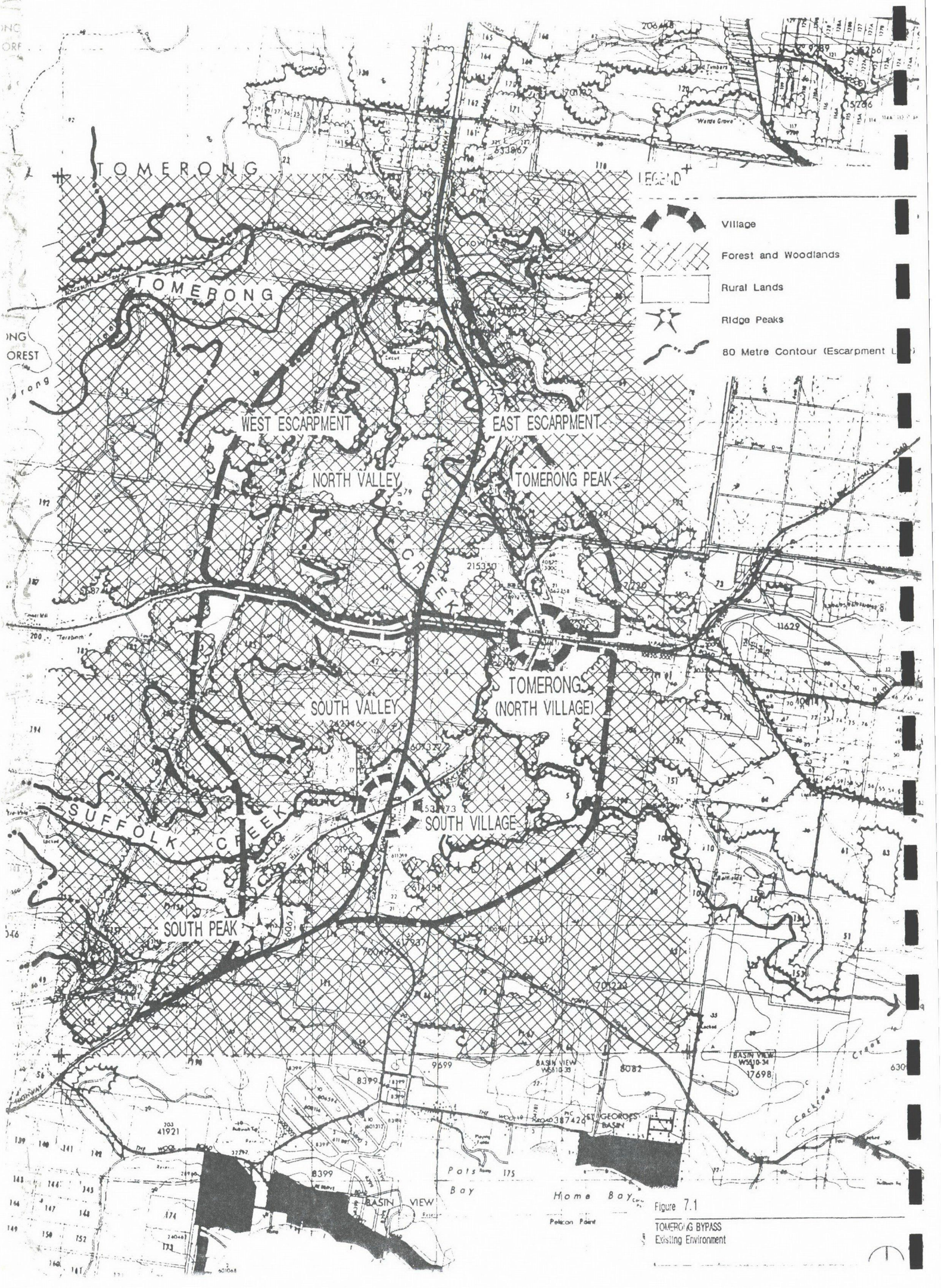


Figure 7.1

TOMERONG BYPASS
Existing Environment

- The southern valley – an open, or partially enclosed, landform which consists of mixed forest and rolling rural lands.

- South Peak – rising above the south approach to the village; it is accented by tall forest and forms the southern landmark punctuating Tomerong Valley.

Rather than being a separate component, the riverine floodplain visually merges with the valley floor – particularly as seen in middistant overlooking views from elevated vantages.
Various short and long views are presently available within the Valley. An indicative set of characteristics viewscapes have been recorded by photograph. (See Photomontages 1 to 6.)

Cultural Features

A variety of scenic features, at a lesser scale than the major landforms and forest types, have been identified which contribute to the village setting and are recognisable as landmarks by the local community. These comprise the following:

- the sawmill – south of The Grange Road;
- town hillock – at the village crossroads;
- town "river forest" – west of the village perimeter;
- village forest – southeast of the crossroads;
- town roadscape – featuring native figtrees, coral trees and norfolk pines; homesteads/residences and other domestic vegetation;
- north and south highway bends – which presently indicate the village approaches;
- bridge crossings – at Tomerong and Suffolk Creeks;
- transmission easements – east and west perimeter, and
- Turpentine stand – along the Grange Road.

In addition, potential or latent vegetation features suitable for accenting within forest sectors along a highway corridor include: clusters of Red Cedar, Sassafrass and Brush Cherry; single species stands of Turpentine, Spotted Gum, and other distinctive vegetation. (See Table 9.1 – Plant Groups.)

7.3 SCENIC CATCHMENT

At the macroscale, the Tomerong Valley has its own distinct landscape character which is quite different from other coastal valley plains along the NSW South Coast.

By definition, the visual catchment of the Tomerong Valley encloses the landform of the valley to its skyline comprising the ridge tops, and escarpment, as well as midland spurs along its open perimeter. Not all parts of the valley catchment will be visible as views can be blocked by elements such as trees, buildings and other structures.

Within this greater area may be identified a local catchment relating to the Highway Bypass. In this respect the Bypass would be visible only from certain vantages which are not obstructed by local landform and other elements.

In addition to vegetation screening, the distance of an observer away from an object will affect its visibility within the scenic catchment. For example, the highway seen from the foreground may be prominent in magnitude while from a distance it may still be visible but significantly reduced in magnitude.

The Tomerong Valley visual catchment has an overall appearance being made up of a number of broad landscape types, or areas with some degree of uniformity, which vary from village townscape and rural landscapes to natural environment. Within each of these types there are many visual characteristics.

The corridor landscape has been classified into a number of landscape units described as highway sectors. These are listed separately. (See Section 7.4 – Visual Character.)

Basically these character units have been developed from five (5) primary landform zones have identified: 1 Upland Ridge, 2: Midland Slopes, 3: Lowland Valley, 4: Riverine Floodway and 5: Townscape plus potential town gateways. (See Figure 7.1.)

Scenic Corridor – Linear Relationships

The highway/sector (unit) relationships form a travel sequence or series of visual landscapes (viewscapes) along the corridor, and through the various primary character zones. (Also see Section 8.2.2 – Scenic Corridor.)

The linear relationship determines a pattern of view changes which result in both regular and dramatic effects. The latter occurs particularly where the motorway emerges from an enclosed forest into a high quality open countryside.

Elsewhere this dramatic effect may occur where the roadway crosses a river offering sudden feature views, or where some other unexpected point of interest arises such as an accented town entry.

In this context, it is critical that open viewbreaks in the roadside landscape are designed or maintained along the corridor. Conversely, roadside screening should only occur where necessary to conceal unfavourable views towards and from the highway.

Distance Zones

The relevance of viewing distance is an important consideration in scenic assessment as variations in proximity (viewer to object separation) will either diminish or increase the prominence of environmental change.

Traditionally, viewing distance is separated into three components: foreground, midground and background, whereby distances may be prescribed according to analysis objectives.

However these definitions are not ideally suitable for the EIS visual assessment for sub-regional analysis required for a sensitive examination of the proposed motorway. As a result the following terms have been formulated to avoid confusion and are defined as follows:

-	Foreground	-	nil to approximately 600 metres
-	Mid distance	-	extending to 3 kilometres
-	Distance	-	extending to 6 kilometres
-	Background	-	far distance extending to infinity.

(The fore - and back-ground terms remain as commonly defined whereas the mid-ground has been separated into two components including the distant ground, to distinguish degrees of visual clarity.)

These preferred terms distinguish between views to and from the existing and proposed highway that respectively show detail features, mass features and almost indistinguishable features. (See Figure 3.1 - Visual Context.)

Distance Zones - Highway Visibility

In broad terms, the proposed motorway would have a potentially significant impact on its close foreground where any adverse affect may be unable to be controlled. Whereas further away (in the mid-ground) any potential impact would recede as the prominence of change diminishes in scale within the scenery.

The lowlying and horizontal form of the proposed motorway would contribute to it having minimal prominence in open countryside when seen beyond the close fore-ground (upto 50 to 100m). In comparison, within close fore-ground views its longitudal form (banks, cuts and carriageway platforms) would be difficult to ameliorate except by visual barriers along its perimeter and these may be accepted as part of the highway form with proper management and landscape treatments.

Overall, the majority (83%) of the Highway Bypass would be completely concealed by existing forest cover and landform except where it would be potentially exposed in limited rural settings.

7.4 VISUAL CHARACTER

Tomerong Valley can be characterised by its forest types, landforms and cultural landscape. A composite breakup into character units enables scenic components to be clearly recognised.

Briefly, there are six (6) types of character zones through which the highway bypass would pass and to which the corridor sectors have been loosely corresponded:

- town centre and village-scape – with roadside features;
- homesteads and rural lands – rolling grassland, midlands;
- upland forest/woodlands – ridge and midslope, (approximately above 80m contour);
- midland and forest/woodlands – enclosed valley and escarpment slopes;
- midland gullies – gully type riverine vegetation, and
- lowland floodway – alluvial riverine vegetation (approximately below 30m contour).

Detail characteristics of the cultural landscape, within each of these zone types vary significantly in response to local attributes of landform, vegetation and the cultural environment.

The Bypass corridor comprises a sequence of highway sectors which have been determined on the basis of relative homogeneity and broad character changes in the (existing and potential) roadside scenery reflecting the major character zones.

These corridor sectors have been identified as Highway Sectors A1 to 10 (referring to the preferred Option "A"), or otherwise described as:

HIGHWAY BYPASS SECTORS

1.	Upland Woodland	– North Tomerong
2.	Upland Forest	– Tomerong Peak
3.	Midland Forest	– Escarpment
4.	Riverine Forest	– Alluvial Type
5a.	Gateway	– West Tomerong
5.	Midland Forest	– West Tomerong
6a.	Riverine Forest	– Gully Type
6.	Riverine Forest	– Alluvial Type
7.	Gateway	– South Tomerong
8.	Midland Forest	– South Tomerong
9.	Midland Rural	– Open Skyline
10.	Midland Forest	– South Peak

(See Figure 7.2)

Besides annotating the sequence of visual transition, each of these sectors will provide a reference for scenic impact assessment and management prescriptions. (See Sections 8 and 9.)

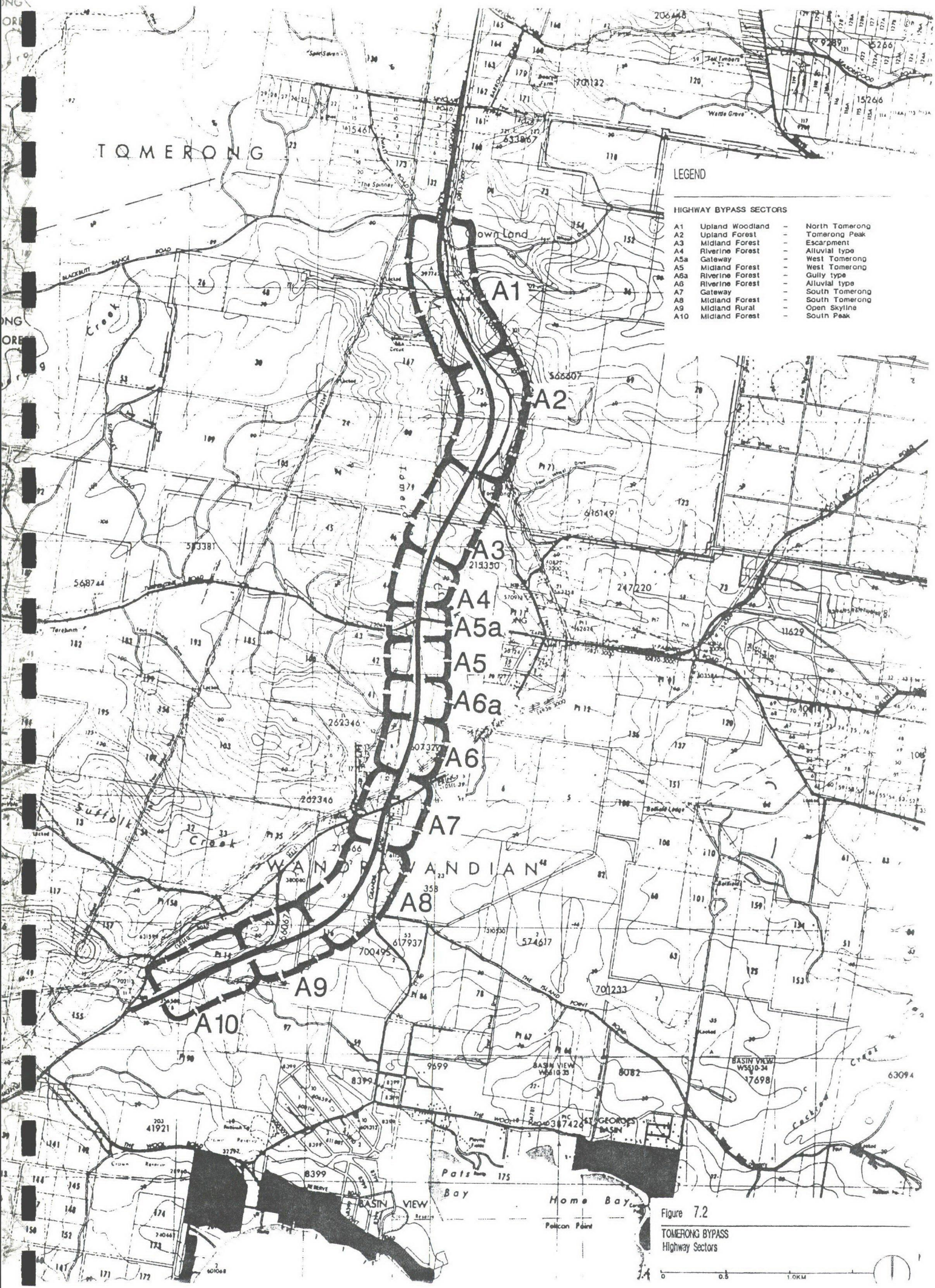


Figure 7.2

TOMERONG BYPASS
Highway Sectors

7.5 SCENIC QUALITY

The whole of Tomerong Valley has been recognised as part of a regionally significant landscape unit, called the Tomerong-Bewong Unit. In this context, the whole valley expresses a high quality scenic environment through which the Highway Bypass should be carefully fitted to minimise disturbance and maximise enhancement of the local character.

The "Illawarra Region: Landscape and Environmental Study" (1981) describes a variety of quality classes within this landscape unit. However within the DOP's overall classification all of the Tomerong Valley merits a high scenic value within the Illawarra Region.

Consequently, the Highway Bypass development should respond to this quality in kind by the RTA adopting a high standard of scenic design and management.

Valley Escarpment and Scenic Classification

The Tomerong Valley is a part of the Tomerong-Bewong Landscape Unit defined by the Department of Planning in its report "Illawarra Region Landscape and Environment Study" (DEP 1981). Regionally, this area has been ranked as having a scenic quality Class IIa and IIIa(II) by the DEP (Rating scale I to V: Low to High). However, along the Princes Highway this ranking takes on an increased value in relation to other highway landscapes - particularly as regional travel sequences are not frequently exposed to high quality Scenic Coastal Protection Areas.

The Valleys present scenic merit lies in its rugged and rolling character which offers panoramic views and enclosed vistas across forested escarpments and valleys, as well as contained open rural fields. It is important that this landscape character is properly managed to avoid unnecessary scarring and unsympathetic patterns which would unwantonly disturb the existing scenic environment. The DEP's recommendations include that skyline protection and retention of native vegetation be sought in the Tomerong Valley and its adjacent environs.

RTA's REF emphasises that skyline protection status be recognised and extended to include that within the viewshed of the proposed Highway Bypass, as well as that seen from the existing highway and main roads. Herein, this visual study concurs that the forest and woodlands of Tomerong's north and south valley are an important part of the escarpment control.

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7.6 VIEW POINTS

The Princes Highway is presently a road feature in many views seen from adjacent residences, businesses and public institutions.

Road intersections also expose the highway to district traffic, and unfolding views of the whole roadway route are available to motorists [*] and other road users. [* Motorist: driver and passengers.]

The existing road network presents a variety of enclosed and panoramic views of the local environment and potential views overlooking the proposed Highway Bypass. In contrast to residences which have views to the present highway there would be few which have potential views of the Bypass development.

A range of viewpoints have been identified which are representative of key vantages around the town and toward the proposed highway. (See Figure 7.3, Photosketches 1 to 3, and Photomontages 1 to 6.)

A distributive analysis of these key viewpoints indicates that the Highway Bypass would be prominent in one single area at South Tomerong. Elsewhere, the Bypass would be concealed or visually absorbed by landform and vegetation patterns. (See Table 7.1.)

The available views are mostly restricted to close foreground views within 400 metres of the proposed development. (See Photosketches 1 to 3.) A middistant view from a rural homestead beneath South Peak would overlook the Bypass descent down the inner east escarpment of Tomerong Park. (See Photomontage 6.)

The creeklines have been recognised as important features, however at present the bridge locations are not visually available to many regular viewers. As a result, these have not been illustrated with photographs.

7.7 VIEWER GROUPS

The potential sensitivity of views can be indicated by the number of observers likely to see any particular view. Typically a large number of viewers will tend to increase the likely sensitivity of a view to public concern, whereas a view without an observer has no scenic significance except for its potential attraction.

By definition, public sensitivity toward a view will also be affected by activity of the viewer, distance of the viewer, length of viewing time, as well as contributing factors such as angle of viewing in the horizontal and vertical plans, and percentage of total view occupied by a particular subject. (See Glossary – Visual sensitivity.)

Table 7.1 - Viewpoint Distribution

VIEW DISTANCE AND DIRECTION	VIEWPOINTS AND VANTAGE TYPE Existing Roadways	Existing Dwellings	Elevated Lookouts
Foreground View			
. photosketches	1	2,3	
. photomontages	1,3,5		2
Middle Distance			
. photomontages			6
Distance			
. viewpoints not available			
Background/Far Distance			
. viewpoints not available			

NOTE : "Before and after" photosketches have been illustrated to compare the likely effects resulting from the highway bypass.

: Photomontages have prepared to show countryside character and approximate location of the Bypass – where concealed by landform and existing vegetation.

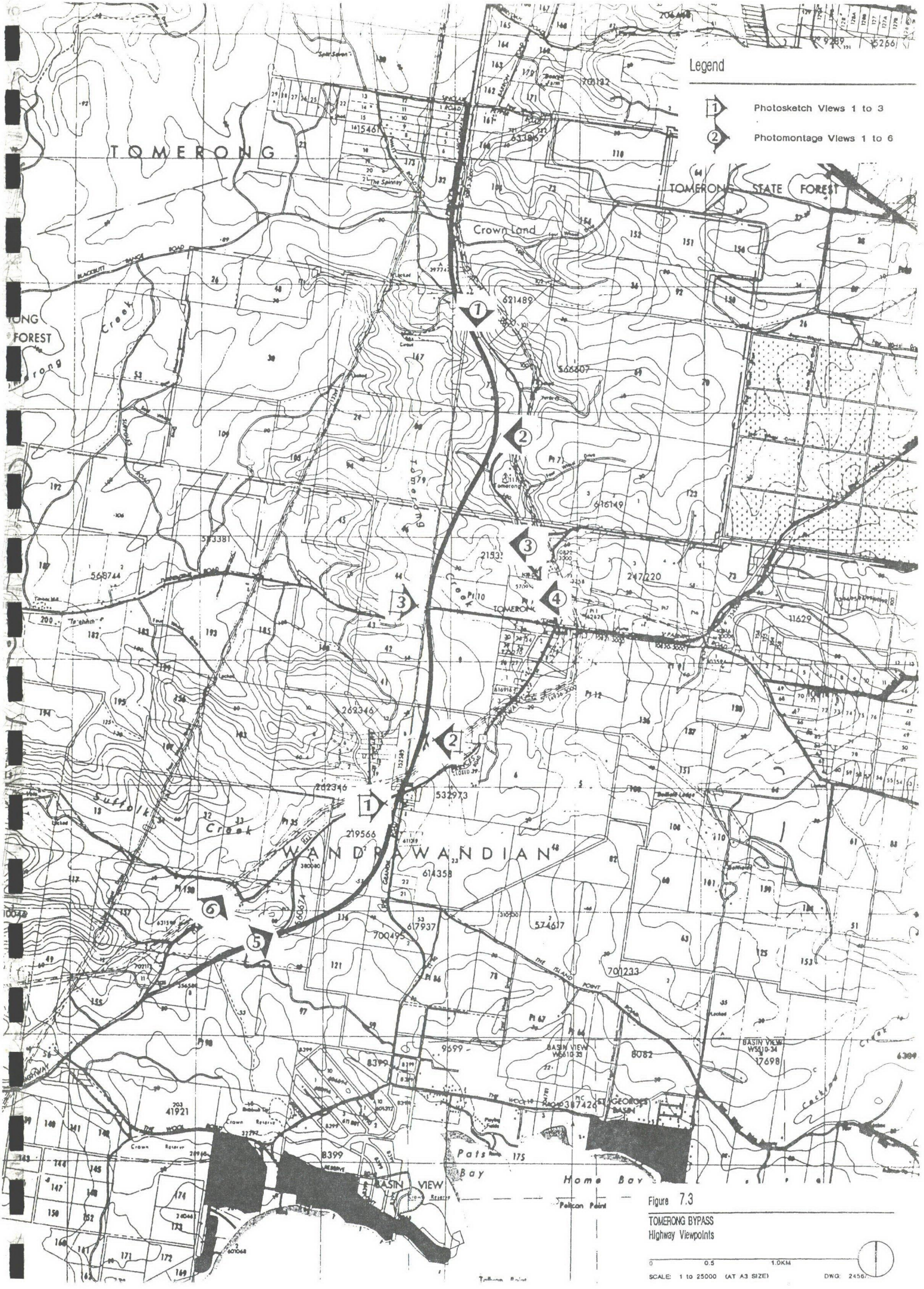


Figure 7.3

TOMERONG BYPASS
Highway Viewpoints

0 0.5 1.0KM

SCALE: 1 to 25000 (AT A3 SIZE) DWG: 2456/

In summary, major viewer groups will comprise the following:

- **Motorists** – commuters, residents, visitors, tourists and travellers from overseas, interstate, regional and local sources on a regular or less frequent basis.

- **Visitors** – local residents, regional day trippers and other visitors (weekenders and holiday makers).

- **Residents** – at workplaces and family homes.

The Tomerong locality has a current population of about 3,000 all of whom will regularly experience the scenic changes brought about by the highway Bypass. However the major viewer population will comprise regional and local traffic using the highway Bypass. Motorists [*] using the present highway and mainstreet intersections have been estimated by translating from AADT counts to comprise about 20,000 persons daily. [* Motorists: driver and passengers.] (See Appendix A2 – Viewer Population.)

The Princes Highway in its present location would be the only major road with a high traffic volume which may potentially expose a significant number of motorists to major parts of the Tomerong Bypass. After developing the Bypass the remainder of traffic using the present highway route we be reduced to local traffic. Other local roads which would afford views to parts of the Bypass are at the Grange and Turpentine Roads.

The Bypass would be routed away from the present Village centre and mainstreet residential development. As a result the viewer population of local residents overlooking a busy main highway would be reduced significantly.

The number of residential viewers looking toward the Bypass would be relatively low, about ten dwellings. These residents would have close foreground views toward the Bypass varying from 15 to 200 metres from buildings and driveways.

Public Sensitivity

Traffic volume and other large or small assemblies of people (stationary or passing) are useful indicators of the possible sensitivity of a landscape scenery to public concern.

The potential sensitivity of any specific view is a tempering factor, and when combined with consideration of other visual criteria such as distance and visibility of the scenery this value assists in determine the significance of change.

High scenic quality of the local setting and absence of any present exposure to highway conditions are factors which may be expected to increase likely viewer sensitivity of residents to the proposed Highway Bypass.

The route minimises disturbance to visual sensitivity by avoiding the Village centre and its mainstreet ribbon development.

At South Tomerong, where the Bypass/town gateway would be relatively close to adjacent residents and roadways, the resulting sensitivity would be relatively high in terms of the overall route.

However, public sensitivity in terms of the number of potential onlooking viewers (motorists and residents) would be low to moderate in comparison with Jervis Bay district and low in relation to the Illawarra region.

8. Environmental Impacts

Tomerong Bypass will be an important part of the Tomerong–Bewong Scenic Landscape Unit. At present the existing highway and proposed bypass would both extend almost the full length of the National Trust landscape unit, which encompasses the RTA study area.

Traditionally, highways have been an accepted part of the community's visual experience (both for residents and visitors). However, today there has also become evident an increasing concern for the protection and enhancement of amenity values along NSW highways. In this context, the National Tree Strategy [*] recognises the importance of highways as potential green corridors through urban and rural areas which may enhance the natural environment. [*: NTS – see Glossary.]

The present condition of Tomerong Valley which comprises the existing highway and its local environs has been used as the base line against which future change can be compared.

A primary objective of the final highway routing and control of construction disturbance will be to regulate the initial degree of impact resulting from the bypass. The ultimate objective of an established/mature landscape scheme will be to achieve an overall net benefit to the scenic environment, as well as integrating with other environmental controls particularly for public access and ecological management.

8.1 EVALUATION OF IMPACTS

Major impacts have been identified and a summary prepared in table format. This shows the type of impact and its management for each highway sector. (See Table 8.1 – Impact Summary.)

A description of the terms used to consider these impacts has been provided as a context for assessment. (See Section 8 – a, b, c, d.)

Then follows a commentary about these impacts related to views from various distance zones and along the proposed highway. (See Sections 8.2, 8.3.) This has been concluded by a statement of impact management. (See Sections 8.2 and 8.3.)

a. **Likely and Managed Impacts**

Impacts arising from changes affecting the built environment are of two types:

- Potential Impacts – which need to be identified so that certain initiatives can be adopted to respectively promote or mitigate the favourable and adverse effects likely to arise from change without thoughtful intervention.

- Managed Impacts – which result from design controls and other suitable initiatives being applied to a potential effect so that problems are reduced and benefits maximised.

The impact of change can be either adverse or favourable. An adverse impact will arise where a potential unwanted effect was either ignored or unable to be mitigated. In contrast, a favourable (striking or subdued) impact would be expected to arise from sound environmental planning and design.

b. **Scenic Capability**

Visual environments have a varying capacity to absorb change without significant effect. Local context and its visual components will influence any landscape setting enabling it to:

- exaggerate negative effects;
- absorb negative effects;
- accent positive effects, or
- temper positive effects.

Scenic capability, or visual absorption capability (VAC) is a term describing the relative ability of a built or natural environment to maintain an unchanged appearance after undergoing a specific type of alteration. This capacity is determined as a function of slope (vertical angle), screening (built or natural), and surrounding patterns (landuse forms and colours) to indicate the likely visibility of any particular development.

This capacity can be amplified or moderated by distance and view direction (horizontal angle). As a result the proposed bypass will have a different effect when seen from viewpoints north, east, south and west.

c. **View Frames – Distributive Analysis**

View frames are camera-like observations of a selected view from a particular viewpoint. Typically these may encompass a swung montage of views representing the natural view of a turning head, which has a greater range than the 60^{0} "field of visual regard" arising from a single viewline.

These frames provide an indicator for examining current conditions and projecting future possible impacts against the existing environment. This tool illustrates the combined effect of scenic capability, coupled with viewing angle and distance upon the visibility of a subject – the existing and proposed highway.

In addition, the effect of scenic impact management can also be represented to show the expected result of site planning and/or landscape design controls to modify a potential impact.

Detailed analyses of selected viewframes toward the highway bypass have been presented separately. (See Table 6.1 – Viewpoint Distribution, Photosketches 1 to 3 and Photomontages 1 to 6.)

d. **Macroscale and Microscale Effects**

Description of the existing environment reveals there are two major scales of view available toward the proposed bypass.

The macroscale includes distant and middle distant views which embrace the broad context of Tomerong Valley and within these views the highway occupies a minute percentage of bulk in the overall viewscape. Microscale or local views are those in which the proposed highway would feature in the foreground and/or occupy a significant percentage of the midground.

These two scales of likely visual impact are discussed separately. (See Section 8.2 and 8.3.)

8.2 MACROSCALE EFFECTS

Views toward the Highway Bypass from within the Tomerong Valley fall into two classes, the macroscale and microscale. There is a significant difference between the upland distant vantage across the whole valley and the mid distant to foreground vantages available along the highway bypass, which permit mostly limited glimpses contained by forest and forest margins or rural fields.

The macroscale environment encompasses a viewing reference which both/either enables a full panoramic expanse of the Valley, or an composite/overall set of sequential views by travelling along a corridor route.

8.2.1 Distant Views

Macroscale views from residences are available from only one distant location, a single homestead beneath Tomerong's south peak. This vantage overlooks both the north and south valley toward Tomerong's north peak–ridge and west escarpment.

The Highway Bypass will likely be barely discernible as a thin swathe sheltered between flanking canopies in this distant view. It would register as a horizontal fuzzy line beneath Tomerong Peak, similar to the existing highway, represented by a thinning in the forest canopy of the North Valley for a short length in the overall view.

As a result of viewing angle (horizontal and vertical) the full length of the bypass will be mostly screened by existing forest and midland terrain. (See Photomontage 6.)

Landscape capability, to absorb the proposed bypass is high because its hazy horizontal swathe form would fit closely against the line pattern of the present highway beneath Tomerong Peak. This capacity for visual absorption is exaggerated by the distance involved reducing the linear mark to that of minute magnitude.

At the macroscale within distance views, the proposed bypass will have a minimal potential impact which would not need to be specifically managed, except to control the local benefit of maintaining roadside tree enclosure.

8.2.2 Scenic Corridor

The Highway Bypass corridor experience will be part of both the macroscale and microscale environment of Tomerong Valley. It offers a foreground sequence of views which combine to give an overall impression of the macroscale environment. In fact the bypass route will increase the number and type of character transitions along the future motorway in contrast to the existing highway. (See Figure 5.2 – Visual Sequence.)

However it does not offer the repeated type of limited panoramic views which are available from the existing highway as seen from beneath Tomerong Park on the north uplands, as well as from the central and southern midlands across rolling open rural terrain. (See Section 7.6 and Figure 7.3.)

At no location has it been found that the bypass corridor will visibly disturb the scenic escarpment where it cuts down the inner west scarp of Tomerong Peak beneath the existing Highway.

Two potential onlooking vantages have been identified at remote open rural fields on the North Valley's western uplands overlooking Tomerong Peak and the Bypass descent. At ground level, this view would be mostly observed by intervening forest canopy and landforms. Future homesteads may obtain mid distant eastward views across the valley, however any possible view of the cutting swathe would be diminished by visual absorption into the ascending canopy of the adjacent forest (See Photomontage 6.) (Note: the effect would be similar to swathe absorption seen from South Peak. See Section 8.1.1.)

Sequentially, the character transitions along the Highway Bypass will require impact management to control the potential effects of final route alignment (horizontal and vertical) and resultant construction disturbance. Impact management will be necessary to maintain and reinforce latent and present character changes as landscape themes – rather than developing a uniform revegetation along the bypass reserve. (See Figure 5.2 – Character Transitions.)

8.2.3 Highway Reassignment and Gateways

Reassigned and/or abandoned sectors of the existing highway will result in its primary afteruse as Tomerong's mainstreet [*] – in four sectors: north, central, south and far south bends, broadly. (See Figure 7.1.) Potentially renamed Tomerong Road, these mainstreet sectors will benefit from a scenic rehabilitation strategy. Future possible enhancement along key parts of this main-street should be discussed between RTA and Council, prior to handover after declassifying the present highway of its main road status. (See Sections 9.2 and 9.4.) In particular the Village crossroads as a cultural landmark will likely lose its central focus after the bypass construction and would benefit from an enhanced thematic definition – Norfolk Pine in Village centre are failing and the present number of Coral Trees, which are both regionally characteristic may be insufficient to accent a village theme. [* mainstreet: herebeing a country road and secondary access spine road maintaining a link through the village.]

In addition, the opportunity has been recognised for a second accent at Tomerong's proposed south gateway alongside Grange Road. This gateway precinct may be defined as the area in which the Bypass emerges from the Forest (Sector 7 – Figure 7.2), however it would focus on the present intersection of the Grange Road and existing highway as well as including the Island Point Road intersection. Thematic emphasis at this future entrypoint will be required to offset the loss of town identity currently provided along the highway by a prominent central area and existing village character.

In this manner, intersection development and possible enhancement of a future mainstreet will become a visibly important part of the bypass corridor development and its impact management. The reassigned south section mainstreet would be visible from the Bypass at the Grange Road and from the connected bypass intersection at a extension of Island Point Road. In addition, further south the presently unmarked skyline of this mainstreet sector would be seen where the bypass emerges in a field between the Ironbark Forest (Sector A8) and South Peak bends (Sector A10) – providing an opportunity for cultural accent planting to be displayed in motorist views and extend the village theme. (See Table 9.1 and Figures 9.4a and b.)

The far south sector of existing highway will be abandoned through the present south bends beneath Tomerong's south peak. A final bypass alignment should seek to maximise the afteruse benefits of highway abandonment with positive management. Potentially, a highway rest area in this location could take advantage of the proposed abandonment of some existing highway bends, set amongst tall forest scenery, as a positive benefit resulting from the bypass development.

Lastly, within the reassigned highway, (village mainstreet) there will be a future opportunity for a South Coast bikeway to be accommodated separately from the Bypass traffic should this be recognised as a long term potential benefit.

8.3 MICROSCALE EFFECTS

The microscale environment represents the viewscape within the mid distant and foreground zones, upto 3.0kms and 600 metres respectively. This scale incorporates local and detail views along the Bypass, as well as including the few associated overlooking residences.

At South Tomerong and north beyond Tomerong Peak, these distance zones visibly overlap with those of the existing highway where proximity and forest breaks permit. Mostly the two roads are visually separated by landform and vegetation. However, where there are common views between the two roadways the importance and scenic sensitivity of this joined viewscape increases in proportion with an expanded viewer population. [*: public sensitivity: see Glossary.]

View Replacement

The Highway Bypass will displace existing views from ten (10) residences alongside the Grange Road and Barham Road at South Tomerong, a sector length of approximately 700 metres.

These views are important as they appear in the one location where the bypass would address open countryside within a mid distant outlook, as well as being associated with the village entry into South Tomerong. At this location, the landscape shows the village and rural foreground framed against midland forest on the left (south west) and riverine forest on the right (S.W.W.) with a glimpse of distant skyline rising beyond the near forest edge.

At present, the nine identified residences enjoy various parts of this viewscape – either intentionally or incidentally. The bypass will obstruct this broad view and it will be important that final routing respects this scenic sensitivity and that a compensatory quality landscape treatment be established along the roadway margin between the bypass and Grange Road.

As part of this view change, it will be important that the bypass development incorporates/recaptures the above surrendered view for availability to motorists. Scenic management of roadside landscape works will be required to maintain this countryside view. The potential loss of this view to the local community and motorists would be an undesirable impact that can be avoided.

The following describes typical microscale effects along the bypass corridor which have been grouped into three nominal classes: Forest, Rural and Highway [*] precincts. [* "Highway lands": indicating where the existing highway will be closely parallel to the bypass and there is potential for a common overlook and/or visual intrusion.]

8.3.1 Forest Lands

Restricted close foreground views will be available into the adjacent forest and along the swathe-vista of the bypass. (See Figure 7.2 - Sectors A 3,4,5,6 and 8.)

a. Character Transition

These forested natural corridor precincts traverse and expose the major vegetation types of Tomerong Valley (tall forest, riverine forest and woodland at different terrain elevations). In particular, the forest types display a range of vegetation associations varying between Spotted Gum forest, Ironbark forest, Paperbark swamp, Cabbage Tree Palm association and other distinctive stands.

It will be important that the natural forest character along the bypass be reinforced to promote the existing transitions, rather than develop a uniform response to replanting the disturbed roadside margins in the forest.

Scenic benefit will decrease markedly and an undesirable adverse impact result should the forest character transitions be concealed by a uniform planting treatment.

b. Bank/Width Disturbance

The majority of the Bypass will be through forest and it will be important that the swathe is minimised by least site disturbance. This will require careful attention to both vertical and horizontal alignments which would reduce the width of swathe scarring and minimise the extent of revegetation.

Critical width of disturbance will vary in relation to the depth of cut/fill and adjacent gradient. The potential for excessive disturbance will occur during construction to allow machine work and crew access at the top and bottom of banks. This potential impact of excessive disturbance must be properly managed or result in an unnecessarily wide swathe, losing mature trees and requiring additional revegetation. (See Appendix A3 - Swathe Disturbance.)

At some locations where the bypass is at or close to existing roads, there may be an opportunity to retain mature trees quite close to the road edge[*] and permit a canopy overhang – tying in with an ecological strategy for arboreal fauna movement. [*: tree barriers should be installed where required.]

c. Rock/Earth Cuttings

The greatest extent of deep bank cuttings exceeding 3.0m height occurs along the bypass descent from Tomerong Peak to Tomerong Creek down the ridge spurs of the inner east forested escarpment. (Adding up to about 550 metres length in an overall 900m sector with a cut scarp reaching to 12.5 metres depth at 2:1 – this would result in a disturbed swathe of about 30.0m.)

Where these cuttings are excavated through stable rock, the incision can be minimised by a steep rock face (c.2:1). Notably, in response to aesthetic values, the final profile should be possibly benched and detailed with attention to the silhouette and surface finish (scraping pattern, etc) to reduce visual impact. In particular the cut–scarp edges should be returned carefully into the adjacent gradient, by rounding out the top profile.

Poorly designed rock–cuttings would result in an unwarranted adverse impact that can be avoided. In contrast, deep earth cutting will be determined by an angle of repose (c. 1:2) and unlike rock cut, these raw earth works may be altered by bank planting.

Overall the degree of impact for rock/earth cuttings would be moderate to low with careful management.

d. Earth/Boulder Fill

Bank fill will not be visually evident to motorists as it would occur below the view line. However, the extent of lateral fill will determine both the swathe width and resultant proximity of mature forest retained alongside the Bypass.

The largest extent of deep fill, above 3.0m depth, occurs in the North Valley where the bypass bridges Tomerong Creek and crosses a midland gully and upland gully heads (the latter located in forested precincts parallel to the Pacific Highway). (Deep fill will total about 1.0 kilometres length in 3000 metres.)

Potentially, the extent of disturbance arising from most of these earthbanks could be contained by use of quarried boulders (should site material be suitable) to form an armoured batter at a steep repose (approx 1:1), rather than an earth batter of relatively moderate repose (approx 1:2). Revetment variations could be designed which combine rock walling or earth batters with a vertical toe wall – which may be useful on long downslopes or where lateral disturbances would be ecologically sensitive.

Overall the impact would likely be moderate to low with careful management of the construction disturbance to reduce unnecessary damage of the forest edge.

Notably, boulder-faced batter would contribute to the ecological strategy by developing an inhospitable terrain for most ground dwelling fauna. This would thereby directly influence fauna movement toward preferred road crossings (such as, underpass culverts beneath embankments and fence breaks at level ground located within the visible centre of the highways straight stretches).

e. Verge Treatment

Within forest areas, the proximity of verge planting will have an effect on visual enclosure of the bypass as seen by motorists. Tree and shrub planting [*] close to the verge will provide an intimate scenic relationship, while open or grass verge will have the opposite effect. [*: Traffic barriers will apply where required.]

Verge planting should mimic and not prevent views into the adjacent understorey, preferably it would maintaining exposure of the forest character alongside the motorway.

Linked with the ecological strategy, it will be desirable to plant shrub along the bypass verge to discourage native fauna feeding on grassland by the roadside and being exposed to potential collisions.

Fencing the bypass reservation through forest has the potential for various degrees of impact depending upon the location of type of fence materials. Strand wire fencing would have low visibility and high scenic absorption. However, the control of ground fauna movement will require barrier fencing to funnel access toward underpass culverts and fence breaks located at strategic level crossings. The preferred chain mesh fence will require visual management to reduce its scenic impact, such as height control, green colour-bonding and/or vegetation screening.

Drainage control will be an important part of the verge management, as there may otherwise result serious adverse impacts such as erosion and sedimentation scarring. Design for drainage should respond to the local terrain and runoff flow. In particular drainage structures (lined channels and discharge outlets) should be built incongruously, rather than display a low quality visible impact.

f. Features - Bridges and Creeks

Tomerong and Stewart's Creek will be the two main watercourse features evident through the forest precinct. These localities will be emphasised by low-bridge crossings across the creek floodways.

Final design of these bridges will contribute to the overall bypass scenery, which would potentially develop either a positive striking or neutral/regular architectural effect.

Design development of these bridges (beyond this EIS visual study) should address the regional context and local bypass environment. Detail consideration should be given to all elements of the bridge architecture to ensure a sensitive and responsive form – particularly addressing the termination walls, abutment walls, piers and railings which enhance the engineered primary structure.

Bridge railings should be defined to permit views through to the creek, rather than obscure this feature resulting in an adverse impact which could be avoided. (See Section 9.2 – Scenic Guidelines.)

Other features within the forest include the scenic transition of forest types and tree associations – described elsewhere. (See Section 8.2.1 Forest Lands – Character Transition.)

g. Other Structures – Highway Elements

Fences and culverts have been discussed elsewhere. (See Section 8.2.1 Forest Lands – Verge Treatment.)

Medians – At strategic places for arboreal fauna movement, where there is a potential that the aerial canopy would be breached by a two-lane highway it may be preferable to separate the traffic lanes and allow retention of mature trees in a median (say 5.0 m wide) to maintain an uninterrupted canopy cover. (SUBJECT to landuse and other site constraints.)

Scenically, this would add a positive benefit to the bypass route by contributing variety and enclosure along the route.

Jersey Kerb (modified) – Certain traffic engineering conditions may warrant the introduction of jersey kerb. This should not be used extensively or it would result in an unnatural visual effect blighting the scenic environment. Where critical, it may also be juxtaposed with guard railing on the opposite roadside to mitigate any potential visual channeling effect.

At required locations along the verge, a modified kerb type of medium height kerb-walling (c 0.5 m height) would be preferable to a full height jersey kerb (c 0.8 m height) which blocks adjacent viewlines and may result in an undesirable impact where features are concealed. Full height kerb-walling should only be used where scenic shielding is required and would be associated with screen planting either in front or behind the kerb. GUIDELINE:A quality assembly and surface finish will be necessary to establish a scenic/urban standard for all concrete walls.

Guard Railing – continuous use of ground railing should be avoided to prevent the unwanted effect of a channelised roadway, except where pedestrian traffic safety conditions apply, and other techniques are constrained. Usually guard railing will be required along the top of fill banks exceeding 2 to 3 m height.

While a variety of guard railings may be available, the basic type has been 'Armco' railing commonly adopted by the RTA for general application. Used with sensitive discretion and not excessively this railing will tend to have a low or neutral impact. However, close screen planting either before of behind this railing will further mitigate its effect and may result in a positive embellishment where appropriate.

8.3.2 Rural and Village Lands

Open foreground views will be available across adjacent village development and rural fields alongside the bypass at limited localities. (See Figure 7.2 – Sectors A5a, A7 and A9.)

a. Character Transition

The rural precincts along the bypass route are restricted to three locations, comprising a total 1.2 km reach of the 7.0 km corridor. Major open views will occur at South Tomerong where the bypass flanks The Grange Road and Barham Road. (The impact on this viewscape has been described in Section 8.2 – View Replacement.)

Minor views of rural areas will be displayed through the forest verge at Turpentine Road, and elsewhere as the bypass emerges between the South Tomerong midland forest and Tomerong's South Peak highway land (at Sectors A5a and A9).

These minor views are important within the overall character transition as they provide scenic relief from the predominant forest which encloses the bypass for the majority (83%) of its corridor length.

As a result diminishment of these minor views by screen planting would be an undesirable impact. Preferably, embellishment of the cultural landscape with a striking exotic and/or native tree composition could enrich the scenic environment and result in a positive benefit. Two examples of impact benefits are described for the lesser rural views.

In particular, where the present highway runs along the skyline which would be seen from the South Tomerong open field break (Sector A9), there is an opportunity for exotic planting in the existing road reservation that would result in cultural landscape effect enhancing the rural view (eg. Silky Oak or Indian Coral tree rows along the skylines, or similar).

At the Turpentine Road locality, the view break is short and slightly restricted by a light forest margin in places. The opportunity for a striking native planting alongside the outward (westside) reservation of the bypass would accent the scenic address to West Tomerong – which is presently zoned rural residential and anticipated to develop slowly as a residential estate.

Bank/Width Disturbance

Overall earthworks through rural lands will be either at-grade or mostly close to present ground levels, resulting in a minimum width of disturbance and maximum opportunity to protect existing tees alongside the proposed bypass.

At South Tomerong, the bypass would be closely parallel to the Grange Road and partly occupy Barham Road through open rural country. **The proposed T-intersection** with the existing highway would occur where the bypass will be at-grade for about 50 m and disturbance limited to the bypass swathe and construction tracks along its verge (15.0m wide). **North of this intersection** the bypass will be on less than 3.0 m fill for about 250 m, resulting in a shallow bank both sides extending up to 6 m in width and a moderate disturbance band (27.0m wide) - which would require a careful alignment to minimise loss of adjacent individual trees and the forest edge (both of which are minor features in this locality). **South of the intersection** the bypass would be in less than 3.0 m cut for about 200 m, resulting in a shallow bank and a moderate disturbance band (approximately 27.0m) - similar alignment care will be required to maximise protection of existing solitary trees and stands which are mature features alongside the Grange Road residential strip.

An avoidable local impact at the South Tomerong gateway would arise should freestanding trees and finger stands of Turpentine be lost alongside the Grange Road. Careful alignment siting would retain these trees as a major feature in local residential and motorist views.

At the Turpentine road locality, where the Bypass would be set variously within and along the forest edge of a rural clearing and forest growth, the proposed motorway would be at-grade for 300m south of the proposed T-intersection with the existing local road. This will result in a minimum disturbance (15.0m wide). Alignment siting should aim to **retain a maximum number of mature trees** along the westward forest edge by locating the bypass within the Spotted Gum Forest.

At the South Tomerong locality, where the Bypass emerges into open rural lands between midland forest (Ironbark association) and the tall forest below Tomerong's South Peak, the ground disturbance would be moderate (variously more or less than 3.0m cut across 450 m). However, trees are scattered in this location and the locality is not readily visible from the present nearby highway on the skyline of the above described rising rural land (at Sector A9).

c. Earth Fill/Cuttings

Earth cut banks will be visible to motorists and tend to obscure outward views to rural/village lands from the Bypass. There would be a resultant tendency to direct views along the direction of travel. The motorway would be depressed and concealed from adjacent onlooking views. This effect would occur alongside the Grange Road south of the Tomerong gateway corner, and without landscape treatment, would tend to maintain the existing residential outlook.

Earth fill banks will elevate the bypass and promote views for motorists. However, these banks would be visible to adjacent onlooking residents and encroach on their existing views. This effect would be limited to two homesteads north of the South Tomerong intersection/corner. The local views affected, eastward and westward, toward the Bypass are not significant although close to these residences. The resultant change would have a low-to-moderate effect because of a balance between close proximity and absorption by the forest background. Scenic management with appropriate verge treatment would reduce the impact to either an almost negligible or positive effect, depending upon the detail design response.

Other rural localities at Turpentine Road and the outlying south rural land, are not significantly effected by cut and fill banks in terms of local view changes.

Overall the impacts would be almost negligible or positive with scenic management of the verge treatment.

d. Verge Treatment

Roadside treatment with landscape works has the potential to soften the raw effect of cut/fill banks and/or accentuate the barrier effect of these banks, while also controlling viewlines both along the motorway and outward views to the countryside. Landscape planting may result in either view loss or vista control and should be carefully formulated to achieve a positive effect.

Generally, along the South Tomerong gateway, motorist views should be available westward along the Bypass to maximise a positive outlook, while landscape screening be incorporated to minimise adverse effects of the bypass proximity to residents.

Verge treatment will vary in relation to the adjacent context.

In particular, feature treatment to accent the South Tomerong gateway will result in a positive effect for motorists and the local community. Alongside the Grange Road and at the two intersections/corners (Island Point Road and present highway) it would be appropriate to introduce a strong cultural planting treatment, such as Fig Trees, Silky Oak or other trees typical of the South Coast villages and countryside.

North of Grange Road, alongside the three (3) affected residences, this part of the gateway locality could be treated with landscape works which merge with the adjacent forest. South of these residences, accent treatment could begin to link with the feature treatment suggested for the intersection/corner and alongside the Grange Road.

At Turpentine Road, verge treatment along the Bypass could be extended along the country road for the extent of intersection works to enhance this locality. The open outlook should be retained by low planting and open tree groups. Future housing should be screened from headlight glare by low shrub, which also permits outward views.

Along the bypass in the outlying south rural land, northward views should be maintained toward the skyline where the present highway is located. Verge treatment should comprise open tree groups and low planting (low shrub, rural grasses etc) to achieve a preferred effect of maintaining the rural outlook.

e. Features – Bypass Intersection

The intersection/corners and margin between the Bypass and the Grange Road offer an opportunity for feature planting. (See Verge Treatment above.) Tree selection should be based on the cultural species common to the South Coast Region which builds on the existing character tradition, or adds to this by another plant selection. The present common trees such at Native Figs, Indian Corals, Silky Oaks may variously contribute stature, form and colour as a distinctive accent, especially when massed and contrasted against each other or the adjacent forest trees.

f. Other Structures

The C–Type intersection proposed at the South Tomerong Intersection/corner will incorporate a median and pedestrian refuge. It would be associated with luminescent yellow refuge bollards and the overhead signage of a pedestrian crossing, without formal zebra–lines.

This median refuge has the potential to be developed as either a "dog–leg" fenced enclosure or as "dog–leg" kerb–wall barrier (modified jersey kerb).

A kerb–wall barrier within the median would offer visual benefit and increased physical security, particularly if the median width incorporated a shallow bank planted with groundcover between the kerb–wall (c. 0.8m ht) and a raised kerb (c. O.3ht). (See Figure 9.4 – Pedestrian Refuge.)

The scenic effect of the walled barrier would result in a soft feature and accentuate the intersection as a positive element along the Bypass. The fenced refuge would be an incongruous element subject to periodic damage and, with/out maintenance, may become a comparatively detractive element, albeit minor, along the bypass.

g. **Property Access**

Visual/physical disturbance of rural driveway entries would only occur to one property as a result of Barham Road being partly incorporated into the Bypass.

This residential property would be readdressed by direct access to the Bypass with a new driveway.

Undeveloped rural residential and forest property both north and south of Turpentine Road which are presently serviced by a crown land road easement would be dislocated. These forestry estates and existing lot sub-divisions would be readdressed by direct access to the Bypass with rural driveways where required.

8.3.3 **"Highway" Lands (Parallel Lands)**

Restricted close foreground views will be available into the adjacent forest and along the swathe-vista of the bypass with occasional glimpses through the adjacent forest margin on the existing highway. **(See Figure 7.2 - Sectors A1, A2 and A10.)**

a. **Character Transition**

These parallel highway precincts traverse the upland forest/woodland north of Tomerong Peak and the midland forest east of Tomerong's South Peak.

It will be important that the natural forest character along the bypass be reinforced, particularly the linear margin between the two roadways to prevent gradual long term deterioration of this narrow strip from detracting the motorist experience.

Scenic deterioration of this margin would be an undesirable impact and avoidable with careful management

b. **Bank/Width Disturbance**

The bypass will result in various widths of disturbance. A preferred centreline separation of 35m minimum between the roadways has been identified to prevent the two swathes (existing and proposed) becoming opened as a single wide swathe with potentially only occasional mature trees along the separation margin. At present the forest margin along the existing highway is mostly close to the verge throughout these sectors, whereas the bypass swathe will vary with the extent of bank distrubance.

North of Tomerong Peak cut and fill banks will result in a variable swathe primarily as a result of both crossing three minor gullies where **deep fill** (exceeding 3.0m ht.) would be required, and of trimming the geometric approach to ridge spurs where **low cut** (less than 3.0m ht.) would occur. Intermittent sectors would regularly occur at grade resulting in a minimum swathe at these locations.

Deep fill above 3.0m height will result in a moderate degree of bank disturbance (27.0m wide minimum) for about a total 650 metres. At one of these locations (about 250m) the centreline separation would be less than 35 metres between roadways and result in a narrow undisturbed band of about 12 metres wide for protection of mature trees. **Deep cut** will be minimal being less than 25 metres in length. **Shallow cut** will result in a disturbed bank about 20 metres wide for about 600 metres length sections at-grade will have minimum disturbance and total about 1.5km.

Beneath Tomerong's South Peak through forest the Bypass alignment would parallel and intersect the existing highway within a 30m centreline separation. Bank works variously change from both deep and shallow fill to cut across about an 800m total length.

Potentially deep fill exceeding 3.0m with a bank of moderate disturbance (27.0m) will be encountered at two locations totalling upto 150m length, both of which are within 20 metres separation of the existing highway. The result would be an undisturbed margin of 5.0m maximum for protection of mature trees. **Shallow cut and fill** will result in a similar effect of swathe opening as the bypass would have less than 20 metres centreline separation at these locations, particularly at intersections with the existing highway.

c. Earth Fill/Cuttings

Deep cut banks do not occur to any significant extent, and as a result there is minimal hindrance to lateral views by motorists. Shallow cut banks will occur which permit views into the adjacent forest and also across to the parallel existing highway - where this has not been concealed by an insufficient margin separation. Deep and shallow fill together occupy upto about half the length of roadway parallel to the existing highway; while not directly visible to motorists this elevates motorists views into the adjacent forest.

Overall the impact of cut and fill will have a minimal effect on motorist views and there are no onlooking residents. Scenic management by verge planting in keeping with the adjacent forest character will further reduce the scenic impact.

d. Verge Treatment

The proximity of verge planting through the forest will contribute to visual enclosure along the bypass. In particular, tree and shrub planting will be required where parallel swathes begin to merge as a single wide disturbed bank.

(Also see Section 8.2.1 Forest Lands – Verge Treatment.)

e. Features – Escarpment Peaks

There are no built features within these perimeter forest lands. However, the rugged terrain beneath Tomerong's north and south peaks alongside the roadway does provide a nature feature in terms of rising and/or falling ground above and below the motorway. This is a local effect which enhances the forest character rather than contributing a significant landmark.

f. Other Structures

Fences and culverts have been discussed elsewhere. (See Section 8.2.1 Forest Lands – Verge Treatment.)

8.3.4 Temporary Stockpiles and Site Compounds

The location of site compounds will be determined at detail design stage or as part of the construction contract.

It is anticipated these would be erected at more than one location. Within the upland forest, these are likely to occur parallel to the existing highway for convenient access to telephones, power, water and roadway. A position alongside the bypass construction on the side away from the existing highway will prevent a potential visual detraction for motorists during the bypass development and avoid any additional disturbance in the forest margin between the two roadways. Similarly the use of available ground which is already at-grade and sparse in trees will minimise disturbance. As a result the impact in this location would be minimal, should these management precautions be adopted.

Other favourable sites would be locatable in the open-understoreyed forests south of Turpentine Road and west of the Grange Road, for the central and southern bypass sectors.

Boulder stockpiles would be anticipated to be minimal as a result of rockwall construction being implemented in-tandem with deep cut quarrying through the sandstone sections. Similarly, the earth subgrade material would be relocated to its final position during the bypass construction as a part of the balanced cut/fill operation.

Demolition of trees and understorey along the bypass swathe should be controlled and all stockpiling, prior to disposal or final location (by timber harvesting, woodchip mulching, burning, off-site cartage or ecological recycling), would be strictly avoided in any area outside the preferred maximum disturbance line – being 3.0m beyond the finished banks and at-grade verges. Except for site sheds, disturbance beyond this line will result in an undesirable impact which can be avoided by site management.

Designated areas outside the disturbance should be established to stockpile site topsoil, woodchip mulch and selected timber/stumps suitable for reuse in the landscape/ecological strategy. In particular, site topsoil and forest litter which is abundant with native plant seed should be locally stockpiled within the vegetation character zone from where it was stripped for reuse in the same zone. This type of site management will be important to prevent mixing the plant themes alongside the bypass, as regeneration within replanting beds would be expected to match the current vegetation zones.

8.3.5 Planting Themes and Wildlife Habitat

A variety of planting themes have been prescribed for scenic management along the Highway Bypass perimeter. (See Figure 9.5 and Table 9.1.)

Themes have been identified which will fit into the character of the present environment through forest and rural/village areas. In addition the planting structure (height and mass arrangement) has been recommended to conceal or mitigate the presence of the Bypass in views from adjacent residences and roadways.

Landscape arrangements and final selection of plant species will also be integrated with the ecological strategy for maintaining wildlife habitats and discouraging the movement of native fauna on to the motorway. In particular, shrub planting will be reestablished upto the road verge through forest areas and grass edges prohibited to discourage roadside feeding by native animals.

Other highway landscape elements will also be strategically incorporated to address fauna movement. These would include the location of perimeter fences and fence breaks, rock walling, fauna culverts and signposting of at-grade crossings (opposite fence breaks). In addition, there has been identified the potential retention of canopy overpasses by identification of strategic tree stands during the design development and construction phase. It is understood that the consultant ecologist would be retained for advice during these stages.

The above principles and actions would support a landscape strategy which will reduce the risk of fauna-strike and are compatible with thematic requirements for mitigating the visual effect of the proposed highway bypass. (Also see Section 9.2 - Management Guidelines.

8.3.6 Highway Lighting and Night Effect

Overhead lighting will be introduced at the two intersections associated with the South Tomerong Village gateway (Sector A7, at chainages 21.75 and 23.33 kms). At present there is no street lighting in these locations and this lighting will affect adjacent businesses and residences. Lighting would be similar to regular urban street lamps and the proximity to the adjacent buildings would be sufficient (20 metres minimum) to avoid any undesirable direct glare during the night. The adverse impact would be minimal and the lighting would be likely to result in a positive benefit in terms of addressing these locations for the business/residential occupants.

Other night effects likely to occur which may affect existing and future residences are headlight glare from passing motorists. This potential would only be present past rural/village areas alongside the Grange/Barham Roads and Turpentine Road. However, direct headlight glare would not occur, rather only passing lights and these would be mostly screened by landscape planting along the road perimeter. Vehicle exit from bypass intersections would also not directly affect adjacent residences. As a result this type of potential impact will be negligible.

8.4 IMPACT MANAGEMENT

A different response will usually be necessary to manage the effect of a highway development on the macro and micro scale environment. However at the macroscale of the whole Tomerong Valley, the view change will be inevident with escarpment control management.

At the microscale, a prominent change will result only at some locations limited mostly to the proposed road intersections and associated approach lanes, especially past rural/village lands at South Tomerong.

In terms of macro and microscale sequential views along the motorway, the Highway Bypass would be developed as a scenic corridor through the Tomerong Valley – strung between the Village's north and south upland peaks descending into lowlying lands of the valley floor and across creeks. Mostly the bypass would be concealed within the local forests which will be displayed along the motorway for the scenic benefit of motorists.

The Tomerong Bypass will also result in redevelopment of a regional gateway to Jervis Bay and St. Georges Basin as well as affecting the local village entry. It will be important to address the gateway at South Tomerong as a distinctive landmark for regional visitors and the local community.

Table 8.1
IMPACT SUMMARY

Main purpose is to identify issues and the management control. Rating is simply a general indicator for comparison not substantive evaluation.

(READ IN CONJUNCTION WITH FIGURE 7.2 – HIGHWAY SECTORS.)

Highway Sector/Impact Types	Potential Impact	Managed Impact	Management Control*
			* See Section 9.2.4
NORTH VALLEY			
A1. Upland Woodland – North Tomerong			
Macroscale effect will be nil. Macroscale effects will include:	o	o	–
. Highway reassignment, resulting in existing north bends becoming a country road	1+	N/A	xxiv
. Bypass proximity to existing highway, requires separation of two swathes	2	0	v
. Bypass intersection with existing highway	1	1+	i
. Cut and fill banks, +/– 3m ht. – raw to finished effect	2	2+	xxii
. Width of swathe disturbance	2	1+	iv

KEY: COMPARATIVE RATIO

N/A : Not Applicable
0 : Nil effect
1 : Low rating
2 : Moderate
3 : High rating

( ) : Negative adverse effect
(+) : Positive benefit effect

. These ratings are used as a broad indication for comparison within each of the respective macro and microscale contexts.

. The Managed Impact rating indicates whether enhancement will improve the potential impact; apart from showing the general degree of benefit it is not intended as a quantitative evaluation, rather being a numerical code of relative effects.

Highway Sector/Impact Types	Potential Impact	Managed Impact	Management Control*
A1 (CTD)			
. Property address altered, at Bike Farm	2	1+	xxii
. Public sensitivity: motorist/ residential views	1	0	xxii
TOTAL SECTOR, A1	2	1+	
A2. Upland Forest – Tomerong Peak			
Macroscale effect will be nil. Microscale effects will include:	o	o	–
. Highway reassignment, as for A1. – loss of scenic views and panorama	2	N/A	xxiv
. Bypass proximity, as for A1.	2	0	v
. Bypass intersections – nil	0	0	–
. Cut and fill banks, as for A1 – including deep rock cuttings	2	1+	xxii
. Width of swathe disturbance	2	1	iv
. Property address – nil issue	0	0	–
. Public sensitivity – nil onlook	0	0	–
TOTAL SECTOR, A2	2	1+	
A3. Midland Forest – North Valley			
Macroscale effect will include:			
. Escarpment swathe – distant visibility	2	0	iii
Microscale effects will include:			
. Highway reassignment, as for A1. – loss of scenic views and panorama	2	N/A	xxiv
. Bypass proximity – nil issue	0	0	–
. Bypass intersections – nil issue	0	0	–

Highway Sector/Impact Types	Potential Impact	Managed Impact	Management Control*
A3 (CTD)			
. Cut and fill banks, as for A1	2	2+	xxii
. Width of swathe disturbance	2	1+	iv
. Property address – nil issue	0	0	–
. Public sensitivity – nil onlook.	0	0	–
TOTAL SECTOR, A3	2	1	
A4. Lowland Forest – TOMERONG CREEK			
Macroscale effect will be nil	0	0	–
Microscale effects will include:			
. Highway reassignment, resulting in existing village main street becoming a country road – creek feature displayed along Bypass – possible roadside treeplanting along mainstreet toward village	2+	2+	xxiv
. Bypass proximity, nil issue	0	0	–
. Creek feature – disturbance	2	2+	xi
. Bridge structure, approx 14m span	2	3+	xvii
. Cut and fill banks, +3m ht. predominantly	2	2+	xxii
. Bypass intersections – nil issue	0	0	–
. Width of swathe disturbance	2	1+	iv
. Property address – nil issue	0	0	–
. Public sensitivity – nil onlook.	0	0	–
TOTAL SECTOR, A4	2	2+	

Highway Sector/Impact Types	Potential Impact	Managed Impact	Management Control*
A5a. Gateway – Turpentine Road			
Macroscale effect will be nil.	0	0	–
Microscale effects will include:			
. Highway reassignment, resulting in existing village crossroads becoming a safe and opportune town centre for land enhancement [*] [*: RTA initiatory discussions with Council suggested to convey and share development skills, eg RTA design and plants; SCC labour and maintenance.]	1+	3+	xxiv
. Bypass separation from village centre – possible enhancement of link road	0	1+	xxiv
. Cut and fill banks /–3m ht; mostly near existing grade	1	2+	xxii
. Bypass intersection with Turpentine Road – opportunity for (seagull) gateway accent, ie feature planting and signage.	1	3+	i
. Width of swathe disturbance – minimum bank works	1	1+	iv
. Property address/access altered, at north and south of Turpentine Road for timber management. Direct access to the Bypass will be provided with rural driveways.	1	1+	xxii
. Public sensitivity – foreground onlook by one (1) homestead, Turpentine Road motorists local pedestrians and future rural residential development.	2	2+	xxii
TOTAL SECTOR, A5a	1	2+	

Highway Sector/Impact Types	Potential Impact	Managed Impact	Management Control*
A5 Midland Forest – Central Valley			
Macroscale effect will be nil.	0	0	–
Microscale effect will include:			
. Highway reassignment, as for A4.	1	0	xxiv
. Bypass proximity, nil issue	0	0	–
. Cut and fill banks, /–3m ht. visible only from roadway	1	2+	xxii
. Bypass intersections – nil issue	0	0	–
. Width of swathe disturbance – minimum bank works	1	1+	iv
. Property address – nil issue	0	0	–
. Public sensitivity – nil onlook	0	0	–
TOTAL SECTOR, A5	1	2+	
A6. Lowland Forest – SUFFOLK CREEK			
Macroscale effect will be nil.	0	0	–
Microscale effect will include:			
. Highway reassignment, pedestrian /cycle lanes required across existing bridge (ie road markings)	2+	0	xxiv
. Bypass proximity, nil issue	0	0	–
. **Creek feature** – disturbance	0	0	xi
. **Bridge structure**, approx 14m span	2	3+	xvii
. Cut and fill banks, +/–3m ht., excluding /+3m cut.	1	2+	xxii
. Bypass intersections – nil issue	0	0	–
. Width of swathe disturbance	1	1+	iv

Highway Sector/Impact Types	Potential Impact	Managed Impact	Management Control*
A6. (CTD)			
. Property address – nil issue	0	0	–
. Public sensitivity – nil onlook.	0	0	–
TOTAL SECTOR, A6	1	2+	
A7. Gateway – South Tomerong			
Macroscale effect will be nil.	0	0	–
Microscale effect will include:			
. Highway reassignment, resulting in opportunity for main street enhancement; also similar opportunity for the Grange Road. (See Note: A5a for Council Works along north side of Grange Road.)	1	3+	xxiv
. Bypass proximity to outlying village perimeter – requires cultural address and mature buffer separation from the Grange Road	3	3+	i
. Cut and fill banks, /–3m ht; "seagull" intersection at grade.	1	2+	xxii
. Bypass intersection with existing highway and The Grange Road – opportunity for (seagull) gateway accent. [See Note: A5a]	1	2+	i
. Width of swathe disturbance – rural	0	0	–
. Property address – nil issue, except to outlying homestead along Barham Road requiring direct access to the Bypass.	2	1+	xxii
. Public sensitivity – foreground onlook by about 10 residences, plus village main street and the Grange Road motorists and village pedestrians.	3	2+	xxii
TOTAL SECTOR, A7	2	2+	

Highway Sector/Impact Types	Potential Impact	Managed Impact	Management Control*
A8. Midland Forest – South Tomerong			
Macroscale effect will be nil.	0	0	–
Microscale effect will include:			
. Highway reassignment, resulting in parallel rural sectors of the "village mainstreet (south)" and the Grange Road becoming two conjoined country roads.	1	1+	xxiv
. Bypass proximity – nil issue, bypass concealed by a mature buffer forest separating viewers along the Grange Road	1	0	xxii
. Bypass intersection with Island Point Road extension, as part of the "seagull" intersection entry for south Tomerong. (Low key treatment: could be Red Cedar or local species feature eg, Iron Bark and Turpentine.)	1	1+	i
. Cut and fill banks, +/–3m ht, excluding /+2m fill.	2	2+	xxii
. Swathe width disturbance	2	1+	iv
. Property address – nil issue	0	0	–
. Public sensitivity – nil onlook, except from Bypass Intersection with Island Point Road extension	0	0	–
TOTAL SECTOR, A8	1	1+	
A9. Rural Midland – South Tomerong			
Macroscale effect will be nil.	0	0	–
Microscale effect will include:			
. Highway reassignment, as for A1	1+	N/A	xxiv
. Bypass proximity, nil issue	0	0	–
. Bypass intersection – nil	0	0	–

Highway Sector/Impact Types Management	Potential Impact	Managed Impact	Control*
A9. (CTD)			
. Cut and fill banks, variously +/−3m ht., excluding nil /+3m fill	1	1+	xxii
. Width of swathe disturbance − nil issue (rural field)	0	0	−
. Property address − nil issue	−	−	−
. Public sensitivity − single onlook from homestead mostly absorbed; nil onlook from existing highway due to terrain.	1	0	−
TOTAL SECTOR, A9	1	1+	
A10. Midland Forest − South Tomerong Bends			
Macroscale effect will be nil.	0	0	−
Microscale effect will include:			
. Highway abandonment, resulting in existing south bends becoming alienated − possible reuse as highway rest areas for north and south traffic	0	0	xxiv
. Bypass proximity, to alienated highway remnants, requires separation of swathes and vegetation/afteruse of abandoned segement	2	0	
. Bypass intersections − nil	0	0	−
. Cut and fill banks, variously +/−3m ht. and at grade, excluding nil /+3m cut.	2	2+	xxii
. Swathe width disturbance	2	1+	iv
. Property address altered at timber estate requiring new entry to rural driveway	1	0	xxii

Highway Sector/Impact Types	Potential Impact	Managed Impact	Management Control*
A10. (CTD)			
. Public sensitivity – nil onlook except from future possible rest areas	1	0	xxii
TOTAL SECTOR, A10	2	1+	
TOTAL SECTORS, A1 TO A10	2	2+	

In Summary, the Bypass development would be likely to result in a moderately adverse impact (2) as a "raw" engineering works. However, the RTA requires engineering and landscape works to be fitted together and the resulting managed effect would have an overall moderate benefit (2+) to the local scenic environment by ensuring a high standard of finish and by increasing visual accessibility to the countryside.

NOTES:

1. Cut and fill banks: will leave a raw effect of varying magnitude – landscape revegetation will conceal and/or significantly improve the appearance of bank works to a consistent degree through forest. Rockcutting/boulder placement will rely on engineering detail for a quality appearance.

2. Swathe disturbance: will result in varying width of clear felling related to the bank works – mature revegetation will significantly reduce the width of disturbance.

3. Other visual impacts: will rely on alignment fit and landscape finish to develop a finished quality effect.

4. Highway reassignment will result in the Bypass Highway and Village "mainstreet"/country road both offering views to the countryside. A comparison has been made of the scenic opportunity lost to Bypass travellers (potential impact) and future opportunity to enhance the mainstreet (managed impact) although not directly correlatable.

9. Environmental Controls

The Tomerong Valley in which the Highway Bypass would be located has been recognised as a high quality scenic environment. This may be seen from the existing highway and other country roads. The Bypass will offer another set of views which could be available to a large number of travelling motorists and those from local communities.

Beyond the immediate setting along the corridor, the Highway Bypass would make no significant change to views from the predominant vantages around the valley which may be available to visitors and residents.

The major effect of the Bypass will be a shift from the present highway vantage which looks across the valley affording a variety of forest, rural and escarpment views to the proposed route which mostly would provide a variety of detail forest views and limited rural/escarpment outlooks.

STATEMENT OF ENVIRONMENTAL EFFECTS

It is considered that there are no likely impacts on the scenic environment which are either serious or insurmountable. A Thematic Landscape Concept has been formulated which would reduce adverse effects and establish a high quality visual setting that will be recognisable at the regional level.

The likely impacts of most significance are as follows:-

- Establishment of a village gateway/s - by landscape works:(+).
- Increase of available views through forest - for motorists:(+).
- Reduction of available rural views - for through motorists(-).
- Maintenance of existing village/rural/forest views - from the existing road:(o).
- Protection of significant trees - within forest and rural/village lands:(+).
- Minimum disturbance along the Bypass verge - by proposed construction management:(o).
- Negligible visual effect on the escarpment - beneath Tomerong Peak:(o).
- Adaptive reuse of the existing highway alignment - where appropriate:(+).

- Loss of rural views – available to residents looking westward from Grange road:(–).

- Replacement of above lost rural views – by thematic gateway landscaping:(+).

- Presentation of Tomerong and Suffolk Creeks – as natural features(+).

- Development of Creek bridges – as motorway features:(+).

[Key: (+)o(–) indicate positive, neutral and negative degrees of impact, respectively. The evaluation has been subjectively based on professional opinion as a simple guide for impact comparison.

A majority of these impacts are favourable or have an almost neutral effect, while undesirable changes are able to be absorbed by suitable impact management.

The management concept and supporting guidelines have been established to control and/or influence the bypass development during post–EIS design development and the construction phase, and after as landscape finishing works, as well as to indicate the benefits of environmental monitoring. (See Figures 9.1 to 9.5 and Report Sections 9.1 to 9.3.)

9.1 BYPASS CONCEPT – A SCENIC MOTORWAY

The "Scenic Motorway" or parkland concept envisages a traffic corridor which responds to the natural and cultural landscape as well as traffic engineering challenges. Importantly, this concept seeks to best fit the motorway within the corridor terrain and incorporate a curvilinear geometry for scenic interest and travel relief – while responding to State road standards and other constraints imposed by adjacent land use.

In this approach, parts of the existing highway would be recycled and upgraded where this opportunity may occur along the bypass corridor. Through existing and "greenfield" sectors of the corridor, such as forest and rural areas, disturbance to character and significant features would be minimised by control of batter width and construction works.

Roadside treatment with finishing landscape works would respond to urban/rural/natural countryside character by thematic controls and other sensitive design guidelines.

The development of roadway structures and other "road furniture" elements, such as bridges, guard rails, kerb walls, medians and pedestrian–crossings should be appropriately coordinated and have visual appeal through a high standard of design and finish.

A scenic motorway standard will accommodate provision for bikeways and footpaths where these may be required, especially across bridges and in the vicinity of town and village centres. At Tomerong this would be accommodated along the existing highway through the village, as well as by adoption of NAASRA standards along the bypass highway.

In particular, the concept recognises the scenic address afforded by gateways to cities, towns and other settlements. Gateways, as landscape/architectural accents at town entries and parkway exits offer a landmark identity – as a sense of arrival and direction.

Viewbreaks along the motorway should maintain the opportunity to observe both town and countryside. Tree groups, understorey and grassland would be strategically incorporated to maintain and direct views toward features and conceal unwanted views to and/or from the highway.

In summary, this "scenic motorway" concept emphasises the benefit of displaying the town and countryside as a feature. It seeks to take opportunity of scenic values in the close and distant setting while ensuring a high standard of engineering design and roadside facilities for the community.

9.2 SCENIC MANAGEMENT – GUIDELINES

The EIS landscape plan for the Highway Bypass has been developed in response to both positive and adverse impacts belonging to the cultural, scenic and natural environments.

Coordination with and input from RTA's road designers and environmental consultants, especially the team ecologist have contributed to formulation of the Landscape Management guidelines.

In brief, this plan advocates the following impact management:

- refinement of the route alignment – taken into account during the EIS team studies;
- "thematic fit" into and improvement of both existing and proposed corridors;
- "gateway" address to the town/village entries;
- landscape themes based on existing vegetation character (see Table 9.1: Plant Groups);
- valley/escarpment scenic controls;
- highway afteruse and fragmentation;
- bicyclist route – separated from traffic by route deviation, gradient, railing or wall (ultimate staging) – in longterm cooperation with Council;

- road cuttings and embankments built/planted to match urban, rural and natural (forest, woodland) conditions;

- traffic-hazard barriers to protect trees and other structures against motorists, increasing safety - by including grade separation, earth mounds, dense scrub, armour railing and concrete barriers (architecturally modified jersey kerbs);

- drainage controls physically and biologically integrated into the surrounding environment - including gross pollutant traps (boulder formed, etc.), storm channels (boulder lined, etc.) and wetland/riverine plants (macrophytes and shrub);

- road edges (after road cuttings) - in natural areas planted with native shrub to edge of road shoulder (to discourage birds and animals feeding on grasses);

- medians and pedestrian refuge - headlight glare reduction by planting and/or other structures; safety barriers; at key intersections only;

- roadside management - protect and conserve all significant trees and other plants, cull and control all pest plants such as kikuyu and other invasive species;

- vegetation techniques - semimature, advanced, semiadvanced, tubestock, hydroseeding and regeneration (seedstock, topsoil stockpile etc.);

- topsoil stockpile - all site topsoil and leaf mulch will be stripped prior to road construction and stockpiled as a native soil and seed bank - for reuse in the same character locality - proper horticultural stockpile techniques will apply;

- fire breaks - electrical/service easements will maintain existing status quo;

- rest areas - shelter, picnic seats, toilets, sign information;

- bridges, underpasses, culverts - design standard to match urban and natural conditions - road and rail - architectural input, finishes;

- fencing - selection to match urban, rural and forest/fauna conditions, ie railing, wirestrand and chainmesh types;

- signage - town address, traffic safety, cyclist route (village), and commercial exposure;

- features of interest and other sensitive elements - to be safeguarded during construction;

- valley segments - minimise the lateral extent of fill banks with boulder revetment or equal treatment;

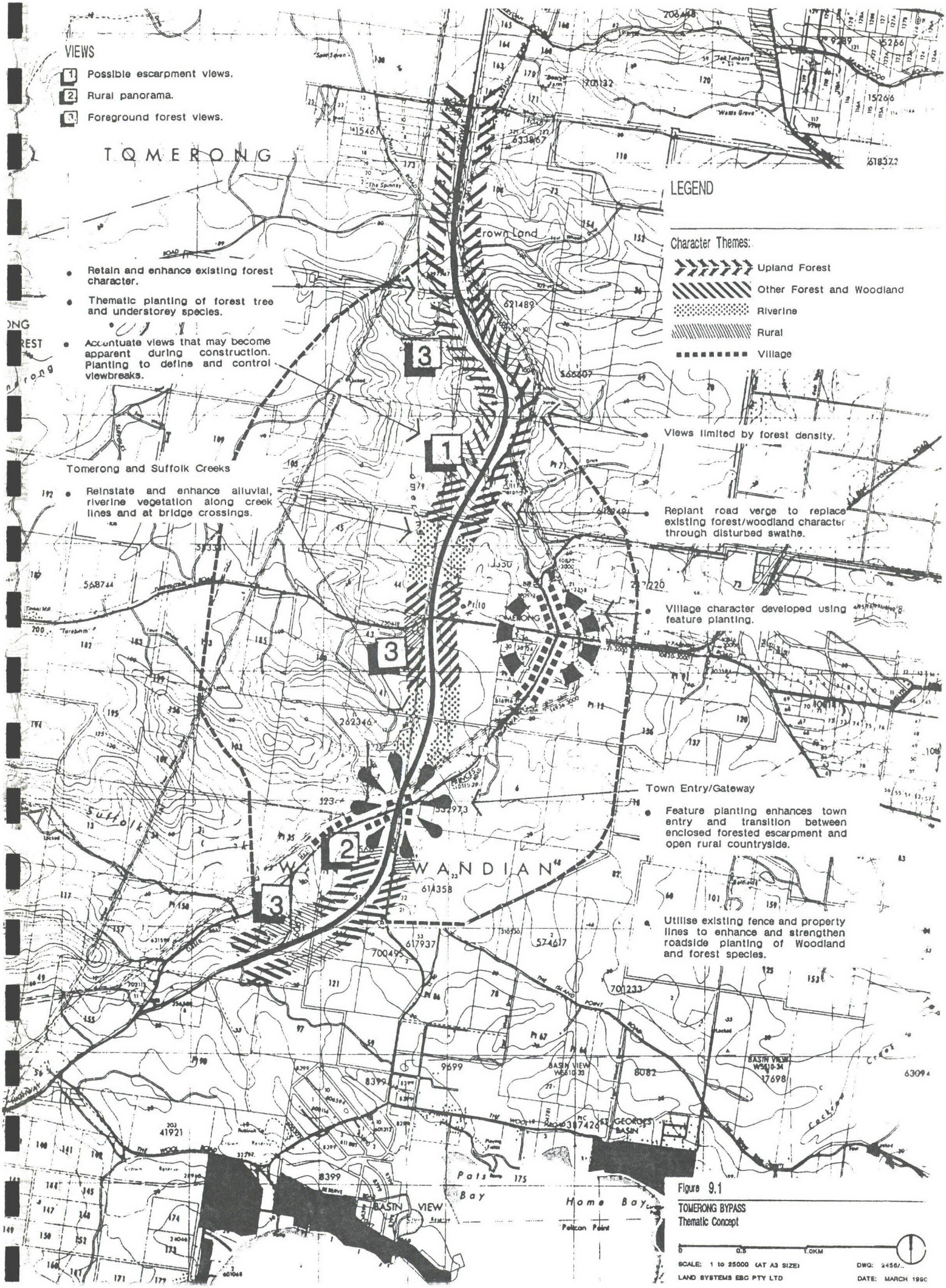


Figure 9.1

TOMERONG BYPASS
Thematic Concept

0 0.5 1.0KM

SCALE: 1 to 25000 (AT A3 SIZE) DWG: 2456/..

LAND SYSTEMS EBG PTY LTD DATE: MARCH 1990

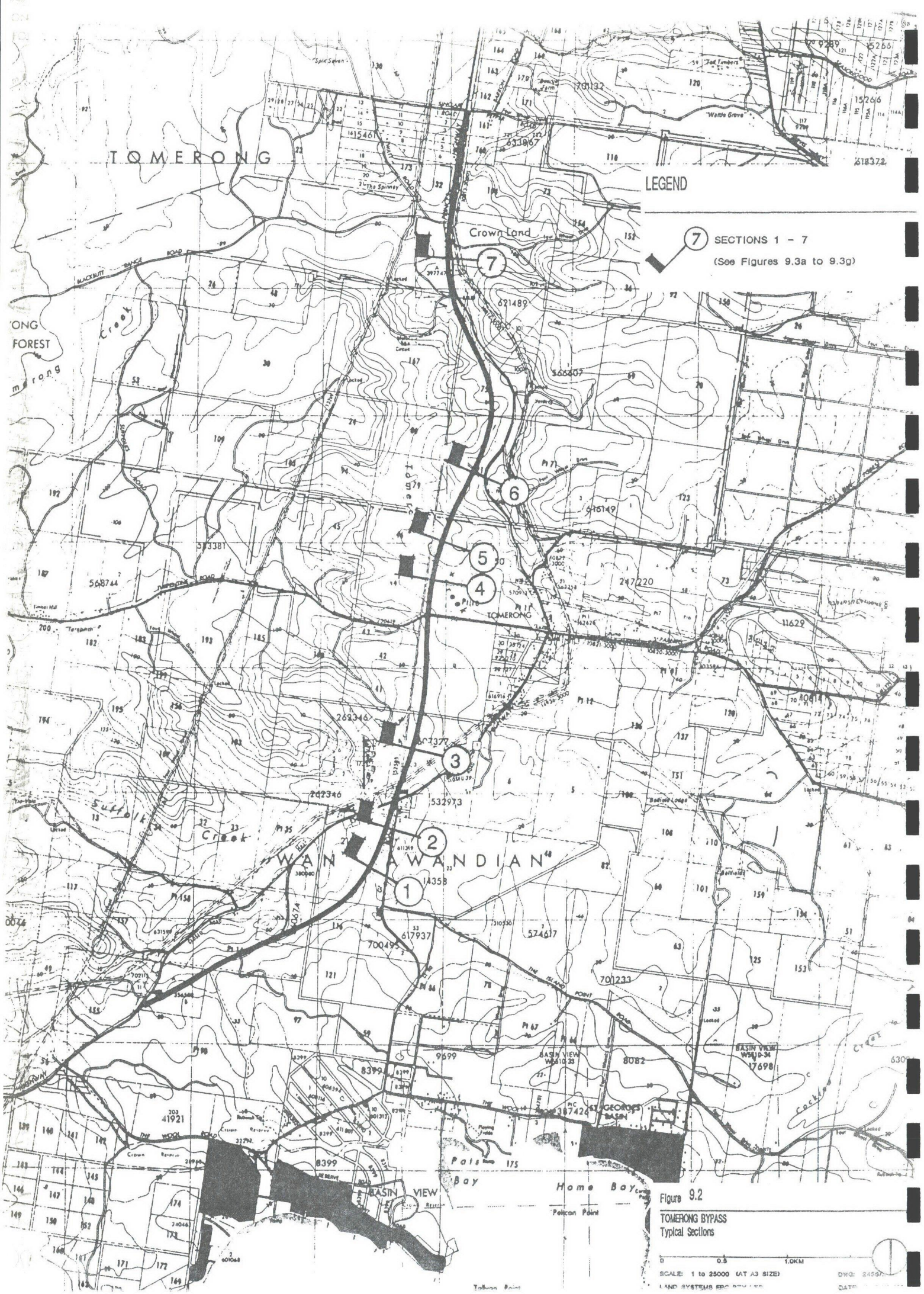


Figure 9.2

TOMERONG BYPASS
Typical Sections

0 0.5 1.0KM

SCALE: 1 to 25000 (AT A3 SIZE)

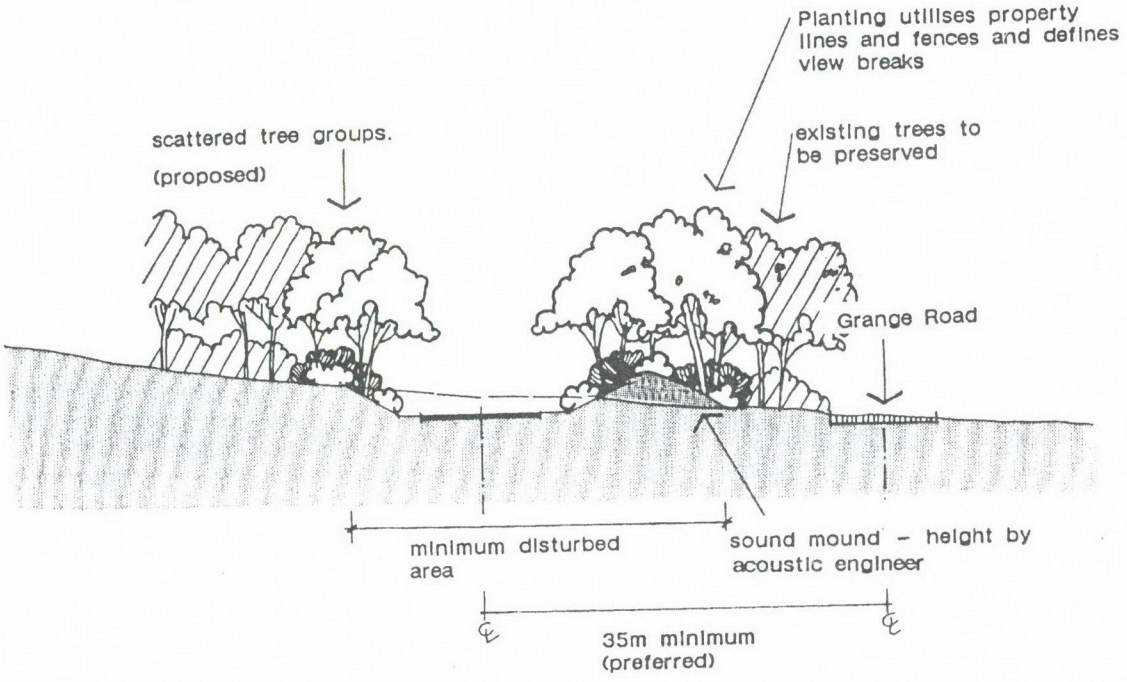


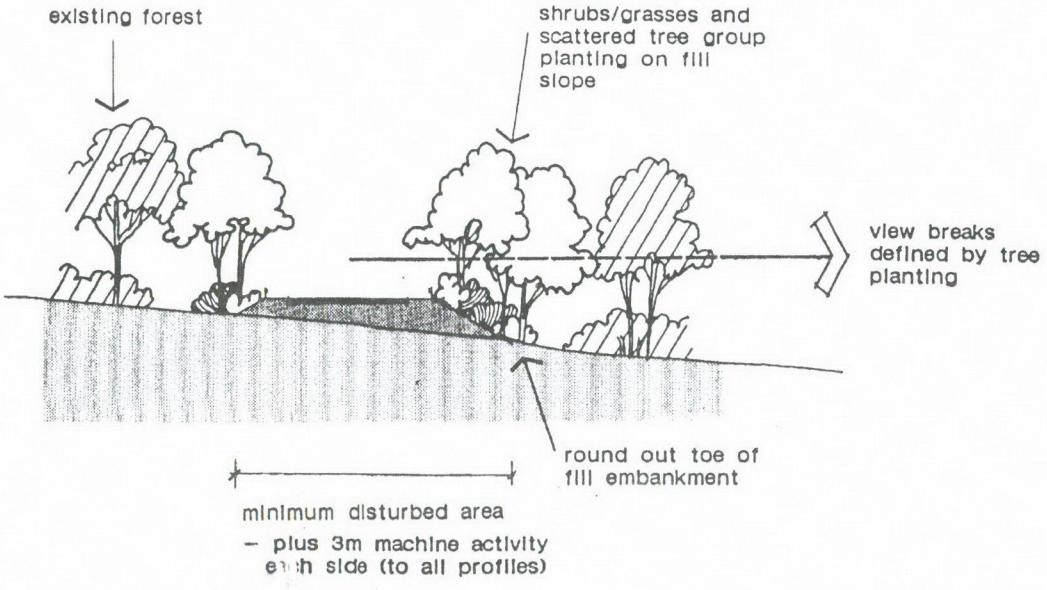
Figure 9.3b

TOMERONG BYPASS Typical Sections

Section 2
Rural Cut Ch. 22000km

Scale 1:400 (AT A4 SIZE)

LAND SYSTEMS EBC PTY LTD. DATE: MARCH 1990



Note:
1. round out top and toe of all cut and fill banks along the bypass.
2. adopt a constant bank gradient through forest areas, rather than a constant width bank to minimise site

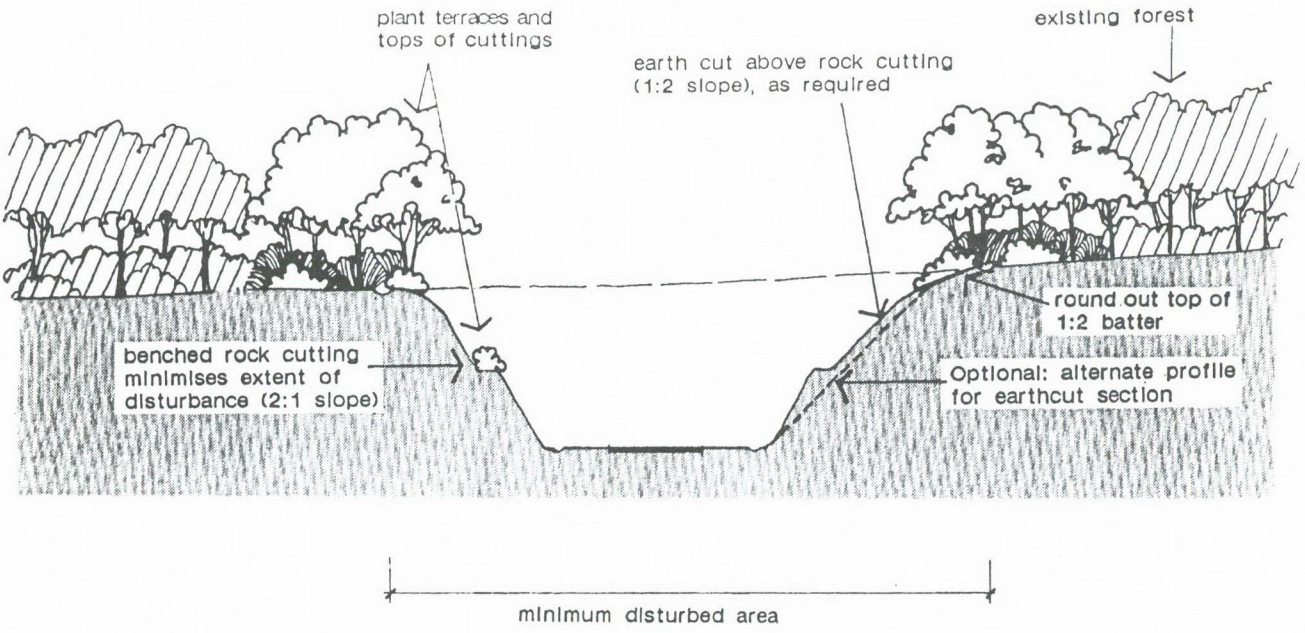
Figure 9.3a

TOMERONG BYPASS Typical Sections

Section 1
Rural Fill Ch. 22400km

Scale 1:400 (AT A4 SIZE)

LAND SYSTEMS EBC PTY LTD DATE: MARCH



NOTE: detail design development required to determine surface finish to rockcut face, e.g. "chiselled" for variation effect.

Figure 9.3f

TOMERONG BYPASS Typical Sections

Section 6
Forest Cutting Ch. 19000km

Scale 1:400 (AT A4 SIZE)

LAND SYSTEMS EBC PTY LTD. DATE: MARCH 1990

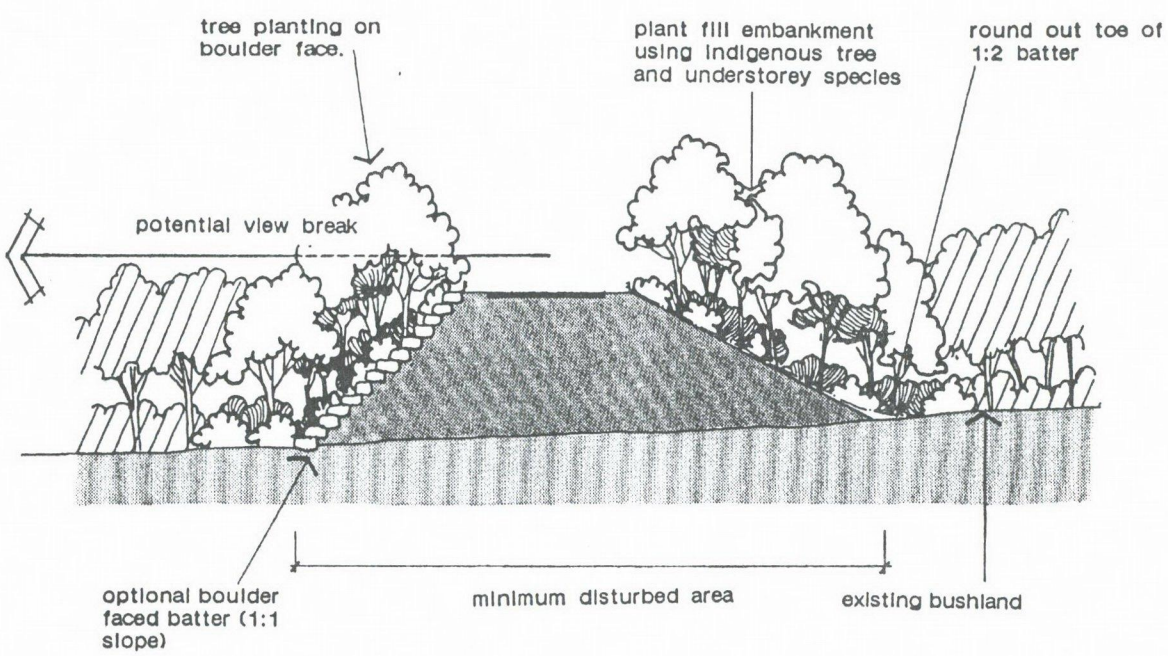


Figure 9.3e

TOMERONG BYPASS Typical Sections

Section 5
Forest Fill Ch. 19450km

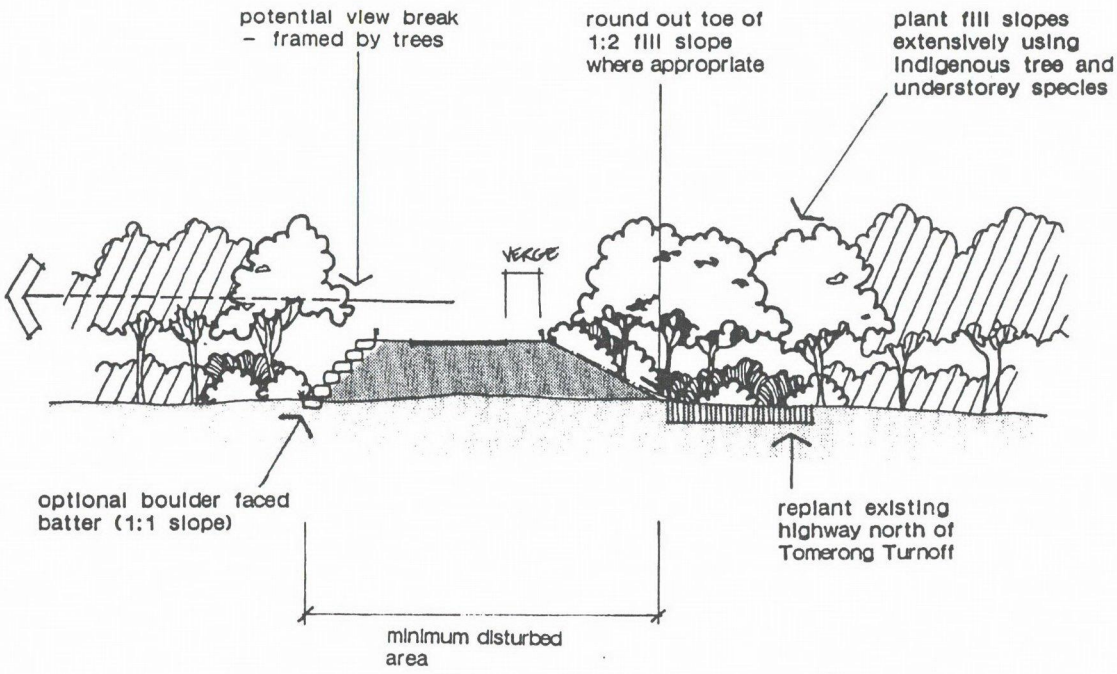


Figure 9.3g

TOMERONG BYPASS Typical Sections

Section 7
Woodland Fill Ch. 17050km

Scale 1:400 (AT A4 SIZE)

LAND SYSTEMS EBC PTY LTD. DATE: MARCH 1990

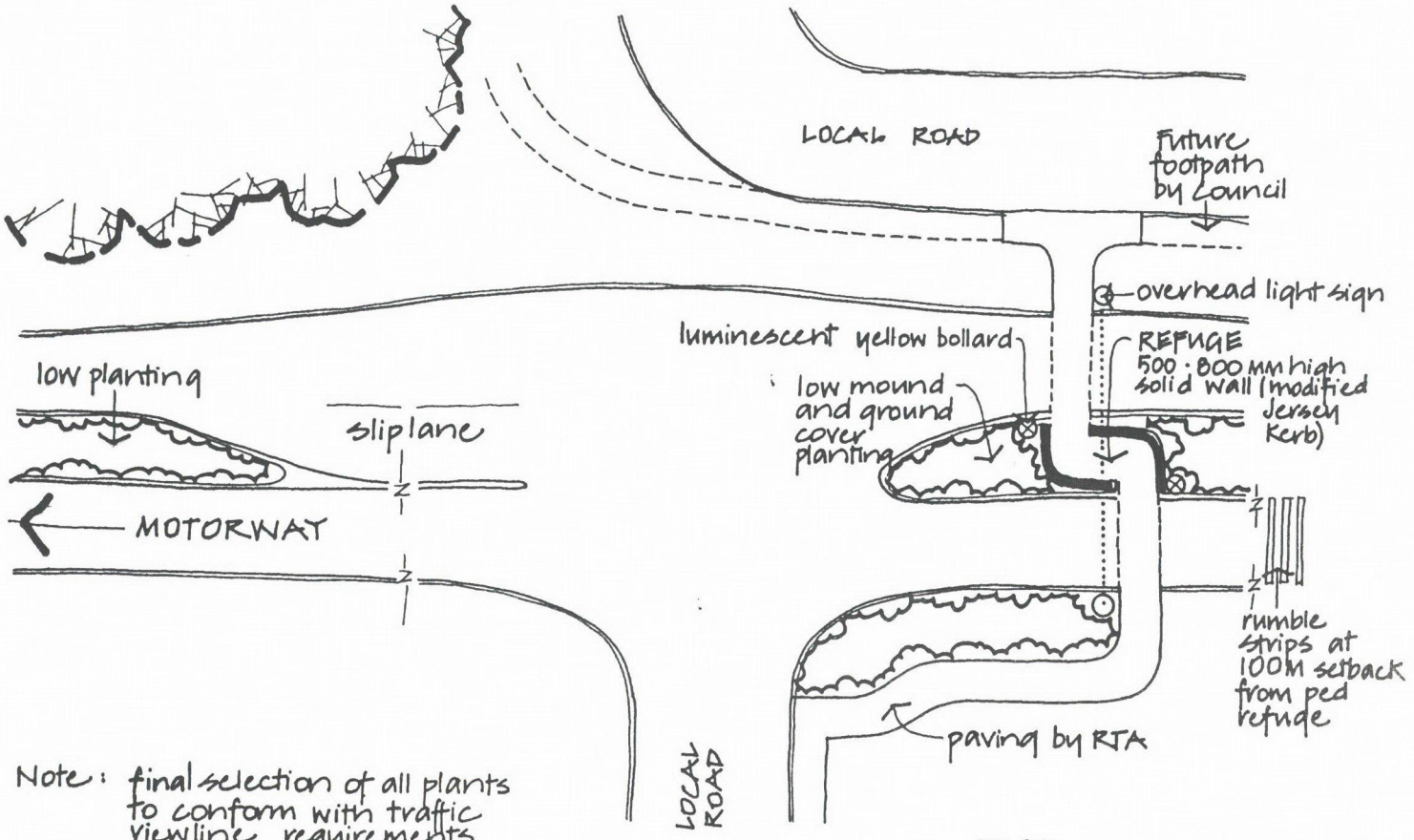


Figure 9.4a

TOMERONG BYPASS - Guide Sketch

Pedestrian Refuge

Scale: NTS

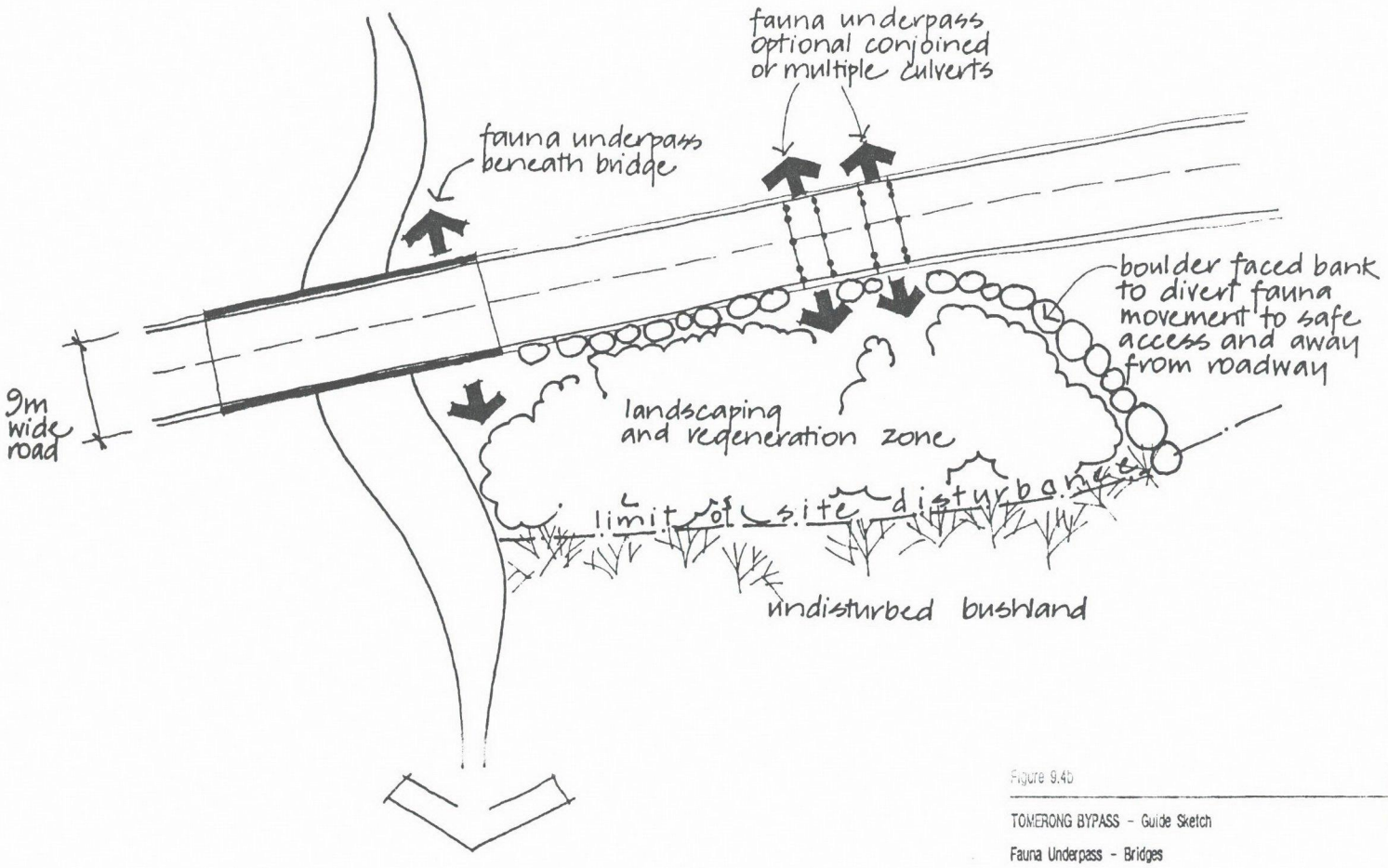


Figure 9.4b

TOMERONG BYPASS - Guide Sketch

Fauna Underpass - Bridges

Scale: NTS

LAND SYSTEMS EBC PTY LTD DATE MAY

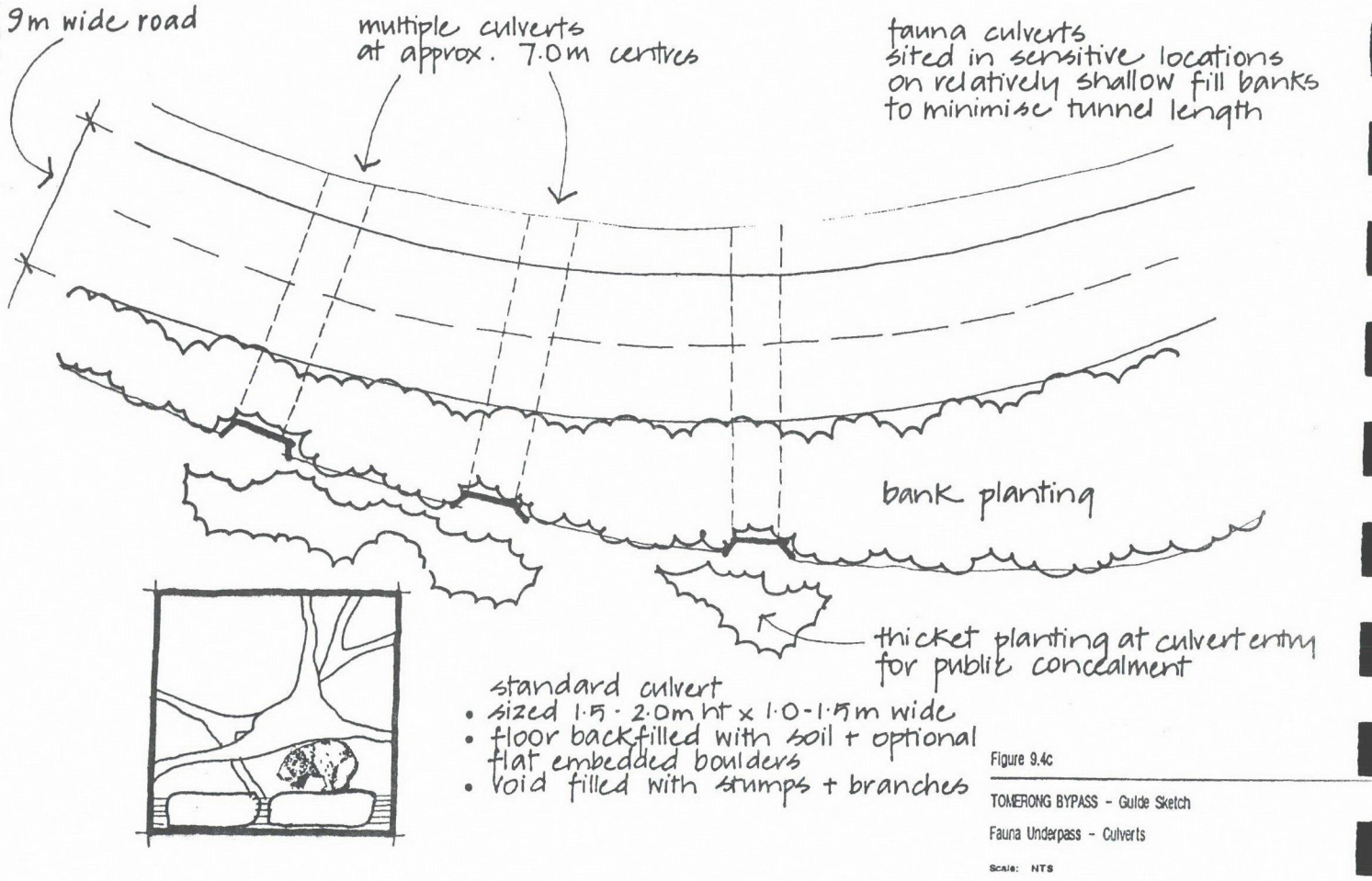


Figure 9.4c

TOMERONG BYPASS - Guide Sketch

Fauna Underpass - Culverts

Scale: NTS



LEGEND

EARTHWORKS

- Fill > 3m
- Fill < 3m
- Cut > 3m
- Cut < 3m

BANK TREATMENTS

- Boulder Faced Batter
- Benched Rock Cut
- Planted Embankment
- At Grade

PLANTING THEMES

- Upland Forest
- Other Forest & Woodland
- Lowland Forest – Alluvial Riverine
- Rural Terrain
- Native Feature Planting (Proposed)
- Village Feature Planting (Proposed)

OTHER ELEMENTS

- Town Entry
- Town Centre – Tomerong
- Bridge
- Creek & Direction of Flow
- Fauna Underpass – multiple culverts
- Fauna Crossing – fence breaks
- Fauna Overpass – canopy overhang
- Fauna fences
- A1 to A10 Highway sectors – see Visual/Landscape Study Technical report for proposed planting groups.

Note: Buildings within the Graphic Band along the Route are not shown

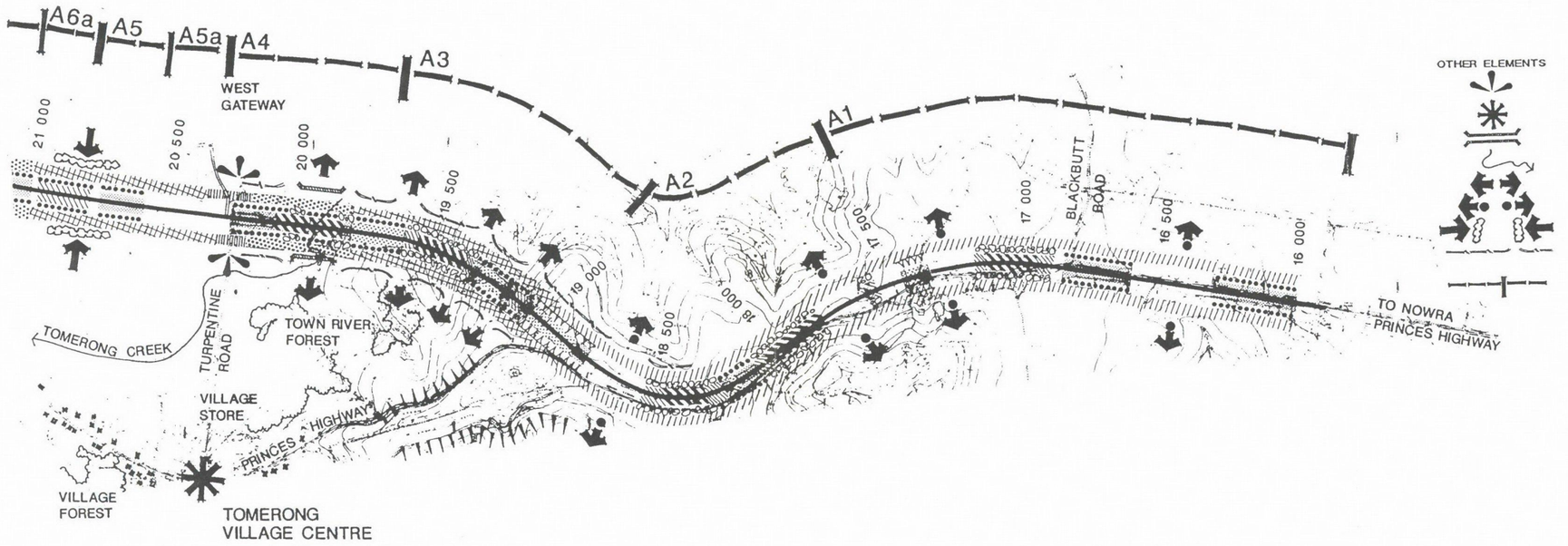
Figure 9.5a

TOMERONG BYPASS
Landscape Concept

0 0.5 1.0KM

SCALE: 1 to 10000 (AT A1 SIZE) DWG: 2456/..

LAND SYSTEMS EBC PTY LTD DATE: MARCH 1990



LEGEND

EARTHWORKS

- Fill > 3m
- Fill < 3m
- Cut > 3m
- Cut < 3m

BANK TREATMENTS

- Boulder Faced Batter
- Benched Rock Cut
- Planted Embankment
- At Grade

PLANTING THEMES

- Upland Forest
- Other Forest & Woodland
- Lowland Forest – Alluvial Riverine
- Rural Terrain
- Native Feature Planting (Proposed)
- Village Feature Planting (Proposed)

OTHER ELEMENTS

- Town Entry
- Town Centre – Tomerong
- Bridge
- Creek & Direction of Flow
- Fauna Underpass – multiple culverts
- Fauna Crossing – fence breaks
- Fauna Overpass – canopy overhang
- Fauna fences

A1 to A10 Highway sectors – see Visual/Landscape Study Technical report for proposed planting groups.

Note: Buildings within the Graphic Band along the Route are not shown

Figure 9.5b

TOMERONG BYPASS
Landscape Concept

0 0.5 1.0KM

SCALE: 1 to 10000 (AT A1 SIZE) DWG: 2456/..

LAND SYSTEMS EBC PTY LTD DATE: MARCH 1990

- rehabilitation priorities for planting – sensitive locations requiring detail planting along creeks and other fauna passages;
- nursery stock preorder programme – nursery order placed 6 to 24 months before road pavement is scheduled for completion;
- construction programming and strategy – prioritising site management;
- forward planting – at feature locations and sensitive sites;
- viewlines at intersections and features – motorist sightlines kept clear of obstructions by suitable landscape plant selection.

(See Section 9.2.4 – Highway Features, Structures and Landscape Works.)

9.2.1 Highway Alignment

The reuse and/or association of the proposed bypass with existing corridor swathes and clearing edges will help to reduce a degree of disturbance to the cultural and natural landscape. This approach will maximise the recycling of disturbed land and/or consolidate the grouping of corridor swathes, with particular controls for public access and fauna movement.

The Highway Bypass corridor which has been proposed (Option A) takes advantage of existing road corridor patterns by a near–parallel association with the North Tomerong present highway bends and southward alongside The Grange Road; centrally it will utilise and/or be closely aligned with the highway redevelopment of the Barham Road forest swathes.

Through 'greenfield' undisturbed natural areas and rural lands the final alignment would be adjusted to avoid local features (significant trees, special plants, creek meanders, cultural sites, etc.) and take advantage of opportunities for exposure or concealment resulting from landscape elements (terrain, treegroups etc.).

This type of route adjustment will also be required for highway–bypass sectors utilising or parallel to existing swathes.

Horizon and vertical alignment will be subject to design development in accord with the EIS management guidelines, where appropriate and not already incorporated in the EIS team study process. It will be anticipated that consideration should be given to developing a suitable curvilinear alignment which avoids (regular long straight sections and responds to local constraints features and patterns) without significantly affecting the traffic design speed.

Highway geometry will follow the design convention of visually prompting the motorist in advance of changes in alignment before major bends and dips. This type of geometric prompting should also be used to enhance viewlines and indicate motorway intersections, where relevant. Geometric prompting can also be accented by landscape cues, such as a row of trees making a curve visible beyond the seen alignment horizon.

Generally – refinement of the route alignment has been taken into account during the EIS team studies at 1:10000 scale mapping.

Declassified Highway

The existing highway after completion of the bypass will remain as the "mainstreet" of Tomerong servicing public, commercial and residential properties.

It is understood this declassification will result in the local government being responsible for its periodic improvement and maintenance.

The opportunity for discussion between RTA and Local Council should be established to determine a mainstreet improvement programme addressing local safety and the village character, prior to road handover.

While RTA has no formal obligation to assist Council with enhancement of this reassigned motorway, co-ordinated action may benefit the community. This may involve shared funding, a design scheme or labour/skills/nursery contribution to establish maybe fifty (50) trees about the present village centre, such as Fig-Trees and Red Cedar.

9.2.2 Thematic Landscape

The highway bypass cannot be considered independently of its macro-scale context. (See Section 8.1 – Impact Evaluation.)

As a result scenic alteration should be developed to "best fit" within the large environment of visual sequence available to motorists.

A high standard of scenic quality improvement will be necessary along the Highway Bypass and the deproclaimed highway to make certain the proposed changes will compensate for the loss of motorist views toward the forest escarpment, and the roadside treatment is developed in accord with natural and cultural conditions (particularly local character) adjacent to the motorway.

It is important that a coordinated thematic landscape be developed which accounts for character variation and continuity along this scenic corridor (See Figure 5.2 – Character Transitions.)

9.2.3 Theme Planting

Planting themes have been determined for each of the key highway sectors associated with the bypass development, which relate to the existing vegetation character transitions. (See Table 9.1 and Figures 7.2, 9.1 and 9.5.)

These thematic relationships have been described for each sector as follows:

A1. **Upland Woodland (North Tomerong)** – Scribbly Gum/Bloodwood association, with Banksia and Teatree understorey accent.

A2. **Upland Forest (Tomerong Peak)** – Scribby Gum/Turpentine association with Banksia understorey accent.

A3. **Midland Forest (escarpment)** – Spotted Gum/Apple association, with Cycad understorey accent.

A4. **Riverine Forest (alluvial type)** – Bangalay/Blue Gum association, with Paperbark stands along the creek.

A5a. **Minor Gateway (West Tomerong)** – Blackbutt/Mahogany association, with Blueberry Ash understorey accent; plus Red Cedar/Sassafras feature stand.

A5. **Midland Forest (West Tomerong)** – Spotted Gum/Turpentine association, with Teatree and Cycad understorey accent.

A6a. **Riverine Forest (gully type)** – Bangalay/Mahogany association, with Brush Cherry and Coachwood accent.

A6. **Riverine Forest (alluvial type)** – Blackbutt/Mahogany association, with Brush Cherry and Lilly Pilly accent, plus Cabbage Tree Palm feature stand – latter subject to availability.

A7. **Primary Gateway (South Tomerong)** – Blackbutt/Bangaly association, with understorey screen shrubs, plus Fig Tree and Sassafras feature stands.

A8. **Midland Forest (South Tomerong)** – Turpentine/Apple association, with Teatree understorey accent.

A9. **Midland Rural (open skyline)** – Turpentine/Apple association; plus optional Silky Oak along skyline, le of existing highway.

A10. **Midland Forest (South Peak)** – Scribbly Gum/Bloodwood association, with Native Daphne understorey accent.

The above description is indicative and highlights key elements of a potential landscape replanting scheme. A comprehensive list for tree and understorey shrub selection has been prepared elsewhere. (See Table 9.1 and EIS Appendix: Ecologist's study.)

This indicative thematic structure should be confirmed and enhanced during design development with RTA's landscape architect and team ecologist.

9.2.4 Highway Features Structures and Landscape Works

This section recommends management guidelines for highway structures and landscape treatment of environmental controls addressing scenic, cultural and natural conditions.

I) Town Entry

The Village gateway at South Tomerong to Jervis Bay and St. Georges Basin would be accented by a composition of exotic and native feature tree groups with a shrub strata of planting. Another gateway, west of the Village centre along Turpentine Road could be accented by a major grouping of native feature trees.

Thematically these could be represented by Fig Trees, Red Cedar and other trees which promote the South Coast townscape character at both respective locations. (See Table 9.1.). Town signage should be incorporated at the main entry.

The North entry into Tomerong has not been identified as a major gateway and landscape treatment should be oriented to the existing character and rehabilitation of disturbance arising from the Bypass development.

II) Signage

Road and tourist signs should be coordinated with town entries to meet national, state and local codes. Attention should be given to the sign setting to backdrop sign structures and avoid unintentional future screening.

At Tomerong, signs should be provided to mark the town address and for pedestrian safety possibly with an overhead walk-light above the median refuge at the main entry to the village. In addition, cyclist route signs may be worthwhile to direct bicycle transport through the village centre for safety and alternate tourist scenery.

Commercial signage which may be visibly evident along .the Bypass, where it passes South Tomerong should be to a high standard and carefully revealed so as not to present a distraction to motorists.

iii) Valley/Escarpment Scenic Controls

Canopy trees will be replanted along the disturbed verge as close as possible [*] to the sealed road-shoulder to reduce the visible swathe through forest/woodland resulting from highway construction. [* Tree/road setback - say, variously 3 to 4 metres from the road-shoulder]. Use tree barriers where required. (See xivTraffic Barriers -this section.)

This landscape control will minimise any possible adverse impact of a forest swathe in existing and future views from elevated positions overlooking the north and south valleys. Gradual reclosing of the construction swathe will be achievable as there will be no aerial services permitted by RTA within the bypass corridor.

iv) Corridor Swathe - Disturbance Limit

The width of corridor disturbance during highway construction has been anticipated at approximately (for two lane sections):

- 15 metres - minimum - through forest/woodland on moderately level terrain;
- 15 metres - tightly controlled through forest across environmentally sensitive creeklines;
- 30 metres - average through moderately steep terrain requiring cut/fill of approximately 3 m depth (1:2 gradient);
- 35 to 40m - through rugged steep terrain where cut/fill varies between 5 to 10 m depth (at 1:2 bank gradient).

A major benefit of canopy planting alongside the road verge will promote fauna movement of arboreal animals including small birds which rely on a close canopy for territory access. (Also see (v) Highway Margins - Rural Lands.)

v) Highway Margins - Generally

These margins comprise the road verge and batters/disturbed areas resulting from road construction. Bypass margins will be landscaped/rehabilitated with trees, shrub and grasses/groundcover (exotic and/or natural) to match or contrast the adjacent areas of urban, rural and natural conditions, in accord with the Landscape Concept. (See Figure 9.5.)

- Natural Areas - Replant with native shrub up to edge of the road shoulder, particularly to discourage the traffic hazard of native birds and animals feeding on roadside grasses (leading to undesirable fauna strikes).

. Rural Areas – Strategically plant various groups of native shrub and/or selected grasses along the road edge to control views (viewbreaks and screens) and to develop a controlled fauna habitat, which discourages roadside foraging by native animals.

Note: tree and shrub planting along highway sectors through open rural areas will assist fauna movement between otherwise separated forest and woodlots, where opportune.

. Urban areas – Exotic and native plants (trees and shrubs etc) will be introduced along the townscape roadways, at the bypass intersection and the village road (existing highway) and its local vicinity for scenic improvement to promote the town's regional qualities and compensation for changed conditions affecting residents, including headlight glare, pedestrian traffic control, dust mitigation and noise attenuation (audible and psychological).

vi) Highway Fencing

Highway fencing would be selected to match adjacent conditions, likely to vary between urban, rural and forest settings. The following fence types may be applicable:

. Urban – lattice railing or chain mesh, 1.0 to 1.2m ht.
. Rural – wire strand and post, 1.0 to 1.2m ht.
. Forest[*] – chain mesh, 1.5 to 1.8m ht.

[* Forest habitat: at localities identified by RTA's team ecologist to require fauna control.]

Forest fences for control of fauna movement along the road verge would be restricted to sensitive sites of known fauna habitat. Elsehwere, fencing within forest would be suitably installed to a rural standard.

Preferably, forest fencing should be trenched into the ground down to 150 – 300mm approx. depth. Alternately, this fence should be butted firmly into the ground and ensure that no gaps are left to encourage burrowing. Optionally, forest fencing may comprise a PVC "green" colour-bond to reduce its visibility and for long term durability.

vii) Highway Medians

Where required, these will preferably be planted at least width low shrub to control headlight glare and reflect margin treatment – however in certain circumstances grasses (ornamental selection) may be wanted for view control and to match adjacent conditions; trees and shrub/grasses wanted, and traffic barriers required for safety. DIMENSIONS – usually a narrow width median restricted to key intersection locations, ie "seagull" intersections at Turpentine and The Grange Roads.

viii) Highway Batters – Hard/Earth and Softworks Treatment

These batters include rock walls, rock cuttings, earth banks and other civil structures which may be required either for grade-separated medians or along the road verge. Final development will involve coordinated civil and landscape activities, especially during the design development stage prior to construction.

During the detail design stage, wherever planting has been scheduled, soil analysis and morphological information will be required concerning the following ground strata conditions:

. subgrade soil;

. surface soil;

. mulch layer (including debris layer). (See XX Native Soil Stockpiles – this section.)

The following treatment should be selected to match local conditions:-

Alluvial Soils

- Scour control may be required along level ground within creek floodways.
- 1:2 banks will require erosion control, such as "spray mulching"; banks exceeding 3.0 m height may require erosion matting; all mulched areas are likely to require light stabilisation netting; final selection will be determined by RTA's roject manager.

Shale/Siltstone Soils

- Rockfall fences or buffer-strips may be required where deep cut faces could be unstable, particularly where a sharply inclined natural strata may crumble or slip.
- 1:2 fill banks should be treated similarly to alluvial soils (above).

Rock Outcrops

- Feature outcrops should be retained where practical and if necessary stabilised bey concealed techniques.

Rock Cuttings

- Quarry techniques would be used for excavation; final treatment of the rockwall face whould be finished to present a rugged surface - which may develop the vertical profile by accounting strata lines as ledges and indent the face by varying the horizontal profile.
- Ledges, fissures and setbacks will provide a basis for planting and natural regeneration.

Boulder Revetment

- A technique available for revetment of deep fill (at 1:1) to minimise lateral bank disturbance, particularly in sensitive sites and on steep cross-grades such as gullies to control tailing of the bank.
- Variations include full bank and toe wall revetment.
- This rugged batter treatment also rovides a suitable inhospitable terrain to control fauna movement similar to a fencline.
- Subject to availability of suitable rock material.
- Alternatives: include "gabion" walls, however these require carefully designed articulation (controlled variation of terraces and batter profiles) to avoid a harsh unnatural effect.

Batter treatment should be selected in accord with civil, ecological and landscape/visual requirements.

Generally surface compaction should not exceed 85-90% Standard Dry Density for all landscape areas - whether for planting, seeding or soil regeneration. Rock raking and ground cultivation may be required to benefit local conditions, subject to detail design preparation. (Also see Soil Analysis and Treatment - this section.) (See XV Highway Drainage.)

Note: RTA guidelines generally recommend a 1:2 (50%) profile gradient for most earthworks. Elsewhere SCS guidelines also should be considered for incorporation into a final design. A standard will be adopted which incorporates a "soft" resolution of profile edge-effect, by rounding out gradient transitions.

ix) Tree-wall Protection

At certain locations where significant trees are preferred to be retained and the road alignment can not be altered, the construction of tree-walls may be advantageous. These would be suitable for construction at the baseline of banks as an indented type of toe-wall. Generally this type of treatment will require a guard rail at the top of bank.

x) Fenceline Planting

Through open rural areas the use of fencelines and junctions for strategic groups of trees and shrub will reinforce existing and potential landscape patterns. However, consideration should be given that grouped or continuous planting along the highway route will not interfere with onlooking public views which may be available to distant quality scenery.

Planting along fencelines outside of the road reserve will require cooperation from the local Council and consent from landowners. However, this approach could be developed as part of the National Tree Programme, Land Care Scheme and NSW Total Catchment Strategy. RTA alone may not be required to make a large contribution, or any, beyond its highway reserve - however, the opportunity for cooperative activity associated with the highway project could have far reaching benefits to the community.

xi) Fauna Underpasses

Two types of fauna underpass have been proposed by the team ecologist. These comprise the use of:

- bridge underpasses - at Tomerong and Suffolk Creeks;
- culvert underpasses - uplands and midlands of north and south valley.

Both of these need to be specially prepared to be suitable for native fauna movement. In particular, to develop a safe refuge and access for colonies and single creatures. (See Fig 9.4b and c - Guide Sketches.)

Bridge Underpasses - along creek banks

Creeks banks should be protected during construction and the water channel not disturbed except within the construction zone (15.0 m wide, subject to site inspection).

Where the bank has been disturbed this will be re-profiled similar to the original form. Tree stumps and trunks, stockpiled during site clearing, will be replaced half-emergent into the finished surface and arranged by grouping into natural patterns or randomly strewn during final earthworks.

The underpass at top of bank will be 2.0 to 2.2 m height and a minimum 3.0 m wide (between the abutment and creek bank). Its critical minimum height will be 1.5 m ht.

Early planting around the bridge areas will be critical to the reestablishment of this disturbed fauna corridor. The staging of bridge construction should occur early in the highway programme to reestablish this planting as soon as possible. It is recommended that 5.0L, 1.5L and tubestock be planted in these sensitive locations.

Culvert Underpasses – beneath raised embankments

Multiple concrete culverts will be located at known fauna passes identified by the team ecologist. The extent and spacing of these will depend on fauna species requirements and typically 5 to 7 culverts at 4 to 7 m centres will be clustered together for (slow moving) wombat herds and other ground dwelling creatures. The strategy for size, clustering and treatment of culverts is important and responds to objectives for control of territorial colonisation and safety from feral preying within the culverts, as well as to colony and individual fauna habits. The final layout and design for fauna culverts will be determined by the ecologist. (See EIS Appendix – Ecologists Report.)

Preferred dimensions and treatment have been illustrated. Allowance for drainage will be determined by terrain location. (See Fig 9.4c – Guide Sketch.)

Critical dimension for these culverts will range between 1.5 to 2.0 m height and 1 to 1.5 wide – others various sizes to manage fauna behaviour, ie 1 x 1.5 ht, 1.5 x 2.0 ht, 1 x 2.0 ht and 1.5 x 1.5 ht. Final sizing will also consider human access for treatment preparation and longterm maintenance, eg possibly after bushfires.

Treatment: culverts will be lined with an earth/sand floor embedded with boulders/logs, rootballs and covered in mulch. Airspace will be controlled by an arrangement of logs and thick branches to resemble a forest tangle or understorey. This treatment will enhance the culverts as a habitat passage and avert human access.

The culvert opening will be partly screened by reestablishment of local plants, including tall and/or low shrub which allow fauna passage through a stem-enclosed or thicketed entry.

xii) Macropod Crossings

Fencing (fence breaks) and other controls such as steep rugged banks may be used to direct macropods (wallabies etc) and other ground fauna across the Bypass at strategic locations which offer favourable sight lines for motorists.

Preferably, these crossings would be located where the motorway is near level with the adjacent ground and at a central position in a long section of roadway for clear visibility.

All fauna level-crossings should be identified with standard signs to indicate wallabies and wombats in the locality.

xiii) Arboreal Crossings

Aerial-borne fauna access across a motorway will be dependent on the proximity of tree canopys to the roadside and the opportunity for gliders and creeping fauna to swing across the road carriageway. The preferred situation may be developed by retention of mature trees along strategic parts of the Bypass.

At certain locations along a motorway traversing a sensitive fauna site, this type of native arboreal faunal movement will benefit from protection of canopy trees in the roadway median, whether of a 2 to 4 lane carriageway. At Tomerong, as a result of suitable forest conditions this requirement would not be necessary.

xiv) Traffic-hazard Barriers

At strategic locations it may be considered worthwhile to physically separate traffic from mature trees, power poles and other potentially hazardous structures alongside the roadway to benefit motorist safety. Similarly, certain locations which require bicycle/pedestrian separation from traffic will also benefit from physical barriers.

A range of traffic barriers are available to suit varying locations and conditions which may require either "hard" restraints or "soft" constraints against vehicle impacts. These include the following.

- **Kerb-walls** – a generic term including "New Jersey" kerbs (820mm height and standard profile), "Modified New Jersey" kerbs (500mm height and variable profile) and similar freestanding walls. A "scenic motorway" standard should promote a high quality finish for kerb walls which relates to the natural/cultural context – such as an architectural standard (grit blasting, formwork lines, or other selected detailing) or incremental formation, rather than standard precast segments except where these achieve a well aligned placement.

- **Guard railing** – "Armco" or "Fletcher" guards are proprietary terms for corrugated armour deflective barriers used along the road verge. These are conventionally used along the top of banks exceeding 1.0m height and at bridge approaches, in conformity with established RTA guidelines.

- **Grade separation** – a technique whereby the motorway would be depressed below an adjacent traffic-hazard by being constructed in (deep or shallow) cut ground; or a similar effect developed by forming an elevated bank alongside the roadway to install otherwise hazardous objects.

  In this way mature trees would be retained above the grade cutting or bank, or be planted on the bank at a safe distance up the elevation.

- **Earth mounds/swale** – low to medium size formations which may be incorporated between the road and a potential hazard. Height/depth, width and gradient will depend upon available separation distance. A combined formation with a sharp swale and mound/bank may also be an effective "soft" barrier to arrest a vehicle.

- **Buffer planting** – a thicket of small trees or shrub with stems maturing to bollard dimensions which will arrest the impact of a vehicle, similar to a bollard barrier. Useful in locations where deflective railing/walls or earthwork banks are not suitable, or may be used in conjunction with these other types of barriers.

All of the above traffic may be used in varying combinations. In particular where a kerbwall on one side may be required for both hazard protection and sound attenuation, the opposite roadside may have different requirements and be installed with guard railing rather than wall duplication which would create a "tunnel" effect along the roadway.

xv) Drainage Controls

Three basic types of drainage structures will be required to control water discharge from the Bypass. These comprise:

- holding ponds – sufficient to contain the first flush runoff (1:10 year storm), trapping gross pollutants and sediments from the motorway, as well as mitigating the discharge of oil and grease products by outflow baffles.

- lined catch drains – located parallel and upslope of the motorway to prevent natural runoff (clean water) mixing with road runoff (contaminated water).

- temporary structures – to control erosion and sediment, including diversion banks, drains, sediment traps and sediment fences.

Holding ponds will be located downslope of the roadway and use the gully heads or other depressions, across which an earth berm would be constructed. The pond berm and basin should be revegetated with endemic plants, in forest areas. Planting may include clear-stemmed shrub and waterplants (sedges, grasses etc) on the basin floor; and dense shrub/groundcovers on the banks - all subject to the overall landscape strategy. Note: avoid sensitive locations and minimise ground disturbance.

The berm wall may be lined with quarry boulders as a retaining wall for aesthetic purposes and to reduce the bank toe in steep locations. In addition a boulder lining at the outflow will also act as an energy dissipator. This would also be appropriate at the outlet of drainage culverts, while single use fauna culverts may not require this detailing.

Catch drains will be located on the upslope of the roadway, at the top of cut banks and as swales within the edge of disturbed road margins, to direct natural runoff into collection points and culverts prior to discharge back into the natural drainage system. Bank drains on steep slopes will be lined to minimise ground water infiltration and potential slippage or erosion of unstable soils. Concrete lining should be avoided where this would be visible to onlookers. Preferably, these drains will be rough lined with corrugated sheeting, erosion matting or inter-bonded boulders.

Temporary controls which are earth formed should be stabilised where likely to remain for a significant period of the bypass construction programme. Depending upon the nature of the formation, temporary grassing (Rye Corn, Lupens etc) or spray mulching ("Alginure", bituminous straw, etc) would be appropriate.

Permanent banks and other earth surfaces should be progressively re-established by stabilisation and with vegetation in place with completion of works.

Adequate buffer zones and edges between disturbed areas and natural drainage lines should be suitably prepared using permanent and/or temporary controls, as relevant, to maintain a stable drainage system downslope of the Bypass.

xvi) Bicyclist Route

At present no formal bicycle strategy has been developed for the South Coast Region, however recognising present trends and longterm growth this may ultimately be desirable. NAASRA [*] standards should be adopted as a preferred minimum requirement which would allocate this cyclist activity within a motor breakdown lane (2.0m wide). The Bypass will not be built to this preferred standard as a result of present low regional demand. Where a motorway has not been built for this provision, then the unsealed road shoulder should be suitably maintained to allow a bicyclist to leave the sealed travel land in the advent of other dangerous traffic. [*: See Glossary.]

Through Tomerong the opportunity would be available to direct a bicyclist route by signage onto the village mainstreet (decommissioned sector of the Princes Highway) as a safe and scenic alternative to the Bypass. This could be facilitated by directional signage and using the proposed left/right turn sliplanes into/out-of the village mainstreet.

xvii) Bridge Features

Two conventional platform bridges ("simple plank on bored pile construction") have been proposed consecutively across Tomerong and Suffolk Creeks, respectively a single span of 15m and a double span of 22m in length. Lesser watercourses would be crossed with pipe and/or box culverts.

In relation to the "scenic motorway" standard preferred for the bypass, there would be a design opportunity to develop a pair of modest feature bridges which emphasise the high quality environmental setting of the whole route. However, it is recognised that a final decision by the RTA would be based on a cost comparison showing a minimal difference in potential budget allocations.

Prior to design development (following this EIS) the following guidelines are suggested for various components of these bridges:

- Gate walls - a bollard termination located above the abutment, such as a concrete solid elongated cylinder expressed with an architectural finish, such as annular grooves.

- Railings - standard panel frames with diagonal rails converging to the bridge centre, or otherwise alternating with each panel to simulate a false truss.

- Piers - a single solid elongated cylinder at midspan with headstock beam concealed within the span deck, by additional reinforcing.

. Abutment wall – a vertical wall returned along the side abutment and expressed with an architectural finish.

The railings could be emphasised by colour-bonding all steel components to RTA's "river blue". Colour-bonding by a powder coated enamel process will control the undesirable effect of flaking paint on a galvanised surface, avoiding a long term maintenance problem.

In addition to the basic bridge structure, there will be a ecological benefit from installing conjoined culverts at natural grade setback behind the abutments in the rampart bank. Two to three culverts each side would provide an additional fauna underpass to supplement the bridge span underpass within these important riverine fauna corridors. (See xi Fauna Underpasses, for size and treatment of bridge underpasses.)

Rock-armouring of the rampart bank will also significantly contribute to the control of fauna movement and direct native animals toward the bridge underpass. Flaring the rock armour away from the road along the bridge approach perpendicularly for up to 10 to 15 metres will also contribute to this strategy, containing fauna movement to the creek corridor rather than permitting native animals to climb upto the road approach. (See Fig 9.4c – Guide Sketch.)

xviii Construction Compounds

Compound sites will be preferably located on level ground which has been already disturbed or within minimum understorey vegetation and the felling of trees avoided.

These sites will <u>not</u> be established in sensitive environments, either visually or ecologically. Riverine environments and public roadside locations will be strictly avoided.

Rehabilitation of construction compounds will incorporate landscape works in accord with the overall thematic character development.

xix) Construction Tracks

Generally these should be kept to within 3.0 metres of the top or toe of banks. Elsewhere, divergent tracks may be required and these should be carefully sited to avoid sensitive sites and to minimise disturbance to other natural settings.

All edges of tracks and manoeuvring spaces (the limit of disturbance) will be marked by temporary protective fencing – such as luminescent PVC meshed web fence line.

Walking tracks for work crew which are located outside the fenced haulage and machine-activity zone for pedestrian safety should also be enclosed by protective fencing in sensitive locations, resulting in a parallel fenceline unless a divergent track is required.

xx) **Native Soil and Forest Litter Stockpiles**

Site topsoil will be stripped along the disturbance bank established for construction of the roadway and banks. The available depth will vary from 100mm to 1.0m, depending upon the location through sandstone, shale and alluvial soil types. A final determination should be made during detail design documentation.

Preferably all native soil and forest litter should be stockpiled within disturbed areas of the corridor swathe. Where stockpiling is required outside of the construction zone, these sites should be carefully selected to minimise additional disturbance by location on level ground with minimum tree and understorey cover. Protection of the stockpiles will incorporate erosion controls and temporary mulching of the surface, as required. Topsoil will require aeration venting to a horticulture standard to maintain living organisms and the seed bank, should the stockpile exceed 1.5m height for in excess of one month.

It will be critical that stockpiles are kept separately identified and relate to the various vegetation zones from which these have been stripped. Topsoil and mulch respreading will be replaced to the original zone from which the material was taken, as this will facilitate landscape character matching of plant regeneration from the soil seed bank.

In addition minor stockpiles of logs, root stumps and other material suitable for ecological recycling should be stored separately. These would be used for re-establishment of fauna habitats in sensitive site such as along creek margins disturbed by bridge construction.

Woodchip should be prepared from timber offcuts harvested during the swathe clearing. This site product will be a valuable resource and a maximum quantity should be obtained, ideally to permit a 75mm deep cover from all landscaped areas.

xxl) Programming – Environmental Management

The Bypass will be constructed as a single stage project. However within this approximate 2 year construction period the programming of works will be important as this will assist in disturbance control and early re-establishment of the scenic landscape and ecological habitats, prior to the bypass being commissioned for traffic.

The following programme guide has been suggested for site and finishing works, excluding the sub-grade and pavement formation.

Site Preparation

- survey marking – pegging/taping of centreline, reserve perimeter and limit of approximate disturbance (3.0m beyond the bank lines)
- identification marking – of significant trees, other plants and features to be protected.
- temporary protective fencing – along the limit of disturbance (using Humes 'Paraweb' fencing or equal web meshed fencing).
- understorey clearing – chitter/slashing to disturbance limit.
- permanent and temporary erosion controls – as required and necessary.
- demolition of approved trees – timber harvesting and woodchip stockpiling.
- forest litter removal – scraping and stockpiling by vegetation zone.
- native topsoil removal – scraping and stockpiling by vegetation zone.
- site compounds – establish after preliminary site preparation

Roadworks Development

- Earthworks to progressively commence – after site preparation.
- Bridge works to commence – as a priority after site preparation.
- Road development to commence – in accord with regular programming practices.

- Traffic diversion and temporary connections – as required.

Finishing Works: temporary and permanent

- Progressive stabilisation of all exposed surfaces and batters – by spray mulching or other appropriate techniques (eg, bituminous spray mulch, "alginure").

- Progressive topsoiling of all finished sub-grades and stabilisation with final mulching (woodchip, erosion mat etc).

- Forward planting of (publicly and ecologically) sensitive sites – including gateways and riverine environments, in particular adjacent to bridgeworks alongside the creek. [Separable documentation may be required for forward works.]

- Final landscaping – by progressive installation of all planting in accord with design documents.

- Highway furniture – co-ordinated by design and relationship of materials.

Early completion of the bridgeworks will be an important part of the rehabilitation strategy for fauna habitats and possage. It is anticipated that forward works for landscape revegetation may be established after basic earthworks have been completed and while the bridge deck is being developed.

xxii) Landscape/Revegetation Works

The final landscape works will conform to detail design documents which would be prepared after the EIS and based on the guideline recommendations for environmental management.

Landscape rehabilitation and feature treatment of disturbed areas along the road margin will be established by a variety of planting and regeneration techniques. Predominantly this will require the pre-ordering and acclimitisation of semi-advanced (1.5 litre) and tubestock trees and shrub grown at the RTA's regional nursery. However, at sensitive locations it would be preferable to install semi-mature (100L, 200L) and advanced (5L, 10L) tree and shrub species as part of a forward planting strategy.

Preferably endemic species of plants should be cultivated from seeds collected on the site, germinated and grown on into tubestock and semi-advanced containers. Fibre containers, such as "bio-pots", will provide a benefit for successful establishment as these would not require the rootballs to be disturbed during planting.

Collection of native seed from the corridor will be required to facilitate a genetic correlation of species in sensitive locations. This activity should be co-ordinated into a forward programme for producing suitable nursery stock.

In addition, the careful recycling of native topsoil and forest litter to its original vegetation zones will permit the natural regeneration of many small plants and groundcovers not commercially available or otherwise able to be successfully established.

xxiii) Design Survey

"Prior to road and landscape design development proceeding, detail survey of landscape elements will be needed to establish locations and levels of relevant features. These are for example creek banks, existing mature trees and edgelines of good quality vegetation.

xxiv) Highway Afteruse and Fragmentation

A majority of the existing highway will be reassigned to provide local traffic conditions as a country road or village mainstreet. Typically of wide motorways, this redefinition may entail reduction of pavement width, removal of surplus pavement, reconstruction of edges and revegetation of trimmed-off margins. At Tomerong these type of road works would not be required. However, affected by the Bypass, the potential loss of town centre activity/focus at the present Village Crossroads should not be dismissed completely. Small softworks, such as tree planting, to restitute some part of the original charm or cultural identity belonging to the Village centre may be generously delivered as an environmental benefit of the Bypass development.

Other parts of the existing highway will become alienated where the Bypass may intersect old geometric curves. In some cases, the entire highway segment could be rehabilitated and where this would be required the pavement would be broken up and clean fill imported to develop new cross-sectional profiles for landscape treatment.

xxv) Contractual Safeguards

"Construction operations will be contained within an agreed limit of minimum disturbance and fencing constructed to define the precise limits of construction activity. Formal constraints and safeguards should be put into the contractual obligations of all operatives to ensure control over unspecified spillage, damage to vegetation and landform, spread of debris and refuse, and storage and access for materials and equipment.

9.3 MONITORING STRATEGY

Monitoring will be an important part of the overall management strategy. This would be required during design development, during and after construction and at longterm intervals to assess management performance and possible remedial works.

The thematic landscape concept for the Tomerong Bypass will require design development and implementation to achieve the recommended standard of visual management for a "scenic motorway". Preferably a professional consultant would be engaged to refine the landscape concept and document the required works for all sensitive locations.

During and after landscape establishment and at longterm intervals, regular maintenance checks will be necessary to see that plant health is responding suitably and the design intent being achieved.

A log book of maintenance checks and actions should be kept. In particular all herbicide and pesticide applications, plant replacement selective culling and other horticultural practices.

In addition to horticultural checks, ongoing ecological monitoring of endemic fauna populations and movements will be desirable to observe how certain types and number of native animals are responding to the controls and precautions built into the Bypass landscape works. Note: design structures and location of forest plan species have been recommended which should minimise the likelihood of fauna strike along the motorway.

9.4 RESPONSIBLE AUTHORITIES

Management of the scenic environment associated with the Tomerong Bypass and along its adjacent road corridors will involve both state and local authorities.

Preferably, initial monitoring would be undertaken by the RTA Environmental Branch in conjunction with an independent consultant working together with the Divisional Office of the Project Manager.

Ultimately, the RTA will remain responsible for landscape works within the highway reservation. Long term monitoring should be undertaken within the framework of the regional programme for review of Divisional works, future projects and a co-ordinating strategy.

The Shoalhaven City Council would become responsible for any landscape works in public areas outside of the highway reservation.

Should the RTA want to improve parts of the present highway with strategic landscape works, such as the Village centre and other places where Bypass views would be improved, then prior discussion would be required with Council.

It is possible that works of this type could be shared with Council, whereby RTA may provide design advice and mursery plant stock, while Council may be responsible for plant establishment or other agreed arrangments.

TOMERONG BYPASS TABLE 9.1a

Landscape Concept - Existing Species Groups

PLANT GROUP A (Woodland – upland ridgetops)			Mature Height
Trees:	Eucalyptus sclerophylla	Hard-Leaved Scribbly Gum	14–20m
	Eucalyptus gummifera	Red Bloodwood	14–20m
	Syncarpia glomulifera	Turpentine	14–20m
	Casuarina littoralis	Black She-Oak	6.0m
Shrubs:			
	Helichrysum diosmifolium	"Everlasting Daisy"	3.0m
	Epacris pulchella	"Slender Heath"	1–2m
	Leptospermum attenuatum	"Flaky-bark Teatree"	3.0m
	Lambertia formosa	Mountain Devils	2.0m
	Hakea sericea	Silky Hakea	2.5m
	Banksia spinulosa	Hairpin Banksia	2.0m
	Boronia pinnata	"Purple Boronia"	2.0m
	Acacia falcata	"Falcate Acacia"	4.0m
Groundlayer:			
	Leaf mulch and regeneration of grasses and herbs		

PLANT GROUP B (Tall Open Forest – upland/midland slopes)			
Trees:			
	Eucalyptus maculata	Spotted Gum	14–20m
	Syncarpia glomulifera	Turpentine	14–20m
	Angophora floribunda	Rough-barked Apple	14–20m
Shrubs:			
	Macrozamia communis	Cycad/Burrawang	2.0m
	Kunzea ambigua	Tick Bush	2.0m
	Correa reflexa	–	1.5m
	Acacia falcata	–	
	Acacia longifolia var. longifolia	Sydney Golden Wattle	4.0m
	Leptospermum attenuatum	–	.
	Pittosporum undulatum	Native Daphne	5–14m
Groundlayer:			
	Leaf mulch and regeneration of grasses and herbs		

TABLE 9.1a (ctd.)

PLANT GROUP C (Tall Open Forest – lowland slopes)

Trees:

Eucalyptus botryoides	Bangalay	20–30m
Eucalyptus saligna	Sydney Blue Gum	20–30m
Eucalyptus maculata	Spotted Gum	20–30m
Elaeocarpus reticulatus	Blueberry Ash	4–7.5m
Tristaniopsis collina	–	
Livistona australis	Cabbage Tree Palm	15–20m
Syncarpia glomulifera	Turpentine	20–30m

Shrubs:

Pittosporum undulatum	Native Daphne	5–14m
Melaleuca styphelioides	Prickly Paperbark	5–10m
Melaleuca linariifolia	Snowstorm Paperbark	5–10m
Acacia mearnsii	Black Wattle	to 16m
Kunzea ambigua	Tick Bush	2.0m
Prostanthera violaceae	Mintbush	to 1.0m

Groundlayer:

Leaf mulch and regeneration of grasses and herbs

PLANT GROUP D (Tall Open Forest – lowland/valley floor)

Trees:

Eucalyptus maculata	Spotted Gum	20–30m
Eucalyptus pilularis	Blackbutt	20–30m
Eucalyptus pellita	Large-fruited Mahogany	20–30m
Eleaocarpus reticulatus	Blueberry Ash	4–7.5m

Shrubs:

Acacia binervata	Two-veined Hickory	3.0m
Acacia implexa	Hickory Wattle	12.0m
Kunzea ambigua	Tick Bush	2.0m
Correa reflexa	–	1.5m
Pultanaea villosa	Bacon and Eggs	to 1.5m
Leucopogon juniperinus	"White Bell Heath"	to 1.0m

Groundlayer:

Leaf mulch and regeneration of grasses and herbs

TABLE 9.1a (ctd.)

PLANT GROUP E (Riverine Forest)

Trees:

Eucalyptus pilularis	Blackbutt	20–30m
Eucalyptus saligna	Sydney Blue Gum	20–30m
Livistona australis	Cabbage Tree Palm	15–20m
Acmena smithii	Lilly Pilly	10–18m
Backhousia myrtifolia	Grey Myrtle	8.0m
Tristaniopsis laurina	Water Gum	to 7.0m
Syzygium paniculatum (endangered species)	Brush Cherry	to 2.0m
Melaleuca pauciflora	–	to 6.0m
Callicoma serratifolia	Black Wattle	6–12m
Ceratopetalum apetalum	Coachwood	to 10m

Shrubs:

Ceratopetalum gummiferum	Christmas Bush	6.0m
Acacia binervata	Two-veined Hickory	3.0m
Goodenia ovata	–	1.5m
Eupomatia laurina	Native Guava	6.0m

Groundlayer:

Leaf mulch and regeneration of ferns, grasses and herbs

PLANT GROUP F (Exotic Trees)

Trees:

Erythrina indica	Indian Coral Tree	10–15m
Araucaria heterophylla	Norfolk Island Pine	30–40m
Ficus macrophylla	Morton Bay Fig	20–30m

PLANT GROUP G (Native Feature Trees)

Ficus rubiginosa	Port Jackson Fig	14–20m
Elaeocarpus reticulatus	Blueberry Ash	4–7.5m
Toona australis	Red Cedar	30–40m
Doryphora sassafras	NSW Sassafras	20–30m
Grevillea robusta	Silky Oak	20–30m

NOTE: Plant Groups A to E have been based on an interpretation of Tomerong Bypass EIS Ecological Study vegetation associations. A detail correlation has not been attempted but rather to identify predominant species in the associations and generally link these to the EIS Visual Study highway sectors. (See Table 9.1b.)

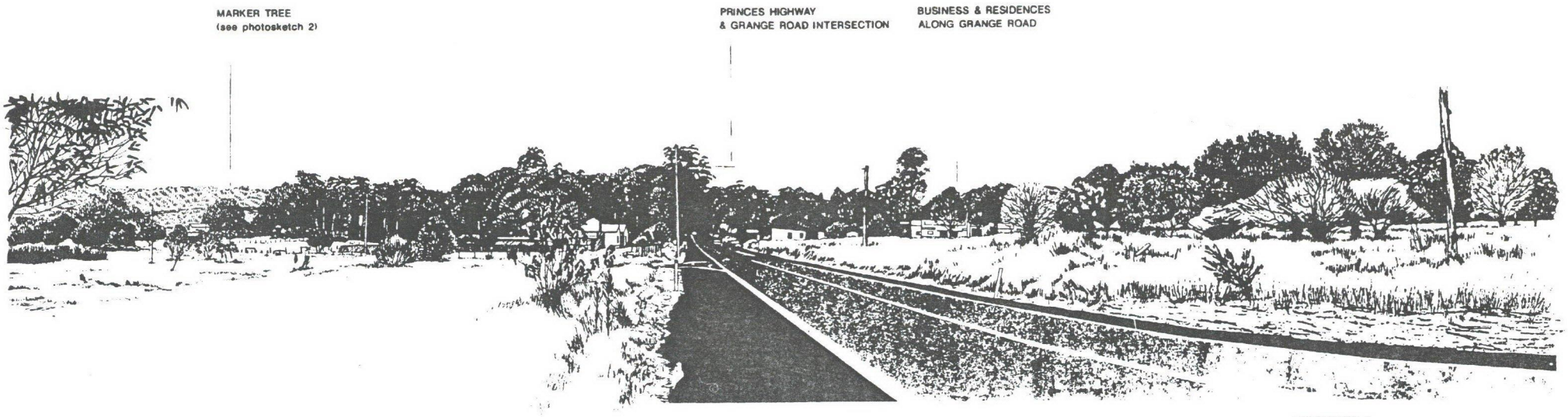
TOMERONG BYPASS TABLE 9.1b

Landscape Concept - Plant Groups/Proposed Locations

PLANT SELECTION

Plant Group	Highway Sectors									
	1	2	3	4	5a	5	6	7	8	9	10
A – Woodland; ridgetops	+	+									
B – Tall Open Forest; upper slopes		+				+					+
C – Tall Open Forest; lower slopes			+						+	+	
D – Tall Open Forest; valley floor					+		+				
E – Riverine Forest; gullies/ floodways				+			+				
F – Exotic Tree Stands; village/ rural roadways					+			+		+	
G – Native Feature Trees; selective locations								+	+		

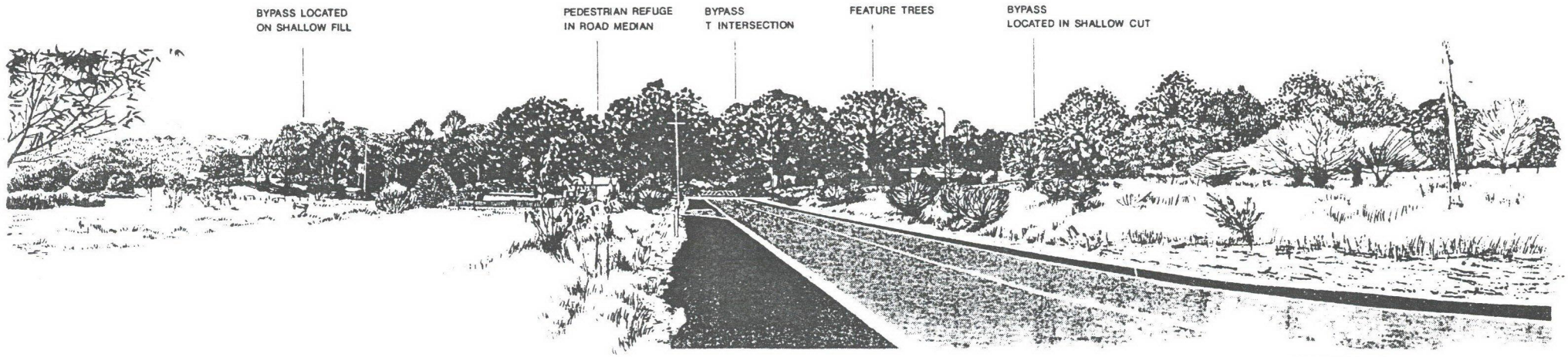
(See Figures 7.2 and 9.4 – for mapping correlation with Highways Sectors.) a:



PHOTOSKETCH 1

South Tomerong - Gateway

Viewpoint from the South



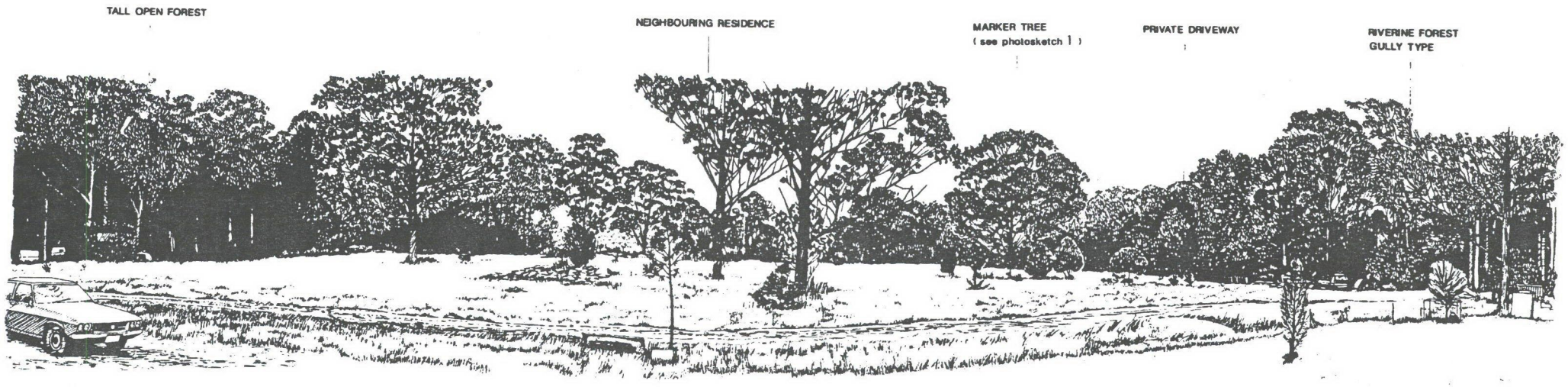
Highway bypass location concealed by landscaping

Bypass concealed by landform and vegetation

PHOTOSKETCH 1a /Afterview

South Tomerong - Gateway

Veiwpoint from the South



PHOTOSKETCH 2

Barham Road Locality

Viewpoint from Northward Homestead

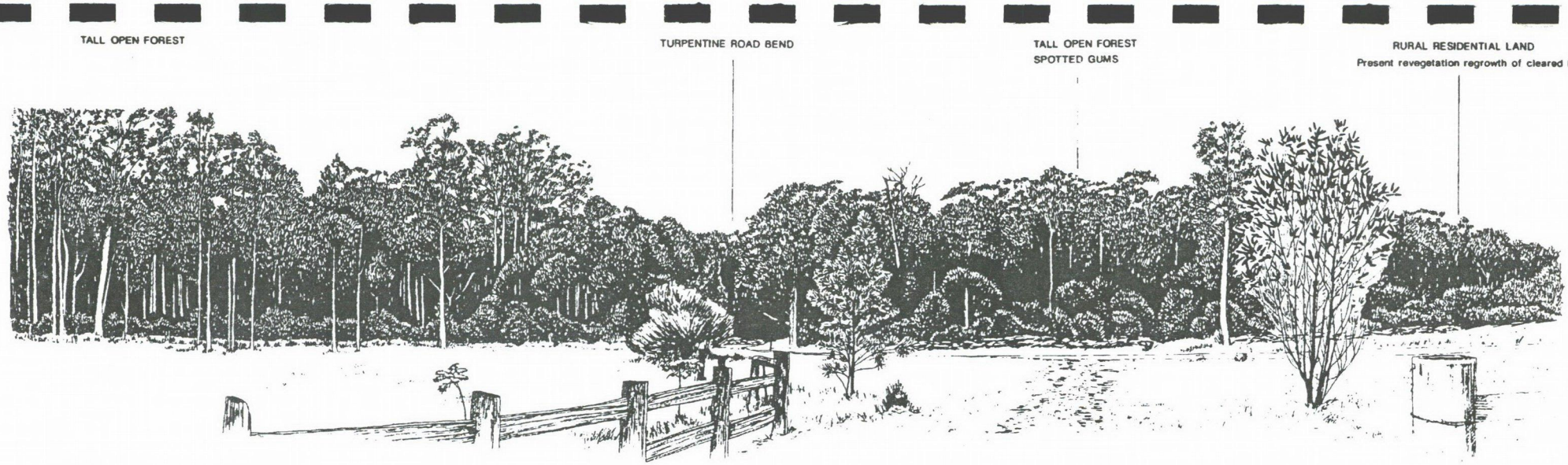


Highway bypass location concealed by landscaping

PHOTOSKETCH 2a /Afterview

Barham Road Locality

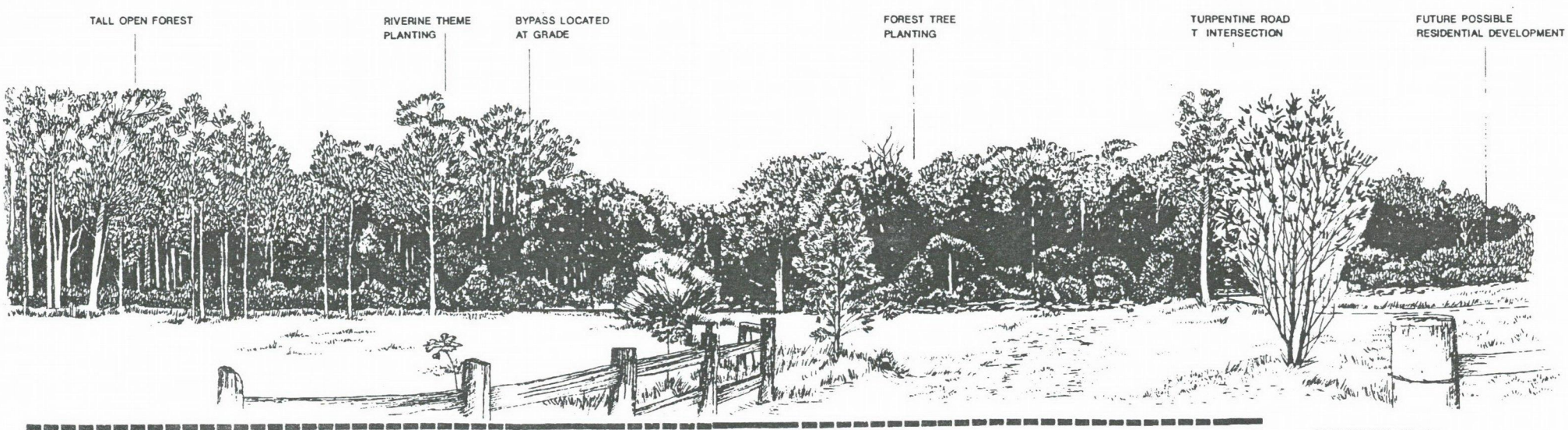
Viewpoint from Bypass Northward Homestead



PHOTOSKETCH 3

Turpentine Road

Viewpoint from the West



Highway bypass location concealed by landscaping

Bypass concealed by landform and vegetation

PHOTOSKETCH 3a /Afterview

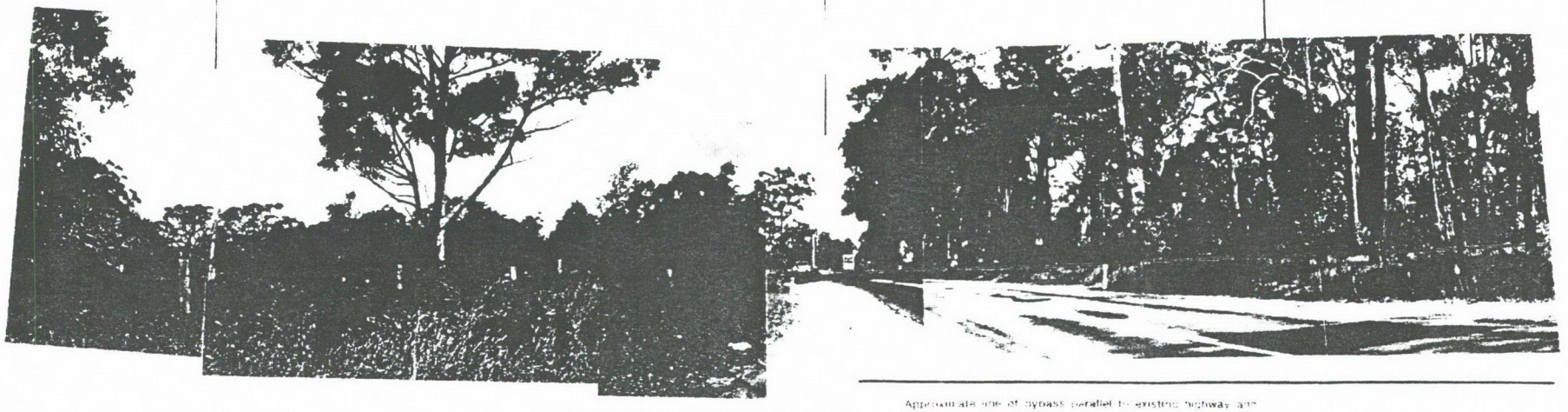
Turpentine Road

Viewpoint from the West

TRANSMISSION EASEMENT

BIKEFARM
MAIN ENTRY

WOODLAND CHARACTER



Approximate line of bypass parallel to existing highway and concealed by vegetation

Bypass concealed by landform

PHOTOMONTAGE 1

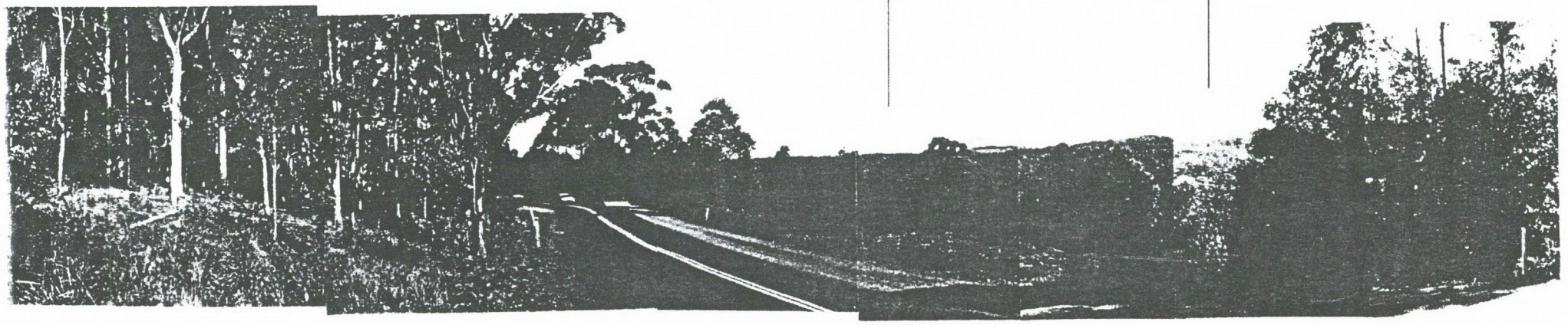
North Highway

View Southward into First Bend

FOREST & WOODLAND

WESTERN ESCARPMENT

NORTH VALLEY



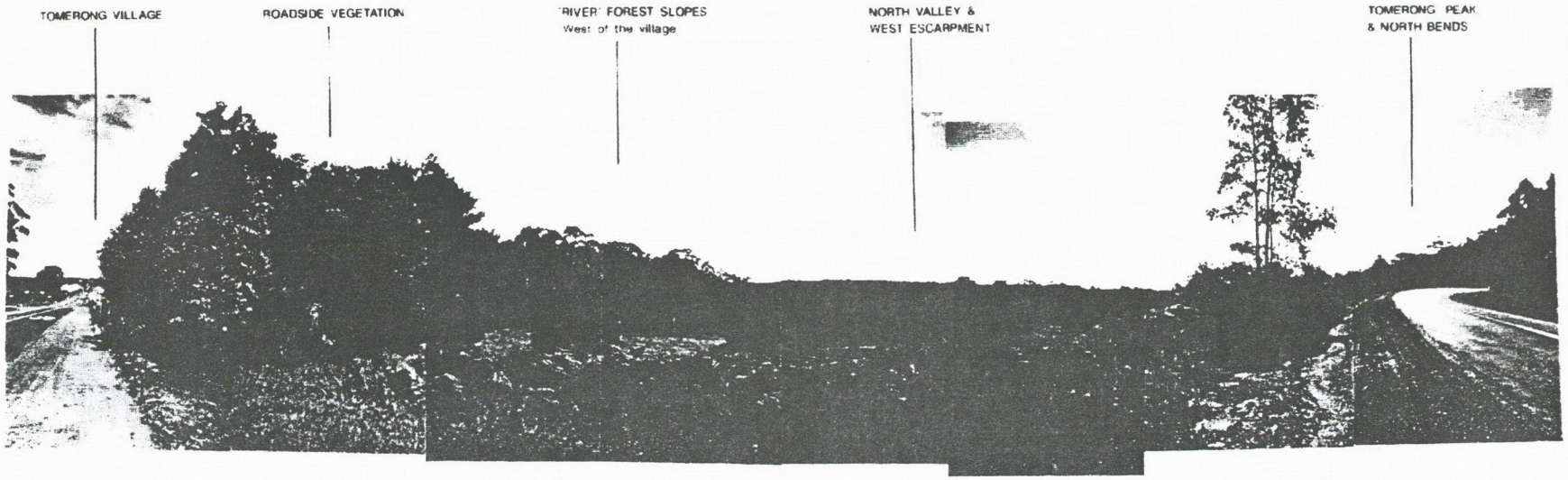
Bypass concealed by landform

Approximate line of bypass down the road east escarpment and valley forest

PHOTOMONTAGE 2

North Bends Beneath Tomerong Peak

Westerly View Across North Valley

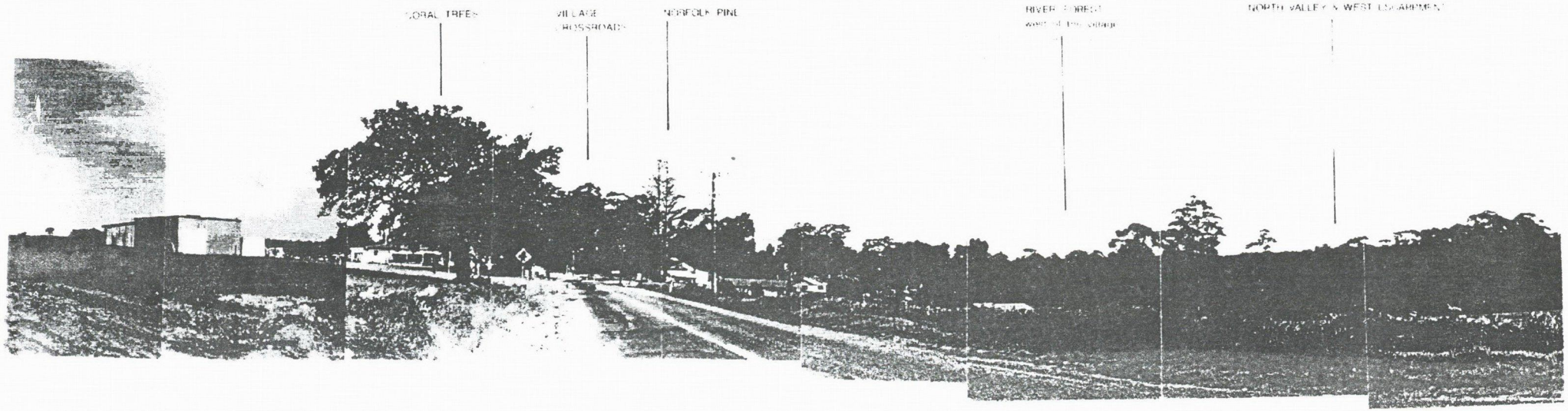


Approximate line of bypass concealed by vegetation and landform

PHOTOMONTAGE 3

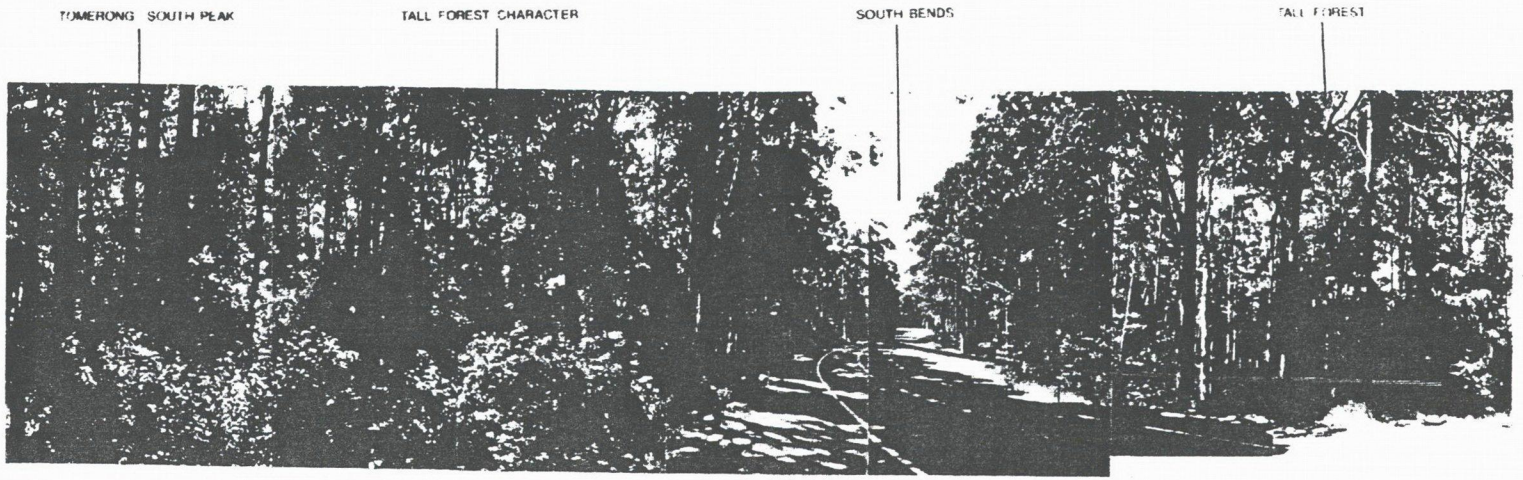
Tomerong Village Entry

View Westward Across Valley



PHOTOMONTAGE 4

Tomerong Village



Bypass concealed by landform and vegetation

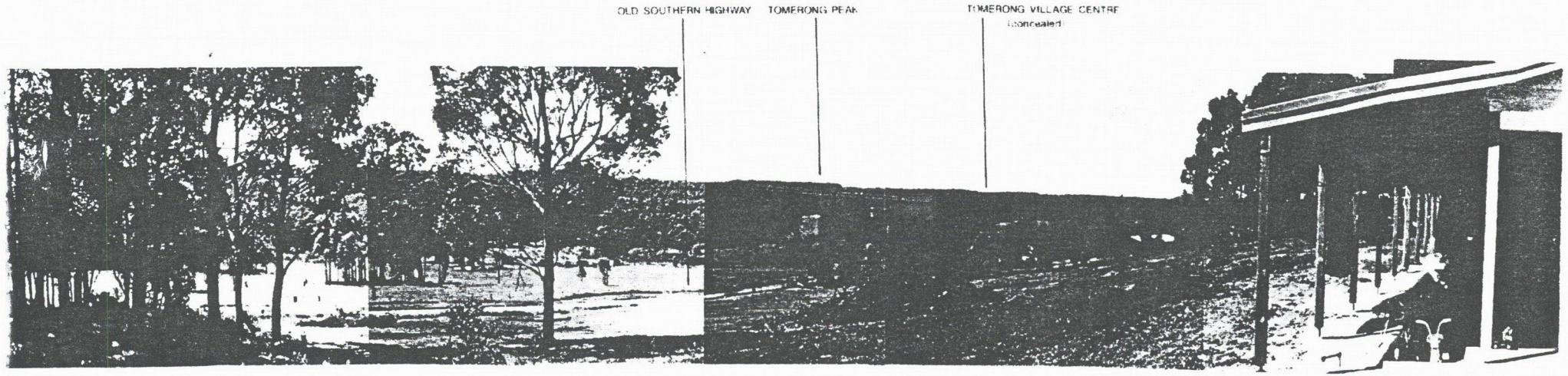
Bypass exposed at crossover until traffic is redirected

Approximate line of bypass concealed by forest

PHOTOMONTAGE 5

Highway Bends Beneath South Peak

View Northward along South Bends



Approximate line of bypass down the inner east escarpment concealed by forest

Bypass concealed by landform

PHOTOMONTAGE 6

Homestead Beneath Tomerong's South Peak

Northward View Across Tomerong Valley

GLOSSARY

Scenic Motorway	–	a standard of motorway specifically developed to promote the scenic attributes of the town and countryside which this route passes through; in particular referring to a motorway developed through a regionally significant or merit quality scenic environment, eg the Tomerong–Bewong Scenic Landscape.
Motorway	–	syn. roadway; generally all classes of RTA managed roadways including: freeway, highway, other main roads and tourist drives.
Freeway	–	usually referring to a 4 to 6 lane motorway with a broad sweeping geometry, eg for design speeds above 100kph.
Parkway	–	a first class standard of scenic motorway specifically developed to enhance the scenic qualities of its environmental setting, with particular attention to the cultural and natural landscape and architectural features of towns and countryside to which the motorway will contribute; in particular referring to state or nationally significant scenic environments, eg the Blue Mountains.
Public Sensitivity	–	syn. visual sensitivity; the potential sensitivity of views to public exposure which can be indicated by the number of observers likely to see a particular view; generally, public sensitivity will increase with a large viewer population (of passing motorists and to cal observers) and be low in remote locations with minimum viewers. Note: in special circumstance, public sensitivity may further increase as a result of public interest being expressed toward particular environmental issues associated with development and/or conservation.
Visual Absorption	–	syn. scenic capability; the capacity of a built or natural landscape to absorb change by maintaining an unaffected appearance after being subject to development or other alterations.
National Tree Strategy	–	A Commonwealth Programme to direct the initiative for replanting forests and trees throughout Australia.

ABBREVIATIONS

EIS	–	Environmental Impact Statement
REF	–	Review of Environmental Factors
REP	–	Regional Environmental Plan
LEP	–	Local Environmental Plan
RTA	–	Roads and Traffic Authority
DOP	–	Department of Planning (1988 to present); syn. Department of Environmental and Planning (1980 to 1988)
SCS	–	Soil Conservation Service
SCC	–	Shoalhaven City Council
AADT	–	Average Annual Daily Traffic; two way vehicle counts identified by RTA.

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The following comments and ranking have been determined.

Group 3 – The Existing Corridor has been discarded as an option. This would not resolve the unwanted visual impact of heavy traffic through the village residential corridor.

Notably, the positive impacts resulting from highway landscaping of Option D (Highway Redevelopment) which would enhance the townscape quality remain as a public opportunity – which should be discussed between the RTA and Shoalhaven City Council.

Option E would result in retention of the existing visual quality of the town and highway approach – which are depauperate in places and could benefit from scenic improvement based on cultural landscape features which are already present and part of the Mid South Coast regional town and village character. (See Section 2 – Existing Environment.)

Group 2 – The Village Perimeter Corridor (Option B) offers the benefit of being close to the existing town centre and would retain views toward the village, exposing it as an identity place to passing motorists. This option retains much of the status quo for landscape scenery, except for the addition of a riverine forest character at the deviation. It has a comparatively high visual absorption and low public sensitivity (numerical – quantitative).

The main drawback is a high cultural sensitivity (emotional – qualitative) shown by the community to unwanted disturbance of the "village rainforest". This public response to Option B was expressed at an RTA–convened public meeting (7.9.89).

Group 4 – The Western Corridors offer to motorists the visual interest of a high variety of character transitions, although a full range is not afforded as a result of avoiding all village roadscape zones. All three options (Options F, G and H) have a distant setback from the village centre, which reduces the opportunity for a close town address point. Visual absorption is moderate–high, which moderation in this instance tends to reflect alignments through or edged by open rural lands not already exposed to a highway corridor.

Major disbenefits occur as all these options affect the forested escarpment–valley complex, likely to result in unwanted linear swathes especially visible from southern homesteads along the existing highway and rural byroads; and from the towns (*) northern approach along the existing highway bends overlooking the valley–escarpment. (*: Indeed so does Option A – but this will be noticable only from the "old" present highway, which will be declassified as a main road.)

APPENDICES

TOMERONG BYPASS
VISUAL/LANDSCAPE STUDY

Appendix A1 -
ALTERNATE CORRIDORS

TOMERONG BYPASS – 2456

Appendix A1: Alternate Corridors

OPTIONS ASSESSMENT – COMMENTARY

Four major groups of corridor types have been identified arising from the seven (7) highway–bypass options, which comprise Group 1 (A), Group 2 (B), Group 3 (D, E) and Group 4 (F, G and H).

Group 1
A. The central corridor – The Grange Way

Group 2
B. The perimeter corridor – West Tomerong

Group 3
D. The existing highway – Redevelop
E. The existing highway – Do Nothing

Group 4 – The Western Corridors
F. SW for alignment – Upland/escarpment option
G. SW close alignment – Midland/valley option
H. N–S mid alignment – Valley/escarpment option

The four groups of corridor have been examined in terms of five major criteria:

			Opposites
.town–entry address	–	identity	(close .. distant)
.motorway scenery	–	outlook	(interest/variety .. common)
.visual absorption	–	onlook	(dramatic .. concealed)
.public sensitivity	–	viewers	(greatest .. least)
.existing patterns	–	linear	(reuse .. abandonment)

A summary table has been prepared of the options assessment showing the matrix relationship between corridor options and the scenic parameters. (See Table A1.1.)

Group 1 – The Central Corridor (Option A) alignment duplicates existing corridor patterns as a linear swathe alongside the north and south highway bends into the village, including on alignment alongside The Grange Road. Between Turpentine and Barham Roads an existing fire–service track already disturbed would be redeveloped to fit a 1.5km highway bypass sector. This utilisation and/or association with existing swathe patterns minimises the negative impact of a new corridor by reducing disturbance of the unbroken natural landscape.

(In addition, this approach maintains the future opportunity for a 4–lane traffic separated highway by redevelopment of the existing upland corridor north of Tomerong Peak, when safety/volume demands require traffic separation.) See separate –to be developed in a final report.

Option A offers a moderately close proximity between the bypass intersection at Turpentine Road and the town–centre crossroads. The location of this tee intersection (Type B and future possible Seagull–type combination) associated with the forest edge of a present rural residential clearing will provide an opportunity for a town gateway (west) from the highway bypass, which may be accented by a cluster group of feature trees and suitable signage. A second gateway (south), potentially the primary address, could be developed at the intersection associated with The Grange Road and existing highway where the village–scape is already represented and there is open land with middistant views suitable for making a gateway statement. (Note: The gateway effect should be developed to match the village scale of Tomerong and as a "portico" to Jervis Bay and Georges Basin. This could be a local landmark, rather than requiring a regional effect.) A southern gateway at this location would also help to visually unify the Battunga Road residential cluster by coordinated character treatment with the whole identity of the village, rather than further the present fragmentation.

Option A has a high variety of scenic transitions through a full range of character types. Visual absorption is also high, whereby a majority (75%) of the route would be enclosed within a forest swathe or along the forest edge. Public sensitivity is low in terms of existing residential onlook.

Notably, this option avoids the escarpment slopes although it is likely that the deviation route away from the existing highway and north of Tomerong Creek will be seen as a linear swathe through the forested northern valley from the existing highway bend above Yerunda Road.

RECOMMENDATIONS

Option A – the central corridor offers the preferred route to maximise the potential for a high quality scenic route with a reasonable address to Tomerong retained. It has a high degree of visual absorption while minimising disturbance to the residential close foreground viewscape. In addition it utilises or is associated with existing swathes thereby minimising and/or consolidating the extent of potential impacts.

In overview, the total corridor options have been arranged/ranked in order of preference from maximum to least positive effect, ie least to greatest detrimental impact as follows.

1. Option A – Central Corridor
2. Option B – Perimeter Corridor
3. Option H)
4. Option F) – Western Corridors
5. Option G)
6. Option D – Highway Redevelopment
7. Option E – Do Nothing

(The above order has been interpreted from Table A1.1 and the options assessment commentary.)

During the EIS and design development, the preferred corridor will require refinement of a route alignment within the corridor band to further maximise benefits and reduce adverse effects. Ultimately, the final alignment will also rely on suitable landscape treatments along the highway reserve to fully integrate it with its surrounding town, forest and rural countryside.

The next phase of the visual study will focus on the preferred corridor and generate alignment refinements for RTA review, prior to developing a landscape concept and management guidelines.

TOMERONG EIS VISUAL STUDY

TABLE A1.1 - Corridor Options - Comparison

OPTION GROUP	SCENIC PARAMETERS *				
	Town Address	Motorway Scenery	Visual Absorption	Public+++ Sensitivity	Existing Corridors
	(Proximity)	(Transition)	(Visibility)	(Exposure)	(Recycle)
Groups 1&2					
A.Central Option (7.1km)	MODERATE 1.0km west	HIGH/6TYPES 16 sequ- ences+	HIGH = 75% 5.3kms++	LOW 4 resid.	MODERATE
B.Perimeter Option (7.5km)	CLOSE 0.5km west	MOD./5TYPES 14 sequences	HIGH = 75% 5.6kms	LOW 8 resid.	MODERATE
C. -					
Group 3					
D.Existing Upgraded (7.9km)	CENTRAL Crossroads	MOD./4TYPES 13 enhanced	MOD. = 50% 4.1km	HIGH 50 resid.	HIGH
E.Do Nothing (7.9km)	Ditto Crossroads	HIGH/5TYPES 13 exist.++	Ditto = 50% 4.1km	HIGH 50 resid.	HIGH
Group 4 Western Corridor					
F. (6.6km)	DISTANT 2km west	HIGH/4TYPES 21 seq.	MOD-HIGH+++ 4.4KM = 66%	LOW	NIL
G. (6.6km)	Ditto 2km west	Ditto/4TYPES 17 seq.	4.1km = 62%	LOW	NIL
H. (6.8km)	Ditto 1.5km west	Ditto/5TYPES 19 seq.	4.7km = 70%	LOW	NIL

RATING: High, Moderate (Average), Low.

* Scenic Parameters: Public sensitivity – measure of viewer population ie.. residents and daily motorists.

Motorway scenery – note RURAL LANDS, north and south valley deficient.

– note this draft does <u>not</u> include motorists views and views beyond 100m.

Others – see Glossary.

\+ plus escarpment/valley views

++ note: valley swathe

+++ note: escarpment swathe

TOMERONG BYPASS
VISUAL/LANDSCAPE STUDY

Appendix A2 -
VIEWER POPULATION

TOMERONG BYPASS

Appendix A2: Viewer Population

This appendix presents an estimate of the viewer population which would directly overlook the proposed Highway Bypass.

No direct statistics are available and the following populations have been calculated by adopting a subjective assumption about traffic breakup and vehicle occupation, as well as dwelling occupation.

1. TRAFFIC POPULATION

Tomerong Traffic – 1200 vehicles per day (v.p.d.) [Ref: RTA AADT counts.]

Assumptions –

1. 50/50% traffic breakup: ratio of two-way commuter to one-way through traffic.
2. 2 to 2.5 persons per vehicle as an annual average,
3. Commuter traffic will reduce real traffic population by 50% to reflect a returning vehicle with the same occupants.

Calculation:

. Two way commuters = 12000 v.p.d.) x 50% x 50% + 2.25 persons = 6750

. One way travellers = 12000 v.p.d.) x 50% x 100% + 2.25 persons = 13500

Total daily traffic population/motorists = 20250 persons

2. RESIDENTIAL POPULATION

Adjacent dwellings: ten (10) dwellings within 200 metres
Assumptions: 2.5 people per dwelling occupancy.

Calculation:

. Potential close onlookers = 10 x 2.5 persons = 25

Total daily residential population/onlookers 25 people

The above figures are indicative and serve to establish a common basis of measure which can be compared with other regional localities.

No comparison can be made between the population of motorists and residential viewers, as each would have a completely different visual experience (being sedentary/occupational versus travelling/sequential) of the effects arising from an adjacent development, in this case the Highway Bypass.

TOMERONG BYPASS
VISUAL/LANDSCAPE STUDY

Appendix A3 -
SWATHE DISTURBANCE

TOMERONG BYPASS

APPENDIX A3 - SWATHE DISTURBANCE

[SEE SECTION 8.3 – MICROSCALE EFFECTS, BANK/WIDTH DISTURBANCE]

ROAD	ROAD SWATH Carriageway Width	Road Shoulder	Bank (+)	Edge Tracks (1)	Total Swathe
Two Lanes	7.0m	2.0m	+	6.0m	15.0m(+)
Three Lanes	10.5m	2.0m	+	6.0m	18.5m(+)

EXAMPLE:

Two lanes raised on 3.0m ht fill = 15m + bank width
= 15m + 12m (forest earth fill)
= 27m swathe

NOTES:

(+) Bank width – calculated to a constant gradient and variable elevation

- Rockcutting (2:1) x 1.0mht = 0.5m wide
- Rockwalling (1:1) x 1.0mht = 1.0m wide
- Earthfill – forest (1:2) x 1.0mht = 2.0m wide
- Earthfill – rural (1:3) x 1.0mht = 3.0m wide

(1) Edge track – allowance for a 3.0m wide track alongside the top or base of banks each side of the roadway, totalling 6.0 metres. The final width of the edge works disturbance will be determined by the RTA Project Manager.

TOMERONG BYPASS
VISUAL/LANDSCAPE STUDY

Appendix A4 -
GUIDELINE PRESCRIPTIONS

TOMERONG BYPASS

APPENDIX A4 - GUIDELINE PRESCRIPTIONS

[SEE 9.2.4 HIGHWAY FEATURES, STRUCTURES AND LANDSCAPE WORKS]

I	Town Entry
II	Highway Signage
III	Valley/Escarpment Scenic Controls
Iv	Corridor Swathe – Disturbance Limit
v	Highway Margins – Generally
vI	Highway Fencing
vII	Highway Medians
vIII	Highway Batters – Hard/Earth and Softworks Treatment
Ix	Tree–wall Protection
x	Fenceline Planting
xI	Fauna Underpasses – bridges and culverts
xII	Macropod Crossings
xIII	Arboreal Crossings – canopy overpass
xIv	Traffic–hazard Barriers
xv	Drainage Controls
xvI	Bicyclist Route
xvII	Bridge Features
xvIII	Construction Compounds
xIx	Construction Tracks
xx	Native Soil and Forest Litter Stockpiles
xxI	Programming – Environmental Management
xxII	Landscape/Revegetation Works
xxIII	Design Survey
xxIv	Highway Afteruse and Fragmentation
xxv	Contractual Safeguards

8.3 FLORA AND FAUNA

Survey Report by Roslyn Muston and Associates

FLORA AND FAUNA SURVEY REPORT

CITY OF SHOALHAVEN

STATE HIGHWAY NO. 1

PRINCES HIGHWAY

TOMERONG BYPASS

Prepared by
Roslyn Muston & Associates Pty Limited.
1990

CONTENTS

		Page No.
1.0	**SUMMARY**	1
1.1	Outline of Proposal	1
1.2	The Study	1
1.3	Alternative Route Options	2
1.4	Major Findings of the Flora Survey	2
1.5	Major Findings of the Fauna Survey	3
1.6	Environmental Impacts	4
1.7	Evaluation of the Relative Impacts of the Options	5
2.0	**INTRODUCTION**	6
2.1	The Project	6
3.0	**THE STUDY AREA**	7
3.1	Landform and Soils	7
3.2	Landuse	7
4.0	**VEGETATION SURVEY OF THE STUDY AREA**	9
4.1	Methods	9
4.2	The Woodland	10
4.3	The Open Forest	11
4.4	Riverine Vegetation	12
5.0	**SIGNIFICANCE OF THE VEGETATION**	15
5.1	Intrinsic Scientific Value	15
5.2	Conservation Value	15
5.3	Aesthetic Value	16
5.4	Commercial Value	16
6.0	**FAUNA SURVEY OF THE STUDY AREA**	17
6.1	Mammals	19
6.2	Birds	25
6.3	Reptiles and Amphibia	26

7.0 SIGNIFICANCE OF THE FAUNA 27

7.1 Individual Species of Conservation Significance 27
7.2 Faunal Habitat Values 28

8.0 POTENTIAL ENVIRONMENTAL IMPACTS 30

8.1 Impact of Earthworks on Landform, Soils and Water Quality 31
8.2 Impact of Road Construction on the Vegetation 33
8.3 Impact of Road Construction and Usage on the Fauna 36
8.3.1 Habitat Destruction 36
8.3.2 Fragmentation of Habitat - Impacts on Native Fauna 37
8.3.3 Fragmentation of Habitat - Impacts on Road Users 38
8.3.4 Disruption of Aquatic Habitats 38
8.4 Visual Impacts 39
8.5 Synthesis of Environmental Impacts 39

9.0 RECOMMENDATIONS TO REDUCE ENVIRONMENTAL IMPACT

9.1 Erosion and Sediment Control 41
9.2 Reduction of Vegetation Disturbance 42
9.3 Reduction of Disturbance to Native Animals 43
9.4 Protection of Visual Amenity of the Study Area 45

References

LIST OF APPENDICES

Appendix 1 Structural Formations in Australian Vegetation
Appendix 2 Plant Species Recorded in the Study Area During the Vegetation Surveys
Appendix 3 Riverine Vegetation - Options A & B Corridors
Appendix 4 Mammals Considered Likely to Occupy the Study Area
Appendix 5 Avifauna Considered Likely to Occupy the Study Area
Appendix 6 Reptiles and Amphibia Considered Likely to Occupy the Study Area
Appendix 7 Suggested Revegetation Species - Tomerong Bypass
Appendix 8 Study Team

FIGURES

Figure 1 Location of Tomerong Bypass route options A B F G & H
Figure 2 Vegetation Community-types in the study area
Figure 3 Fauna survey areas
Figure 3 Findings of environmental significance

1.0 SUMMARY

1.1 Outline Of Proposal

The Roads and Traffic Authority is considering construction of a major deviation of the Princes Highway with the aim of providing a bypass to the Village of Tomerong, improving the vertical and horizontal alignment and providing overtaking opportunities. The proposed Tomerong Bypass would deviate from the existing highway 16 km south of Nowra and pass for seven or eight kilometres on the western side of the Village of Tomerong before rejoining the existing highway.

1.2 The Study

At the request of the Roads and Traffic Authority, flora and fauna surveys were conducted on five possible route options (Options A, B, F, G and H). The investigations reported in this document are components in the consultative and iterative process of site selection.

Three botanical surveys were conducted. In June-September 1989 a survey was conducted of the eastern options (Options A & B) in which the species composition and significance of the plant communities were assessed. The first survey indicated the presence of a locally significant riverine plant community on the floodplains of Tomerong and Stewart's (Suffolk) Creeks. The second survey which focussed on this community assessed the species composition, location and size of the riverine vegetation community. The third survey assessed the significance of all vegetation communities affected by the three western route options (Options F, G and H). (Sections 4 & 5)

The faunal investigation was conducted in two stages. In June-July 1989, a survey was made of the eastern options for the Bypass (Options A & B). This survey identified animal species present in the survey area, their significance and their likely distribution in the region. In February-March 1990, a survey was made of the general area of the three western routes (Options F, G and H). In addition, some findings from the earlier survey were investigated further in March 1990 (Sections 6 and &7).

This document also includes an evaluation of the potential impacts upon the flora and fauna of construction of the bypass in each route option (Options A, B, F, G and H) (Section 8). Finally, recommendations are made which aim to reduce the adverse impacts identified by the findings of this study (Section 9). Species lists compiled in the course of the study are contained in Appendices 2-6. Figures 2-4 show the location and distribution of species and communities relevant to the report's recommendations.

1.3 Alternative Route Options

All options commence their deviation from the existing highway on the Nowra Sandstone plateau.

Option A makes one steep descent from the plateau and crosses the primary valley floor of two major drainage systems, i.e. Tomerong and Stewart's (Suffolk) Creeks. Option B differs from Option A in that it passes along the floodplain of Tomerong Creek and crosses Stewart's (Suffolk) Creek east of the existing highway.

Options F, G and H all pass further to the west of the Village of Tomerong and join the existing highway further south than Options A and B. All three traverse the deeply dissected terrain of the upper catchments of Tomerong and Stewart's (Suffolk) Creeks and re-cross the Nowra Sandstone plateau west of Tomerong.

1.4 Major Findings Of The Flora Survey

1.4.1 Three main plant community types were identified in the study area. All have been influenced by selective logging and early clearing for grazing purposes. The two most extensive, woodland and open forest, have been considerably modified by these influences and now exist (with the exception of relic, isolated, "pre-logging" trees) as regrowth forests. The third, riverine vegetation, is limited in area and contains many sawn tree stumps, but is still relatively intact on the floodplains of the major creeks. In the upper gullies of the catchments the riverine vegetation has been more severely affected by logging and fire.

1.4.2 The riverine vegetation located on the floodplains is identified as having local significance and being potentially vulnerable to alteration as a result of road construction. The location and distribution of this vegetation-type is shown on Figure 2.

1.4.3 One endangered plant species, the Brush Cherry (*Syzygium paniculatum)*occurs on the banks of Tomerong and Stewart's (Suffolk) Creek (Figure 2&4). This species is of scientific conservation significance as it is considered to be at risk of disappearing from the wild state within one or two decades. One individual of this species occurs within the existing road reservation within Option A. A second individual is located on the same floodplain to the east of the road reservation. Nine more individuals were located in a 1 km stretch of the floodplain of Tomerong Creek. All individuals of this species which would be likely to be in the vicinity of the selected route have been mapped so that efforts can be made to protect them during road construction.

1.4.4 Options A and B pass through immature stands of commercial timber of significant future sawlog potential.

1.4.5 All options pass through an area identified by the Department of Planning as a scenic protection area in which future developments must recognise the need for protection of the skyline and retention of native timber.

1.5 Major Findings Of The Fauna Survey

1.5.1 The faunal survey focussed on land containing predominantly native vegetation with tree cover. Most of these areas, both in the path of the western routes (Options F, G and H) and in the path of the eastern routes (Options A & B), were found to contain species of scientific and popular conservation significance.

1.5.2 One animal species observed in the region, the Yellow-bellied Glider (*Petaurus australis*), is considered to be rare and occur in populations that are limited in size and extent. The species is therefore of scientific conservation significance. Several groups of Yellow-bellied Gliders were recorded (see Figure 4):

- (1) adjacent to Turpentine Road on the south side, Option A;
- (2) adjacent to Turpentine Road on the north side, Option A;
- (3) south of the existing highway, adjacent to Grange Road, Option A;
- (4) south of Turpentine Road, Option G;
- (5) west of Bettunga Road, Option F;
- (6) between farm paddock and power lines north of Turpentine Road, Option G.

1.5.3 One tree on Option A was confirmed as an actively used Yellow-bellied Glider den tree. It has been identified so that an attempt can be made to avoid disruption to this animal. The botanical survey supported the belief that suitable habitat for this animal extends throughout the study area.

1.5.4 Other animal species of popular conservation significance were observed to be widely distributed throughout all options. In addition, Platypuses (*Ornithorhynchus anatinus*) are considered likely to be living in Tomerong and Stewart's (Suffolk) Creeks both of which are crossed by Options A and B. Platypus are adversely affected by erosion and subsequent sedimentation within their habitat. Construction of the road through all options has the potential to threaten the aquatic environment.

1.5.5 It is likely that large animals (wombats, wallabies and kangaroos) will create a hazard to traffic in areas where the route crosses primary floodplains. Areas of recent wombat activity were found on the primary flood plains (See Figure 4):

- along Option A, near Tomerong Creek and Stewart's (Suffolk) Creeks;
- in the southern part of Options F, G and H near existing agricultural land and Stewart's (Suffolk) Creeks;
- in the mid-north section of Option G, where it crosses current agricultural land.

1.6 Environmental Impacts

The potential major adverse impacts identified in this report are:

1.6.1 Impacts associated with major excavations and fills which include major structural changes to landform; potential soil erosion, sedimentation and reduction of water quality; destruction of flora and fauna habitat.
1.6.2 Localised reduction or alteration of riverine vegetation.
1.6.3 Disturbance of individuals of plant and animal species of scientific significance.
1.6.4 Localised loss of animal habitat.
1.6.5 Fragmentation of animal habitat.
1.6.6 Potential short-term disturbance to aquatic habitats.
1.6.7 Potential hazards to traffic through movement of large animals across the new road.

Many of these adverse impacts may be ameliorated by careful, sympathetic design and construction techniques. Recommendations which aim to reduce impacts are included in Section 9.

1.7 Evaluation Of The Relative Impacts Of The Options

Option A has been selected as the most suitable route for construction of a by-pass. The extent and scale of potential environmental impacts caused by the major earthworks associated with the western routes outweigh the localised and specific potential impacts caused by construction of the road in the eastern routes. Option F, G and H are specifically rejected on the basis that construction of a by-pass in the western area will significantly fragment the habitat of a rare animal species, the Yellow-bellied Glider. Option B is rejected on the basis that it posses a direct threat to the locally significant riverine plant community on Tomerong Creek and a population of the endangered plant, the Brush Cherry.

Key issues in sympathetic design of a bypass in the vicinity of Option A are specifically:

1.7.1 protection of the large, diverse communiy of riverine vegetation, west of Tomerong Village on Tomerong Creek;

1.7.2 protection of individuals of the endangered plant species, Brush Cherry;

1.7.3 protection of the Yellow-bellied Glider's "den" (hollow) trees;

1.7.4 control of soil erosion and sedimentation;

1.7.5 protection of the aquatic habitat;

1.7.6 provision of free-passage for animals underneath the road in the location of major drainage lines;

1.7.7 retention of tall trees on road verges to retain passage over the road for arboreal mammals.

2.0 INTRODUCTION

2.1 The Project

This report presents the results of the flora and fauna surveys which were conducted on behalf of the Roads and Traffic Authority of New South Wales (RTA). The RTA is considering a major deviation of the Princes Highway between 16.0 km and 24.0 km south of Nowra to provide an improved vertical and horizontal alignment, a bypass of the village of Tomerong and improved overtaking opportunities with auxillary lanes. At the time of this study, a number of potential route options had been identified (Options A, B, C, D, E, F, G and H). This study assesses in detail vegetation and fauna of the 100m wide corridors of Options A, B, F, G and H. Option D (upgrading of the existing alignment) and Option E (do-nothing option) were considered not to significantly affect the environment. Option C was not surveyed as it had already been considered unsuitable on the basis of economics and efficiency.

The report includes:

- identification of the plant communities and plant species in the corridor which would be affected by Options A, B, F, G and H;
- identification of the mammals, birds, reptiles, amphibia and aquatic vertebrates in the Option A corridor;
- identification of the mammal species in the vicinity of the western corridors (Options F, G and H);
- an assessment of the significance of the vegetation and fauna;
- an assessment of the direct and indirect impact of the proposed bypass upon the vegetation and fauna;
- the advice of relevant officers from the National Parks & Wildlife Service, Soil Conservation Service, Department of Planning and Forestry Commission (NSW) who were consulted about the proposal and the findings of this study;
- recommendations which aim to reduce any adverse impacts of the proposed road.

3.0 THE STUDY AREA

The route options are located within the local government area of Shoalhaven City Council and the southern part of the Illawarra Region for which a Regional Environmental Plan was prepared in 1981 by the Department of Environment and Planning (the route investigated for each option is shown on Figure 1). The study area described in this report encompasses all the land between the existing Princes Highway and the corridors of Options G and F. Detail comments are made about each route option where relevant.

3.1 Landform And Soils

All route options pass across the Permian Sedimentary Associations of the Shoalhaven Group. Above the 80m contour all routes intercept the Nowra Sandstones. In these areas the soils are typically thin, gravelly yellow earths. Underlying the Nowra Sandstone are the Wandrawandian Siltstones and shales. Steep slopes mark the descent from the sandstone in all parts of the study area. The soils on these slopes are deep, sandy and clay loams which are scattered at the higher elevations with broken sandstone rocks. The water courses which originate on the sandstone ridges cut deeply through the siltstones and flow over steep, boulder strewn channels to the 40m contour. Between the 40m and 20m contour, valleys are wide and drainage is via meandering channels incised in deep alluvial soils.

Severe soil erosion and gullying was observed in the north of the study area where a motor bike circuit occupies the floodplain and steep slopes associated with Tomerong Creek. Localised erosion was also observed where vehicle and foot tracks cross Stewart's (Suffolk) Creek. All soils on the siltstones slopes and alluvial floodplains are likely to be susceptible to erosion if they are disturbed or denuded of vegetation.

3.2 Landuse

The study area is located within a broad district, parts of which are used for passive and active recreation. Large tracts of land in the district are managed as National Parks and others for commercial timber production. As a consequence, the district is one of contrasting landuses; of intense landscape modification in places and protection from Man-made change in others.

The study area is freehold land, with the exception of a small area of State Forest through which Option G passes, and undeveloped road reservations.

With the possible exception of some small areas of creek bank vegetation, all of the plant communities in the study area appear to have been modified by land management, in particular selective logging and grazing. On the sandstone soils there are areas which are totally cleared of tree cover and many dead ring-barked trees are located in areas where a living tree cover is regenerating and where the species composition and structure of the understorey indicated a high frequency of fire. Firewood gathering was observed in the woodland area.

The open forest and riverine vegetation in the remainder of the study area has been cleared in several places for grazing purposes and, in one area, a motor bike circuit. Regrowth of dense Acacia thickets occur on many recently cleared areas. The dense Acacia thickets are a response to removal of large, old canopy trees and areas of sparse herb/fern ground cover indicate a response to frequent, low intensity fires. There is evidence of selective logging throughout the area. Along Option A there is dense regrowth of saplings to pole-size trees where tall open forest has been substantially altered by removal of old trees. Species dominance of forests appears to have been altered by timber management practises to favour commercially valuable timber species. Forest regrowth is more mature in the upper valleys and several very large Eucalypt trees were observed in the upper reaches of the creek tributaries.

Despite the evidence of extensive creek channel modification, the presence of terrestrial orchids, ferns and other small plant species indicates that there has been little long-term modification of surface soils over most of the area.

A number of beehives were observed being moved around the study area during the surveys indicating that tree and shrub blossom are being used for honey production.

4.0 VEGETATION SURVEY OF THE STUDY AREA

On a structural basis (Specht 1981 - classification shown in Appendix 1) there are three basic vegetation types in the study area;

(i) a low woodland with a sparse sclerophyll shrub understorey;

(ii) a medium to tall open forest with low herbaceous ground cover or a tall, dense sclerophyll shrub understorey;

(iii) riverine vegetation varying from tall open forest to low closed forest or closed shrub all of which have a dominant mesic component.

Of these, the most extensive and structurally variable is the open forest which varies throughout the corridor depending on the history and nature of local management techniques. The least disturbed is the riverine vegetation which is restricted to the creek banks at the lower elevations.

The same three basic vegetation types can be described in terms of their species composition. Tree species tend to be confined to each type, although several occur in all types but vary in relative abundance between sites. There are some shrub and herb species which are ubiquitous but most are confined to one or other of the forest types. The survey indicates a strong association between species composition and structural type, drainage patterns and lithology through the influence of soils.

4.1 Methods

For the original survey of the eastern options plant species compositions were determined by a field survey conducted during June-September 1989. Community distributions were confirmed by aerial photograph interpretation and then re-checked in the field. Zig-zag traverses were made and areas of disconformity indicated on the aerial photographs, but missed in the zig-zag survey, were individually checked in the field. The species composition of the vegetation and a subjective assessment of relative species abundance and species association were made during the field survey.

Searches were made for species of conservation significance which are recorded for the region in relevant literature on the woodland and forest vegetation of the South Coast (Mills 1984, Dames & Moore 1985, 1987(a), 1987(b), Ingwersen 1976, Ward & Ingwersen 1978, Braithwaite et al. 1988, Forestry Commission of NSW 1982, National Parks & Wildlife Service of NSW undated). These documents were researched to determine the representative nature of the corridor vegetation and to identify any possible omissions which would require additional field searching.

The plant species lists derived from this survey are not meant to be exhaustive but are intended to be comprehensive enough to indicate the significance of the impact of road construction on the vegetation. Some uncommon species, species which were dormant at the time of the survey (e.g. many terrestrial orchids and other geophytes) and many native grass and sedge species will therefore not appear in the species lists.

During the second survey an intensive field search was made of the riverine vegetation occupying the creek banks and meanders of Tomerong Creek immediately west of Tomerong Village. This search was repeated at the Option A creek crossing of Stewart's (Suffolk) Creek and Tomerong Creek. During this search all species encountered were identified and the distribution and extent of the riverine vegetation community was assessed. Appendix 3 lists the species recorded and the areas in which they were observed.

For the third survey, the routes of the western options were walked and an assessment was made of the vegetation communities observed. Generally, few additional plant species were recorded although tree species dominance was observed to vary with change in aspect and altitude.

The vegetation in the study area will be discussed under the major structural types, i.e. woodland, tall open forest and riverine vegetation. The distribution of vegetation communities is shown on Figure 2 and individual species are listed in community types in Appendix 2 & 3.

4.2 The Woodland

The Nowra Sandstone soils support a dry, open woodland which includes the co-dominant tree species Scribbly Gum (*Eucalyptus sclerophylla*), Red Bloodwood (*E. gummifera*), Turpentine (*Syncarpia glomulifera*) and White Stringybark (*E. globoidea*). Also found in this community as isolated trees, are young Spotted Gums (*E. maculata*), Blackbutt (*E. pilularis*), mature Sydney Peppermint (*E. piperita ssp. urceolaris*), Silvertop Ash (*E. sieberi*) and (on the road verge) Rough barked Apple (*Angophora floribunda*). Canopy cover varies from property to property but is generally <10%. Tree height rarely exceeds 15m.

Most remaining old trees emerge above the living tree canopy as dead stags. There is evidence of early clearing of trees and ringbarking can be seen on most of the older trees. The living woodland trees are consistently saplings or young trees 10-15m tall with an irregular canopy cover.

A denser stratum of Turpentine saplings occurs between 1m - 6m tall. The shrub understorey is discontinuous to around 2m with most shrubs being 1m tall. The shrub species are dominated by proteaceous species, Acacias, Epacrids and the leguminous pea species.

The herb and fern ground cover is dominated by Blady Grass (*Imperata cylindrica*) and Bracken Fern (*Pteridium esculentum*) and includes a number of species of native grasses, ferns and terrestrial orchids. The epiphyte orchid *Cymbidium suave* is also found here, mostly in dead trees and tree stumps.

4.3 The Open Forest

A tall open forest community was observed on the steep slopes and the valley floors. These forests correspond to the deeper sandy-clay loams and upper slopes of alluvium which are derived from the Wandrawandian Siltstones. The dominant tree species, degree of tree canopy cover and tree height vary and have been strongly influenced by forest management practises, in particular selective logging and burning.

Blackbutt and Spotted Gum dominate towards the ridgetops. On the lower slopes, Bangalay (*E.botryoides*), Sydney Blue Gum (*E. saligna*), an intermediate form between these species, young Spotted Gum and Blackbutt are common. Grey Ironbark (*E. paniculata*) and Large-fruited Red Mahogany (*E. pellita*) were also observed to be less common on these slopes. The Mahogany is prevalent at the sandstone-siltstone interface in the western part of the Tomerong Creek catchment. The Burrawang (*Macrozamia communis*) occurs on the upper slopes where the forest understorey is grassy and ferny. Many large tree-canopy gaps occur on these slopes particularly in the vicinity of Tomerong Creek north of Turpentine Road. These gaps are filled with dense thickets of Sydney Golden Wattle (*Acacia longifolia var. longifolia*) and Black Wattle (*Acacia mearnsii* and *Acacia irrorata*) to 5m tall. Tall Eucalyptus emerge from these thickets and where the thicket has matured and thinned there are sapling Turpentines. In dense thickets the ground cover beneath is sparse and where the Acacia are less dense grasses and ferns predominate. In the upper reaches of the valleys, where the forest is older, a diverse shrub understorey which includes many mesophytic species occurs.

Where the forest is young in the vicinity of Option A, the forest canopy rarely exceeds 20m in height. In the upper reaches of the tributary creeks, the regrowth forest is older and its canopy height is mostly between 30-40m. An occasional older tree, which predates logging, emerges above the forest canopy. In the vicinity of the major creeks the shrub stratum is tall (4-5m) and dense. Common shrub species here are Black Wattle (*A. mearnsii*), *Acacia irrorata*, Two-veined Hickory (*A. binervata*), *Baeckea virgata*, *Leptospermum* spp. and *Melaleuca* spp. Vines, ferns and herbs are abundant.

The forest on Option A from Turpentine Road south is dominated by pole-sized Spotted Gums with less abundant Blackbutts and an occasional Large-fruited Red Mahogany (*Eucalyptus pellita*). Forest management in this area appears intensive but ecologically sound. Several old, mature living and dead Eucalypts occur along the road reservation and an occasional older, tall Eucalypt occurs within the younger stand of trees. This timber is currently being thinned and appears to be being managed for future sawlog harvest. The understorey is extremely sparse and ground cover consists of grasses, ferns and terrestrial orchids indicating a high frequency, low intensity fire regime. The forest to the west of Option A did not appear to be intensively managed. It is more diverse in age-structure and species composition and in most places includes a tall, dense shrub stratum and heavy litter loads.

A small patch of closed-shrub, dominated by Tick Bush (*Kunza ambigua*) was found just outside Option A on a rocky outcrop south of Grange Road. This is similar to a community specifically mentioned as being significant in the Environmental Impact Statement for the Electricity Transmission Line from Nowra to Ulladulla (1985) and to that described as "shrub/open scrub" in the Upper Parma Creek area by Mills (1984).

4.4 Riverine Vegetation

Particular attention was given to the riverine vegetation within the study area because of opinions expressed at the public meeting which indicated a public perception of this vegetation type as one of local conservation significance. Field survey indicated that the riverine vegetation is now confined to the upper gullies and the meander bends and banks of the major creeks (Figure 2).

Two forms of riverine vegetation occur in the study area. In the upper reaches of the gullies, where drainage flows over boulder strewn creek beds, the riverine vegetation extends across the gully floor and up the south-facing slopes as tall open forest. In most cases, the upper tree canopy consists of Blackbutts and Sydney Blue Gums with Turpentine either represented as a low regrowth canopy or as tall, old emergent trees.

The lower strata differ markedly from those on the ridgetops and north-facing slopes in that, in the gullies, a tall Cabbage Palm stratum is present. Beneath this a simple mesic tall shrub - low tree canopy occurs dominated by Lillypilly, Two-veined Hickory (*Acacia binervata*), *Backhousia myrtifolia*, and Blueberry Ash (*Elaeocarpus reticulatus*). The ground is densely covered by dead palm fronds, ferns and numerous moss - covered fallen logs. Vine cover is dense in the heads of the gullies and on the outer limits of this form of riverine community. Evidence of selective logging throughout these gullies is present as cut tree stumps (some very large) and numerous overgrown timber haul tracks. It is likely that, since selective logging began, fire has had a simplifying

influence on this vegetation type. In a non-structural classification, this community form would be classified as Wet Sclerophyll Forest with a rainforest understorey. This form of riverine community is common in the upper gullies on the NSW South Coast (Mills 1987, Dames & Moore 1985 and 1987, Helman 1987). A similar but apparently palm-free community is described by Mills (1984) for the gullies in the Upper Parma Creek catchment approximately sixteen kilometres north-west of the study area.

The second form of riverine vegetation in the study area is restricted to the deeper alluviums below the 40m contour. A sparse Eucalypt canopy (50% - 30% canopy cover) occurs above a low closed forest (100% - 70% canopy cover) stratum which consists almost exclusively of mesic species. Intense areas (2m - 20m wide) of this form of riverine vegetation occurs on most creek banks. Where the creeks follow wide meanders floodways and cut-off channels occur. This form of riverine vegetation is more extensive but still limited to the present-day flood terrace. The species richness of this vegetation type was found to increase as the lateral extent of the vegetation community increased. At the Option A crossing of Tomerong Creek, the community does not exceed 5m either side of the creek and 51 mesic species were identified. On the meander bends of Stewart's (Suffolk) Creek at the Option A crossing, 68 mesic species were identified. Where the community was extensive (up to 140 wide either side of the creek) across the Tomerong Creek floodplain beside Option B, 101 mesic species were identified (Table 1).

TABLE 1. - COMPARISON OF THE NUMBER OF MESIC PLANT SPECIES IN RIVERINE VEGETATION ON OPTIONS A & B

	Option A		**Option B**
	Stewart's Creek	Tomerong Creek	Tomerong Creek
ferns	11	5	15
vines	16	10	20
palms	1	1	1
shrubs & trees	33	27	53
herbs	7	8	12
Total	68	51	101
Endangered species individuals	1	0	9

The species composition of this second form of riverine vegetation is consistent with the Warm Temperate Rainforest sub-formation described for southern New South Wales (south of Ulladulla) by Helman (1987) and for the Illawarra Region of New South Wales by Mills (1988). Most representative stands of this vegetation type occur on freehold land or in State Forests and are thus indirectly or directly influenced by management programs in surrounding open forests, in particular canopy disturbance and exposure through logging and burning.

The stands of this community in the study area are weed-free although they have most probably been disturbed and reduced in lateral extent by early logging activities through selective removal of timber and alteration of light and moisture regimes. Although there is little evidence of fire-induced changes, fire scars on trees indicate that this community has not been free of fire. Large stumps, indicative of an earlier different community structure and spatial distribution, remain adjacent to the drainage lines. Paperbark (*Melaleuca* spp.) swamps also occur on the deep alluvium where the creek channel widens into small swamps. Native epiphytic orchids and vines are abundant. With the exception of the Brush Cherry, all of the species observed are widespread and common.

Two individuals of the Brush Cherry (*Syzygium paniculatum*) were observed adjacent to Stewart's (Suffolk) Creek; one on the creek bank in the road reservation and one in a canopy opening on the flood terrace of the creek. Nine more individuals of this specie were observed in a 1 km stretch of Tomerong Creek beside Option B. This species is listed in Briggs and Leigh (1989) as being Endangered, i.e. in serious risk of disappearing from the wild state within one or two decades if habitat depletion continues. The species has a range over 100 km in Australia but occurs in small populations in highly specific habitat. It is represented in several national parks and reserves but is considered inadequately reserved with a total population of less than 1,000 plants known to occur in reserves. This species naturally occurs as isolated individuals. The deep alluvium in the study area is an uncommon habitat for the Brush Cherry. Mills (1988) states that this species is restricted to littoral rainforest (i.e. on coastal sand dune deposits) from Bulahdelah to St. Georges Basin. Benson (pers. comm.) of the National Parks & Wildlife Service commented that due to possible previous misidentifications, the species may not be as limited in numbers and distribution as once thought but large stands were still worthy of protection because the species is rendered vulnerable by its restricted habitat and the fact that it commonly occurs as isolated individuals.

5.0 SIGNIFICANCE OF THE VEGETATION

The issues considered under this heading include the vegetation's:

- scientific value;
- conservation value;
- aesthetic value;
- commercial value.

5.1 Intrinsic Scientific Value

In terms of species composition all of the vegetation communities observed in the study area are found elsewhere on the Permian Sedimentary Associations in the district and are represented elsewhere on the coast between the Victorian border and the Illawarra Region. The riverine vegetation has local scientific significance because it is limited in area, inadequately reserved and restricted to gullies and deep alluvium in this district. Helman (1987) and Mills (1988) consider that similar plant communities on the South Coast are insufficiently conserved and currently under threat. There is ample evidence that the riverine vegetation in the study area is not currently being managed for protection and is being progressively depleted by subdivision, fire, clearing and creek bank erosion. One species which is considered endangered (Briggs and Leigh 1989) was identified in the study area.

5.2 Conservation Value

Particular reference is made in the Fauna Survey (Section 7) to the value in terms of faunal habitat of specific sections of the vegetation. In addition, it is noted that the wildflower display of the woodland, the more mature sections of the tall open forest and the riverine vegetation, have popular appeal. However, none of these communities are static. All will change in appearance and, consequently public appeal, as they mature or are affected by management practises. Much of the tall open-forest will experience further Man-made changes as the commercially valuable timber is managed and harvested. The riverine vegetation is relatively intact and in places may not change substantially, but is at serious risk of damage through fire, soil erosion and over-clearing of the adjacent forest canopy. As a consequence, even in the absence of road construction, the future is likely to contain changes in all of these vegetation communities which will cause popular concern.

5.3 Aesthetic Value

The scenic quality of the landscape through which the route options pass was noted as being significant in a National Trust of Australia (N.S.W.) publication "Illawarra Region: Landscape Survey" (1976). The National Trust document stated that, whilst land-use was in sympathy with natural features, change was acceptable provided it did not destroy the scenic quality of the area. This judgement of the scenic value of the area was reinforced by the Department of Planning in the report "Illawarra Region Landscape and Environment Study" (D.E.P. 1981). In that report the area including the route options was classified on a scale of (I) to (V), with (I) being the lowest scenic quality and (V) being the highest scenic quality. The corridor includes classes (II) and (III) with class (II) indicated in its middle section. At present all scenic quality class II & III areas are being cleared or managed for timber harvest. The recommendations made by that report include protection of the skyline along Turpentine Road and retention of native vegetation in the remainder of the area affected by the corridors. As the new road would expose more of the area to view, it is presumed that the skyline protection zoning should be extended to the visual catchment of the proposed road provided construction works and rehabilitation are handled sensitively.

5.4 Commercial Value

Timber

Individual property owners and officers of the Nowra District NSW Forestry Commission Office have expressed the view that specific stands of timber within the Option A corridor possess a high potential commercial timber value. Particular reference was made to the future prime sawlog value of the stands of timber on either side of Turpentine Road and that in the south of Grange Road. Most of the species throughout the corridor are considered to have a commercial value as poles or sawlogs. Commercial timber should be salvaged before road construction begins.

Apiary

The presence of large collections of beehives being moved around the northern and southern parts of the corridor indicates that blossom from trees and shrubs is currently being used for the production of honey. The commercial value of this honey production was not assessed. No investigation was made of the usual patterns of movement of beehives within and beyond this area. Removal of trees and shrubs during road construction may remove a blossom resource which is required for honey production. Landscaping should be used as an opportunity to replace this resource.

6.0 FAUNA SURVEY OF THE STUDY AREA

The faunal surveys were conducted (i) within the 100m wide corridors of Options A and B, and (ii) in a major block of native vegetation to the west, through which Options F, G or H pass.

The fauna surveys needed to be effective within the given time constraints. They therefore consisted of searches for material evidence of occupancy and activity of animal species and identification of habitat types with which particular species of animals are believed to be commonly associated. The first survey was conducted in June-July 1989 and the second in February-March 1990. It was thus not possible to compile a comprehensive species list of the fauna. This is especially true for seasonally active species (e.g. reptiles and amphibia), migratory species (e.g. some birds), cryptic species and species in very low abundance, which require the investment of large amounts of time for the location of animals and quantification of their abundance.

The time constraint was not considered a serious limitation because several fauna studies have already been carried out in similar habitat types within the region. It was therefore found to be possible to use this survey to:

i) confirm that the survey area was representative of the habitat-types already described in the literature for the region;

ii) to determine whether the study area was likely to contain features of special faunal conservation significance.

This survey considers the four main faunal groups which would be likely to be affected by construction of a highway in the study area, i.e. mammals, birds, reptiles and amphibians. For the purposes of the fauna survey, the area to be affected was divided into five distinct areas, based primarily on habitat types. These are illustrated in Figure 3, and include:

Area 1 The northern-most section of the proposed road, which lies mostly within the existing road reserve. This area contains dry woodland vegetation with an understorey of sclerophyllous shrubs, herbs and ferns typical of sandstone environments. Some isolated large dead Eucalypt trees (which had been ringbarked) and many smaller Eucalypts (mainly saplings) were also present.

Area 2 The section immediately south of Area 1, where the proposed road deviates from the existing highway, south as far as Turpentine Road. Vegetation in this area contains a mix of sclerophyll and mesic species. The area is traversed by several creeks and gullies. A relatively dense grass or ferny cover is present in many places, and tall thickets of Acacia species are common.

Area 3 The section south from Turpentine Road, to Grange Road. Spotted Gums (E. maculata) predominate in this area, with very little shrub understorey. Some large old trees have been retained, but most are relatively young due to timber management activities. Toward Stewart's (Suffolk) Creek, the vegetation becomes mesophyllic with a denser understory.

Area 4 The southern - most section, consists mainly of Spotted Gum (*E. maculata*), but in association with other species found less often to the north. Whilst the south-western portion is of a relatively even age and retains little understorey (again due to timber management), the remainder contains a higher diversity of trees, shrubs and herbs and in parts a relatively dense understorey.

Area 5 The area encompassed by the western routes consists of a series of elongated spurs running roughly west to east on which Spotted Gum and Blackbutt dominate. On the valley slopes, Bangalay (*E. botryoides*), Sydney Blue Gum (*E. saligna*), young Spotted Gum and Blackbutt are common. The majority of trees in this area are relatively young and even-aged indicating a history of intensive timber husbandry. On the valley floors the species composition and structure of the forest habitat change dramatically with the tall canopy being replaced with a closed palm canopy and the open shrubby-grassy understorey replaced with a dense shrub and vine cover. A small sandstone escarpment is located in the far western part of Area 5 where there are also broad benches on which some isolated, mature specimens of remnant rainforest species occur. Upslope of this escarpment occurs a forest similar in species composition to that found in Area 1 but with Large-fruited Red Mahogany (*E. pellita*) dominant on the escarpment edge.

6.1 Mammals

A total of four days and three nights in June-July 1989, was spent surveying areas 1, 2, 3 and 4 (on the Option A and B routes, see Figure 3). A similar time was spent surveying area 5 in the vicinity of the western routes (Options F, G and H), in February-March 1990. The aims of these surveys were as follows:

i) determining habitat types, and assessing the likelihood of occurrence for particular species;

ii) identifying animal activity through observations of diggings, tracks, scats and shelters;

iii) positively identifying, where possible, particular species and assessing their relative abundance in the area.

In addition, detailed observations were made in February-March 1990 of the trees along Option A which were previously identified as likely "den-trees" for Yellow-bellied Gliders.

Intensive daytime surveys of each route were carried out on foot to locate scats, distinctive tracks, tree markings, diggings and trails which reveal the presence of particular species. In June-July 1989, scats collected along the route of Option A were sent to Barbara Triggs for positive identification.

Nocturnal mammals were surveyed by spotlighting at night, using 12V, 100W quartz-halogen spotlights. Spotlighting was carried out on foot along existing roads and other trails, in order to minimize the noise and difficulty associated with cross-country transects. Each area was surveyed for a minimum of two hours, during weather conditions suitable for detection of the species likely to be in the area. All species likely to be in the area, including the species positively identified in these surveys, are listed in Appendix 4. Locations of sightings of particular significance are shown in Figure 4.

Area 1 was not surveyed by spotlighting, due to its proximity to the highway and the likelihood of spotlights causing distraction to drivers. The species considered likely to occur in area 1 are discussed.

Since the proposed route crosses two major creeklines, aquatic vertebrates were also considered and the area surveyed for suitable aquatic habitat.

One species detected, the Yellow-bellied Glider (*Petaurus australis*), is considered to be rare and limited (Strahan 1983). This species is considered `rare' because it occurs in small groups with a distribution limited to mature mountain Eucalypt forest on the Eastern Australian seaboard. This habitat is declining rapidly through development and fragmentation. Individuals of this species were found feeding on large flowering Spotted Gums (*Eucalyptus maculata*) in June-July 1989, in three of the four areas surveyed at the time. In February-March 1990, animals were again recorded in areas 2 and 3 (areas1 and 4 were not re-examined). During the second survey other groups of these gliders were observed feeding on flowering Bloodwoods (*Eucalyptus gummifera*) in two locations along the western Options (Figure 4). All other species detected in the survey are considered to be relatively common throughout their range. Two species considered to be Rare (Squirrel Glider - *Petaurus australis*) or Sparse (Great Pipistelle - *Pipistrellus tasmaniensis*) were recorded for similar habitats by the Forestry Commission of N.S.W. and Braithwaite et al. (1988). No evidence was found of their presence in this survey.

While no Platypuses (*Ornithorhynchus anatinus*) were seen in either Tomerong or Stewart's (Suffolk) Creeks, they are known to occur in other streams in the Clyde River - Jervis Bay catchments (Grant 1988, unpublished report to N.S.W. National Parks and Wildlife Service) and are reported in both Parma and Falls Creeks close to the study site (pers. comm. NPWS, Nowra). Since Platypuses have been caught in other regions in creeks of similar size and appearance to those in the study area (Grant & Denny 1987), it is considered likely that they occur in both the creeks crossed by the proposed highway. The only other aquatic mammal possibly occuring in the area is the Water Rat (*Hydromys chrysagaster*), although no evidence of its presence was found along the creeks surveyed. No assessment of fish species present was carried out but a number of species, including the Australian Bass (*Percaletes novemaculeatus*), are noted as including the survey area in their distribution (Pollard et al. 1980).

Detailed observations of species sighted or detected, as well as those expected to occur in the five designated areas are outlined below:

Area 1

This area consists primarily of woodland vegetation with an understorey of flowering plants (including *Banksia spinulosa, Lambertia formosa* and *Eucalyptus gummifera*) known to be used by several mammal species for food during flowering (Goldingay et al. 1987, Carthew unpubl. data). One scat was found on a *Banksia spinulosa* inflorescence confirming the presence of small mammals in the vicinity. In addition, the presence of many large dead Eucalypt trees (which had been ring-barked) and adequate ground cover (including

hollow logs, clumps of grasses and trees which had been uprooted and left) indicate that ample shelter is available for small mammals in this habitat. Species which utilise the flowering plants and are expected to occur in this community include the Brown Antechinus (*Antechinus stuartii*), the Sugar Glider (*Petaurus breviceps*) and the Eastern Pygmy Possum (*Cercartetus nanus*). In addition, it is expected that the Bush Rat (*Rattus fuscipes*) would occur here, and possibly the Common Brushtail Possum (*Trichosurus vulpecula*). Overall, the area appears modified due to ongoing wood cutting activities and frequent fire, rubbish dumping and predation by feral and domesticated animals. Although small-mammal species are likely to be present here it is therefore unlikely that they are in large numbers. Wallabies were numerous throughout the area as evidenced by their scats and tracks, as well as the many runways encountered criss-crossing the area. Two Red-necked Wallabies (*Macropus rufogriseus*) were seen during the late afternoon, moving out of the wooded area to graze in the clearing immediately behind the road-house. Other Macropods thought to occur here include the Eatern Grey Kangaroo (*Macropus giganteus*) (as evidenced by scats and tracks), and the Swamp Wallaby (*Wallabia bicolor*) which is commonly found in this habitat. Many dog tracks were found here and it is likely that cats also inhabit the area due to the close proximity to habitation. Rabbit activity was also observed, but these do not appear to be in high numbers.

Area 2

Area 2 was much wetter than the other areas along the proposed route and showed considerable mammal activity, particularly in the vicinity of Tomerong Creek. Wombats (*Vombatus ursinus*) appear to be abundant throughout this area; several burrows were observed quite close to the creek, some showing evidence of recent use, and scats and tracks were numerous across the grassy slopes. It appeared that Wombats were using the soft alluvial deposits adjacent to the creek for their burrows, and the siltstone soils on the slopes for feeding. Another animal thought to be in high numbers in this area was the Swamp Wallaby. A large group was spotlighted moving through the paddock, adjacent to the 19 km point, and abundant scats were found throughout the area. Other animals detected were bandicoots; diggings were found and were particularly prevelant towards Turpentine Road, near Tomerong Creek. Scats belonging to Brushtail Possum (Common or Short-eared), Grey Kangaroo, Rattus sp. (probably Bush Rat) and a small Dasyurid (probably Brown Antechinus) were collected. Other species recorded here from sightings were Common Brushtail Possum, Ringtail Possum (*Pseudocheirus peregrinus*), Greater Glider (*Petauroides volans*), Sugar Glider, Yellow-bellied Glider, Echidna (*Tachyglossus aculeatus*), European Fox (*Vulpes vulpes*) and Rabbit (*Oryctolagus cuniculus*). However in most cases only one individual of each species was seen.

Area 3

This area is divided into two distinct habitat types; an open forest with very little understorey, and a wetter area of dense vegetation associated with Stewart's (Suffolk) Creek. The open forest consists primarily of Spotted Gum (*E. maculata*) which has been intensively managed for timber production, resulting in most trees being of a fairly even, young age. Some large old trees remain, mainly beside the unsealed track to the south of Turpentine Road. These provide potential shelter in the form of tree hollows for several arboreal species. When in flower (during the winter), these trees also provide an abundant food resource for many species of birds, mammals and insects. Ground cover throughout much of the open forest is sparse, with very few logs or other shelter sites remaining for use by small ground-dwelling mammals. Shrubs are scarce and herbaceous ground cover sparse, making this area unsuitable for those mammals which require dense cover. The area does, however, have some thickets of Acacia which may provide limited shelter for small mammals.

Towards Stewart's (Suffolk) Creek, the vegetation becomes mesophyllic and more dense with substantial undergrowth and thickets of Acacias. Throughout this section fallen logs are quite prevelant and many small trails run through the undergrowth, indicating the presence of small ground-dwelling mammals, although no animals were seen. Several Wombat scats were found and abundant wombat activity is indicated. A single fox scat was found to contain mainly swamp wallaby remains. Dog prints were present throughout the area. In addition, tracks and several scats belonging to goats were found in the vicinity.

Spotlighting through Area 3 revealed an abundance of Swamp Wallabies. During one, two hour period wallabies were sighted and/or heard moving through the forest on six occasions. During the same period one Greater Glider was seen in a large Eucalypt adjacent to the firetrail running down towards Stewart's (Suffolk) Creek. On another occasion, four Yellow-bellied Gliders were identified in the same general vicinity, whilst an individual Sugar Glider was also observed here. Three Yellow-bellied Gliders were sighted on three occasions feeding in flowering Spotted Gums surrounding the junction of Turpentine Road and the proposed road. An attempt, in June-July 1989, to locate the den tree of the Yellow-bellied Glider (a tree, with suitable hollows, in which these animals would rest during the day: a group of gliders would be expected to have several within their home range), revealed that they came from the south of Turpentine Road and probably used the large trees still existing on the road reserve. This was confirmed in the February-March 1990 survey, when animals were seen leaving a hollow on one of these trees at dusk. In this February-March 1990 survey, another group of Yellow-bellied Gliders was heard, simultaneously, further south in area 3, nearer to Stewart's (Suffolk) Creek, confirming observations made in June-July 1989 and indicating that there was a high density of these animals in this quite disturbed forest. It is not

known whether these animals were all part of a large family group or of several groups with adjacent home ranges. This species is known to have large home ranges (up to 40-90 ha) and to move over quite long distances (several km) in a single night (Henry & Craig 1984, Goldingay 1989a, b).

Area 4

This area is similar in many respects to the northern section of Area 3 and probably contains similar animal species, although fewer arboreal species were detected. Towards the west, where there is little undergrowth and few mature trees, animal activity appeared correspondingly low. Macropods, which were particularly noticeable in a regenerating area close to the existing highway, were the only animals sighted in the western part of area 4, and scats of Swamp Wallaby and Grey Kangaroo were collected.

The remainder of the area appeared relatively less modified and many large trees had been retained. Grassy areas beneath trees provide good grazing for wallabies, as evidenced by scats found throughout the area and animals heard moving through at night. Closer to Grange Road the undergrowth is thicker, with some dense shrub thickets in places. Small runways through the grass were evident here, as well as bandicoot diggings and rabbit scrapes. Scats from a small Dasyurid (probably Brown Antecinus) were collected. A single wombat burrow was also located, although it had not recently been used.

The only arboreal species sighted in this denser forest area was the Yellow-bellied Glider. Two individuals were recorded early in the evening gliding up from the south and these animals remained in the area during the two hours spent spotlighting. This species is thought to be found only in mature forest habitat (Craig 1985 and references therein) which would be expected to provide shelter for a number of other arboreal species. Scats of Brushtail Possum (Common or Short-Eared) were collected from this area. It was considered unusual, therefore, that no other species were detected here. However, it should be noted that on those nights spent spotlighting, the moon was full (or close to being full) and animal activity in general seemed lower than expected in all areas. Reduced detectability of arboreal species during periods of full moon has been documented (Goldingay & Kavanagh, 1986 and references therein) and may be one reason for the low frequency of sightings. Other species expected to occur here are the Sugar Glider, Greater Glider and the Feathertail Glider. Somewhat suprisingly, the Feathertail Glider (*Acrobates pygmaeus*) was not detected over any of the proposed route. Although it is possible that it may be absent from the area, it is commonly found in habitat such as this (Goldingay pers. comm.).

Area 5

This area is characterised by relatively large variations in relief, a large number of streams which pass through relatively large blocks of continuous native vegetation which has been disturbed by past logging activities. A powerline forms a boundary in the west with a large treeless swathe across which some animal species may rarely cross.

Sightings of large terrestrial mammals were common throughout this area. Swamp Wallabies (*Wallabia bicolour*) and Grey Kangaroos (*Macropus gigantea*) were recorded throughout the length of this area, and Red-necked Wallabies (*Macropus rufogriseua*) were expected to be there though not positively identified. Wombats were recorded in the southern portion near Stewart's (Suffolk) Creek.

Evidence of aboreal mammals was also common throughout this area. Scratchings on trees were found frequently, indicating the presence of Brushtail Possums. Yellow-bellied Gliders were seen feeding in Bloodwood trees along Option G south of Turpentine Road and were heard calling in the vicinity of:

- Option F south of Turpentine Road;
- Option H just north of Turpentine Road; and
- Option G north of Turpentine Road, in the forest between the power lines and existing agricultural land.

Sugar Gliders and Grey-headed Flying Foxes were heard calling in most areas, and were seen feeding from Bloodwood blossoms. Feathertail Gliders were expected to be found feeding from the Bloodwood blossoms but were not recorded. A Ringtail Possum was seen in the vicinity of Option G north of Turpentine Road, between the powerlines and existing agricultural land.

6.2 Birds

Assessment of the avifauna was done by censusing birds along the eastern routes using the rolling survey method. Species were sampled at short, irregular intervals in both north-south and south-north directions. A distance of approximately 50 metres was maintained between the bi-directional sampling, with a sampling swath width of approximately 25 metres either side of both sampling transects. This permitted adequate sampling of the 100 metre-wide corridor. Species identification was based on visual sighting and call. Individuals flying over or through the canopy were also recorded.

Censusing for nocturnal species was also carried out. The nocturnal survey involved one south-north survey along the line of the proposed route, using Miner's spotlights. This sampling was confined to areas accessible by tracks (approximately 60% of the daytime sampling area was covered during the night).

A total of 43 species were observed during the census, none of which are considered rare or endangered. Since the survey was carried out at one time of the year only, it is likely that not all species visiting and using the area were observed. Furthermore, during winter, species diversity and abundance is significantly influenced by the reduced availability of nectar, blossom and to a lesser extent, insects. Species diversity could, therefore, be expected to be considerably higher in other seasons.

The presence of a breeding pair of Grey Goshawks (*Accipiter novae-hollandiae*) was first indicated by local residents at the first public meeting and supported by further comments at the second public meeting. A nest believed to be that of the Grey Goshawk was subsequently observed in March 1990. Appendix 5 lists all species recorded during the survey, as well as those which might be expected to inhabit the area (based on records from Jervis Bay and the Nowra district). In Figure 4, specific localities of some sightings are recorded.

Significant features of the avifauna include:

i) the observation of Turqoise Parrots (*Neophema pulchella*) (courtesy of D. Wright, 1988), an uncommon species which favours the woodland/cleared land ecotone. This species has been observed to occur spasmodically in the vicinty of Area 2;

ii) the presence of Superb Lyrebirds (*Menura novaehollandiae*) in area 2. Three individuals were observed, and five display mounds were located;

iii) the relatively high abundance of locally mobile species such as the Brown Warbler (*Gerygone mouki*) and the Variegated Wren (*Malurus lamberti*). A group of 12 individual Brown Warblers were recorded in a pocket of closed forest along Stewart's (Suffolk) Creek, whilst 10-15 individual Variegated Wrens were observed in rank vegetation along the northern tributary of Stewart's (Suffolk) Creek (Area 3);

iv) the presence of the Grey Goshawk adjacent to Option A in Area 3.

v) a high diversity and abundance of honeyeaters, lorikeets, Gang-gang Cockatoos and other nectar - or blossom foraging species in areas of flowering Spotted Gums. Nine species were recorded and groups of more than 50 individual honeyeaters were observed in those sections of Areas 2 and 3 containing flowering trees. These Eucalypts provide an important source of nectar in winter when food is locally scarce for species such as those mentioned above.

6.3 Reptiles And Amphibia

The original brief from the RTA requested consideration of reptiles and amphibia on the eastern routes. No detailed censusing of reptiles and amphibians was carried out, due to the time of year at which the initial survey was conducted. The activity of this group is much reduced during the colder months, making them difficult to locate and identify. No request was made for survey of this group on the western routes. Appendix 6 lists those species of reptiles and amphibia thought likely to occur in the area. The only species actually recorded were from casual observations made whilst surveying for mammals. Those recorded were the Long-necked Tortoise (*Chelodina longicollis*) (a carapace was found) and two species of frogs (*Ranidella signifera* and *Litoria verreauxi*).

7.0 SIGNIFICANCE OF THE FAUNA

Six features of the area are identified as warranting particular consideration in order to guard against adverse impacts during road construction:

7.1 Individual Species Of Conservation Significance

7.1.1 Approximately six groups of Yellow-bellied Gliders were found in these surveys, at least one group in direct line or in the vicinity of each of Options A, B, F, G and H (see Figure 4). This species lives in family groups of two to six individuals and requires relatively large areas (up to 90 ha) of suitable habitat for its home range. In the region, other populations are known from Callala Beach, Tomerong State Forest, Yerriyong State Forest and Kioloa (Goldingay pers.comm). Although the distribution of this species extends along the length of the eastern seaboard, its distribution is considered to be patchy and discontinuous (Craig 1985) and animals in this region are thought to be the northern most group to the south of Sydney (the next known populations to the north are in the Wyong district). In addition to scientific significance, this species has popular conservation appeal.

7.1.2 Lyrebirds were located in the northern part of Area 2, Option A and evidence was found to indicate their occurrence throughout the study area. This species also has a high popular profile. Three individuals were seen on Option A and several display mounds were noticed. An uncommon species, the Turqoise Parrot has also been found in this area.

7.1.3 The nest site of the Grey Goshawk is located in Area 3, Option A. The Grey Goshawk has no specific recorded scientific conservation significance (pers comm - D. Andrews, NPWS), but has local popular significance. The Grey Goshawk is an uncommon rapture which is widely distributed on the north eastern coast of Australia, south eastern South Australia and Tasmania. The Goshawk is expected to feed in the riverine forests on Stewart's (Suffolk) and Tomerong Creeks. This species is faithful to a single nest site but could be expected to replace a nest after damage or loss of the nest or nest tree (pers comm - R. Jordon). The critical period for disturbance is expected to be July to September while the nest is being prepared for breeding and September to December while young are in the nest.

7.2 Faunal Habitat Values

7.2.1 Although the forests in this area appear to have been profoundly modified by land management activities they still possess a high faunal habitat value. Such modifications may result in animal species being selectively favoured or reduced in numbers, depending on the degree and nature of the modification. For example, areas in which the understorey has been largely removed and replaced with grasses (as is the case throughout much of this area), may be particularly favourable for herbivorous species such as Wallabies. The tree canopy represents valuable arboreal mammal and bird habitat. In contrast to the above, the diversity of animals occuring in the vicinity of the riverine vegetation on Tomerong and Stewart's (Suffolk) Creeks appears to be quite high. Many ground dwelling mammals utilise this area, as is evidenced by the number of tracks, trails, diggings and scats observed. In particular, the Wombat is high in numbers where the alluvial soils are deep, and several bird species were also abundant in vegetation bordering the creeks. It is also expected that Platypuses would occur in both main creek channels.

7.2.2 Spotted Gums (*E. m aculata*) occurred through much of the area surveyed. Most of these are young trees and few "over-mature" trees of any species have been retained. Spotted Gums provide an important source of food for nectarivorous animals (birds, mammals, insects) during flowering. When "over-mature", they also provide nesting sites in the form of hollows for a variety of animals including mammals and birds. One such tree was identified on the Option A route as a nesting site for Sulphur Crested Cockatoos and another was found to be a den tree for a family of Yellow-bellied Gliders. Other such trees in the area are likely to be inhabited by species such as the Sugar Glider, Greater Glider and Brushtail Possum. Retention of this rare habitat resource, large trees with hollows, is considered to be important to preserve the diversity of animals in the area. However, it should be noted that ongoing management of land in the region may mean that the future of the remaining over-mature trees is vulnerable regardless of the proposed road construction.

7.2.3 Flowering Bloodwoods (*Eucalyptus gummifera*) scattered throughout the survey area were also recorded as being used extensively by animals in the flowering season (February-March survey). Grey-headed Fruit Bats, Sugar Gligers and Yellow-bellied Gliders were observed feeding at these trees. In addition, Sugar Gliders and Yellow-bellied Gliders are known to incise trunks and branches of this tree species to harvest sap (Goldingay 1989b), especially at times in which nectar resources are scarce. It is believed that trees of this species represent another significant habitat resource for arboreal mammals in the area.

7.2.4 Family groups of Yellow-bellied Gliders are known to occupy large areas of forest as their home range. It is believed that such a large area is required to satisfy their primary habitat requirements of food (nectar and sap) and shelter (suitable den trees). Although this species of gliding possum has been recorded to glide large distances in tall-forest habitats (up to 90m - Goldingay 1989b), most glides are of shorter distance, especially where lower forests provide no opportunity for high take-off points. Therefore, swathes of disturbance with no tree cover may constitute a significant barrier to movements of these animals within a previously continuous home range. If large swathes of disturbance cut formally continuous forest cover into sections that are individually smaller than the area required for a home range, this species would be expected to become locally extinct. Two important considerations are therefore : (i) to locate road construction such that the dissection of continuous forest cover into small units is minimised; and (ii) to design roads in such a way that tree to tree distances across road reserves are less than 40-50m for a significant stretch of road.

8.0 POTENTIAL ENVIRONMENTAL IMPACTS

The potential environmental impacts which would be likely to be caused by construction of the bypass are assessed in this section. The major issues anticipated as a result of these investigations include:

- the direct and indirect visual and ecological impacts created by earthworks (Subsection 8.1);
- the possible alteration of a significant vegetation community-type (Subsection 8.2);
- the possible localised loss of individuals of an endangered plant species (Subsection 8.2);
- localised loss, disturbance and fragmentation of animal habitat, in particular that of a restricted animal species (Subsection 8.3);
- subsequent to road construction, hazards caused by movement of large animals across the carriageway of the new road (Subsection 8.3);
- temporary reduction in the visual amenity of the study area (Subsection 8.4);

In this section each issue is discussed firstly in general terms. Secondly, the degree to which these issues relate to each of the proposed route options is evaluated. The section is concluded with a table (Table 3) which summarises and compares the impacts of the various route options.

8.1 Impact Of Earthworks On Landform, Soils And Water Quality

All of the options involve earthworks which will result in excavations and fills. These earthworks will have a direct impact on the immediate construction area and a potential indirect impact can be expected to be associated with local alteration of drainage patterns, and discharge volumes and velocities, through the drainage system. Soil erosion, sedimentation and other pollutants resulting from major road developments are significant problems unless adequate controls are planned and implemented at all stages of development. These stages commence with investigations prior to any design and conclude with maintenance after the construction is complete. The on-site costs of soil erosion are high and include rehabilitation of the site, higher maintenance costs and extensive increases in construction time due to equipment down time through sediment damage and inadequate site drainage.

In the absence of adequate soil erosion controls, Tomerong and Stewart's (Suffolk) Creeks, as well as Erowal Bay in St Georges Basin, may be rapidly infilled with soil particles carrying high concentrations of the nutrients phosphorus and nitrogen. The nutrients contained in stormwater runoff can be responsible for the alteration of the chemical regimes of the water bodies, causing excessive growth of algae and other waterplants. Excessive sediment loads can also have a severe impact on the physical characteristics of the streams leading to distribution of aquatic habitat, reduced hydraulic capacity, streambank erosion and stream realignment. Up to 2500 tonnes of sediment can erode annually from each hectare of exposed construction site. An increase in the level of flooding can also occur. Much of the sediment is mobilised during the land development phase.

The advice of the Soil Conservation Service has been sought and guidelines have been provided for general soil erosion and sedimentation controls for the proposed bypass. These guidelines are contained in Section 9.1. It should be possible to reduce the risk of an unacceptably high impact through adherence to these guidelines although that risk must increase as the scale of earthworks required increases. The size of the area likely to be destroyed by earthworks will be directly proportional to the depth of excavations and fills, the number of excavations and fills, and consequently the area occupied by the batters. In the long-term it is better to ensure a stable, maintenance-free batter than to risk incremental future impacts either through batter instability or maintenance activities. In addition, the vulnerability of the downstream environment to indirect impacts of earthworks will increase with each additional valley which requires filling and each additional drainage channel with which the construction interferes. It is anticipated that soil erosion controls will be difficult to implement lower in the catchments where soils are deep and unconsolidated and where discharge velocities and volumes are high. A different scenario of soil erosion problems is presented by the western route options where an increase in the number of drainage lines crossed and an increase in the scale of excavation and fill must increase the risk and scale of direct and indirect adverse impacts.

All of the route options investigated traverse the same two major catchments, i.e. that of Tomerong Creek and Stewart's (Suffolk) Creek - Table 2 gives an indication of each option's degree of interference with these drainage systems.

TABLE 2. - DEGREE OF INTERFERENCE WITH THE DRAINAGE SYSTEMS OF TOMERONG AND STEWART'S (SUFFOLK) CREEKS

	Option B	Option A	Option H	Option G	Option F
No of primary creek crossings	2	2	1	0	1
No of tributary creek crossings	0	2	11	12	9

Although Options A and B cross the primary creek channels (over deep alluvium) of both major creeks, they have a negligible impact on the tributary drainage network. Soil erosion and sedimentation controls would be needed at the two major creek crossings for each of these options.

Option B has an added problem in that it occupied approximately one kilometre of the primary floodplain of Tomerong Creek. Soil erosion controls could be expected to be difficult to implement in this area of deep alluvium and diffuse drainage direct to the broad meanders and floodways of the creek.

Options F, G and H lie to the west of Options A and B and in the deeply dissected terrain of both major catchments. Soil erosion and sedimentation controls would be needed on each of the multiple drainage lines crossed by these routes. Although selection of the western routes may reduce the direct impact on the primary creek channels, the impact on the tributary drainage network would be profound thus rendering the whole of the drainage network vulnerable.

The total area likely to be directly involved in construction through excavation, fill and sedimentation controls increases in a westerly direction. In Options A and B major earthworks can be restricted to the north eastern tributary gullies of Tomerong Creek. Major earthworks for Option H extend throughout the route from the north-eastern tributary gullies of Tomerong Creek through the north-western tributary gullies of Stewart's (Suffolk). The total area likely to be directly involved in construction is therefore much greater for Options F, G and H than for Options A and B thus increasing both the potential for soil erosion and the total area of ecological disturbance.

In summary, in relation to the environmental impacts of earthworks on landforms, soils and water quality, Options A and B would be likely to have less direct and indirect impacts than Options F, G and H. A comparison of Options A and B indicates that reduction of the impact caused by soil erosion, sedimentation and alteration of water quality would be more difficult to achieve in Option B than in Option A because of the close proximity of Option B to the meander channels and deep alluviums of Tomerong Creek immediately west of Tomerong Village. Option A thus appears to present the least potential impact on the drainage systems of Tomerong and Stewart's (Suffolk) Creeks and the least total area of land disturbance. Some degree of environmental impact can still be expected to occur associated with construction of creek crossings over Tomerong and Stewart's (Suffolk) Creeks.

8.2 Impact Of Road Construction On The Vegetation

All of the options would create a direct impact as a result of construction of a linear cleared path through the vegetation communities. Indirect impacts would involve localised plant death and alteration of the species composition of communities through:

- erosion of soil and sedimentation of drainage channels;
- disturbance of the tree canopy which alters light and moisture regimes;
- alteration of drainage patterns and the moisture regime of local vegetation stands;
- weed invasion.

The significance of the direct biological impacts will be directly related to the width of the area of vegetation cleared and the location of the route.

Within the study area, the form of riverine vegetation which grows on the deep alluvial soils associated with the flood plains of Tomerong and Stewart's (Suffolk) Creeks has been identified in this report as a plant community of local significance. This assessment is supported in the literature which describes similar stands of this community-type in other south coast areas (Helman 1987, Mills 1988). In addition the endangered Brush Cherry (*Syzygium paniculatum*) was identified within this community in the study area. The individuals of the Brush Cherry located in the study area have been identified in this report as being of high conservation significance. This view was supported by opinions expressed during consultation with the National Parks & Wildlife Service (J. Benson, pers. comm.). All options involve some degree of disturbance to the riverine vegetation;

(i) Option B presents the greatest threat to the most extensive and species rich stand of the significant vegetation community, i.e. the stand on Tomerong Creek immediately west of Tomerong Village. This stand contains at least nine individuals of the endangered plant species. All of these plants were observed growing in the creek bank where they are most vulnerable to loss through erosion or creek bank collapse.

(ii) Option A presents a much more limited threat to the riverine vegetation. Two individuals of the endangered plant were identified over 100m apart in the Stewart's (Suffolk) Creek stand. A route which passes between both of these plants would pass through a section of the Stewart's Creek riverine forest which has previously been cleared and which now has an open ferny ground cover with Eucalypt sp. overstory. In this location the impact of the road would be limited to indirect disturbance of the significant vegetation community at the crossings of Tomerong and Stewart's (Suffolk) Creeks.

(iii) Options F, G and H all threaten small, somewhat disturbed stands of riverine vegetation at their crossings of tributaries of Stewart's (Suffolk) Creek. However, all three options would destroy extensive areas of the less diverse riverine vegetation form at each of their tributary creek crossings, i.e. 11 crossings for Option H, 12 for Option G and 9 for Option F.

The stands of riverine vegetation on the floodplains cannot be considered in isolation from the less diverse form which grows in the western tributary gullies of both catchments. Both forms of vegetation are integral parts of the botanical riverine ecosystem in the study area. The communities in the upper gullies provide a seed and potential nutrient source for the communities at lower elevations. Together, both forms provide the "links" in the corridors of movement of the animals and plants (seeds and pollen) for which the special shelter and food resources of this community-type are vital to survival and establishement. Many animals move throughout the different topographic units of the study area in search of seasonally variable food resources. Although each stand may be limited in size, together they represent a much larger area of plant and animal habitat in the form of a reticulate network which links the sandstone ridges in the north and west with the alluvial floodplains of the east and south. Options A and B potentially cut this network in two places each. In both places the impact of isolating sections of the network could be reduced if bridges are used in creek crossings. Options F, G and H cut this network at each crossing of a drainage line where deep fills and extensive vegetation destruction will be required to achieve acceptable road alignments.

When the riverine vegetation is broken into small isolated fragments or "islands", canopy openings are increased and the light and moisture regime of at least the edges of each small stand changes. There is then a tendency to increase the incidence of weed invasion and thus reduce the species diversity of the native species. A reduction in availability of plant pollinators and breeding partners (through disturbance of animal populations and reduction in plant populations respectively) may contribute to this impact and subsequent change in the vegetation community. This impact can be expected to occur on each option but must be more profound in options where clearing of vegetation is more extensive.

In summary, Option B is likely to have the greatest direct impact on the significant vegetation community and endangered plant species. Option A could also have an indirect impact on the significant plant community and potentially threaten two plants of the endangered plant species. Although Options F, G and H have minimal direct impact on this community and the endangered plant species, the extent of earthworks which they involve could potentially render both at risk through indirect impacts, if soil conservation and sedimentation controls fail. In addition, Options F, G and H could be rejected on the grounds of their extensive direct impact on the riverine vegetation network as a whole. Despite the potential problems associated with Options A and B their adverse impacts could be substantially reduced if a route could be selected which avoids large areas of alluvial soils.

8.3 Impact Of Road Construction And Usage On The Fauna

There are habitat differences between the eastern and western options. These differences could mean that certain animal species, which focus their distribution on particular habitats, could be more affected by the selection of one of either the eastern or western routes. Most of the animal species recorded in the areas were present in, or are expected to travel through all of the route options (A, B, F, G, H).

The animals which occupy or use all of the route options would be directly affected by the impacts of major earthworks and vegetation clearing which have already been described in this section. The animals are directly affected by localised destruction and disturbance of habitat. After the road has been constructed indirect impacts occur through road kills and fragmentation of habitat.

The major impacts on fauna caused by the bypass are expected to be:

- habitat destruction;
- fragmentation of habitat;
- disruption of aquatic habitats.

8.3.1 Habitat Destruction

Although clearing will be limited to a relatively thin strip of land, the impact on many animal species may be great. Firstly, the process of vegetation clearing itself will result in the displacement and/or loss of many animals residing in the area. Animals particularly affected would be small ground-dwelling species. Secondly, mature trees which are already scarce in the area may be lost. Many of those remaining are likely to contain suitable den hollows and be important food resources, particularly when they are in flower. Loss of the more mature trees may result in local loss of individual animals which rely on these particular trees. Of particular concern is the Yellow-bellied Glider and other arboreal mammals which rely on the den hollows to provide daytime shelter. These animals were observed throughout the study area. A further problem may be created by excess spillage of construction material away from construction areas. This could result in further disturbance of habitat, particularly in the tributary gullies to the west of the study area.

With regard to the birds, the species most likely to be affected by loss of habitat resulting from the proposed road include ground-dwelling or ground-frequenting birds such as the Superb Lyrebird, Satin Bowerbird, Eastern Whipbird, White-browed Scrub-Wren, Superb Blue Wren, Variegated Wren, Brown Warbler, the nest of a pair of Grey Goshawks and occasional visitors such as the Turquoise Parrot. Of these species, the Superb Lyrebird which is territorial and Turquoise Parrot would be among the most affected birds.

8.3.2 Fragmentation Of Habitat - Impacts On Native Fauna

Construction of the road will also result in fragmentation of the existing faunal habitat. In light of the present rate of change in forest habitat, it is not surprising that there is increasing community concern about the impact of this on animal populations (Robinson 1977, 1985, Lunney & Barker 1986). The proposed road will affect individual species in different ways, depending on their life strategy. Of general significance is the barrier it creates, particularly to small mammals thus causing isolation of populations.

Lyrebird activity was observed on all route options. The localised home range (often a radius of less than 500 m2) and pronounced territoriality of adult Superb Lyrebirds make this species particularly susceptible to localised habitat loss or disturbance. The existing road already represents a barrier to corridor movement of lyrebirds between the east and west.

The long, continuous gap in the tree canopy created by the road will also affect some arboreal mammals whose home ranges currently include both sides of the road. Of most concern are the gliding mammals, and in particular the Yellow-bellied Glider, a species which is thought to be particularly sensitive to clearing and habitat fragmentation (Craig 1985).

Population numbers of Yellow-bellied Gliders are known to fluctuate within an area as the food resource fluctuates. These animals are known to use several den trees in an area and have been observed to move from a den tree during disturbances (Goldingay pers. comm.). Family groups of this species have a home range area of 30-90 ha (Henry & Craig 1984, Goldingay 1989). The groups of gliders observed were using areas of currently continuous forest in the path of each of the route options considered in the surveys. It is probably inevitable, therefore, that the current home ranges of some groups of Yellow-bellied Gliders will be divided by the selection of any of these options. Furthermore, the transmission lines and cleared land which already dissect the landscape have probably rendered this species locally vulnerable and effectively isolated the local population from others outside the study area.

It is difficult to predict the precise impact of the proposed construction on these animals without detailed long-term research. On the arguments presented above (namely: (i) the currently isolated nature of the study area, sandwiched between a large powerline right-of-way and cleared land; (ii) the limited capacity of individual gliders to cross treeless swathes through the forest; and (iii) the requirement of a large area of forest with suitable den and food resources for a home range), the road option which poses the fewest problems will be one which (i) retains the largest patches of continuous canopy forest and (ii) permits road construction with continuous canopy closest to the road verge, ie. Options A & B.

8.3.3 Fragmentation Of Habitat - Impacts On Road Users

Large ground-dwelling mammals (for example the Wombat and Macropods) are also likely to have home ranges which are crossed by the route. For these animals, the road is not likely to act as a barrier; they are expected to regularly attempt to cross the road and a high incidence of road kills would be expected. In addition, animals wandering on the road (particularly at night) are a hazard to traffic and the likelihood of accidents may also be high. This is of particular concern in the vicinity of the two primary creek channels along the proposed route, since the larger animals appear to be in relatively high densities in these areas. However, these densities did not appear to be as high as those recorded on the Hume Highway where wombat road-kills have caused problems (Gunninah Consultants, 1987, 1989). Other animals expected to be killed on the road due to their use of roads (or road verges) are the reptiles and many bird species including Lyrebirds.

8.3.4 Disruption Of Aquatic Habitats

Probably the most important impact from road building on aquatic systems is the potential for uncontrolled release of sediment into creeks and rivers from access and excavation activities. These have the potential to markedly affect organisms which occupy these water bodies, as a result of the smothering effect of sediment on the benthic species which are an important link in the food web. It is well documented that such sedimentation can change both the numbers and species diversity of benthic invertebrates (Blyth 1980, Blyth et al. 1984, Davey et al. 1982, 1983, Richardson 1985). The Platypus which is likely to occur in the primary creek channels, depends on these benthic communities for its food (Faragher et al. 1979, Grant 1982). Some native fish and water birds (Pollard et al. 1980, Frith 1967) and also the Australian Water Rat (Wollard et al. 1978) also include benthic invertebrates in their diets.

In summary, the impact on fauna of all route options is likely to be directly proportional to the area of the animal habitat which is disturbed by construction. Options F, G and H are likely to cause a much more extensive area of habitat destruction than Options A and B because of the scale of the earthworks associated with construction in western routes. In addition, the wide, disturbed corridors associated with Options F, G and H would be likely to present a greater barrier to animal movements than those of Options A and B.

In Options A and B there is greater possibility of a degree of eventual tree canopy closure over the carriageway. Provision of localised unrestricted animal movement may be able to be created by the use of bridges for major creek crossings. Additional faunal underpasses could be used on all options to reduce the "barrier" impact of the road. Options A and B present a greater risk of short-term disturbance of aquatic habitat but failure of erosion controls on Options F, G and H could similarly affect any aquatic fauna in the two major drainage systems.

8.4 Visual Impacts

All options would create a localised alteration to the recognised visual amenity of the study area. The degree of visual impact is likely to be related to the area of vegetation required to be cleared for road construction purposes and the area of rock and soil batter involved in excavations and fills. As each of these factors is expected to be greater on the western route options it is assumed that the visual impact of a bypass in any of the western routes would exceed that of the eastern routes. The opportunities for landscape treatment along the verges of the new road could be used to reduce the visual impact of construction in the longer term.

8.5 Synthesis Of Environmental Impacts

The synthesis of environmental impacts shown in Table 3 indicates that although Options A and B do present specific, significant threats to the environment of Tomerong and Stewart's (Suffolk) Creeks, overall they represent less environmental impact on the study area. On environmental grounds the eastern options appear preferable provided:

- local presence of the endangered plant species can be maintained;
- the potential "den" trees for Yellow-bellied Gliders can be protected;
- the area of disturbance of floodplain riverine vegetation (particularly in Tomerong Creek immediately west of Tomerong Village) can be minimised through reduction of the area to be cleared and/or implementation of erosion controls;
- the aquatic habitat of both primary creek channels can be protected.

TABLE 3. - SUMMARY OF THE DEGREE OF IMPACT OF EACH ROUTE OPTION

IMPACTS	LOW	MID	HIGH
Impact of earthworks on landform, soils and water quality	A	B	F, G, H
Total area of vegetation altered through direct and indirect impact	A	B	F, G, H
Total area of significant riverine vegetation disturbed	F, G, H	A	B
Direct threat to the endangered species	F , G, H	A	B
Direct and indirect threat to the riverine vegetation network	A	B	F, G, H
Fragmentation of faunal habitat	B	A	F, G, H
Total area of faunal habitat disturbed	A	B	F, G, H
Short term threat to significant aquatic habitat	F, G, H	A	B
Visual impact		A, B	F, G, H

9.0 RECOMMENDATIONS TO REDUCE ENVIRONMENTAL IMPACT

This section includes specific recommendations which relate to construction of the proposed bypass. The recommendations relate to:

- reduction of soil erosion and sedimentation (subsection 9.1);
- reduction of the impact of the road on vegetation communities (subsection 9.2);
- reduction of the impact of the road on native animal populations (subsection 9.3);
- reduction of the visual impacts of road construction (subsection 9.4).

It is recommended that Options F, G and H be rejected on the basis of the anticipated extent of general environmental impact associated with construction of the proposed bypass in the deeply dissected terrain of the two major catchment systems and that Option B be rejected on the basis of the anticipated threat to the riverine vegetation community and population of the endangered Brush Cherry.

9.1 Erosion And Sediment Control

In order to control soil erosion, sedimentation and nutrient exports associated with road construction works, road designers and planners should include adequate controls at all stages and consider the following (guidelines provided by Noel Kesby, District Soil Conservationist Nowra, Soil Conservation Service, NSW):

9.1.1 The limitations of the development site particularly in regard to soils (eg, mass movement, highly erodable and dispersable soils), topography (eg, steep slopes) and drainage (eg, floodplains, watercourses and swamps).

9.1.2 Adequate buffer zones between the area of disturbance and the natural drainage lines should be identified, documented and accommodated in the design. These buffer zones must be given high priority for the protection of these drainage lines from environment degradation.

9.1.3 Vegetation is the most effective method of minimising erosion and sedimentation. The areas of disturbance and land shaping must be restricted to retain the maximum cover of native vegetation. Temporary revegetation of disturbed area (short term stabilisation) during construction phases is critical for soil erosion control. Progressive permanent revegetation will be necessary to stabilise completed works. This will need to be implemented concurrently as final construction proceeds, eg, fill batters will require permanent revegetation in stages as each batter is constructed.

9.1.4 The increased total volume of runoff water and peak discharge rate resulting from road construction in major drainage lines and streams, which in turn can lead to increased flooding and erosion downstream of road development, must be taken into consideration in the planning and design phase. This means that the permanent sediment control ponds should incorporate flood mitigation and control of accidental pollution.

9.1.5 The construction of sediment and erosion control measures such as permanent sediment basins and traps should be the initial step in land disturbance. The design and construction of these measures is critical to ensure that they function efficiently as poor design and construction can actually accelerate erosion.

9.1.6 A stable drainage system must be established throughout the zone of disturbance. Runoff water must be controlled in a stabilised drainage system from the top of each catchment within the road easement to final disposal into the floor of the natural drainage system. Hydrological calculations must be undertaken to ensure that the drainage can adequately handle the increased volumes of runoff.

9.1.7 The design and location of temporary erosion and sediment control structures such as diversion banks, drains, sediment traps and sediment fences are essential for the protection of the road construction and the environment. The design of these temporary works must be integrated into the stable drainage system mentioned in the previous point. Some of these works will require construction on a daily or weekly basis to guard against any inclement weather overnight or during the weekend.

9.1.8 Cut and fill operations should be kept to a minimum wherever possible. The minimum batter grade should be 2H:1V. This is particularly important for the Tomerong Bypass as dispersable and erodable soils have been identified as major site limitations. To further safeguard against road construction problems resulting from the soil and topographical limitations of this site, the road designers should make every effort to find and design the placement of suitable rock facing to permanently stabilise fill batters. This would allow batter grades of 1.5H:1V to be achieved with environmental safety and considerably reduce the impact on flora and fauna.

9.1.9 The stripping and stockpiling of topsoil, including light vegetation and surface mulch from disturbed areas, is critical. This operation will require the selection and documentation of storage areas in which both the topsoil and the environment can be protected from erosion and sediment damage. This material must be respread to achieve revegetation.

9.1.10 All diversion drains must be lined and erosion control structures, both temporary and permanent , must be topsoiled and revegetated.

9.1.11 There must be regular maintenance of all erosion , sediment and pollution control structures.

9.2 Reduction Of Vegetation Disturbance

In addition to those listed under the previous subheading, the following recommendations are made:

9.2.1 In order to minimise the extent of disturbance to a significant plant community it is recommended that disturbance of the riverine vegetation community (particularly on the floodplains south of Turpentine Road) be kept to a minimum through careful route selection and sensitive choice of engineering solutions to creek crossings.

9.2.3 It is recommended that no endangered plants be destroyed on the Tomerong Creek floodplain and that care be taken to avoid those on the Stewart's (Suffolk) Creek floodplain. However, it would be preferable to lose an individual of this species on the Stewart's (Suffolk) Creek floodplain in order to minimise destruction of the riverine vegetation community in this area.

9.2.4 To avoid introduction of non-endemic species to the roadside communities it is recommended that the long term aim of a revegetation program be the replacement of species which occur in nature in those communities, ie, sandstone woodland species in the woodland section, forest understorey species in the forested sections and riverine rainforest species on the deep alluvial soils of the floodplains. Appendix 7 lists appropriate species for direct seeding. To enhance the visual amenity of major creek crossings certain rainforest tree species could be planted in these specific locations. These might include Sassafras, Brush Cherry, Coachwood and Red Cedar (all of which are known to have been or still be endemic to the study area). Other species used as tube stock plantings should be chosen from the lists in Appendix 3.

9.2.5 It is anticipated that certain soil conservation plantings could focus native herbivore attention on the road verges. In addition to having a deleterious impact on revegetation efforts, this could endanger road users by encouraging the movement of large animals across the road. It is recommended that:

- non-grass species be chosen for long term revegetation work;
- grassed nature strips be avoided or confined to short term soil conservation strategies;
- revegetation work be progressive as road construction proceeds so that, on completion of the road, the earliest grassed stages of revegetation have been replaced by less palatable shrub cover.

9.3 Reduction Of Disturbance To Native Animals

The recommendations under 9.1 and 9.2 should contribute to a reduction of impact on native fauna. The following recommendations are made in relation to specific faunal impact problems which have been identified in this report:

9.3.1 To preserve arboreal animal habitat several design criteria have been recommended.

(i) As many large trees with hollow trunks and branches be retained as possible, particularly in areas where few such specimens occur. A Yellow-bellied Glider den tree has been identified adjacent to Option A so that steps can be taken to avoid removing this tree.

(ii) To facilitate movement of arboreal animals across the proposed road, and thus minimise fragmentation and isolation of habitat, it would be desirable to retain as many trees as possible close to the roadside. It is acknowledged, however, that large trees may have to be removed to construct road batters in areas of fill and that large trees on the edge of cuttings could become unstable. Tall trees in particular should be retained, if they can be without prejudicing road safety, since a glider would be able to travel through the air from taller trees (ie, the greater the height at which it takes off, the further the potential distance of its glide) and possibly across the road.

(iii) Since Yellow-bellied Gliders are a species of particular concern, both in the patchiness of their distribution and their apparent sensitivity to disturbance, it would seem appropriate to monitor the groups already identified in the area. Insufficient information is available to accurately anticipate their response to the proposed road. Monitoring these groups during and after construction of the road would provide the information needed to ensure that future roadworks in similar habitats have less adverse environmental impact.

9.3.2 Since roadkills are expected to be a major problem, precautions should be taken to inhibit the use of the road by animals, particularly the larger ones such as the Wombat and Macropods. Measures recommended in this report to inhibit the movement of large animals across the new road are also recommended to facilitate the effective passage of small animals underneath the road.

(i) Provision of maximum possible free passage for animals is recommended beneath bridge spans in the creeks which tend to be the focus of animal movements. A clearance of at least 1.5m beneath some part of the bridge span and the creek bank will be needed to allow the passage of the larger macropods.

(ii) The degree of cover available to animals between the undisturbed forest and the road is of critical importance to the successful functioning of bridge spans or culverts as animal underpasses. It may be neccessary to plant semi-advanced plants in these areas to ensure a rapid return of dense, effectively tall vegetation cover in these specific areas. Dead plant material and rocks should be used to provide animal shelter in these areas, therefore, rocks, large felled trees with hollow trunks and branches should be placed amongst tube stock and other plantings.

(iii) The use of rock armouring on the western road batters to the north of Turpentine Road may inhibit the movement of animals from the Tomerong Creek floodplain onto the roadway. In addition, rock armouring can be used as a positive barrier which directs animal movements towards the bridge spans.

(iv) It has been suggested that culverts may be marked by individual animals thus inhibiting their use by other animals of the same species (Gunninah Consultants 1989, 1989). The number of underpasses provided could thus determine the number of animals successfully passing under the road. It is recommended that any underpasses installed should be of a moderate size (e.g. 1m x 1.5m) so they may be used by both small and large animals. The design of the culverts will need to accommodate the placing of brush, logs and rocks through the culvert to provide shelter for small animals. It will be necessary to examine the detailed designs for the road and the study area to determine the most appropriate underpass locations, numbers and sizes.

(v) Although not effective on their own as solutions to the wild animal road-kill problem, signs indicating the presence of wildlife could alert drivers of potential danger and appropriate fencing erected alongside the road may curb the movements of these animals.

9.3.3 To avoid the loss of a productive breeding season for the Grey Goshawk it is suggested that disturbance or removal of the known nest tree adjacent to Stewart's (Suffolk) Creek be avoided during the July to December period if possible.

9.3.4 To minimise any potential impact on the aquatic species in the creeks (e.g. platypus), the banks of the creeks should be disturbed as little as possible during bridge construction.

9.4 Protection Of Visual Amenity Of The Study Area

No recommendation can be made to reduce the visual impact of the road at the time of construction. The road's longer term visual impact can, however be considerably reduced by the rapid return of a vegetation cover which is visually harmonious with the vegetation in the area. To achieve this aim it is recommended that the species used for rehabilitation should be selected from those removed for road construction. If there is sufficient time, seed could be collected in the area prior to road construction. Use of this seed would permit protection of the local gene pool although it is difficult to make a strong argument for this in view of the degree of disturbance of the forests and woodlands in this area. If time is limited, commercial seed is available for some of the species in the area.

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APPENDIX 1

STRUCTURAL FORMATIONS IN AUSTRALIAN VEGETATION (After Specht 1981)

LIFE FORM OF TALLEST STRATUM	PROJECTIVE FOLIAGE COVER OF TALLEST STRATUM				
	100-70%	70-50%	50-30%	30-10%	<10%
Trees >30m	Tall Closed Forest	Tall Open Forest	-	-	-
Trees 10-30m	Closed Forest	Open Forest	Open Forest	Woodland	Open Woodland
Trees <10m	Low Closed Forest	Low Open Forest	Low Open Forest	Low Woodland	Low Open Woodland
Shrubs >2m	Closed Shrub	Open Scrub	Open Scrub	Tall Shrubland	Tall Open Shrubland
Shrubs 0.25-2m	Closed Heathland	Open Heathland	Open Heathland	Low Shrubland	Low Open Shrubland
Shrubs <0.25m	-	-	-	Dwarf Open Heathland	Dwarf Open Heathland
Hummock Grasses	-	-	-	Hummock Grassland	Open Hummock Grassland
Herbaceous Layer:					
Gramminoides	Closed Grassland	Grassland	Grassland	Open Grassland	Very Open Grassland
Sedges	Closed Sedgland	Sedgeland	Sedgeland	Open Sedgeland	Very Open Sedgeland
Herbs	Closed Herbland	Herbland	Herbland	Open Herbland	Very Open Herbland
Ferns	Closed Fernland	Fernland	Fernland	Open Fernland	Very Open Fernland

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APPENDIX 2

PLANT SPECIES RECORDED IN THE STUDY AREA DURING THE VEGETATION SURVEYS

Nomenclature follows Beadle N.C., Evans O.D. and Carolin R.C. (1982) *"Flora of the Sydney Region"* except for species not listed in that reference which were identified by the National Herbarium of N.S.W.

The plant community-types in which each species was observed are indicated as follows:

A *Eucalyptus sclerophylla* - *Eucalyptus gummifera* woodland (Scribbly Gum - Bloodwood)

B *Eucalyptus maculata* - *Syncarpia glomulifera* (Spotted Gum - Turpentine) with *Acacia spp.* thickets

C *Eucalyptus maculata* - *Eucalyptus saligna/Eucalyptus botryoides* forest (Spotted Gum - Sydney Blue Gum/Bangalay)

D *Eucalyptus maculata* - *Eucalyptus pilularis* forest (Spotted Gum - Blackbutt)

E Riverine vegetation

NOTE: The observed species composition of the community types in the study area indicate a profound modification of the native plant community resulting from localised land management practises. In many places on the road route options, wide ecotones exist in which there occur representative species from several community-types.

PTERIDOPHYTA	Community-type
ADIANTACEA	
Adiantum aethiopicum L.	B C E
Adiantum formosum R.Br.	B C E
Cheilanthes sp.	A
Pellaea falcata (R.Br.) Fee	B
ASPIDIACEAE	
Lastreopsis microsora (Endl.) Tindale	E
Polystichun australiense Tindale	E
BLECHNACEA	
Blechnum cartilagineum SW.	B D E
Blechnum nudum (Labill.) Mett ex Luerss	B C D E
Doodia aspera R.Br.	B C
Doodia caudata var. caudata (Cav.) R.Br.	E
Doodia caudata var. laminosa F.Muell	E
Doodia media (R.Br.) Benth	E
CYATHEACEAE	
Culcita dubia (R.BR.) Maxon	B E
Cyathea australis (R.Br.) Dom.	E
DENNSTAEDTIACEAE	
Dennstaedtia davallioides (R.Br.) T.Moore	E
Histiopteris incisa (Thunb.) J.Sm.	B E
Hypolepis muelleri N.A. Wakef.	B E
Pteridium esculentum (Forst.f.) Cockayne	A B C D E
GLEICHENIACEAE	
Gleichenia dicarpa R.Br.	B E
Sticherus flabellatus (R.Br.) St John	E
LINDSAEACEAE	
Lindsaea linearis SW.	A B
GYMNOSPERMAE	
ZAMIACEAE	
Macrozamia communis L.A.S. Johnson	B

DICOTYLEDONEAE	Community-type
ACANTHACEAE	
Brunoniella australia (R.Br.) Bremek	B C D
Pseuderanthemum variable (R.Br.) Radlkf	E
APIACEAE	
Hydrocotyle acutiloba (F.Muell) N.A. Wakefield	B C
Platysace linearifolia (Cav.) C. Norman	A B
Xanthosia pilosa Rudge	B C
APOCYNACEAE	
Parsonsia straminea (R.Br.) F.Muell	E
ARALIACEAE	
Astrotricha latifolia Benth.	E
ASCLEPIADACAE	
Marsdenia rostrata R.Br.	E
Tylophora barbarta R.Br.	B
ASTERACEAE	
Helichrysum diosmifolium (Vent.) Sweet	A E
Olearia tomentosa (Wendl.) DC	B
Senecio lautus Forst.f.ex Willd	B
Sigesbeckia orientalis L.	E
ATHEROSPERMATACEAE	
Doryphora sassafras Endl.	E
BAUERACEAE	
Bauera rubioides Andr.	B
BIGNONIACEAE	
Pandorea pandorana (Andr.) Steen	B C E
CASSYTHACEAE	
Cassytha paniculata R.Br.	C
CASUARINACEAE	
Casuarina littoralis Salisb.	A B
CARYOPHYLLACEAE	
Stellaria flaccida Hook	E
CELASTRACEAE	
Cassine australe (Vent.) Kuntze	B E

	Community-type
CUNONIACEAE	
Aphanopetalum resinosum Endl.	D E
Callicoma serratifolia Andr.	E
Ceratopetalum apetalum D.Don	E
Ceratopetalum gummiferum Sm.	E
Schizomera orata D.Donn	E
DILLENIACEAE	
Hibbertia dentata R.Br. ex DC.	B C D E
Hibbertia empetrifolia (D.C.) Hoogl	A
Hibbertia obtusifolia DC.	A B C D
Hibbertia scandens (Willd.) Gilg.	A B C E
DROSSERACEAE	
Drosera binata Labill.	B
Drosera peltata Sm. ex Willd.	B
Drosera spathulata Labill.	B
EBENACEAE	
Diospyros australis (R.Br.) Hiern	E
ELAEOCARPACEAE	
Elaeocarpus reticulatus Sm.	B C D E
EPACRIDACEAE	
Atrotriche serrulata (Labill.) R.Br.	A B
Epacris pulchella Cav.	A B
Leucopogon juniperinus R.Br.	A B C D E
Leucopogon lanceolatus (Sm.) R.Br. var. lanceolatus	A D E
EUPHORBIACEAE	
Breynia oblongifolia J.Muell.	B
Claoxylon australe Baill.	E
Croton verreauxii Baill.	E
Glochidion ferdinandi (J. Muell.) F.M. Bailey	E
EUPOMATIACEAE	
Eupomatia laurina R.Br.	E
FABACEAE: Faboideae	
Daviesia ulicifolia Andr.	A
Glycine clandestina Wendl.	B E
Gompholobium grandiflorum Sm.	A B
Hardenbergia violacea (Schneev.) Stearn.	A B
Indigophora australis Willd.	A B
Kennedia rubicunda (Scneev.) Vent	A
Oxylobium ilicifolium (Andr.) Domin.	A C D
Platylobium formosum Sm.	A
Pultenaea villosa Willd.	A D
Pultenaea retusa Sm.	A B

	Community-type
FABACEAE: Mimosoideae	
Acacia binervata DC	B C D E
Acacia brownii (Poir.) Steud	B
Acacia falcata Willd.	A B
Acacia implexa Benth.	D
Acacia irrorata Sieb. ex Spreng	A B C D E
Acacia longifolia (Andrews) Willd. var. longifolia	A B C D
Acacia maidenii F.Muell	E
Acacia mearnsii De Wild.	A B C D
Acacia myrtifolia (Sm.) Willd.	A B
Acacia stricta (Andrews) Willd.	D
Acacia suaveolens (Sm.) Willd.	A B
Acacia terminalis (Salisb.) Macbride	A
Acacia ulicifolia (Salisb.) Court	A
GERANIACEAE	
Pelogonium australe Willd.	B
GOODENIACEAE	
Dampiera stricta (Sm.) R.Br.	A B
Goodenia bellidifolia Sm.	A B
Goodenia ovata Sm.	B E
Goodenia sp.	D
HALORAGACEAE	
Gonocarpus teucrioides DC.	A
LABIATAE	
Prostanthera lasianthos Labill	E
Prostanthera violacea R.Br.	C D E
LAMIACEAE	
Prostanthera sp.	C E
LAURACIAE	
Cryptocarya glaucescens R.Br.	E
Cryptocarya microneura Meisn	E
LOBELIACEAE	
Lobelia sp.	A B
MALVACEAE	
Howittia trilocularis F.Muell.	B C E
MELIACEAE	
Synoum glandulosum (Sm) A.Juss	D E

	Community type
MENISPERMACEAE	
Sarcopetalum harveyanum F.Muell.	E
Stephania japonica (Thunb.) Miers var. discolor (Bl.) Forman	E
MONIMIACEAE	
Hedycarya angustifolia A.Cunn	E
Palmeria scandens F.Muell	E
MORACEAE	
Ficus coronata Spin.	E
Ficus rubiginosa Desf. ex Vent	D
Malaisia scandens (Lour.) Planch	E
MYRSINACEAE	
Rapanea howittiana Mez.	E
Rapanea variablis Mez.	B C D E
MYRTACEAE	
Acmena smithii (Poir.) Merrill et Perry	E
Angophora floribunda (Sm.) Sweet	B
Backhousia myrtifolia Hook.f.et Harv.	E
Baeckea virgata (Forst. et f.) Andr.	B C E
Eucalyptus botryoides Sm.	B C
Eucalyptus eugenioides Sieb. ex Spreng?	B
Eucalyptus globoidea Blakely	A B
Eucalyptus gummifera (Soland. ex Gaertn.) Hochn.	A B
Eucalyptus maculata Hook	A B C D E
Eucalyptus paniculata Sm.	B D
Eucalyptus pellita F.Muell.	D
Eucalyptus pilularis Sm.	A B D E
Eucalyptus piperita ssp. *urceolaris* (Maiden et Blakely) L. Johnson et Blaxell	B
Eucalyptus saligna Sm.	B C E
Eucalyptus saligna x botryoides	C E
Eucalyptus sclerophylla (Blakely) L. Johnson et D. Blaxell	A
Eucalyptus sieberi L. Johnson	A
Kunzea ambigua (Sm.) Druce	A B C D
Leptospermum flavescens Sm.	C
Melaleuca sp.	B C E
Melaleuca pauciflora Turcz	E
Melaleuca styphelioides Sm.	C E
Melaleuca linariifolia sp.	C E
Rhodamnia rubescens (Benth.) Miq.	B E
Syncarpia glomulifera (Sm.) Niedenzu	A B C D E
* *Syzygium paniculatum* Gaertn. **(endangered species)**	E
Tristaniopsis collina P.G. Wilson et J.T. Waterhouse	C D E
Tristaniopsis laurina P.G. Wilson et J.T. Waterhouse	E

	Community type
OLEACEAE	
Notelaea longifolia Vent.	B D E
Notelaea venosa R.Br.	E
OXALIDACEAE	
Oxalis corniculata L.	B
PASSIFLORACEAE	
Passiflora herbertiana Ker	C E
PITTOSPORACEAE	
Billardiera scandens Sm.	A C E
Bursaria spinosa Cav.	B
Citriobatus pauciflorus A.cunn ex Ettingh	E
Pittosporum revolutum Ait	E
Pittosporum undulatum Vent.	B C E
POLYGALACEAE	
Comesperma ericinum DC.	A
PROTEACEAE	
Banksia spinulosa Sm.	A
Hakea dactyloides (Gaertn.) Cav.	A
Hakea sericea Schrad.	A
Lambertia formosa Sm.	A
Lomatia ilicifolia R.Br.	A
Persoonia levis (Cav.) Domin.	A
Persoonia linearis Andr.	A
Persoonia mollis R.Br.	A B D
Petrophile sessilis Sieb. ex Schult. et. f.	A
Stenocarpus salignus R.Br.	B E
Xylomelum pyriforme (Gaertn.) Knight	A B
RANUNCULACEAE	
Clematis aristata R.Br. ex D.C	E
RHAMNACEAE	
Alphitonia excelsa (Fenzl) Benth.	E
Pomaderris multiflora Sieb. ex Fenzl.	E
ROSACEAE	
Rubus rosifolius	B E
Rubis sp. (aff. moorei)	E
RUBIACEAE	
Morinda jasminoides A.Cunn	E
Opercularia aspera Gaertn.	B
Pomax umbellata (Gaertn.) Soland. ex A. Rich	B
Psychotria loniceroides Sieb.ex DC	E

	Community type
RUTACEAE	
Acronychia oblongifolia (A. Cunniex Hook)	E
Boronia pinnata Sm.	A B
Correa lawrenciana Hook. ssp. cordifolia	C D E
*Correa reflexa (*green form) (Labill.) Vent.	B
RUTACEAE (CONT)	
Correa reflexa (red form) (Labill.) Vent.	B D
Zieria smithii Andr.	B
SANTALACEAE	
Exocarpus cupressiformis Labill.	A
Leptomeria acida R.Br.	A
SOLANACEAE	
Duboisia myoporoides R.Br.	E
Solanum prinophyllum Dunal	E
Solanum pungetium R.Br.	E
Solanum stelligerum Sm.	B
STACKHOUSIACEAE	
Stackhousia monogyna Labill	D
STERCULIACEAE	
Commersonia fraseri J.Gray	E
THYMELIACEAE	
Pimelea linifolia Sm.	A D
TREMENDRACEAE	
Tetratheca ericifolia Sm?	A B
ULMACEAE	
Trema aspera (Brongn.) Blume	E
URTICACEAE	
Urtica incisa Poir.	B
VERBENACEAE	
Clerodendrum tomentosum R.Br.	E
VIOLACEAE	
Viola hederacea Labill.	B
VITACEAE	
Cissus antarctica Vent	E
Cissus hypoglauca A. Gray	C E

	Community type
WINTERACEAE	
Tasmannia insipida (R.Br. exDC) A.C. Smith	D E
MONOCOTYLEDONEAE	
ARACEAE	
Gymnostachys anceps R.Br.	E
ARECACEAE	
Livistona australis (R.Br.) Mart.	C E
CYPERACEAE	
Carex longebrachiata Boeck.	E
Caustis flexuosa R.Br.	A
Gahnia aspera (R.Br.) Spreng	A B E
Gahnia melanocarpa R.BR	C E
Lepidosperma laterale R.BR	A B
Lepidosperma elatius Labill	E
IRIDACEAE	
*Patersonia fragilis (*Labill.) Druce	B
JUNCAGINACEAE	
Triglochin procera R.Br.	E
LILIACEAE	
Dianella caerulea Sims	B
Schelhammera undulata R.Br.	E
ORCHIDACEAE	
Acianthus caudatus R.Br.	A B
Caladenia carnea R.Br.	A B C D E
Corybas aconitiflorus (Salisb.)	B D
Cymbidium suave R.Br.	A B C D E
Diuris sp.	D
Glossodia major R.Br.	B C D
Phrasophyllum? striatum R.Br.	A
Pterostylis grandiflora R.Br.	A B C D
Pterostylis longifolia R.Br.	B C D
Pterostylis nutans R.Br.	A B C D
Pterostylis pedunculata (R.Br.)	B C D
PHILESIACEAE	
Eustrephus latifolius R.Br.	A B
Geitonoplesium cymosum (R.Br.) A.Cunn. ex. Hook	E

	Community type
POACEAE	
Anisopogon avenaceus R.Br.	A B
Entolasia stricta (R.Br.) Hughes	A B C D
Imperata cylindrica (L.) Beaur	A B C D
Oplismenus aemulus (R.Br.) Kunth	B E
Oplismenus imbecillis (R.Br.) Roem. et Schult.	E
Poa sp.	A
Stipa ramosissma Trin.	E
Themeda australis (R.Br.) Stapf	A B
RESTIONACEAE	
Lepyrodia scariosa R.Br.	A
Restio sp.	A B
SMILACACEAE	
Ripogonum album R.Br.	E
Smilax australis R.Br.	E
Smilax glyciphylla Sm.	B
XANTHORRHOECEAE	
Lomandra glauca (R.Br.) Ewart	A
Lomandra longifolia Labill.	A B C D E
Lomandra obliqua (Thunb.) Macbride	A
Lomandra spp.	D
Xanthorrhoea resinosa ssp. concava Lee	A B

APPENDIX 3

RIVERINE VEGETATION - OPTIONS A & B CORRIDORS

The following list identifies the species present in the survey corridors for Options A & B at those places where riverine vegetation occurs.

The species are listed as:

f	fern
v	vine
p	palm
s	shrub < 3m tall
t	tree > 3m tall
s-t	shrub-tree (indicates that the individuals observed are immature but have the potential to develop into a tree > 3m tall or were observed as a tree > 3m tall)
h	herb
*	endangered species

		Option A		Option B
	Plant form	Stewart's Creek	Tomerong Creek	Tomerong Creek
Adiantum aethiopicum	*f*	+	+	+
A. formosum	*f*	+		+
Lastreopsis microsora	*f*	+	+	
Polystichum australiense	*f*	+		
Blechnum cartilagineum	*f*	+		+
B. nudum	*f*	+	+	+
Doodia aspera	*f*	+	+	+
D. caudata var. caudata	*f*		+	
D. caudata var. laminosa	*f*			+
D. media	*f*			+
Culcita dubia	*f*	+		+
Cyathea australis	*f*	+		+
Dennstaedtia davallioides	*f*			+

Hypolepis muelleri	*f*	+	+	+
Pteridium esculentum	*f*	+	+	+
Sticherus flabellatus	*f*			+
Pseuderanthemum variabile	*h*			+
Astrotricha latifolia	*s*		+	+
Parsonsia straminea	*v*	+		+
Marsdenia rostrata	*v*	+	+	+
Tylophora barbata	*v*		+	+
Helichrysum diosmifolium	*s*	+		
Sigesbeckia orientalis	*h*		+	
Pandorea pandorana	*v*	+		+
Stellaria flaccida	*h*		+	+
Callicoma serratifolia	*t*	+	+	+
Ceratopetalum apetalum	*t*	+	+	+
Schizomera ovata	*t*			+
Hibbertia dentata	*v*	+		+
Hibbertia scandens	*v*	+	+	+
Diospyros australis	*t*	+		
Elaeocarpus reticulatus	*t*	+		+
Leucopogon juniperinus	*s*			+
Leucopogon lanceolatus	*s*			+
Claoxylon australe	*s*	+	+	+
Croton verreauxii	*s*			
Glochidion ferdinandi	*s-t*			+
Eupomatia laurina	*s*	+	+	+

Glycine clandestina	*v*	+		+
Acacia binervata	*t*	+	+	+
A. irrorata	*t*		+	+
A. maidenii	*t*			+
Goodenia ovata	*s*	+	+	
Prostanthera lasianthos	*s-t*			+
Howittia trilocularis	*s*		+	
Doryphora sassafras	*t*	+	+	+
Hedycarya angustifolia	*s-t*			+
Palmeria scandens	*v*			+
Synoum glandulosum	*s-t*	+	+	+
Cryptocarya glaucescens	*t*	+	+	+
C. microneura	*t*	+		+
Ficus coronata	*t*	+	+	+
Malaisia scandens	*s*			+
Sarcopetalum harveyanum	*v*	+		+
Stephania japonica	*v*		+	+
Rapanea howittiana	*s-t*	+		+
R. variaiblis	*s-t*			+
Acmena smithii	*t*	+	+	+
Backhousia myrtifolia	*s-t*	+	+	+
Baeckea virgata	*s*		+	+
Eucalyptus maculata	*t*			+
E. pilularis	*t*			+
E. saligna	*t*	+		+
E. saligna x botryoides	*t*		+	+

Melaleuca pauciflora	*s*		+	+
M. styphelioides	*t*		+	+
M. linariifolia	*t*		+	+
Rhodamnia rubescens	*s*	+		+
Syncarpia glomulifera	*t*	+		+
* *Syzygium paniculatum*	*s-t*	+		+
Tristaniopsis collina	*s*	+		+
T. laurina	*s-t*			+
Notelaea longifolia	*s-t*	+		+
N. venosa	*s-t*	+		+
Passiflora herbertiana	*v*		+	
Citriobatus pauciflorus	*s*			+
Billardiera scandens	*v*	+		+
Pittosporum revolutum	*s*	+		+
P. undulatum	*s*	+	+	+
Stenocarpus salignus	*s-t*		+	+
Alphitonia excelsa	*t*		+	+
Rubus rosifolius	*v*	+	+	+
R. sp. (aff. moorei)	*v*			+
Clematis aristata	*v*	+		
Pomaderris multiflora	*s*			+
Morinda jasminoides	*v*	+	+	+
Psychotria loniceroides	*s*	+	+	+
Acronychia oblongifolia	*t*	+	+	+
Correa lawrenciana	*s*	+		+

Duboisia myoporoides	*s*					+		
Solanum prinophyllum	*h*	+						
S. pungetium	*h*	+		+				
S. stelligerum	*h*	+						
Trema aspera	*s*			+		+		
Urtica incisa	*h*	+						
Clerodendrum tomentosum	*s*	+			+		+	
Viola hederacea	*h*					+		
Commersonia fraseri	*s*	+		+		+		
Cissus antarctica	*v*	+				+		
C. hypoglauca	*v*	+		+		+		
Tasmannia insipida	*s*					+		
Gymnostachys anceps	*h*	+				+		
Livistona australis	*p*	+		+		+		
Carex longebrachiata	*h*					+		
Gahnia aspera	*h*	+						
Gahnia melanocarpa	*h*	+		+		+		
Lepidosperma elatius	*h*					+		
Triglochin procera	*h*					+		
Schelhammera undulata	*h*					+		
Cymbidium suave	*h*			+		+		
Eustrephus latifolius	*v*	+		+		+		
Geitonoplesium cymosum	*v*					+		
Oplismenus aemulus	*h*			+				
Oplismenus imbecillis	*h*			+				

Stipa ramosissma	*h*			+				
Ripogonum album	*v*	+						
Smilax australis	*v*	+			+		+	
S. glyciphylla	*v*					+		
Lomandra longifolia	*h*			+		+		
Total species		66		51		101		

APPENDIX 4

MAMMALS CONSIDERED LIKELY TO OCCUPY THE STUDY AREA

The list includes:

the information source

(1) those animals detected during this survey
(2) those likely to be in the study area from Forestry Commission of N.S.W. (Nowra District) lists
(3) those likely to be in the study area from Braithwaite et al. 1988.

the habitat area

Area I	northern woodland
Area II	tall open forest north of Turpentine Road
Area III	tall open forest south of Turpentine Road
Area IV	tall open forest south of Grange Road
Area V	tall open forest along western route options

the detection technique

a	sighting
b	scat identification
c	identification of nests, diggings or tracks.

the conservation status (Strahan 1983)

A	common
B	common but vulnerable
C	common to sparse
D	common in limited habitat
E	abundant
F	rare with limited habitat
G	rare
H	sparse

SPECIES	SOURCE	HABITAT	DETECTION METHOD	STATUS
FAMILY ORNITHORYNCHIDAE				
Platypus *Ornithorhynchus anatinus*	2			B
FAMILY TACHYCLOSSIDAE				
Echidna *Tachyglossus aculeatus*	1,2,3	II	c	A
FAMILY DASYURIDAE				
Tiger Cat *Dasyurus maculatus*	2			C
Brown Antechinus *Antechinus stuartii*	1,2,3	II,IV	b	E
Dusky Antechinus *Antechinus swainsonii*	2,3			E
White-footed Dunnart *Sminthopsis leucopus*	2,3			D
FAMILY PERAMELIDAE				
Long-nosed Bandicoot *Perameles nasuta*	1,2,3	II,IV	c	A
FAMILY PHASCOLARCTIDAE				
Koala *Phascolarctos cinereus*	2			D
FAMILY VOMBATIDAE				
Common Wombat *Vombatus ursinus*	1,2,3	II,III	b,c	A
FAMILY PETAURIDAE				
Ringtail Possum *Pseudocheirus peregrinus*	1,2,3	II	a	A
Greater Glider *Petauroides volans*	1,2,3	II,III	a	E
Yellow-bellied Glider *Petaurus australis*	1,2,3	II,III,IV	a	F
Sugar Glider *Petaurus breviceps*	1,2,3	II,III	a	A
Squirrel Glider *Petaurus norfolcensis*	2			G

FAMILY PHALANGERIDAE

Common Brushtail Possum				
Trichosurus vulpecula	1,2,3	II,IV	a,b	E
Short-eared Brushtail Possum				
Trichosurus caninus	2			A

FAMILY BURRAMYIDAE

Eastern Pygmy Possum				
Cercartetus nanus	2			A
Feathertail Glider				
Acrobates pygmaeus	2			A

FAMILY POTOROIDAE

Long-nosed Potoroo				
Potorous tridactylus	2			D

FAMILY MACROPODIDAE

Red-necked Wallaby				
Macropus rufogriseus	1,2,3	I	b,c	A,E
Eastern Grey Kangaroo				
Macropus giganteus	1,2,3	I,II,IV	b,c	E
Common Wallaroo				
Macropus robustus	2			E
Swamp Wallaby				
Wallabia bicolor	1,3	I,II,III,IV	a,b,c	A

FAMILY MURIDAE

Eastern Water Rat				
Hydromys chrysogaster	2			C
Bush Rat				
Rattus fuscipes	1,3	II	b	E
Swamp Rat				
Rattus lutreolus	2,3			A
*Black Rat				
Rattus rattus	3			E
*House Mouse				
Mus musculus	3			E

FAMILY PTEROPODIDAE

Grey-headed Flying Fox				
Pteropus poliocephalus	2			D
Red Flying Fox				
Pteropus scapulatus	2			A

FAMILY RHINOLOPHIDAE				
Eastern Horseshoe Bat				
Rhinolophus megaphyllus	2			D
FAMILY VESPERTILIONIDAE				
Lesser Long-eared Bat				
Nyctophilus geoffroyi	2			E
Bent-wing Bat				
Miniopterus schreibersii	2			E
Goulds Wattled Bat				
Chalinolobus gouldii	2			E
Large-footed Mouse-eared Bat				
Myotis adversus	3			F
Great Pipistrelle				
Pipistrellus tasmaniensis				
(syn. *Falsistrellus tasmaniensis*)		3		
H				
Large Forest Eptesicus				
Eptesicus pumilus				
(syn. *Eptesicus darlingtoni*)	3			E
Little Bat				
Eptesicus pumilus	2			E
FAMILY LEPORIDAE				
*Rabbit				
Oryctolagus cuniculus	1,2,3	I,II,III	b	E
*Brown Hare				
Lepus capensis	3			A
FAMILY CANIDAE				
*Dog				
Canis familiaris	1,2,3	I,III	c	A
*Fox				
Vulpes vulpes	1,2,3	III	b	E
FAMILY FELIDAE				
*Feral Cat				
Felis catus	2,3			E
FAMILY EQUIDAE				
*Horse				
Equus caballus	1,3	II,III	c	A
FAMILY SUIDAE				
*Pig				
Sus scrofa	2,3			E
FAMILY BOVIDAE				
*Goat				
Capra hircus	1	III	b	E

* denotes introduced species

APPENDIX 5

AVIFAUNA CONSIDERED LIKELY TO OCCUPY THE STUDY AREA

Includes actual sightings and species thought to be found within the Nowra district.

Information source

1. sightings made during the survey
2. Forestry Commission of N.S.W. records
3. records from Jervis Bay (Braithwaite et al. 1988)
4. sightings in the locality, courtesy D. Wright 1988
5. sightings in the locality, courtesy of community input

COMMON NAME	SCIENTIFIC NAME	SOURCE
Black Cormorant	*Phalacrocorax carbo*	1
White-faced Heron	*Ardea pacifica*	1,2
Back Duck	*Anas superciliosa*	2,3
GreyTeal	*A. gibberifrons*	2
Wood Duck	*Chenonetta jubata*	1,2
Black-shouldered Kite	*Elanus notatus*	3
Whistling Kite	*Haliastur sphenurus*	2,3
Brown Goshawk	*Accipiter fasciatus*	2,3
Grey Goshawk	*A. novae-hollandiae*	5
Collared Sparowhawk	*A. cirrocephalus*	2,3
Wedge-tailed Eagle	*Aquila audax*	2
Peregrine Falcon	*Falco peregrinus*	2
Little Falcon	*F. longipennis*	2
Brown Falcon	*F. berigora*	2,3
Nankeen Kestrel	*F. cenchroides*	2
Stubble Quail	*Coturnix pectoralis*	2
Painted Quail	*Turnix varia*	3
Masked Plover	*Vanellus miles*	2,3
Topknot Pigeon	*Lopholaimus antarcticus*	2,3
Common Bronzewing	*Phaps chalcoptera*	2,3
Brush Bronzewing	*P. elegans*	3
Wonga Pigeon	*Leucosarcia melanoleuca*	2,3
Glossy Black Cockatoo	*Calyptorhynchus lathami*	2,3
Yellow-tailed Black Cockatoo	*C. funereus*	1,2,3
Gang-gang cockatoo	*Cacatua galerita*	1,2,3
Galah	*C. roseicapilla*	3
Musk Lorikeet	*Glossopsitta concinna*	1,2,3
Little Lorikeet	*G. pusilla*	2,3
Rainbow Lorikeet	*Trichoglossus haematodus*	2,3,4
Scaly-breasted Lorikeet	*T. chlorolepidotus*	2
King Parrot	*Alisterus scapularis*	1,2,3
Crimson Rosella	*Platycercus elegans*	1,2,3
Eastern Rosella	*P. eximius*	1,2,3

Red-rumped Parrot	*Psephotus haematonotus*	2
Turquoise Parrot	*Neophema pulchella*	4
Pallid Cuckoo	*Cuculus pallidus*	2,3
Brush Cuckoo	*C. variolosus*	2,3
Fan-tailed Cuckoo	*C. pyrrhophanus*	1,2,3
Horsfield's Cuckoo	*Chrysococcyx basalis*	2,3
Shining Bronze Cuckoo	*C. lucidus*	2,3,4
Koel	*Eudynamys scolopacea*	2
Channel-billed Cuckoo	*Scythrops novaehollandiae*	3
Boobook Owl	*Ninox novaeseelandiae*	1,2,3
Powerful Owl	*N. strenuta*	3
Barking Owl	*N. connivens*	2
Tawny Frogmouth	*Podargus strigoides*	1,2,3
White-throated Nightjar	*Caprimulgus mystacalis*	2,3
Spine-tailed Swift	*Hirundapus caudacutus*	2,3
Laughing Kookaburra	*Dacelo novaeguineae*	1,2,3
Sacred Kingfisher	*Halcyon sancta*	2,3,4
Azure Kingfisher	*Ceyx azureus*	2
Dollar-bird	*Eurystomus orientalis*	2,3,4
Superb Lyrebird	*Menura novaehollandiae*	1,2
Welcome Swallow	*Hirundo neoxena*	2,3
Tree Martin	*Cecropis nigricans*	2
Fairy Martin	*C. ariel*	2
Pipit	*Anthus novaeseelandiae*	2,3
Black-faced Cuckoo Shrike	*Coracina novaehollandiae*	1,2,3
Cicadabird	*C. tenuirostris*	2,3
White-winged Triller	*Lalage sueurii*	2
Australian Ground Thrush	*Zoothera dauma*	2,3
Rose Robin	*Petroica rosea*	2,3
Flame Robin	*P. phoenicia*	2
Scarlet Robin	*P. multicolor*	2,3
Hooded Robin	*Melanodryas cucullata*	2
Eastern Yellow Robin	*Eopsaltria australis*	1,2,3
Brown Flycatcher	*Microeca leucophaea*	2,3
Crested Shrike-tit	*Falcunculus frontatus*	2,3
Rufous Whistler	*Pachycephala rufiventris*	1,2,3
Golden Whistler	*P. pectoralis*	1,2,3
Grey Shrike-thrush	*Colluricincla harmonica*	1,2,3
Black-faced Flycatcher	*Monarcha melanopsis*	2,3
Leaden Flycatcher	*Myiagra rubecula*	2,3
Restless Flycatcher	*M. inquieta*	2
Rufous Fantail	*Rhipidura rufifrons*	2,3
Grey Fantail	*R. fuliginosa*	1,2,3
Willie Wagtail	*R. leucophrys*	1,2
Eastern Whipbird	*Psophodes olivaceus*	1,2,3
Spotted Quail-thrush	*Cinclosoma punctatum*	2,3
Superb Blue Wren	*Malurus cyaneus*	1,2,3
Variegated Wren	*M. lamberti*	1,2,3
Pilot Bird	*Pycnoptilus floccosus*	2
Rock Warbler	*Origma solitaria*	2

White-browed Scrub Wren	*Sericornis frontalis*	1,2,3
Large-billed Scrub Wren	*S. magnirostris*	2
Yellow-throated Scrub Wren	*S. citreogularis*	2
Brown Warbler	*Gerygone mouki*	1,2,3
White-throated Warbler	*G. olivacea*	2,3,4,
Brown Thornbill	*Acanthiza pusilla*	1,2,3
Striated Thornbill	*A. lineata*	1,2,3
Yellow-rumped Thornbill	*A. chrysorrhoa*	1,2
Buff-rumped Thornbill	*A. reguloides*	2,3
Yellow Thornbill	*A. nana*	2,3
Varied Sittella	*Daphoenositta chrysoptera*	2,3
White-throated Treecreeper	*Climacteris leucophaea*	1,2,3
Red-browed Treecreeper	*C. eryythrops*	2,3
Brown Treecreeper	*C. picumnus*	2
Red Wattlebird	*Anthochaera carunculata*	1,2,3
Little Wattlebird	*A. chrysoptera*	2,3
Noisy Friarbird	*Philemon corniculatus*	1,2,3
Regent Honeyeater	*Xanthomza phrygia*	2
Bell Miner	*Manorina melanophrys*	1
Noisy Miner	*M. melanocephala*	2
Lewin's Honeyeater	*Meliphaga lewinii*	1,2,3
Yellow-faced Honeyeater	*Lichenosyomus chrysops*	1,2,3
Yellow-tufted Honeyeater	*L. melanops*	2
White-eared Honeyeater	*L. leucotis*	2,3
Fuscous Honeyeater	*L. fusca*	
Brown headed Honeyeater	*Melithreptus brevirostris*	1,2,3
White-naped Honeyeater	*M. lunatus*	1,2,3
New Holland Honeyeater	*Phylidonyris novaehollandiae*	2,3
Cresent Honeyeater	*P. pyrrhoptera*	2
White-cheeked Honeyeater	*P. nigra*	2
Eastern Spinebill	*Acanthorhynchus tenuirostris*	2,3,4
Mistletoe Bird	*Diceaum hirundinaceum*	2,3
Spotted Pardalote	*Pardalotus punctatus*	2,3,4
Striated Pardalote	*P.striatus*	2,3
Sivereye	*Zosterops lateralis*	2,3
Goldfinch	*Carduelis carduelis*	2,3
Red-browed Finch	*Aegintha temporalis*	1,2,3
Beautiful Firetail	*Emblema bella*	2,3
Diamond Firetail	*E. guttata*	2
Olive-backed Oriole	*Oriolus sagittatus*	2,3,4
Spangled Drongo	*Dicrurus hottentottus*	2,3
Satin Bowerbird	*Ptilinorhynchus violaceus*	1,2,3
White-winged Chough	*Corcorax melanorhamphus*	2,3
Magpie-Lark	*Grallina cyanoleuca*	2,3,4
Dusky Woodswallow	*Artamus cyanopterus*	1,2,3
Grey Butcherbird	*Cracticus torquatus*	1,2,3
Black-backed Magpie	*Gymnorhina tibicen*	1,2,3
Pied Currawong	*Strepera graculina*	1,2,3
Grey Currawong	*S. versicolor*	2,3
Australian Raven	*Corvus coronoides*	1,2,3

APPENDIX 6

REPTILES AND AMPHIBIA LIKELY TO OCCUPY THE STUDY AREA

List includes: (1) recordings made during the survey; (2) those taken from the Forestry Commission of N.S.W.; (3) from Braithwaite et al. 1988.

REPTILES		SOURCE
Long-necked Tortoise	*Chelodina longicollis*	1,2
Wood Gecko	*Diplodactylus vittatus*	2
Thick-tailed Gecko	*Underwoodisaurus millii*	2
Burton's Snake-lizard	*Lialis burtonis*	2
Common Scaly-foot	*Pygopus lepidopodus*	2
Bearded Dragon	*Amphibolurus barbatus*	2
Jacky Lizard	*A. muricatus*	2,3
Eatern Water Dragon	*Physignathus lesueurii*	2
Lace Monitor	*Varanus varius*	2,3
Skink	*Cryptoblepharus virgatus*	2
Skink	*Ctenotus robustos*	2
Copper-tailed Skink	*C. taeniolatus*	2,3
Black Rock Skink	*Egerina saxatilis*	2
Skink	*Hemiergis maccoyi*	2
Skink	*Lampropholis delicata*	2,3
Weasel Skink	*L. mustelina*	2,3
Skink	*L. guichenoti*	2
Skink	*Leiolopisma entrecasteauxii*	2
Red-throated Skink	*L. platynotum*	2
Eastern Water Skink	*Sphenomorphus quoyii*	2,3
Skink	*S. tenuis*	2
Oak Skink	*Tiliqua casuarinae*	2
Eastern Blue-tongued Skink	*T. scincoides*	2
Blind Snake	*Typhlina nigrescens*	2
Diamond Python	*Morelia spilotes spilotes*	2
Brown Tree Snake	*Boiga irregularis*	2
Green Tree Snake	*Dendrolaphis punctulatus*	2
Common Death Adder	*Acanthophis antarcticus*	2
Copperhead	*Austrelaps superbus*	2
Golden Crown Snake	*Cacophis squamulosus*	2
Eastern Small-eyed Snake	*Cryptophis nigrescens*	2,3
Yellow-faced Whip Snake	*Demansia psammophis*	2
White-lipped Snake	*Drysdalia coronoides*	2
Black-bellied Swamp Snake	*Hemiaspis signata*	2
Eastern Tiger Snake	*Notechis scutatus*	2
Red-bellied Black Snake	*Pseudechis porphyriacus*	2,3
Eastern Brown Snake	*Pseudonaja textilis*	2
Bandy-Bandy	*Vermicella annulata*	2

AMPHIBIA

Tusked Frog	*Adelotus brevis*	2
Giant Burrowing Frog	*Heleioporus australiacus*	2
Eastern Banjo Frog	*Limnodynastes dumerilii*	2
Brown-striped Frog	*L. peronii*	2,3
Spotted Grass Frog	*L. tasmaniensis*	2
Barred Frog	*Mixophyes balbus*	2
Great Barred Frog	*M. fasciolatus*	2
Haswell's Frog	*Paracrina haswelli*	2
Brown Toadlet	*Pseudophryne bibronii*	2,3
Common Eastern Froglet	*Ranidella signifera*	1,2,3
Green and Golden Bell Frog	*Litoria aurea*	2,3
Green Tree Frog	*L. caerulea*	2
Blue Mountains Tree Frog	*L. citropa*	2
Bleating Tree Frog	*L. dentata*	2,3
Brown Tree Frog	*L. ewingii*	2
Eastern Dwarf Tree Frog	*L. fallax*	2
Freycinet's Frog	*L. freycineti*	2
Jervis Bay Tree Frog	*L. jervisienis*	2
Lesueur's Frog	*L. lesueuri*	2
Peron's Tree Frog	*L. peronii*	2
Leaf Green Tree Frog	*L. phyllochroa*	2
Tree Frog	*L. tyleri*	2
Verreaux's Tree Frog	*L. verreauxii*	1,2,3

APPENDIX 7

SUGGESTED REVEGETATION SPECIES - TOMERONG BYPASS

The following lists of plants are the recommended species for direct seeing in disturbed areas in the Tomerong Bypass corridor. Seven criteria have been used as a basis for species selection:

a) the species occur in native plant communities in the area;
b) the species are hardy and adaptable to a range of horticultural conditions;
c) the species produce large quantities of seed on a regular basis;
d) the species have seed which germinate readily and quickly;
e) the species tend to exhibit rapid growth after germination;
f) species for which seed collection, from the general area to be revegetated, should be easy;
g) species with high aesthetic value.

If a decision is made to use local seed for revegetation work, it is suggested that seed collection should begin as soon as possible to ensure that the flowering season of many of these can be included. Most of the recommended species have a long shelf-life.

The species recommended for direct seeding have been listed under the community-types for which each is best suited. Figures 4 & 5 of this report indicate the location of the community-types.

	Woodland	**Tall Open Forest**	**Riverine Vegetation**
Acacia binervata		+	+
A. brownii		+	
A. falcata	+	+	
A. implexa	+		
A. irrorata	+	+	+
A. longifolia	+	+	
A. mearnsii		+	
A. myrtifolia	+	+	
A. stricta		+	
A. suaveolens		+	
A. terminalis		+	
A. ulicifolia	+		
Allocasuarina littoralis	+	+	
Angophora floribunda	+	+	
Baeckea virgata		+	+
Banksia spinulosa		+	
Bursaria spinosa		+	
Callicoma serratifolia		+	
Clerodendrum tomentosum			+
Eucalyptus botryoides		+	
E. globoidea	+	+	
E. gummifera	+	+	

E. maculata	+	+	+
E. paniculata		+	
E. pellita		+	
E. pilularis	+	+	
E. piperita ssp. urceolaris		+	+
E. saligna		+	+
E. sclerophylla	+		
E. sieberi	+		
Glycine clandestina	+	+	+
Gompholobium grandiflorum	+		
Hakea dactyloides	+		
Hakea sericea	+		
Hardenbergia violacea	+	+	
Helichrysum diosmifolium	+	+	+
Howittia trilocularis		+	+
Indigofera australis	+	+	
Kennedia rubicunda	+	+	+
Kunzea ambigua	+	+	
Lomandra longifolia	+	+	+
Leptospermum flavescens		+	
Lambertia formosa	+		
Melaleuca linariifolia			+
M. pauciflora		+	
M. styphelioides		+	
Oxylobium ilicifolium	+	+	
Pittosporum revolutum			+
P. undulatum		+	
Platylobium formosum		+	
Pultenaea retusa	+	+	
P. villosa	+	+	
Pandorea pandorana	+	+	
Prostanthera violacea		+	+
Pimelia linifolia	+	+	
Solanum stelligerum	+	+	
Tristaniopsis collina		+	+
Zieria smithii	+	+	
Syncarpia glomulifera	+	+	+
Themeda australis	+	+	

The use of tube stock would accelerate return of a dense shrub or tree canopy cover, particularly at creek crossings where faunal shelter and visual considerations are important. In these areas species from Appendix 3 are recommended.

APPENDIX 8

STUDY TEAM

Vegetation	Dr R M Muston, Mr A Bofeldt (Wollongong Botanic Gardens)
Terrestrial Fauna	Ms S M Carthew, Dr R.J. Whelan, Dr D. Engel, Mr G Kohler (Australian Flora and Fauna Research Program, University of Wollongong)
Aquatic Fauna	Dr T R Grant
Birds	Mr A J Huggett
Horticulture	Mr A Bofeldt (Wollongong Botanic Gardens) Mr G Kohler (Jamberoo Native Nursery & Native Landscape Design)
Soil Conservation	Mr N Kesby (Soil Conservation Service)
Drafting	Mr D Martin (Cadmart)

8.4 ARCHAEOLOGY

8.4.1 Archaeological Survey by Margrit Koettig

REPORT ON THE SURVEY FOR ABORIGINAL SITES ALONG THE PROPOSED TOMERONG BY-PASS

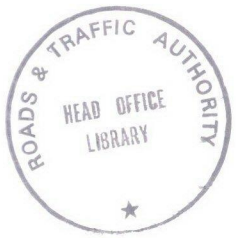
Report to the Roads and Traffic Authority

August 1989

Margrit Koettig

INDEX

Introduction	1
Description of Survey Area	1
Background Research	3
Results of the Survey and Assessment	4
Recommendations	6
Bibliography	



1. INTRODUCTION

The Roads and Traffic Authority are planning to construct a by-pass road around Tomerong, near Nowra, NSW (Fig.1). The archaeologist was required to undertake a survey for Aboriginal sites along the route (Option A) which is approximately 7km in length and 100m wide.

The survey route extends across the boundary of two Local Aboriginal Land Councils: Nowra LALC and Jerringa LALC. Both Land Councils were contacted prior to the survey. Mr Eddie Bloxome from the Nowra LALC arranged for a representative, Mr Max Hill, to accompany the archaeologists in the field. Mr Doug Longbottom of the Jerringa LALC was contacted and subsequently Ms Delia Lowe, who was unable to arrange for a representative to be present during the fieldwork.

Mr Bloxome and Ms Lowe will present the findings of the report to meetings of the respective Local Land Councils. A letter detailing the response of the Land Councils will be sent to the archaeologist.

One open artefact scatter GR1 was located during the survey and three locations of archaeological potential.

2. DESCRIPTION OF SURVEY AREA

The route (Fig.2) is located across the Wandrawandandian Siltstone formation which is part of the Shoalhaven Group of rock. At Tomerong creek there is a narrow strip of Quaternary Alluvium.

Much of the route is forested though some clearing for cultivation has also taken place. The vegetation consists of tall open woodland on the ridges and tall open woodland with rainforest understorey along the creeklines and deeper gullies.

Between 16km and 19km the route is located on a flat ridgetop which was at the time of the survey very wet, almost swampy.

Between 19km and Tomerong Creek the slope is relatively steep and the ground very gravelly.

On the northern side of Tomerong Creek the steep slopes lead right to the edge of the channel, which is diffuse. On the southern side of the watercourse the slopes are much more gentle all the way to Turpentine Road.

Between Tomerong Creek and Suffolk Creek the route follows a low ridge. On the southern side of the creek is an area of alluvial flats which have been cleared.
South of the Princes Highway the route follows the present Grange Road, which has been cut to approximately 70cm below the surface of the slope on the western side of the easement. This cut provided good visibility over a distance of approximately 200m before the route swung to the west. The top of the cut reveals no more than 5cm width of topsoil area.

From Grange Road the route follows a saddle between two gently sloping ridges. This area is well forested with both spotted gum and ironbarks. At the southern end of the route it follows a relatively wide, gently sloping ridge top. There was no ground surface visibility along this section of the route.

The route did not cross any areas which were obvious topographic foci such a rises, benches or interfluves on which it could be predicted with some certainty that sites could occur. The ridgetop at the southern end of the route represents a relatively obvious possible site location. It is similar to the slope and ridge on which site GR1 was located, though it is considerably further from any obvious water source.

Though much of the survey easement was covered with grass and leaf litter there were tracks along some sections which provided very good surface visibility along narrow transects within the route. Their extents are illustrated in Fig.2. In all cases the tracks were 2-3m wide and visibility was 75-100%. In two locations there were larger exposures (40 x 30m approximately).

3. BACKGROUND RESEARCH

Numerous sites have been recorded in the general area of Tomerong. A search of the NPWS site register revealed that between Berrara Beach in the south, Bellawangara in the north and a line through Yerriyong in the west (Fig.1) a total of 289 sites have been recorded. These included the following range of site types:

middens	162
open artefact scatters	21
rock shelters	58
grinding grooves	20
burials	11
ceremonial/mythological	9
waterhole	6
engraving	1
scarred tree	1

From the above data it is evident that most sites have been recorded along the coastline, which is where the midden sites are concentrated. The distribution of sites is very much related to the fact that this is where most survey work and research have been undertaken. Sites have also been recorded to the west in the Budawang Ranges where intensive survey work has been undertaken in a number of areas. The present distribution of sites corresponds well to the amount of investigative work undertaken. This suggests that in areas where so far no sites have been recorded sites in fact will be found.

In the more immediate vicinity of the survey route (Fig.1) only 15 sites have been recorded and except for two sites these are all located along the foreshores and immediate hinterland of Jervis Bay. Two shelter sites have been recorded near Falls Creek which is at least 10km inland. Tomerong is approximately 8km inland. The southern end of the present survey route is within 2km of St Georges Basin.

4. RESULTS OF THE SURVEY AND ASSESSMENT

The survey was undertaken by three people who spaced themselves across the 100m wide easement and inspected any exposures for artefacts and the trees for scars.

One artefact scatter consisting of three artefacts was located during the survey at Grange Road : GR1 (Fig.3).

The artefact scatter GR1 consists of four artefacts distributed over a distance of approximately 100m along the top of a road cutting (Photo 1). The artefacts included 1 quartzite flake, 1 silcrete flake, 1 chert flake and 1 chert broken flake, all less than 3cm in size. Because of the

disturbed context of these artefacts it is not possible to give any indication of how representative the artefacts are of this site i.e. in terms of extent, density of material, range of material. To the west of the road is a wide ridgeline and gentle slope across which more archaeological material could be distributed. The extent of the site would need to be established through limited test excavations.

Three locations (1,2,3) were identified as having potential to be archaeological sites. These all are marked in Fig.3) These three locations include two areas adjacent to creeklines (1 and 2) and one on the gentle slope below a very major hill. The distribution of open sites is not well known for this region because so few sites of this type have been recorded. In the Wollongong to Dapto area some open artefacts scatters have been found, and most of these were along the coastline. Four sites have been recorded further inland and the topographic locations were : one on a saddle at the edge of the escarpment; three on the gently undulating ridges at the foot of the escarpment (Koettig 1987).

The open sites in the sample from the larger area around Tomerong (Fig.1) are recorded as being located on ridges and creekflats, thus sites can be expected to be found in a variety of topographic locations.

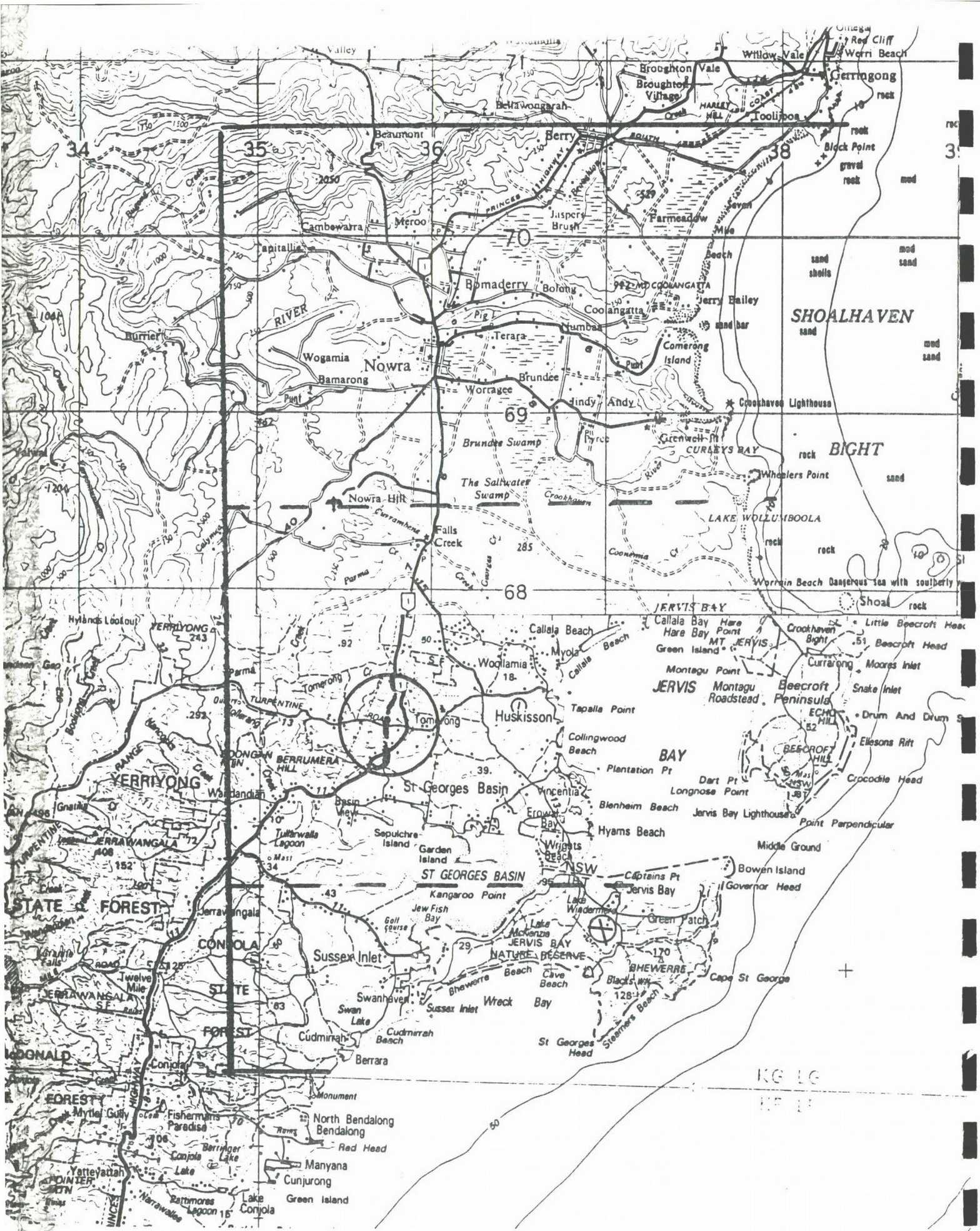
5. RECOMMENDATIONS

The recommendations are :

1) A) that the area of the ridgetop adjacent to site GR1 (area 3 in Fig.3) be avoided so that any archaeological material present is not disturbed.

B) that if the ridgetop adjacent to GR1 cannot be avoided that test excavations be undertaken across the ridgetop to establish the sites extent and content. This will be necessary before an assessment of the site can be made.

2) that test excavations be undertaken in the three areas identified as having archaeological potential (areas 1,2,4 in Fig.3) to establish whether archaeological material is present and assess any sites found.


Willow Vale
Gerringong
Broughton Vale
Broughton Village
Toolijooa
Berry
Beaumont
Kangaroo Valley
Bellawongarah
Farmeadow
Jaspers Brush
Cambewarra
Meroo
Bomaderry
Nowra
Wogamia
Bamarong
Worrigee
Terara
Coolangatta
Comerong Island
Crookhaven Lighthouse
SHOALHAVEN
BIGHT
Wheelers Point
Brundee Swamp
The Saltwater Swamp
Nowra Hill
Falls Creek
LAKE WOLLUMBOOLA
Warrain Beach Dangerous sea with southerly
JERVIS BAY
Callala Beach
Callala Bay
Hare Bay
Green Island
Montagu Point
JERVIS
Montagu Roadstead
Beecroft Peninsula
Currarong
Moores Inlet
Snake Inlet
Beecroft Head
Little Beecroft Head
Crookhaven Bight
Drum And Drum Stick
Ellesons Rift
Crocodile Head
Point Perpendicular
Middle Ground
Bowen Island
Governor Head
Huskisson
Woollamia
Myola
Tapalla Point
Collingwood Beach
BAY
Plantation Pt
Dart Pt
Longnose Point
Jervis Bay Lighthouse
Hyams Beach
Wrights Beach
Captains Pt
Jervis Bay
Lake Wiseman
Green Patch
St Georges Basin
Vincentia
Blenheim Beach
Erowal Bay
Sepulchre Island
Garden Island
ST GEORGES BASIN
Kangaroo Point
Jew Fish Bay
Golf Course
Lake McKenzie
JERVIS BAY NATURE RESERVE
BHEWERRE
Cape St George
Blacks Hill
Bhewerre Beach
Cave Beach
Wreck Bay
Sussex Inlet
Swanhaven
Swan Lake
Cudmirrah
Cudmirrah Beach
St Georges Head
Steamers Beach
Berrara
Conjola
Conjola Lake
Lake Conjola
Green Island
Manyana
Cunjurong
North Bendalong
Bendalong
Red Head
Fishermans Paradise
Myrtle Gully
Yatteyattah
Pattimores Lagoon
Berringer Lake
Tomerong
Huskisson
YERRIYONG
Wandandian
Basin View
Tullarwalla Lagoon
Jerra Wangala
Twelve Mile
STATE FOREST
CONJOLA
Sussex Inlet
Parma
Turpentine
Berrumera Hill
Currambene Creek
Nowra Hill
Falls Creek
Brundee Swamp
Worrigee
Andy
Jindy
Terara
Coolangatta
Comerong Island
Bomaderry
Tapitallee
Burrier
Wogamia
Nowra
Bamarong
Meroo
Cambewarra
Jaspers Brush
Farmeadow
Berry
Beaumont
Bellawongarah
Broughton Vale
Broughton Village
Willow Vale
Gerringong
Toolijooa
Red Cliff
Werri Beach
Black Point
Gravel
Rock
Mud
Sand
Sheils
Beach
Bar
Point
Creek
River
Road
Highway
Princes
Coast
Harley Hill
South
Mile
Valley
Ridge
Hill
Mt
Lighthouse
Island
Head
Bight
Inlet
Lake
Swamp
Lagoon
Basin
Bay
Peninsula
Roadstead
Monument
Mast
NSW
Jetty
Wharf
Rocks
Sand
Mud
Shoal
Contour
Trig
Spot Height
Cliff
Gully
Ridge
Hill
Mountain
Forest
Golf Course
Nature Reserve
Lighthouse
Monument
Jetty
Wharf
Mast

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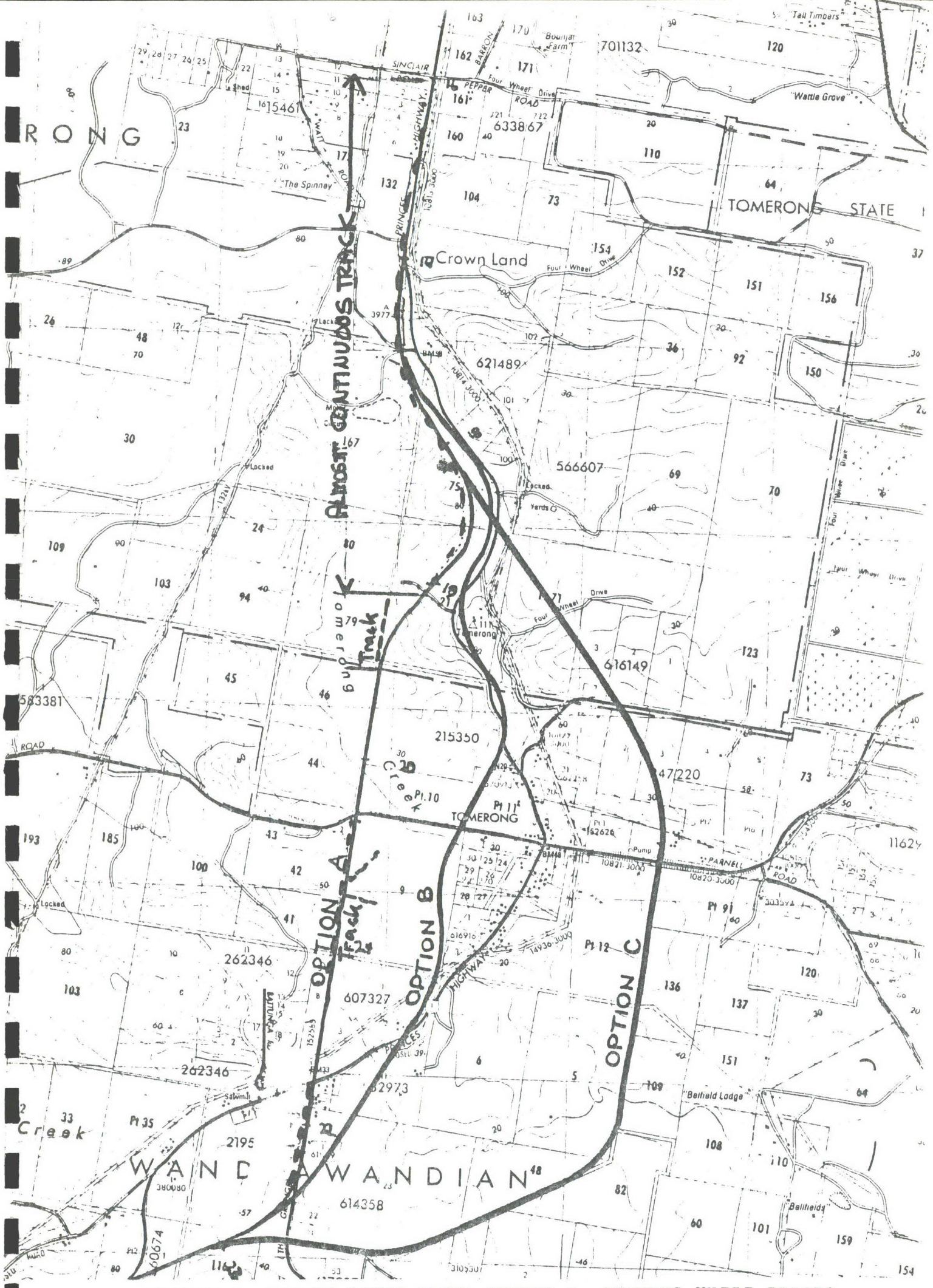

FIGURE 2: SURVEY ROUTE ALONG OPTION A, SHOWING WHERE TRACKS WERE LOCATED



RONG
TOMERONG STATE
Wattle Grove
SINCLAIR ROAD
PRINCES HIGHWAY
WATT ROAD
The Spinney
Four Wheel Drive
Town Land
Locked
Motor Bike Circuit
Yards
Tomerong
Tomerong Creek
TOMERONG
PARNELL ROAD
OPTION A
OPTION B
OPTION C
GR1
WANDRAWANDIAN
Belfield Lodge
Bellfields
Pt 10
Pt 11
Pt 12
Pt 35
Pt 91
Pt 14
16
17
18
19
20
21
22
23
4
15461
633867
621489
566607
616149
215350
47220
262346
607327
262346
219566
614358
617937
700495
574617

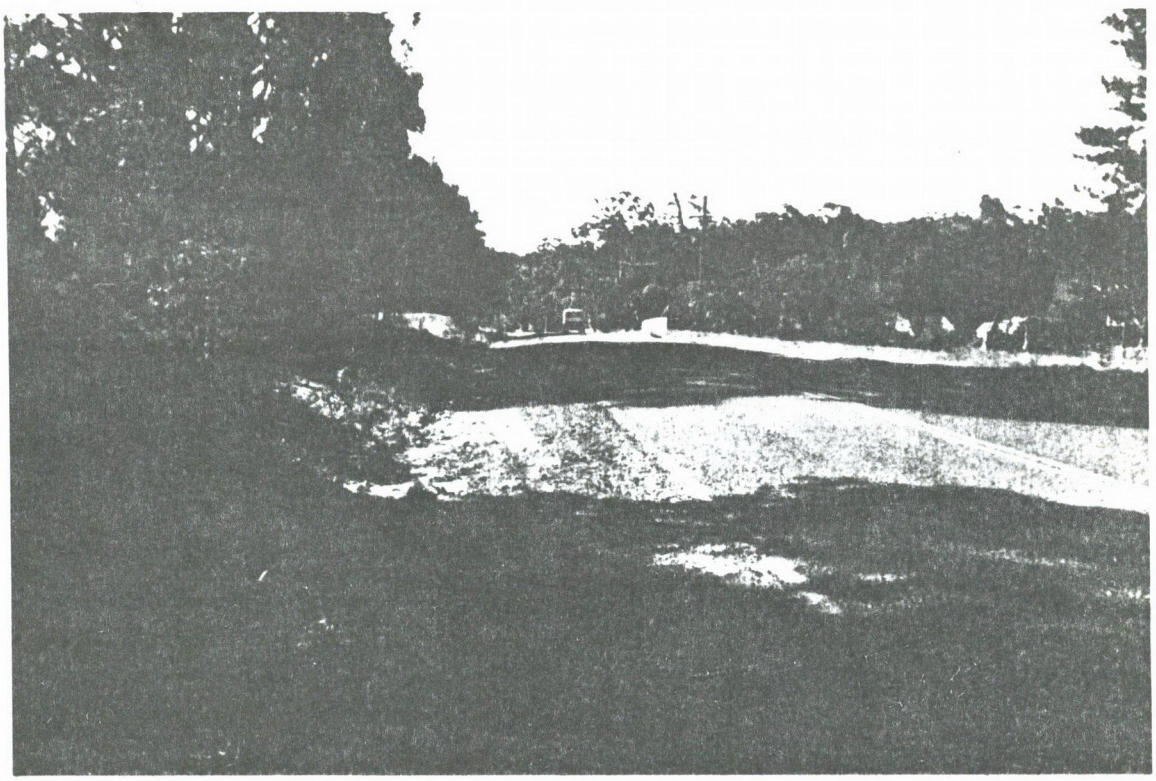

PHOTO 1: SITE GR1 FACING NORTH ALONG GRANGE ROAD

8.4.2 Report on Test Excavations by Rex Silcox

TEST EXCAVATIONS ON THE TOMERONG BY-PASS,

NEAR NOWRA, NEW SOUTH WALES.

REPORT to the ROADS AND TRAFFIC AUTHORITY (NSW)

By
R. SILCOX

For
ARCHAEOLOGICAL SERVICES, SYDNEY

JANUARY, 1989

INDEX

		Page
1.	Introduction	1
2.	Aboriginal Involvement	1
3.	Site Description and Excavation Procedure 3.1 Introduction 3.2 GR1 3.3 TBP1 3.4 TBP2 3.5 TBP3	2
4.	Results	4
5.	Discussion	4
6.	Recommendations	5

Index
Appendix 1: Photographs

LIST OF FIGURES

1. LOCATION OF SURVEY AREA
   Scale : 1:250,000

2. SURVEY ROUTE, SHOWING LOCATION OF SITE GR1 AND TEST EXCAVATIONS
   Scale 1:25,000

3. GR1: Plan of Transects on Site

4. TBP1: Plan of Transects across Area

5. TBP2: Plan of Transects across Site

6. TBP3: Plan of Transects across Site

LIST OF TABLES

1. Summary of Artifacts from TBP3

LIST OF PHOTOGRAPHS

Photo

1. Site GR1- from north

2. TBP1 - from east

3. TBP2 - from south-east

4. TBP3 - from north

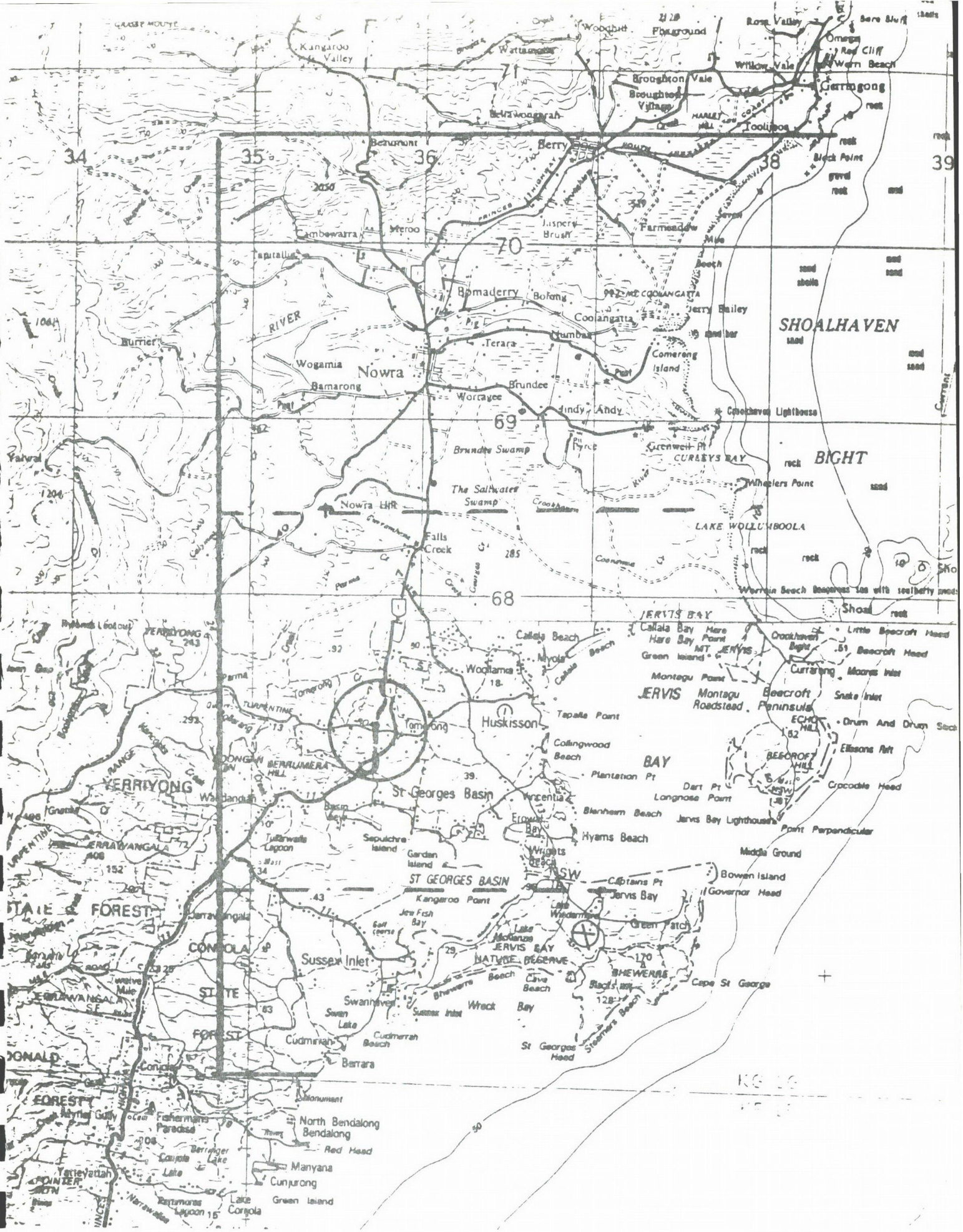

FIGURE 1: LOCATION OF SURVEY AREA
Circle shows location of By-pass Route
Heavy line shows extent of wider area for comparative analysis.

1. INTRODUCTION

The Roads and Traffic Authority (NSW) proposes to construct a road over a distance of 7km to by-pass the village of Tomerong, south of Nowra, New South Wales (Fig. 1). A survey for Aboriginal archaeological sites was carried out along the route in August, 1989 by M. Koettig (1989). As a result of the survey, one site (GR1), consisting of a small surface scatter of artifacts, was found. Several potential campsite locations were also noted, and it was recommended that test excavations should be conducted at 3 of these locations (Tomerong By-Pass 1, 2 and 3) in order to ascertain whether archaeological material was present and to what extent, before a full assessment could be made (Fig. 2).

It was also recommended that test excavations should be carried out at GR1, to determine the extent of the site.

The potential site locations were selected on the basis of several criteria; topography, condition and location relative to impact. Ground surface visibility at the 3 potential locations and adjoining the site GR1 was restricted due to dense grass cover and it was not possible to adequately assess archaeological significance by inspection of the surface only. Because of the small number of surface sites so far recorded in the area, the distribution of such sites across the landscape is not known. Two of the potential locations selected (TBP1, TBP2#) were on alluvial flats bordering major creeks, the other (TBP3) on a broad, sloping ridge top.

As far as could be determined, none of the locations had been affected by ploughing or erosion. Some clearing of timber had occurred along the route but ground disturbance from this source was not apparent.

The test excavation program was carried out over 4 days in December, 1989, by R. Silcox with the assistance of J. Edgar, M. Hill and A. Longbottom.

Artifacts were found in a very low density at GR1 and at TBP2 and TBP3.

2. ABORIGINAL INVOLVEMENT

The proposed road route crosses the territory of two Local Aboriginal Land Councils, the Jerringa LALC to the east of the Princes Highway and the Nowra LALC to the west. The Jerringa LALC is based at Orient Point, east of Nowra.

Mr Eddie Bloxsome from the Nowra LALC arranged for a representative, Mr. Max Hill to participate in the excavations at the two locations (TBP1 and TBP2) in their territory. Mr Tony Longbottom, Chairperson of the Jerringa LALC, assisted at the excavations at the other two locations (GR1 and TBP3) which fell within that Land Councils area.

Both Mr Hill and Mr Longbottom considered there would be no objections from their respective communities to the road proceeding as planned.

Statements to this effect are in preparation and will be forwarded when available.

3. SITE DESCRIPTION and EXCAVATION PROCEDURE

3.1 Introduction

At each location, one or more transects (designated TrA, etc) were set out, preferably in the central corridor of the proposed route where maximum impact from construction would be expected, but also taking into consideration the topography present. Each transect consisted of a hypothetical series of units numbered consectutively and measuring 1m long by 25cm (the approximate width of a shovel blade). Units were excavated by shovel, with each excavated unit being termed a 'trench' and designated acording to the transect it ocurred in (eg. TrA16). Trenches were usually dug in groups of 2 or 3, with intervals of at least one unit left unexcavated between each trench and with varying numbers of units left unexcavated between groups of trenches. All ground left unexcavated along the transects is represented in this report by dashes (-). This approach was taken in order to achieve some balance between attempting to sample as much as possible of the potential site area and retaining an acceptable chance of finding scattered archaeological material by not leaving too great a gap between individual trenches.

The excavated deposit was removed in bulk and then dry sieved through 7mm mesh.

3.2 GR1 (Fig. **3** , Photo 1)

The site GR1 was originally recorded as a thin scatter of 4 artifacts spread over a distance of approximately 100m along the western edge of a shallow road cutting which crosses the end of a low, broad ridgetop (Koettig, 1989). The ridge surface forms a gentle slope to the east, as well as to the north and south. It was decided to test the densely grassed ground surface adjoining the site area on the edge of the road. A series of three transects (A, B and C) were set out at right angles to the road (Fig 3). TrA and TrB were 15m long, TrC was 11m long. Six 1mx25cm trenches were dug along both TrA and TrB (1-3-5/11-13-15) and 4 units along TC (1-3/9-11). Trenches were dug to a depth of between 11 and 22cm. The soil profile across the ridge consisted of a black clay loam layer 8-10cm thick, overlying a brownish light clay which became heavier and more compact with depth.

3.3 TBP1 (Fig. **4** , Photo 2)

At location TBP1, two transects (A,B) were laid out along the gently sloping surface which borders the southern bank of Tomerong Creek. TrA was set out roughly east-west, across the road route and parallel to the creek, over a distance of 19m. Six 1mx25cm trenches were dug at intervals along the transect (1-3/9-11/17-19), to a depth of between 27 and 37cm. TrB was set out at right angles to TrA5, but only a single trench (TrB6) was dug on this transect, to a depth of 26cm.



FIGURE 2: SURVEY ROUTE, SHOWING LOCATION OF GR1 AND TEST LOCATIONS

SCALE 1:50,000

The soil deposit in all trenches was a uniformly dark grey clayey loam, becoming more clayey and heavy with depth.

3.4 TBP2 (Fig. **5** , Photo 3)

Location TBP2 was situated on the banks of Suffolk Creek. A total of 4 transects were set out at the location; 3 transects (TrA, TrB and TrC) were set out on the extensive grassy alluvial flats on the south bank of the creek. TrD was set out at the base of a slope on the north side of the creek, on a bench near the mouth of a small tributary creek, 50m north from where the route crosses Suffolk Creek.

TrA was set out along the approximate centreline of the road easement where it crosses the flats on the south side of the creek. Four trenches were dug along TrA (1-3/14-16) to a depth of between 20 and 36cm.

Five trenches (1-3/9-11/17) were dug along TrB which was set out at right angles from trench TrA16 at the end of TrA, and extended eastwards onto a slight rise.

TrC was set out 25m to the west of TrA, at right angles to Tr12. Three trenches (26-28-30) were dug to a depth of 20-30cm.

The soil on the south side of the creek consisted mainly of a deep upper layer of dark grey clay loam, overlying and gradually giving way to a lighter grey, increasingly clayey waterlogged deposit.

TrD was set out at right angles to the route, near the centreline. Two trenches (1-3) were dug to a depth of 28-29cm into a uniform dark grey heavy clay loam.

3.5 TBP3 (Fig.**6** , Photo 4)

Location TBP3 was situated near the junction of the southern end of the route with the existing Princes Highway, on a broad ridge-top sloping towards the north-east. A single transect (A) was set out across the slope on a heading of 174o. A total of 13 trenches (1-3/14-16-18/29-31-33/44-46/57-59-61) was dug over a distance of 61m, to a depth of between 20 and 32cm. The soil consisted of a friable black clay loam containing scattered quartz and ironstone gravel, overlying a gradual transition zone at 16-20cm depth which gave way to a heavy brown clay.

4. RESULTS

Very few artifacts were recovered from the test excavations. None were found at Location TBP1, 3 at Location TBP2, 1 at GR1 and 10 at Location TBP3. These are summarised in Table 1.

TABLE 1: Artifacts from TBP2, GR1 and TBP3.

Location	Transect/Trench	No.	Raw Mat.	Type	Size(cm)
TBP2	TrA5	1	Silc.	F	3-3.5
"	TrA16	1	"	BF	1-1.5
"	TrB28	1	Quartz	BBF	0.5-1
GR1	TrA33	1	"	FP	1-1.5
TBP3	TrA3	1	Quartz	FP	1-1.5
"	TrA5	1	Q'ite	FP	2.5-3
"	TrA16	1	"	FP	2-2.5
"	TrA20	1	Q'ite	FP	1.5-2
"	TrA26	1	"	FP	2-2.5
"	TrA28	1	Quartz	FP	1-1.5
"	TrA41	2	"	FP	1-1.5
"	TrA43	1	"	FP	1-1.5
"	"	1	"	FP	1.5-2

KEY: Q'ite=quartzite; Silc=silcrete; F=flake; BF=broken flake; FP=flaked piece; BBF=broken bipolar flake;

5. DISCUSSION

The size and diversity of the artifact sample at each location was too low to allow detailed analysis. Quartz was the prevalent raw material at TBP3 (7 of the 10 artifacts found), where quartz fragments occurred naturally in the soil. The existence of the broken bipolar quartz flake at TBP2 indicates that quartz was being flaked by the bipolar technique at this location.

The greatest density of artifacts encountered during the fieldwork was found on a sloping ridgetop, at TBP3. The one surface site (GR1) found during the original survey was also on a ridgetop, where the evidence from the test excavations supports the original observation of a very low density of artifacts on the surface at this site. Although the evidence is limited, and must be considered in the light of such factors as variable exposure and visibility, it might be inferred from this that ridgetops were preferred camping sites over the more poorly drained creek flats.

The distribution of open sites in the region is not well known as few such sites have been recorded. The fact that some archaeological evidence was found at 3 of the 4 locations tested indicates that Aboriginals were present at these locations and therefore it could be suggested that sites can be expected to occur relatively consistently across the landscape. The very low density of artifacts indicates that these particular sites represent infrequent occupation, but why these

areas were associated with low density occupation cannot be assessed until a much larger sample of open campsites is available for comparative analysis.

6. RECOMMENDATIONS

On the basis of the preceding discussion, it is recommended that;

1. no further archaeological work be undertaken at the four locations investigated.

2. the National Parks and Wildlife Service issue permits to allow the destruction of sites GR1, TBP2 and TBP3.

3. there should be no objections on archaeological grounds to the proposed by-pass road being allowed to proceed as planned.

REFERENCES

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Report to the Roads and Traffic Authority

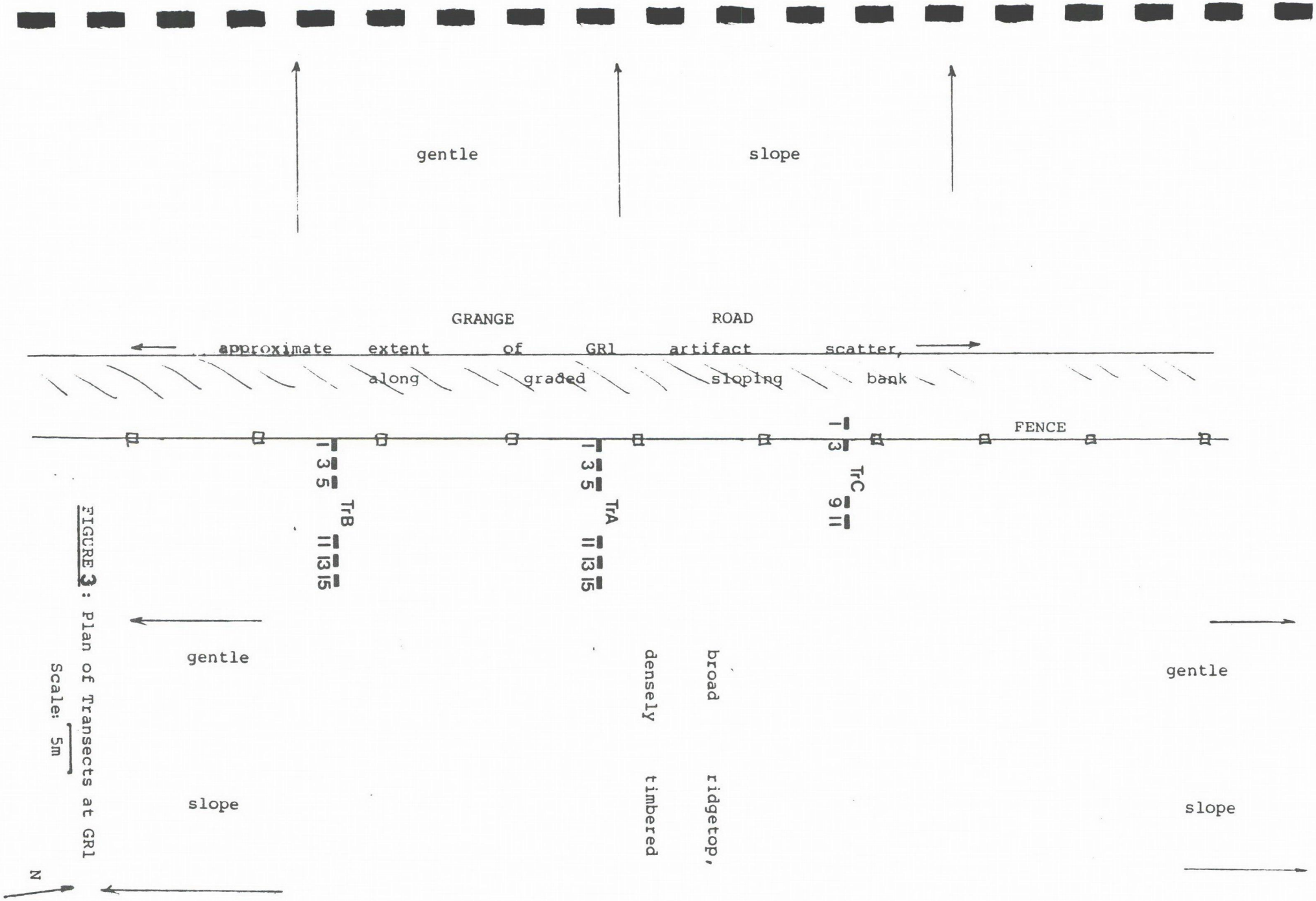

FIGURE 3: Plan of Transects at GR1

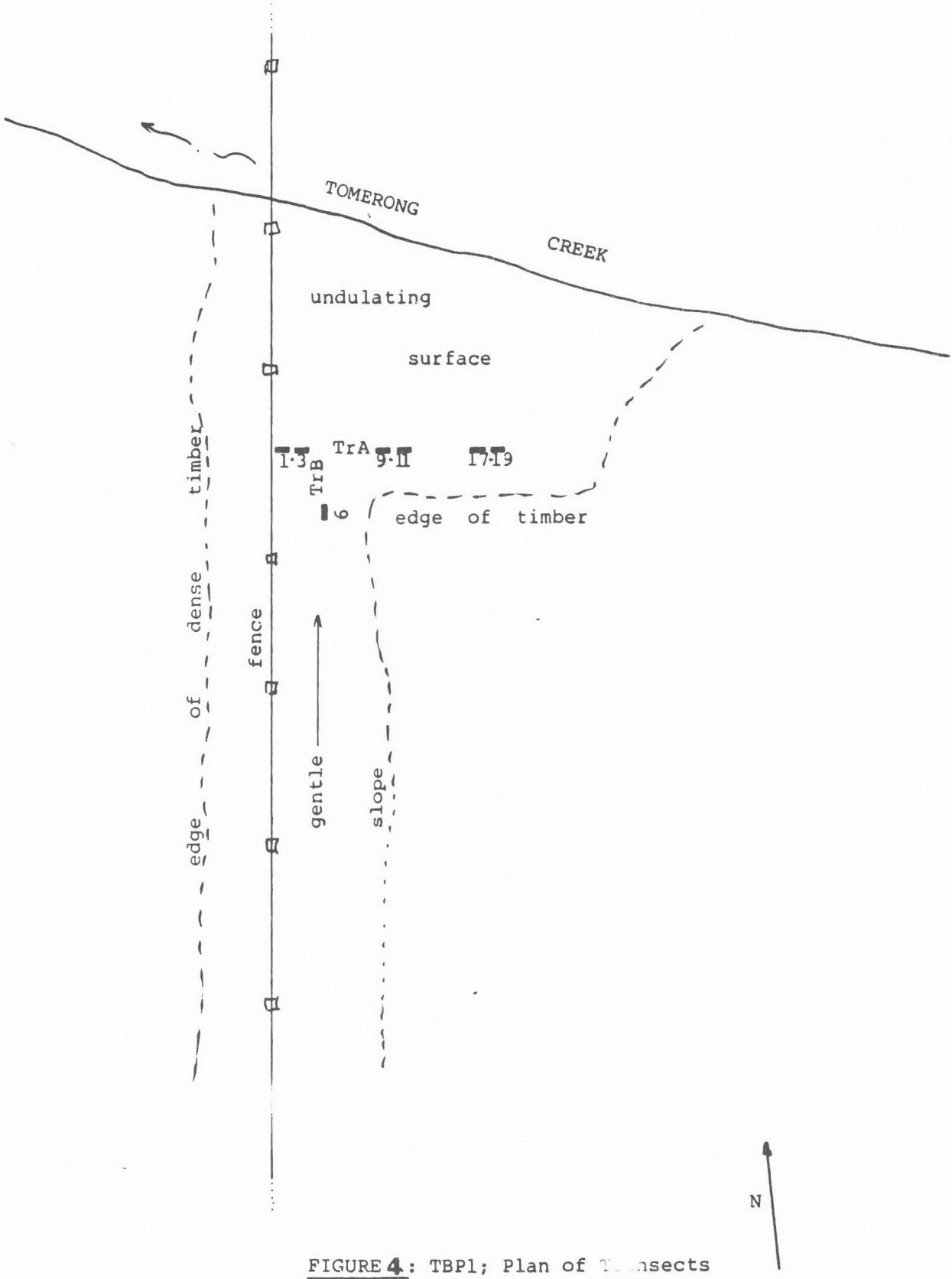

FIGURE 4: TBP1; Plan of Transects

Scale 5m

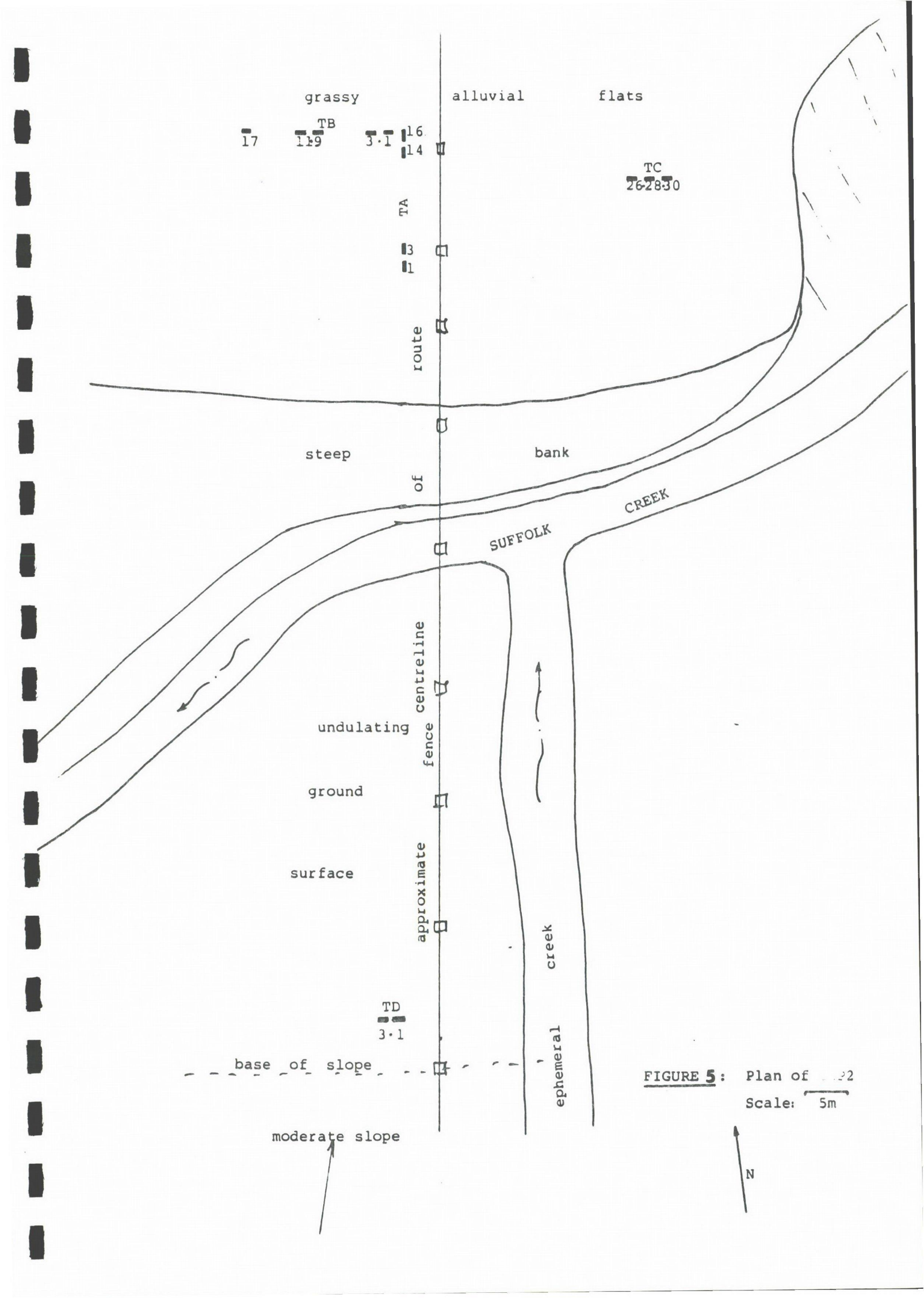

FIGURE 5: Plan of ..2
Scale: 5m

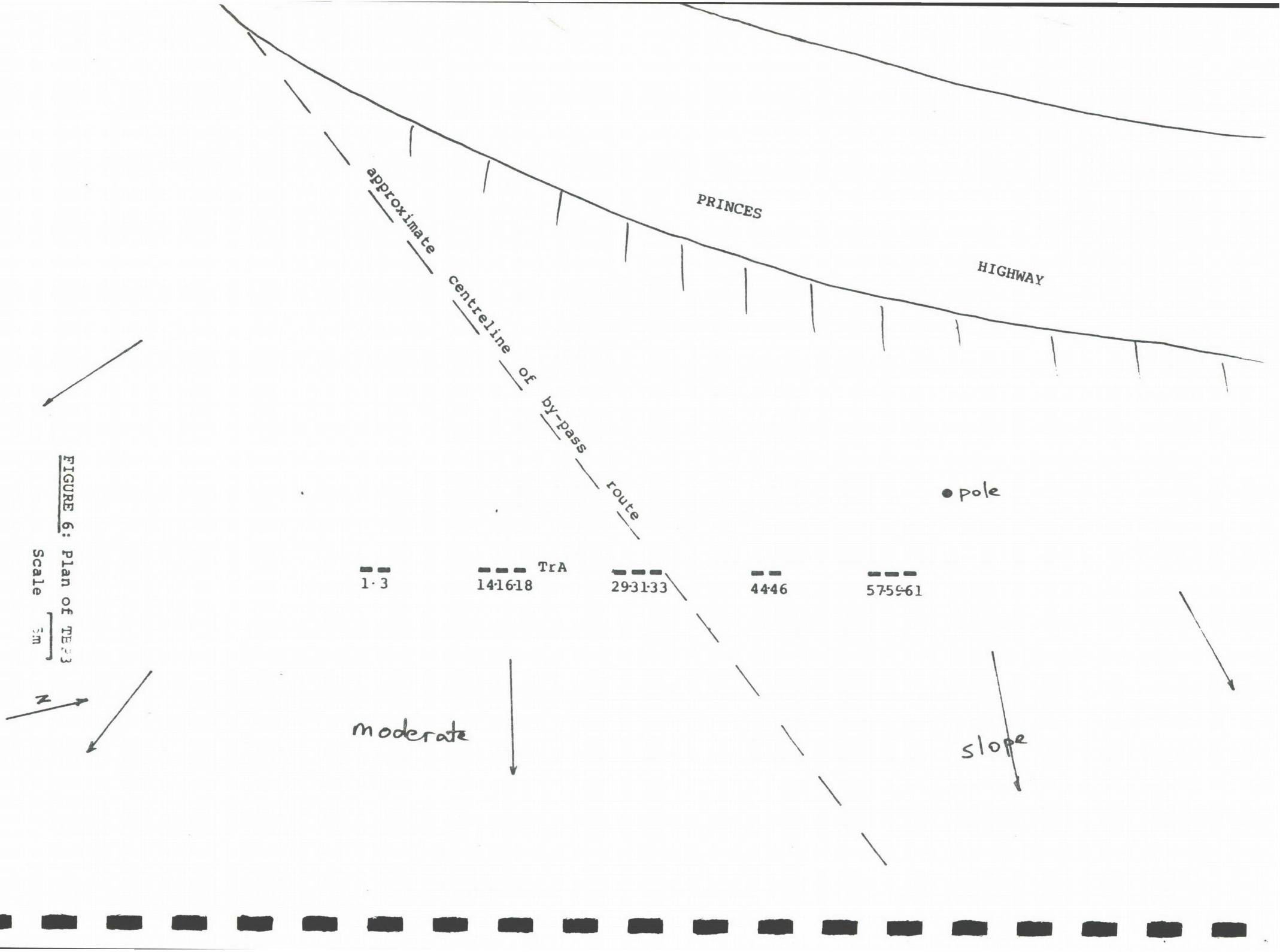

FIGURE 6: Plan of TE 3

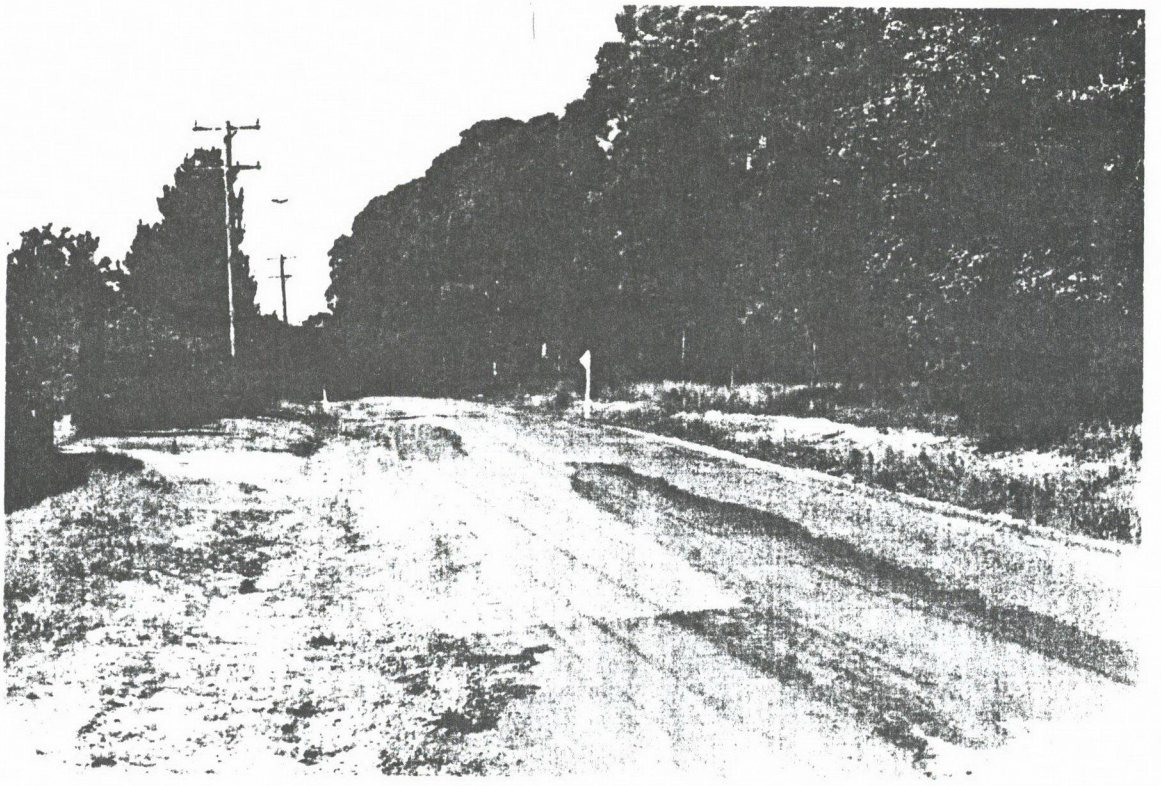

PHOTO 1: GR1, from Grange Road, looking south.
Excavations are amongst timber on top of ridge.



PHOTO 2: TBP1, looking along TrA from east.

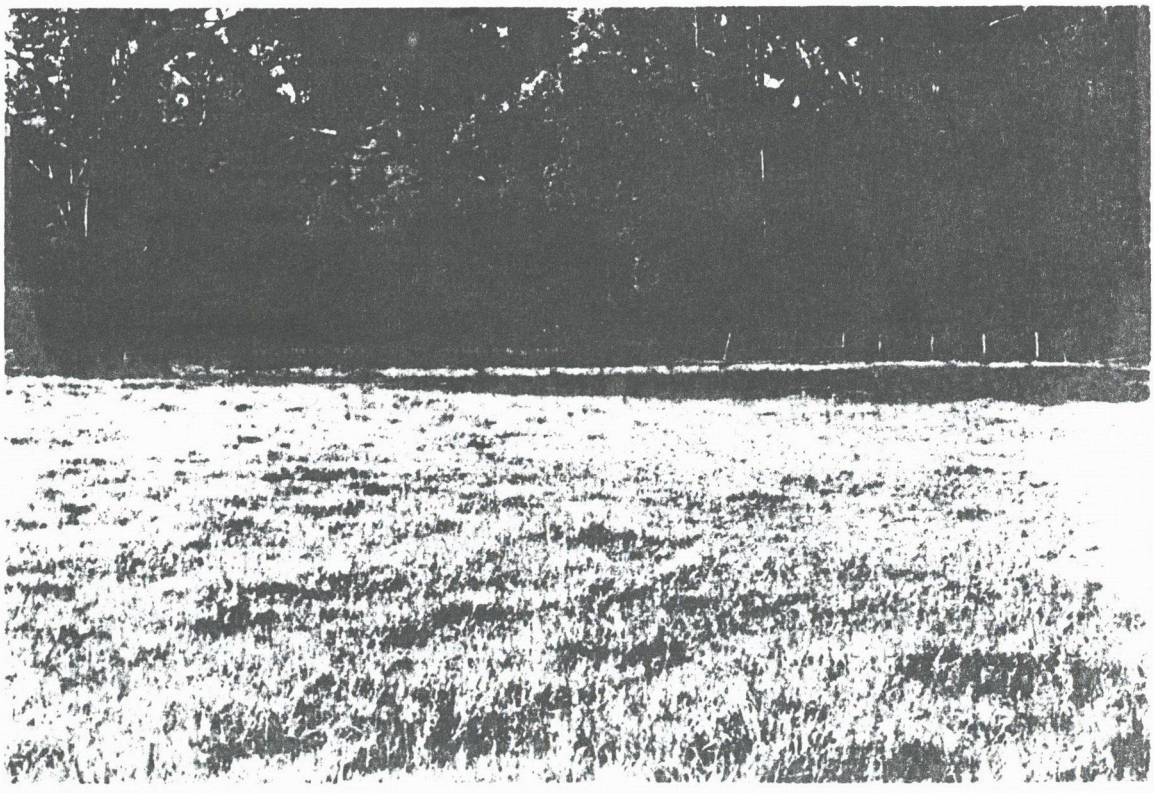

PHOTO 3: TBP2, from south-east, looking across Transects A and B towards Suffolk Creek



PHOTO 4: TBP3, looking from edge of Princes Highway, from north. Transect A extends across slope below pole.

8.4.3 Archaeological Assessment by Kerry Navin

AN ARCHAEOLOGICAL ASSESSMENT OF ALTERNATIVE BYPASS ROUTES FOR THE PRINCES HIGHWAY AT TOMERONG, NSW.

Kerry Navin

March 1990

A Report to Roslyn Muston and Associates
for The Roads and Traffic Authority, NSW.

TABLE OF CONTENTS

Introduction 2

Background to the Project 2

Aims of the Project 2

Environmental Background 4

Topography and Geology 4

Vegetation 4

Archaeological Background 6

Ethnohistoric Information 6

General 6

The Study Area. 7

The Potential Archaeological Resource 7

The Investigation 9

Methods and Procedures 9

Review of Existing Documentation 9

Field Survey 9

Results 9

Aboriginal Participation 14

Site significance and Assessment 15

General 15

Sites 1, 2, 3 and 6 (Open Artefact Scatters): 15

Sites 4 and 5 (Grinding Groove Sites): 16

Sites 7 and 8 (Middens): 16

Discussion 16

Comparative Route Assessment 17

Recommendations 18

References 20

Appendix I: Plates 21

INTRODUCTION

The Roads and Traffic Authority of NSW proposes to construct a new route for the Princes Highway on the south coast of New South Wales which will effectively by-pass the township of Tomerong.

This report documents the archaeological survey of four of the alternative by-pass options for the Princes Highway at Tomerong. The report was commissioned by Roslyn Muston and Associates and forms part of the Environmental Impact Statement.

Background to the Project

An archaeological investigation of Option A was carried out in 1989. The results of this investigation were included in the Review of Environmental Factors. The project reports (Koettig 1989, Silcox 1989) provide evidence that there are no archaeological constraints upon the construction of the by-pass route defined as Option A. However, no archaeological data was available for the alternative routes. This meant that the archaeological impact of the preferred option could not be compared against the other options. This is now considered desirable for the Environmental Impact Statement.

Four of the alternative options, Options B, F, G and H, were considered to warrant archaeological survey.

Aims of the Project

- To carry out field survey of the Tomerong Creek floodplain area which would be directly affected by construction of the by-pass in the Option B corridor.

- To conduct field survey of the sandstone ridges, escarpment and upper valley slopes which are traversed by Options H, F and G and identify and record archaeological sites along each Option.

- To provide a background of local and regional archaeology within which to place the results of the survey.

- To liaise with the relevant Aboriginal communities and determine Aboriginal views pertaining to the project.

- To make a comparative assessment of the surveyed options.



Figure 1: Map of study area, showing route options and site locations. (HUSKISSON 9027-4-N 1:25000 Second Edition CMA Topo.)

ENVIRONMENTAL BACKGROUND

Topography and Geology

The study area is comprised of four road corridors approximately 60–100 metres wide, which are all located within the catchment areas of the Tomerong and Suffolk Creeks. The proposed corridors pass to the west of the Tomerong township and in most cases traverse the flanking ridges and spurs on either side of the creek valley (Figure 1).

The topography of the study area is defined by the underlying rock types. Tomerong is situated at the edge of the Nowra Sandstone where the underlying Wandrawandian Siltsone has been exposed in the downcutting valleys of small tributaries draining to the east. The geology of the Tomerong area is therefore characterised by resistant sandstone ridgetops separated by the softer sediments of the valley bottoms which consist of shales and siltstones mantled by Quaternary alluvial sediments along the stream beds and flood plains.

The Nowra sandstone is massively bedded and therefore readily supports rock walls and overhangs. Small rock scarps and platforms frequently occur on the steeper slopes and gullies associated with the sandstone bedrock. The lower sediments support a more undulating topography with low gradient slopes. broad ridges and open valley floors.

Soils associated with the sandstone are typically sandy and shallow. and support a typical sandstone suite of dry sclerophyll flora and forest structures. Ridgelines and spurs tend to be more open and drier, whereas the gullies are wetter and support a wet sclerophyll understorey. Soils on the siltstones and alluvium are more nutrient rich and have substantial clay horizons.

Options F, G and H transect the sandstone ridgespurs and siltstone valley floors to the west of Tomerong Creek. These options cross the Tomerong Creek valley north of the Turpentine Road. Option G traverses a sandstone scarp area associated with a tributary of Suffolk Creek, approximately 750 metres south of the Turpentine Road. The upper reaches of this tributary are the only portion of the study area with substantial scarps and sandstone platforms. It did not appear that the sandstone was weathering to form shelters, rather it formed sheer scarps and rock walls.

Option B closely follows the route of the extant Princes Highway along the crest of a sandstone ridge north of Tomerong. The proposed route deviates to the west a few hundred metres north of the township and crosses the Tomerong Creek floodplain and its associated Quaternary alluvium deposits. It then joins Option A on a low spur south of Tomerong Creek.

Vegetation

The existing vegetation in the study area, and particularly the age and structure of the forest communities, has been substantially modified by European land use. Some areas on the lower valley slopes have been cleared of native vegetation and now support pasture grasses and open woodland. The remaining forests of the valley floors and lower slopes are dominated by varying stages of forest regrowth and rainforest succession. Most of the existing forest has been managed as a logging resource for an extended period. The isolated mature trees which remain standing indicate the area

once supported tall wet sclerophyll forests with extensive rainforest in gullies and along creek lines.

The structure of the local vegetation during prehistory would have been considerably different to the thick understorey and regrowth typical today. Regular firing may have been practiced by the local Aborigines in the drier forests and sandstone ridges in order to keep access routes open and to encourage new growth to attract game animals. Access through the lower and wetter forests in the main valleys would have been made easier by the more open understorey which is typically encountered in mature forest structures. Established walking trails leading to popular localities would have been used by the Aborigines in this terrain.

ARCHAEOLOGICAL BACKGROUND

Ethnohistoric Information

The Tomerong area is placed within the Wandandian tribal territory, which extended along the coast from the Shoalhaven River to the Ulladulla region (Tindale 1974). The Wandandian spoke Dhurga and were part of a larger inter-tribal group known as the Murring. This group extended up the NSW coast, northward from around Double Bay to the Shoalhaven, and inland to the Wiradjuri eastern boundary (Howitt 1904). The distribution of the Dhurga language appears to have included the Jervis Bay coast and hinterland, and extended down the coast to around Narooma (Eades 1976).

Locations for different local `tribes' are remembered as: the Coolangatta, the south bank of the Shoalhaven River (Roseby Park), Huskisson (Bilong), Wreck Bay and St Georges Basin (Mathews c1960). These appear to parallel the locations of the later, post-European contact Aboriginal camps which formed following the European incursion into Wandandian land.

In July of 1791 the convict transport ship `Matilda', dropped anchor in an `unknown' harbour and made a rough chart of the bay. Less than a month later, Lieutenant Bowan sailed into the same bay on route to Van Diemans Land. He noted `many traces of inhabitants', including many canoes and natives armed with spears (Tench 1793 [1961:242]).

In December of 1797, George Bass landed at Jervis Bay and spent nearly four days exploring there. Following Bass' descriptions, the bay became a regular shelter and supply stop for the large whaling fleet that was by now operating along the coast. Consistent contact between Europeans and the local inhabitants would have begun from this period, providing direct contact with European goods and diseases.

In 1822 Alexander Berry established a homestead at Coolangatta, northeast of Nowra, importing cattle and plants for crops. Berry considered the local Aborigines to be ferocious and potentially dangerous due to their suspected role in the earlier local disappearance of several cedar getters.

Permanent European settlement in the Jervis Bay region began in 1828, marking the beginning of the rapid isolation of the Aborigines from their tribal lands and resources. In 1837 James Backhouse noted that `large herds of cattle' were being grazed in the region (Backhouse 1843).

By 1838, Alexander Berry described the Jervis Bay tribe as consisting of only 62 individuals (Egloff 1981). By the 1840's the regions Aboriginal population had been reduced to remnant groups either wandering large tracts of the coast, or subsisting at the edge of the now permanent European settlements (Egloff 1981).

General

The south coast of New South Wales has been the subject of extensive archaeological research, much of it concentrated along the coastlines and estuaries. This includes excavations of Aboriginal sites and detailed and systematic regional surveys.

The majority of archaeological sites located in this region date to within the last 6,000 years, when sea levels stabilized to approximately the present level (the Holocene stillstand).

A number of systematic surveys have been conducted in the Jervis Bay area. Many of these have been carried out on a commercial contract basis, while a few more extensive and detailed studies have been conducted within an academic research framework.

Hundreds of archaeological sites have been located in the general vicinity of Jervis Bay (Zakarov 1987). There are over 130 sites recorded on Beecroft Peninsula (Cane 1988) and over 60 sites recorded on Bherwerre Peninsula (Sullivan 1977). However only 32 sites are recorded for an area of approximately 400km^2 around the township of Tomerong. Site types include shell middens (19), open artefact scatters (8), axe grinding grooves (2), rock shelter with deposit (2), and burials (1).

Thirteen middens are located at Jewfish Bay, approximately 8km south of Tomerong. Middens are also located near rocky headlands at Plantation Point, and the northern end of Collingwood Beach. Colley (1988) located five artefacts near a known grinding groove site (NPWS Site No. 58-2-258) in the course of a survey south of Moona Moona Creek. Open artefact scatters (sometimes referred to as open camp sites) are located near the Wool Road, along the Worrowing Waterway at Old Erowal Bay, near a quarry site west of Vincentia, and at Jewfish Bay. A site complex comprising a burial, midden and open artefact scatter is located between Currambene Creek and Black Swamp some 9km north east of Tomerong.

Most of the recorded sites in the Jervis Bay region are the result of exploitation of the marine and nearshore environments. The hinterland areas still remain relatively unsurveyed and the distribution of archaeological sites is still not fully understood. Site distribution models proposed for similar coastal hinterland regions in NSW predict that sites will tend to occur on the flat areas of major ridgelines in steep graded country, and on well drained, elevated and flat ground adjacent to wetlands and watercourses in the lowlands. Though limited, the few inland surveys in the region support this model (Cane 1988, Navin 1989, Koettig 1989).

The Study Area.

To date, one archaeological survey has been carried out in the Tomerong area. Koettig (1989) located one site, Gr1, consisting of three artefacts, in the course of a survey of the Tomerong Princes Highway By-pass Option A. Koettig also identified three other locations as `having potential to be archaeological sites.' Further investigation of these areas by Silcox (1990) yielded sub-surface artefactual material at two of the three sites. This material was, however, in very low density and consequently did not `allow detailed analysis' (1990:4).

The Potential Archaeological Resource

Extensive archaeological work along the South Coast has provided an established model of site types and location criteria relevant to the study area environment. Byrne (1982:12-13) suggested that ridgelines provided access routes through the rugged hinterland. Flat areas and saddles were more favoured as site locations for longer term or repeated visits than slopes of more than 15 degrees. Closer to the coast, where topographic slopes become more gradual, some drainage lines may have afforded easier access routes, and sites frequently occur on well drained elevated locations adjacent to wetlands and alluvial flats.

The forested sandstone country and the lower more undulating siltstone country within the Tomerong study area may contain a variety of archaeological sites:-

- Open artefact scatters may occur anywhere that Aborigines have travelled and may be associated with hunting and gathering activities, domestic camps, or the manufacture and maintenance of stone tools. These sites are usually located on level ground, generally in well drained locations.

- Grinding Grooves are the by-product of the manufacture of ground edge tools. This site type generally occurs on suitable sandstone platforms adjacent to a water source. Within the study area, grinding grooves are most likely to occur on the rock platforms adjacent to the stream beds in the sandstone country traversed by Options G, F and H.

- Rock Shelter sites containing occupation deposit and/or Aboriginal art may occur where suitable rock outcrops occur. In the study area, shelters are most likely to occur in the sandstone scarps on the higher ridge slopes.

- Scarred trees result when bark has been removed from a tree for a particular purpose, such as the manufacture of a shield, canoe or coolamon. Scars may also be the result of making footholds to collect foodstuffs or to facilitate the removal of bark. The logged/regenerating forest status of much of the study area makes the existence of scarred trees a remote possibility.

- Burials are generally found in soft sediments, such as sand or alluvial silts, but may also occur in middens, rockshelters and hollow trees. Burials may occur in the study area, especially in the softer alluvial floodplain sediments. However these are generally only visible where there has been some disturbance of sub-surface sediments or where some erosional process has exposed them.

- Isolated Finds are artefacts which occur without any associated evidence for prehistoric activity or occupation. Isolated finds can occur anywhere in the landscape and may represent the random loss or deliberate discard of artefacts, or the remains of dispersed artefact scatters.

- Middens are defined as a concentration of artefactual debris that includes a significant percentage of marine or freshwater shell. They are usually the result of interim or base camp activity and are normally located close to the aquatic environment. Within the study area these sites may occur on elevated ground in the proximity of Tomerong and Suffolk Creeks and their tributaries, particularly in the southern part of the study area where the economic resources of St Georges Basin were easily accessible.

THE INVESTIGATION

Methods and Procedures

Review of Existing Documentation

A range of documentation was used in assessing the state of archaeological knowledge for the area. This material was reviewed prior to field survey in order to place the study area within an archaeological and resource management context.

Sources included information contained in the N.S.W. National Parks and Wildlife Register of Sites, associated files and archaeological survey reports, and previous studies of by-pass Option A conducted by Koettig and Silcox in 1989. Ethnographic literature and journal articles held in the library of the Institute of Aboriginal Studies and the Australian National Library were also referenced.

Field Survey

The survey strategy aimed at achieving maximum coverage of four alternative road by-pass routes, Options B, F, G and H, by walking as much of each route as possible. The survey was carried out by two archaeologists, Ms. Kerry Navin and Ms. Jillian Comber.

Maps used during field work were:

* HUSKISSON 9027-4-N 1:25,000 topo C.M.A. second edition and

* maps provided by Roslyn Muston & Associates, Environmental Management Consultants, which defined each of the proposed road corridors (see figure 1).

Field survey and its effectiveness is necessarily related to surface visibility which is a measure of the bare ground visible to the archaeologist during the survey. The predominant factor affecting surface visibility is the degree of vegetation and ground litter. Recent heavy rains in the region have promoted the growth of thick grass cover over much of the study area. This factor, along with dense vegetation cover in many sections of the proposed corridors, severely limited surface visibility. All forms of surface exposure along the routes were inspected. These comprised mainly erosion scars, vehicular and animal tracks, areas of sparse vegetation and some creek banks. All large, mature trees were inspected for Aboriginal scarring. Sandstone platforms in creeks were surveyed for grinding grooves.

Results

A total of eight sites and one isolated find were located during the course of the survey. One site was located approximately 350 metres west of Option G and consequently will not be affected by any of the proposed routes. The sites comprised two grinding groove sites, four artefact scatters and two remnant middens. Site locations are shown in Figure 1.

All areas were surveyed with the exception of a stretch of creek immediately east of site 5. Sheer scarps and wet vegetation made access to this area impossible.

Site One

Site One is located within the corridor of Option H.

This site is a small open artefact scatter. Three artefacts and one manuport were visible along a farm track, approximately 320 metres from the confluence of Suffolk Creek and an unnamed tributary of Tomerong Creek.

The area has been extensively modified by agricultural land practices. Original vegetation has been cleared, and vegetation now comprises predominantly pasture grasses, with Eucalypts, pittosporum and bracken fern occurring along the creek banks. The soil matrix is a brown/black loamy clay and contains numerous small pebbles and gravels. Visibility along the track was 95%, while off the track it was limited to <5%. This site may extend beyond the present exposure, however as reflected in the low density of artefacts (4 artefacts in 25 metres), the site is interpreted as being originally sparse.

Artefacts (Plate 1):

1. Flake - grey silcrete; platform, bulb, retouch; 5.5 x 3.5 x 3.0cm.

2. Core - red chert; six flake scars; 3.5 x 0.7 x 0.7cm.

3. Flake - grey mottled silcrete; bulb, platform; 4.0 x 2.5 x 0.5cm.

4. Manuport - black/red silicified wood broken pebble; 5.5 x 2.0 x 2.0cm.

Site Two

Site Two is located within the corridors of Options F and H.

The site is a small open artefact scatter. Nine artefacts were located in two exposures on a narrow cattle/4 x 4 track approximately 25 metres west of Suffolk Creek, near its confluence with an unnamed tributary of Tomerong Creek (Plate 2).

The site has suffered disturbance as a result of the track and by vegetation clearance. Present vegetation comprises pasture grasses, bracken fern, and a few scattered Melaleuca sp. The soil matrix is an orange/brown clay Visibility along the track varied from 20-80%, while off the track visibility was limited to <5%.

Artefacts: Exposure 1

1. Core - red chert; flake scars on all sides; 2.5 x 2.5 x 2.5cm.

2. Flake - red chert (pebble); retouch; 2.0 x 2.0 x 2.0cm.

3. Flake - red chert (pebble); 20% pebble cortex; 3 flake scars; retouch; 0.7 x 0.7 x 0.2cm.

4. Flake piece - grey chert; amorphous; <0.5cm.

5. Flake - quartz; <0.5cm.

6. Flake - fine grained light grey chert; retouch; 3 flake scars on platform: erailleur scar; 4.5 x 3.5 x 2.0cm. (Plate 3).

Exposure 2 (Three metres east of Exposure 1).

7. Flaked piece - grey chert; 15% pebble cortex; 4.0 x 1.5 x 2.0cm.

8. Flaked piece - Chert; <2cm.

9. Core - quartz; 3.0 x 3.0 x 2.0cm.

Site Three

Site Three is located within the corridor of Option F.

The site is located 10 -15 metres east of Suffolk Creek and comprises two artefacts (Plates 4 & 5). Artefact 1 was situated on the slope of an actively eroding bank. The artefact was not *in situ* and no other material was evident in or on the bank. Artefact 2 was located on a 4 x 4 farm track approximately 10 metres from artefact 1.

The track runs down to and across Suffolk Creek, and has been excavated 1.5 to 2.0 metres through a yellow/brown clay. Inspection of the banks of the excavation did not reveal any artefactual material. The track and erosion scars provided reasonable visibility over a considerable area, however no other artefactual material was noted. Visibility away from these exposures was limited to less than 5% by thick pasture grasses and bracken, The provenance of these two artefacts is therefore doubtful.

Artefacts:

1. Flake - pink/red silcrete; bulb; platform; 2.2 x 2.5 x 0.2cm.

2. Flake - grey quartzite; 10% cortex; 3.5 x 2.5 x 1.0cm.

Site Four

This site is located approximately 350m west of Option G and will not be affected by any of the proposed routes.

This site consists of six grinding grooves situated on a small (4m x 1.5m) sandstone platform at the headwaters of a northern tributary of Suffolk Creek (Plate 6). Surrounding vegetation comprises dry sclerophyll forest containing Leptospermum, Hakea, Acacia, Lomandra, Melaleuca, Grevillea, Eucalypts, reeds, and bracken fern in the immediate vicinity of the creek banks.

Grinding Groove Measurements (in cms)

Number	Length	Breadth	Depth
1.	15.0	4.0	3.0
2.	26.0	4.0	3.0
3.	22.0	6.0	2.0
4.	19.0	6.0	2.0
5.	10.0	6.0	1.5
6.	12.0	4.0	1.0

Site Five

This site is located within the corridor of Option G.

Site Five comprises four grinding grooves, two of which are well formed, the other two being considerably shallower and less distinct (Plate 7). The grooves are located on a sandstone terrace which forms part of an extensive series of terraces across the creek (a northern tributary to Suffolk Creek). Three metres east of the site these terraces fall away to a sheer drop of

many metres. A small drainage channel empties into the creek three metres south of the site.

Grinding Groove Measurements (in cms)

Number	Length	Breadth	Depth
1.	22,0	7.0	1.0
2.	23.0	7.0	1.0
3.	10.0	5.0	0.5
4.	8.0	5.0	0.5

Site Six

This site is located within the corridor of Option H.

The site is an open artefact scatter. Seven artefacts were located along approximately 30 metres of a well established unsealed road which runs from the Turpentine Road to Battunga Road (Plate 8).

Visibility along the road was 90%, however this decreased to <5% off the road, where thick leaf litter and vegetation obscured the ground surface. The sandstone bedrock of the ridge spur outcrops along the road. The soil is a shallow, light yellow sandy loam containing numerous gravels and quartz and sandstone pebbles. Surrounding vegetation comprises Eucalypt forest regrowth, Acacia, Melaleuca, Geebung and bracken fern.

Artefacts:

1. Core - grey chert; 40% pebble cortex; 2 flake scars; 3.5 x 1.5 x 2.0cm.

2. Flake - grey basalt; 50% pebble cortex; 3.5 x 2.5 x 1.0cm.

3. Broken pebble with percussion marks and possibly hammer-dressing; 5.2 x 4.0 x 2.0cm.

4. Flake - milky quartz; 60% pebble cortex; edge damage; 1.2 x 0.9 x 0.3cm.

5. Flake - milky quartz; 1.8 x 1.0 x 0.2cm.

6. Flake - translucent quartz; 1.3 x 1.3 x 0.4cm.

7. Flake - white/grey chert; 10% pebble cortex; bulb; platform; retouch; 2.2 x 1.2 x 0.3cm.

Sites Seven and Eight

These sites are located in the corridor of Option B.

Small amounts of shell material - very small, fractured pieces of *Anadara trapezia* (bimbla), and (probably) *Mytilus planulatus* (Mussel) - were located in two highly disturbed areas near the southern extent of Option B. The shell is associated with a low, broad spur near a tributary to Tomerong Creek. The position of the material and the species present indicate that the shell is Aboriginal in origin. No lithic artefacts were located.

Koettig (1989), located a sparse scatter of artefacts some 200 metres to the west of Shell Area 1 and 250 north west of Shell Area 2. The shell material may be associated with this site, or it may represent the remains of now substantially disturbed or destroyed midden sites.

Isolated Find 1

This was located on an exposure on a dam wall. The dam has been constructed on the top of a knoll which lies between the southern extents of Options G and F. The area is severely disturbed, and the provenance of the artefact is unknown.

Flaked piece – yellow/grey silcrete; secondary retouch on 1 edge; 1 flake scar; 1.7 x 1.3 x 0.7cm.

ABORIGINAL PARTICIPATION

The study area falls within the boundaries of the Jerringah Local Aboriginal Land (JLALC) and the Nowra Local Aboriginal Land Council (NLALC).

Ms Beverly Gordon (Secretary) and Ms Delia Lowe of the JLALC were apprised of the results of the survey of that area of land which falls within their Land Council boundaries. Following discussions within the community, the Jerringah Land Council consider that Route A is the preferred option. Should any of the other routes (B, F, G or H) be chosen as the eventual route, then the matter should be referred back to the Land Council for further consideration.

Mr Eddie Bloxome (Chairperson) of the NLALC was informed of the sites located within his Land Council boundaries, and of the consultants assessment of each of the routes. This information was subsequently presented and discussed at a Local Land Council meeting held on March 17. 1990.

The Nowra Local Land Council consider that Route A is the preferred option. Should any of the other routes (B, F, G or H) be chosen as the eventual route, then the matter should be referred back to the Land Council for further consideration.

SITE SIGNIFICANCE AND ASSESSMENT

General

Significance of prehistoric sites can be assessed according to a range of criteria including:

- scientific or archaeological significance,
- significance to Aboriginal people,
- aesthetic value,
- representativeness, and
- value to the public as an educational or recreational resource.

Many sites will be significant according to several criteria and these will vary according to the nature and purpose of the evaluation. However, for the purpose of this management oriented investigation, the primary concerns are with scientific significance and Aboriginal significance.

Aboriginal significance is the value placed upon a site or site complex by the local or regional Aboriginal community. A site's significance can be the result of several factors including: continuing cultural links with an historic archaeological or landscape feature, concern for the protection and custodianship of burials, and the value of sites as tangible links with the lifestyle and values of their ancestors.

There are two major components used in assessing scientific significance the potential of a site or suite of sites for scientific research and excavation and the representativeness of a site. Site representativeness is a measure of the degree to which sites in the area of investigation are characteristic of sites known elsewhere in the immediate and surrounding region.

The principle aim of cultural resource management is the conservation of a representative sample of site types from different environment areas Sites with inherently unique features, or which are poorly represented elsewhere in similar environment types, are considered to be archaeologically significant.

A site that contains undisturbed cultural evidence, such as *in-situ* sub-surface material, has a high potential for research and future excavation and is therefore of major significance.

Campsites are most commonly assessed in terms of scientific significance only, as they are not generally perceived to be significant in terms of the other categories listed above. Other than to record their locations dimensions and contents, disturbed and small surface artefact scatters generally hold little scientific significance.

Sites 1, 2, 3 and 6 (Open Artefact Scatters):

This site type is not well represented either regionally or locally. However the paucity of this site type reflects a lack of archaeological survey, rather than a real archaeological pattern. Based on the results of test pitting conducted for the investigation of Option A, Silcox (1989) concluded that very low density artefact scatters could be expected to occur 'relatively consistently' across the local landscape. It is likely that this site type is relatively common in the region, though few probably remain undisturbed.

Sites 1, 2 and 3 form a cluster of sites along the banks of Suffolk Creek.

There is the possibility that sites 1, 2 and 6 may extend beyond the present visible site boundaries, however on present indications this would be in very low densities.

The low density of artefactual material and the disturbed nature of the surrounding landscape indicate that sub-surface, *in-situ* material is unlikely to occur at sites 1 and 2.

The shallow nature of the soils on the ridgeline crest on which Site 6 is located indicate that sub-surface material is unlikely to occur.

The provenance of the artefactual material located at site 3 is uncertain. however it is probable that artefactual material is present along the higher area flanking Suffolk Creek.

As a consequence of the restricted and disturbed nature of these sites, the artefact scatters located during this survey are of limited archaeological significance.

Sites 4 and 5 (Grinding Groove Sites):

This site type is not well represented within the region. Two sites have been previously recorded; one on a major creek associated with a rock shelter site (NPWS Site No: 52-5-0037), and one, associated with an open artefact scatter, on a small tributary adjacent to coastal wetlands (NPWS Site No: 58-2-0258). The study area sites differ from these sites in their associated topographic and archaeological contexts and must therefore be considered to be locally significant.

Sites 7 and 8 (Middens):

Middens are well represented within the region. These range from extensive shell deposits along the coast to smaller shell scatters further inland. The two midden sites in the study area are located on a low, broad spur adjacent to Suffolk Creek. The close proximity of Site Gr1 (Koettig 1989), and the presence of sub-surface artefactual material from TBP2 on the nearby creek flats (Silcox 1989), indicates that the spur line may have been a focus for occupation in the area.

Although important for their locational information, sites 7 and 8 hold little archaeological significance as they consist of very small amounts of material located within a highly disturbed area. The proximity of the three sites on the spur identifies this feature as archaeologically more sensitive than the surrounding slopes. The greater likelihood of encountering artefactual material is offset, however by the disturbed and pauperate nature of the surviving resource. This evaluation is confirmed by the results of the previous archaeological investigations (Koettig 1989, Silcox 1989).

Discussion

Sixty three percent (7 sites) of all sites recorded in the Tomerong area are located in open valleys, either near stream lines or on low spurs adjacent to water courses. All sites are within the Suffolk Creek catchment area. No sites have been identified in the section of the study area north of the Turpentine Road.

Two site concentrations occur along the Suffolk Creek corridor, involving low density artefact and shell scatters. All of the grinding groove sites and two artefact scatters occur in the higher sandstone topography, on ridgecrests, slopes or narrow creek lines. This distribution suggests that the valley floors were more extensively occupied than the higher topography. Access to the major resources of the coast, via the lowland spurs and creeks may have been locally more important than access into the more specialised resources of the hinterland, via the sandstone ridge spurs.

Comparative Route Assessment

Option B will impact sites 7 and 8, situated on a low spur adjacent to Suffolk Creek.

Option F crosses the flats associated with Suffolk Creek and will impact sites 2 and 3.

Option G will impact the locally significant grinding groove site 5.

Option H will impact sites 1 and 2, near Suffolk Creek and site 6 located on a ridgecrest.

The archaeological significance of the sites affected by these options is considered to be low, with the exception of site 5, which is locally significant. Option G is therefore the least preferred route.

All of the remaining options, including Option A, pass through areas adjacent to Suffolk Creek where sites of low archaeological potential are clustered. None of the identified sites on the remaining options are considered to be archaeologically significant. Site types which will be impacted by any one of the remaining alternatives are represented elsewhere in the local area. All of the remaining options are therefore equally weighted with regard to their impact on the archaeological resource.

Given that sub-surface testing and evaluation has been conducted for Option A (Silcox 1989), the accuracy in evaluating sub-surface material must be considered to be greater for this route alternative.

The greater body of data relating to Option A, when placed within the local comparative framework provided by the other option surveys makes the selection of Option A preferable.

RECOMMENDATIONS

The following recommendations are made on the basis of:

* Legal requirements under the terms of the National Parks and Wildlife Act 1974 (as amended) which states it is illegal to deface, damage or destroy a relic or Aboriginal place in N.S.W. without first obtaining the written consent of the Director of the N.P.W.S.

* An assessment of sites using the following criteria:

  - archaeological or scientific significance
  - value to Aboriginal people
  - value as an educational or recreational resource
  - aesthetic value
  - representativeness

* Background research into the extant archaeological record for the region and the Tomerong area.

Recommendations

1. Option A is the most preferable option.

2. Option G is the least preferred option. Should Option G be chosen as the eventual by-pass route the road corridor should be designed to avoid Site 5.

3. Archaeological survey of any deviations of Option G will be necessary.

4. Should Option B be chosen as the eventual by-pass route, consent should be sought from the Director of the NSW National Parks & Wildlife Service to destroy Sites 7 and 8.

5. Should Option F be chosen as the eventual by-pass route, consent should be sought from the Director of the NSW National Parks & Wildlife Service to destroy Sites 2 and 3.

6. Should Option H be chosen as the eventual by-pass route, consent should be sought from the Director of the NSW National Parks & Wildlife Service to destroy Sites 1, 2 and 6.

7. The recommendations and concerns of the two relevant Aboriginal Land Councils should be taken into consideration.

8. All correspondence with the NSW NPWS should be directed to:

   Ms Sue Feary
   Regional Archaeologist
   SE Region and Queanbeyan District Office
   34 Lowe Street
   QUEANBEYAN NSW 2620

9. Three copies of this report should be forwarded to Ms Feary, for consideration by the NSW NPWS.

10. A copy of this report should be forwarded to:

Mr. E. Bloxome
Chairperson
Nowra Local Aboriginal Land Council
Po Box 530
NOWRA NSW 2541

and

Ms. B Gordon
Secretary
Jerringah Local Aboriginal Land Council
PO Box 110
ORIENT POINT NSW 2540

11. Any previously undetected archaeological site uncovered or unearthed during the course of by-pass construction should be reported immediately to Ms. Sue Feary, NPWS, and advice sought on an appropriate course of action.

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APPENDIX 1: PLATES

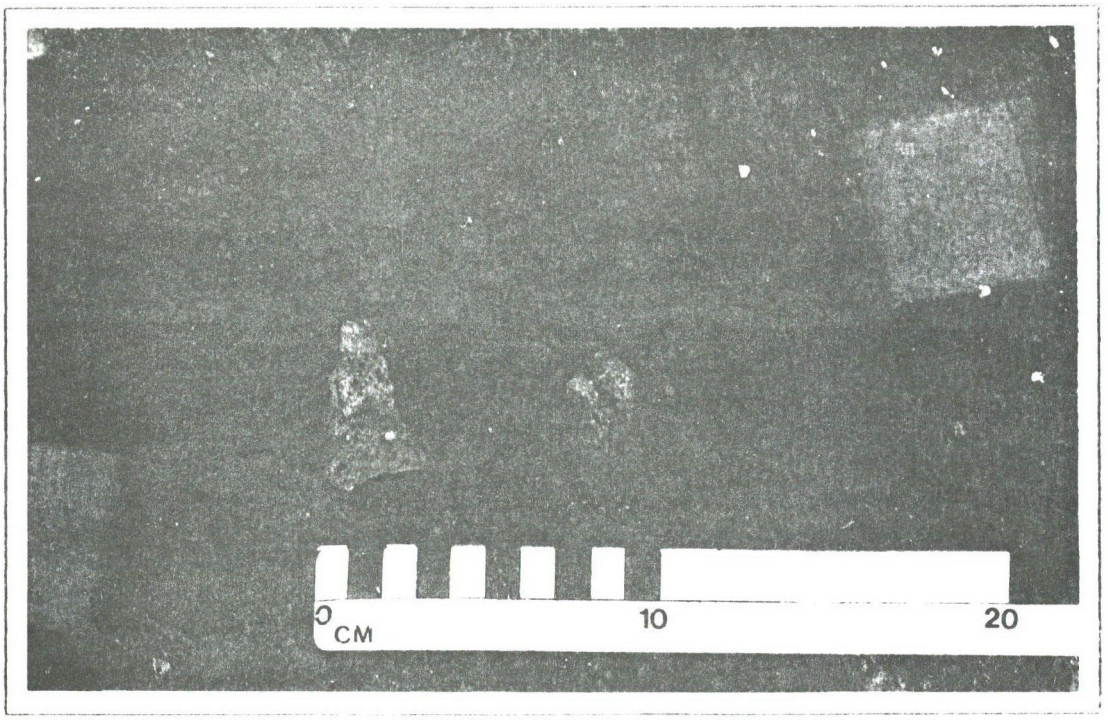


Plate 1 Site 1 - artefacts



Plate 2: Site Two (in foreground), looking east toward Suffolk Creek

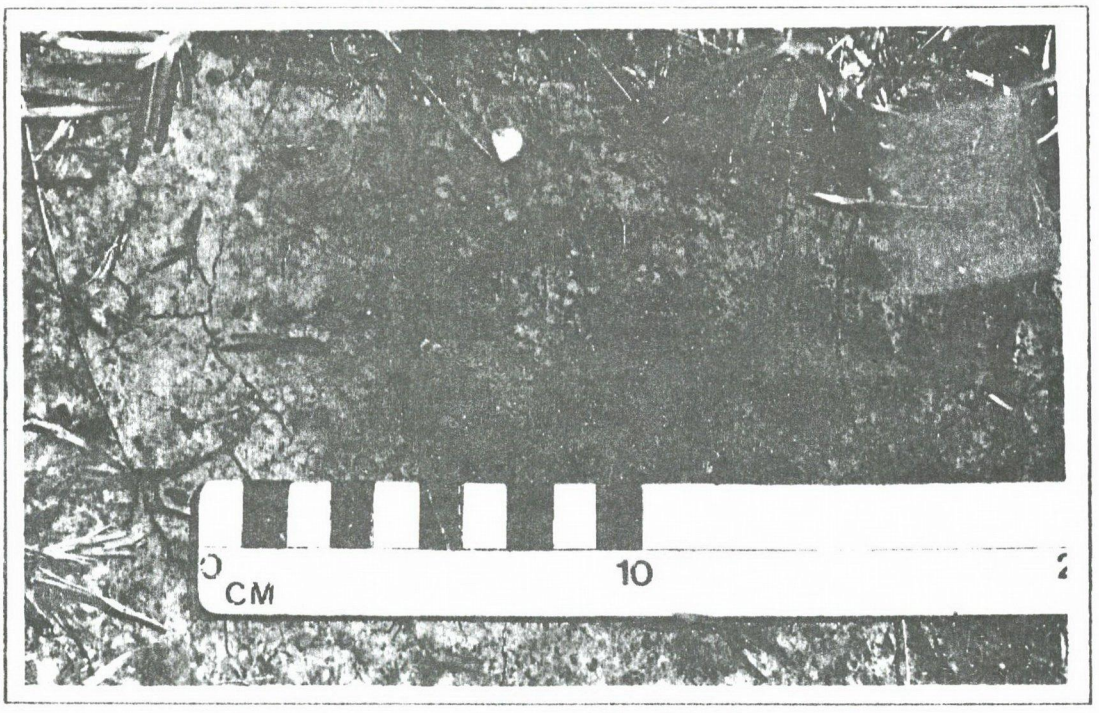


Plate 3: Site Two – artefact.

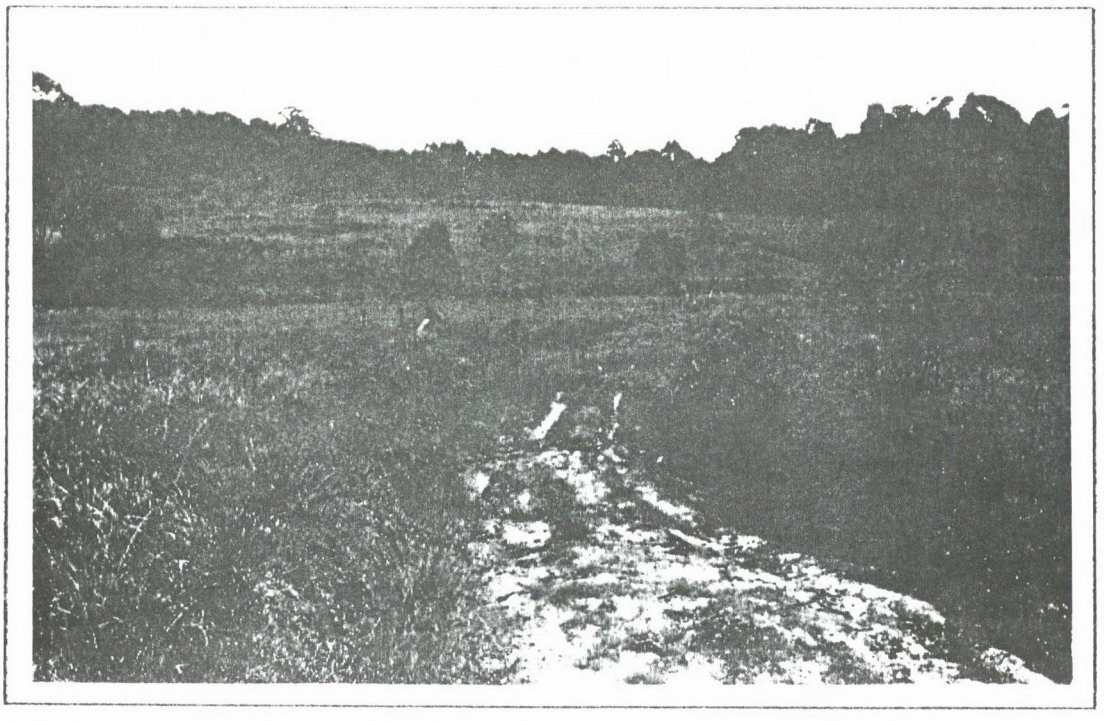


Plate 4: Site Three (in foreground), looking west towards Suffolk Creek.

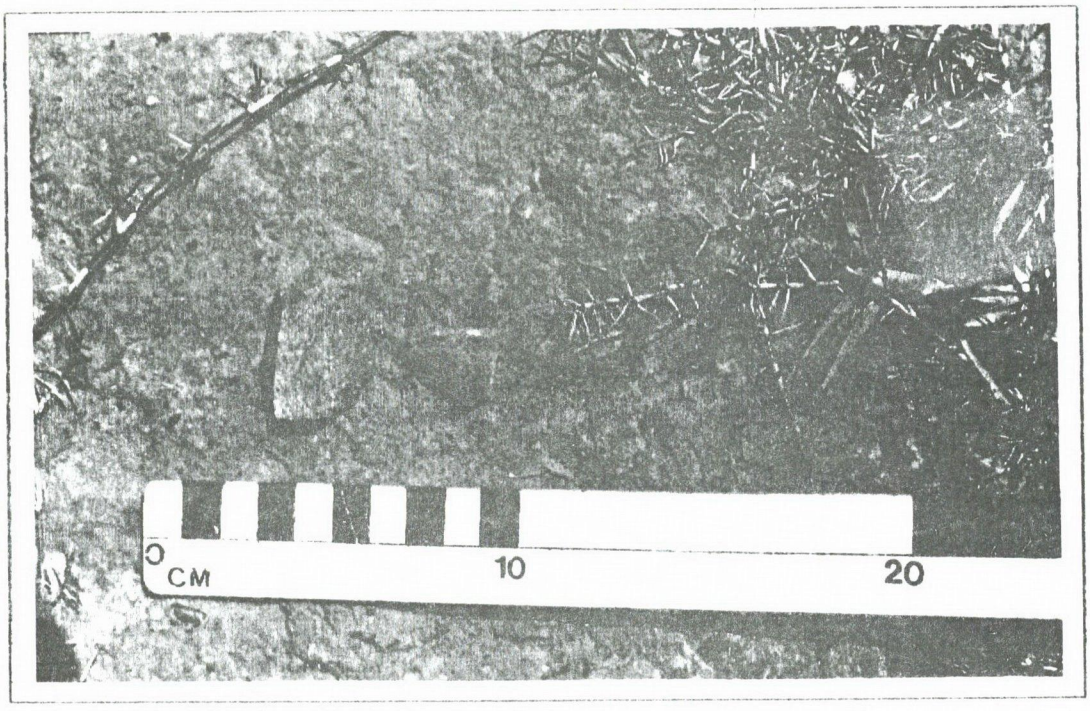


Plate 5: Site Three – artefacts.



Plate 6: Site Four – grinding grooves on sandstone platform.

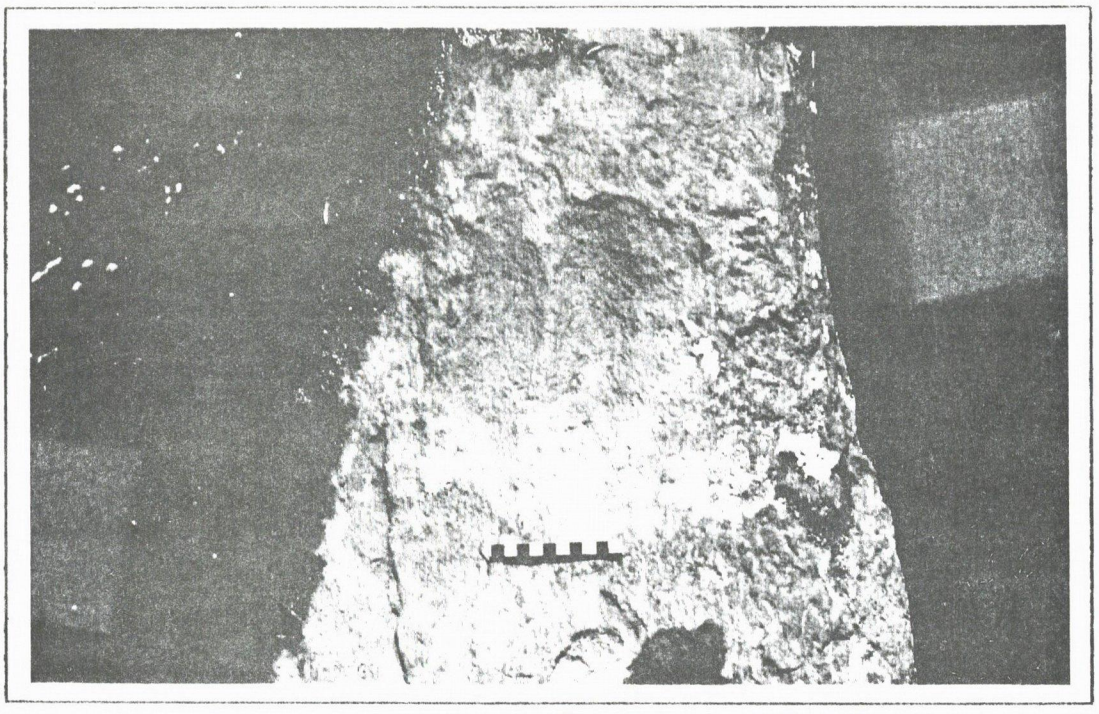


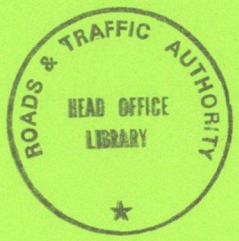
Plate 7: Site Five - grinding grooves on sandstone platform.



Plate 8: Site Six - artefacts scattered approx 30 metres along road.

8.5 NOISE

Impact Assessment by Renzo Tonin and Associates



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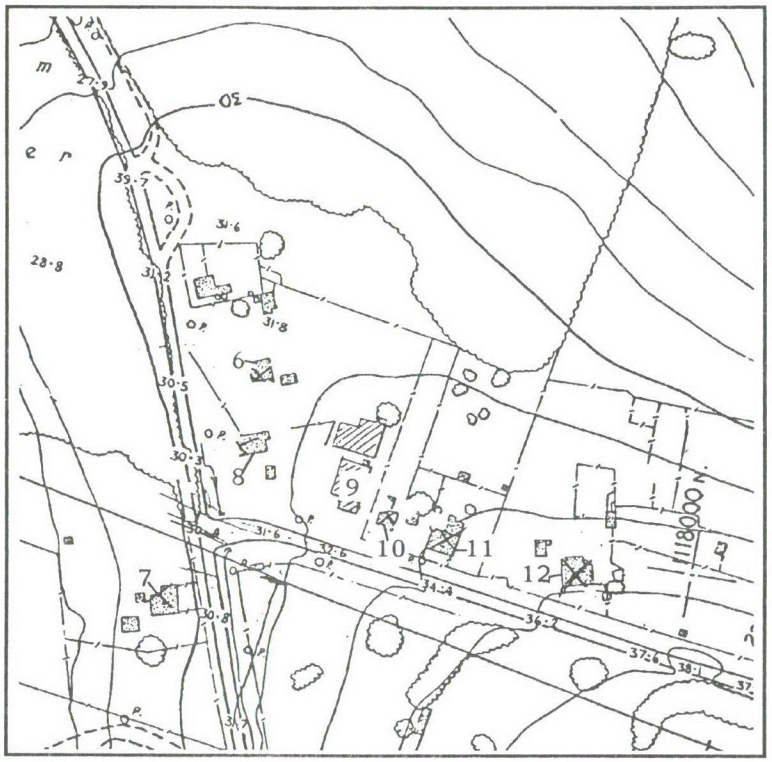
1st floor, 160 Castlereagh St., Sydney, N.S.W. 2000. Telephone: [02] 267 5939 Fax: [02] 261 8294



REPORT No . S696Q412
TOMERONG BY - PASS : NOISE IMPACT ASSESSMENT

CONTENTS

	Page
1.0 SUMMARY	2
2.0 INTRODUCTION	3
3.0 EXISTING ACOUSTIC ENVIRONMENT	4
3.1 NOISE MEASUREMENTS	4
4.0 NOISE CRITERIA	6
4.1 TRAFFIC NOISE	6
4.2 NIGHT-TIME NOISE	6
4.3 CONSTRUCTION NOISE	8
5.0 CALCULATED L_{10}(18hr) TRAFFIC NOISE LEVELS	8
5.1 TRAFFIC DATA	9
5.2 PREDICTED NOISE LEVELS AT RESIDENCES	9
5.3 AMELIORATIVE MEASURES	10
6.0 CALCULATED NIGHT-TIME NOISE LEVELS	13
7.0 CONSTRUCTION NOISE	15
8.0 RECOMMENDATIONS AND CONCLUSION	18

1.0 SUMMARY

A new section of road is proposed to bypass Tomerong, a town situated near Jervis Bay on the South Coast of New South Wales. It will replace the existing section of the Princes Highway between 16 and 24 km south of Nowra.

This report provides an assessment of noise from traffic on this proposed road at each residence within 200m of its route. Where noise levels are predicted to be excessive, ameliorative measures are recommended.

It is concluded that noise levels from the freeway can be controlled to within the environmental goal of 63dB(A) L_{10}(18hr) at all but one residence using a combination of a noise-reducing road surface and barriers and earth mounds. The exception occurs at a residence which is already exposed to noise levels in excess of 63 dB(A). At this location a criterion of existing level plus 2 dB(A) is met.

If noise levels are controlled to within the recommended criterion level, then night-time noise levels will also be acceptable.

To control noise from construction activities, the use of temporary barriers or hoardings is recommended. These should be located adjacent to the road at sections where it passes close to residences, and all construction work should then take place behind the barriers.

2.0 INTRODUCTION

It is proposed that the section of the Princes Highway extending between 16 and 24 km South of Nowra on the South Coast of New South Wales is replaced by a new road. Its proposed route is shown in Figure 1.

It is estimated that by the year 2020, approximately 12330 vehicles will use this road per day. Of this volume about 8% will be heavy vehicles.

The proposed route will pass through a rural area where the noise climate is generally quiet. However as the bypass is to be constructed within one kilometer of the existing section of the Princes Highway, some of the residences affected are already exposed to relatively high levels of traffic noise.

This report provides an assessment of noise levels due to traffic on the Tomerong bypass at locations near the proposed route. It also provides an assessment of noise during construction of the bypass.

3.0 EXISTING ACOUSTIC ENVIRONMENT

The locations marked 1 - 17 on Figure 1 represent the location of all residences within 200m of the route of the proposed by-pass. The acoustic environment at these locations varies considerably.

At residences which are relatively close to the existing highway (residences 1 - 3 and 6 - 12), this is the dominant noise source, with relatively high noise levels being experienced. At residences 9 - 14, traffic on Grange Road also contributes to the existing noise levels.

At residences which are further from existing roads, ambient noise levels are lower, and are due to typical rural sources such as birds, insects and wind in trees.

3.1 NOISE MEASUREMENTS

To more accurately assess the existing acoustic environment, noise measurements were taken at the location of residences 2, 5, 8, 13 and 16, as shown in Figure 1. These locations represent a cross-section of acoustic environments to be found along the route.

Measurements were conducted between 10:00 am and 12:30 pm on 10th April, 1990. Fifteen-minute noise samples were recorded at each site.All measurements were at the same distance from the nearest major road as the house facade. However, the microphone was not adjacent to the facade, therefore no facade correction is applicable.

Equipment used consisted of a Bruel & Kjaer type 2231 sound level meter, using the statistical analysis module. This meter complies with the requirements of Australian Standard AS 1259 - "Sound level Meter Precision." The equipment was calibrated regularly using a B&K type 4230 calibrator. No significant drift in calibration was detected.

Because ambient noise levels vary with tome, a single number noise descriptor does not provide an adequate description of the noise environment. Hence, a statistical approach is used. The L_{10} noise level is the level exceeded for 10% of the time, and is approximately the average maximum sound level meter deflections. The L_{90} level is the level e xceeded for 90% of the time, and is approximately the average minimum noise level. The L_{90} level is often referred to as the "background" noise level. The Leq level represents the average noise energy during the measurement period.

Results of the noise measurements are shown in Table I, below.

TABLE I
RESULTS OF AMBIENT NOISE MEASUREMENTS

RESIDENCE	TIME	MEASURED NOISE LEVEL, dB(A)			COMMENTS
		L_{90}	L_{10}	Leq	
2	12:13pm	43	52	50	Noise from highway
5	11:35am	40	47	50	Highway, insects, some industry noise.
8	10:35am	51	70	66	Highway. Background affected by industry.
13	11:15am	43	51	50	Grange Rd, insects, some industry noise.
16	10:10am	40	48	44	Highway , insects.

It should be noted that the noise levels shown above do not represent the level near a residential facade. Where the major noise source is traffic noise,L_{10} and Leq levels at 1m from the facade would be approximately 2.5 dB above those shown in Table I.

At residences relatively far removed from major roads, daytime background noise levels are
40 - 43 dB(A). Ay residences adjacent to the existing highway (residences 6, 7, and 8), the background noise level rises to 51 dB(A). For residences a little further from the highway (residences 9-12), the background noise level will be between 40 and 51 dB(A).

4.0 NOISE CRITERIA

A detailed discussion of traffic noise assessment criteria is found in our report no. S590A825 - "F2 Freeway: Noise Impact Assessment". The sections below provide a summary of that discussion as it relates to noise assessment for the Tomerong By-pass.

4.1 TRAFFIC NOISE

A NSW Inter-Departmental Committee (IDC) which included representatives from the Department of Environment and Planning, the Department of Main Roads, the Traffic Authority, the State Pollution Control Commission and the Department of Housing has recommended (inter alia) the following noise criteria for arterial roads:

"The Environmental objective of 63 dB(A) L_{10}(18hr), be developed as a provisional working value, to be the basis for road design and construction of arterial roads, for residential area planning and for the treatment of residences..."

Both the State Pollution Control Commission and the now Road Traffic Authority have adopted this recommendation. The SPCC is presently investigating the use of another criterion, based on the Traffic Noise Level (TNL), but no final recommendation has been made. In view of this, we have adopted the 63 dB(A) L_{10}(18hr) criterion for this analysis.

The use of a noise criterion of 63 dB(A) will mean that approximately 18% of the residents who are exposed to the highest level of noise (i.e. those closest to the road) will be highly annoyed. We consider that it is not possible to select a traffic noise criterion which will result in no-one being highly annoyed. Any criterion selected will always represent a compromise between the number of people affected and the technical feasibility of providing further reduction in noise levels.

Where existing traffic noise levels exceed the above criterion, it is generally accepted that noise from any new source should not significantly increase the existing level. The criterion adopted in this case is that the existing L_{10}(18 hr) noise level should not be increased by more than 2 dB.

4.2 NIGHT-TIME NOISE

Night-time traffic noise will generally be less than during the day. It is usual for traffic noise to abate after 10pm but to increase again from 6am. The criterion of 63dB(A) L_{10}(18hr) takes into account only the noise which occurs between 6am and 12 midnight.

It is generally recognized that at sufficiently high levels, traffic noise can affect the sleep of nearby residents. Effects of the noise include an increase in the time taken to get to sleep (sleep latency), an increase in the number of awakenings during the night and changes in the pattern of sleep, notably in the proportion of deep sleep.

The 63 dB(A) L_{10}(18hr) environmental goal represents a level of day- time traffic noise which is acceptable to most of the population exposed. Presumably, residents who can accept the 63dB(A) L_{10}(18hr) noise level find that they can sleep comfortably at night, otherwise they would describe the traffic noise as highly annoying. This is prima facie evidence that the level of night-time noise which results from traffic flows which produce 63 dB(A) L_{10}(18hr) during the hours 6am to midnight is generally acceptable.

However, the mix of traffic at night on some roads may be unusual. (For example, on some roads the number of interstate haulers increases considerably at night.) Therefore the change in noise levels from day-time to night-time may not always be the same when comparing different locations. For this reason, a criterion is required which specifically addresses the level of noise during the night-time. We will take the night-time period for assessing noise impact to be 10pm-6am because this corresponds to the period when most people are asleep.

Existing research provides little guidance in establishing an explicit criterion for night-time noise. The most useful studies in this regard are those by Thiessen and Lapointe (1) and Wilkinson and Campbell (2). In the first study (1), sleeping subjects were exposed to recorded traffic noise levels of 47 dB(A) and 60 dB(A) L_{eq}, and their sleep quality compared with that on nights when no noise was present. At 47 dB(A), there was a slight effect on the proportion of deep sleep, although its significance is unclear. There was no consistent effect on the number of awakenings. At 60 dB(A) the effect on proportion of deep sleep was greater, and there was a definite effect on number of awakenings.

Wilkinson and Campbell[2] studied the effect of reducing traffic noise levels in residents' bedrooms by the use of double glazing. Internal noise levels were reduced from 42 - 52 dB(A) L_{eq} to 36 - 47 dB(A) L_{eq} by this treatment. This reduction resulted in small but measurable changes in proportion of deep sleep and in reaction time after awakening, as well as in reported sleep quality. Unfortunately, the relationship between these changes and the absolute noise level is not reported.

Based on the above limited data, it is suggested that an internal noise level of approximately 45 dB(A) L_{eq} represents a noise level above which sleep quality may deteriorate. It is therefore tentatively suggested that an appropriate criterion for assessment of night-time traffic noise levels is that the internal L_{eq} level for the period between 10 pm and 6 am should not exceed 45 dB(A).

Since internal noise levels through an open bedroom window are approximately 10 dB below external levels, the above criterion is equivalent to a requirement that external night-time noise levels should not exceed 55 dB(A).

4.3 CONSTRUCTION NOISE

The State Pollution Control Commission's Environmental Noise Control Manual sets out criteria for assessment of noise from construction sites. The basic criterion is that noise from a construction site should not exceed the existing background noise level by more than 20, 10 or 5 dB depending on the duration of the construction activity.

In this case, construction will take place in several phases (see section 7.0) and the duration of construction during any phase near a particular residence would generally be less than 4 weeks. In this case, the appropriate criterion from the S.P.C.C.'s manual would be that construction noise levels should not exceed the existing background level by more than 20 dB.

From Table I, above, average daytime background noise levels at measurement sites along the proposed route vary between 40 and 51 dB(A). Relevant construction noise criteria therefore range from 60 to 71 dB(A), depending on the existing background noise level at the residence.

Blasting may be required at some points during construction. The State Pollution control Commission recommends the following maximum levels of airblast overpressure and ground vibration at residences:

Maximum airblast overpressure: 115 dB (lin)

Maximum ground vibration peak particle velocity : 5mm/sec

We are in agreement with the use of these criteria.

5.0 CALCULATED L_{10}(18hr) TRAFFIC NOISE LEVELS

Traffic noise levels were calculated at all the residences within 200m of the bypass route, both for the existing road network and after the opening of the proposed by-pass. Calculations were made using the method described in the manual "Calculation of Road Traffic Noise" produced by the UK Department of Environment (known as the CORTN method). This takes account of the number of vehicle movements, percentage of heavy vehicles, type of ground cover, topography between source and receiver and shielding and reflection from barriers.

An Australian study, published as Australian Road Research Board (ARRB) Research Report No. 122, compared measured noise levels at various locations in Australia with the levels predicted by the CORTN method. This indicated that for sites where a correction for facade reflection is applicable (as is the case for predictions in this report), a correction of -1.7 dB should be applied to the CORTN results to provide the bast estimate of noise levels under Australian conditions. This correction has been applied to the calculated levels in this report.

In all cases, the calculated levels represent the noise levels at 1m from the most exposed facade of the residence.

5.1 TRAFFIC DATA

The predicted volume and mix of traffic on the proposed by-pass were provided by Mitchell McCotter Pty Ltd. It is estimated that by 2020, the annual average daily traffic volume on the by-pass will be approximately 12330 vehicles, with approximately 8% of these being heavy vehicles. Noise level predictions in this report are for the year 2020.

Results from traffic counts on the existing highway and on Grange Rd, provided by Mitchell McCotter Pty Ltd, were used to calculate the existing traffic noise levels at each residence.

Future traffic volumes on Grange Rd are difficult to estimate, but we understand that by 2020 the volume could increase by up to a factor of approximately 2.8 compared with existing volume. This has been assumed in calculating future noise levels at residences near Grange Rd. It is assumed that after the opening of the by-pass, traffic levels on the existing highway would be very low.

The mean speed of the traffic flow is taken as 100 km/h at all points on the by-pass.

5.2 PREDICTED NOISE LEVELS AT RESIDENCES

Table II shows calculated L_{10}(18 hr) noise levels at 1 m from a residential facade at each location marked on Figure 1, both for existing conditions and for the year 2020 with the proposed by-pass. Existing noise levels include noise from the existing highway and, where relevant, from Grange Road.

The road surface of the by-pass is proposed to be chip-seal concrete This will result in road-side noise levels approximately 2dB higher than standard bituminous concrete.

Residence 2 is shielded from the existing highway by a cutting, and this has been allowed for in calculating the existing noise level. No shielding has been allowed for in calculating noise levels from the proposed by-pass.

TABLE II
CALCULATED NOISE LEVELS AT RESIDENCES NEAREST TO THE PROPOSED BY-PASS

LOCATION	CALCULATED L_{10}(18hr) NOISE LEVEL, dB(A)				
	EXISTING	BY-PASS	GRANGE RD	TOTAL	CRITERION
1	61	67	-	67	63
2	64	62	-	62	66
3	63	63	-	63	65
4	51	66	-	66	63
5	50	68	-	68	63
6	67	62	56	63	69
7	69	68	61	69	71
8	67	65	60	66	69
9	63	66	64	68	65
10	63	67	66	70	65
11	62	67	66	70	63
12	62	65	66	69	63
13	52	60	56	61	63
14	52	60	57	62	63
15	51	62	56	63	63
16	53	58	-	58	63
17	57	63	-	63	63

The calculated existing noise levels shown in Table II are in good agreement with the measured levels in Table I, after allowing that:

a) 2.5 dB should be added to the measured levels to allow for the facade effect; and

b) Measured levels at residence 8 were affected by noise from industry as well as the highway.

From Table II it is clear that without ameliorative measures, L_{10}(18hr) noise levels will exceed the recommended criterion at residences 1, 4, 5, 6 and 9 - 12.

5.3 AMELIORATIVE MEASURES

The most economical and realistic measures to control noise from a freeway are alterations to the road surface and the use of barriers and bunds.

Recent research[3] has indicated that significant noise reductions may be gained by the use of open graded asphalt or similar road surfaces, compared with standard surfaces. Results of this research have been incorporated into proposed amendments to the CORTN prediction method, which indicate that the use of these surfaces results in a noise reduction of 2.5 - 3.5 dB, compared with standard bituminous concrete, or approximately 5dB compared with chip-seal concrete.

From Table II, a reduction of approximately 5 dB in noise levels from the proposed by-pass would mean that noise levels would be within the criterion level at residences 1, 4 and 5. It is therefore recommended that open-graded asphaltic concrete or similar surface be used for the proposed by-pass for at least 300 m on either side of these residences.

At residences 9 - 12, the use of a noise-reducing road surface would reduce noise levels from the by-pass itself to within the recommended criterion. However, noise from traffic on Grange Rd would increase the total level to above the criterion. Further measures are therefore required to reduce noise from traffic on Grange Rd. This would take the form of a barrier along the eastern side of Grange Rd, which would provide shielding for noise from both Grange Rd and the by-pass.

The CORTN model provides a method for calculating the noise reduction due to barriers. However, this model assumes that the acoustic centre of the noise source is 0.5 m from the ground. While this is a reasonable approximation for a car, it is too low for a heavy vehicle, and results in an over-estimation of the attenuation due to the barrier.

The major noise source from a typical heavy vehicle is the engine, the acoustic centre of which is at approximately 1.5 m from the ground. Noise from the exhaust, at 3.6 m from the ground, is approximately 8 dB lower than that from the engine.

In calculating the effect of a barrier, the total traffic noise level was partitioned into three parts, as shown in Table III. The effect of the barrier on each component was calculated separately, and the levels were then added to give the total noise level.

TABLE III
COMPONENTS OF TOTAL TRAFFIC NOISE LEVEL

SOURCE	HEIGHT ABOVE GROUND, m	NOISE LEVEL RELATIVE TO TOTAL, dB
Cars	0.5	-1.9
Truck engines	1.5	-5.1
Truck exhausts	3.6	-13.1

The exact attenuation due to a barrier depends on the relative locations and heights of source and receiver.

Calculations indicate that noise levels at residences 9 - 12 will be within the criterion levels with the provision of the following ameliorative measures:

- use of open-graded asphaltic concrete, or similar noise-reducing road surface, on the proposed by-pass from 300 m north of residence 9 to 300m south of residence 12; and
- provision of a 2.5 m high solid barrier on the eastern side of Grange Rd, from the corner of the existing Highway to 100 m south of residence 12. The barrier would need to be designed to allow access to residences from Grange Rd, but without allowing line-of-sight to the road. It could be constructed of any suitable material, such as solid timber, which has a transmission loss greater than approximately 15 dB at 125 Hz.

With the above recommended noise control measures, the total predicted L_{10}(18hr) noise level at each residence is shown in Table IV below.

TABLE IV
CALCULATED L_{10}(18hr) NOISE LEVELS WITH NOISE CONTROL MEASURES

LOCATION	L_{10}(18hr) NOISE LEVEL, dB(A)	CRITERION
1	62	63
2	60	66
3	61	63
4	61	63
5	63	63
6	57	69
7	66	71
8	61	69
9	62	65
10	63	65
11	63	63
12	62	68
13	59	63
14	59	63
15	59	63
16	53	63
17	58	63

From Table IV, calculated noise levels at all residences are within the criterion for that residence, and all are within the fundamental criterion of 63 dB(A) L_{10}(18hr) with the exception of residence 7. At this residence, the existing noise level is 69 dB(A) L_{10}(18hr) due to traffic on the existing highway, and the introduction of the proposed by-pass will result in a decrease of 3 dB in noise level.

It may be noted that if through traffic on Grange Rd were diverted to the proposed by-pass before residence 12, then noise levels at residences 9 - 12 would be acceptable with a noise-reducing surface on the by-pass but with no barriers on either Grange Rd or the by-pass.

6.0 CALCULATED NIGHT-TIME NOISE LEVELS

To find night-time Leq values, hourly L_{10} values were calculated for each hour between 10 pm and 6 am, using the CORTN model, and a constant 3 dB difference was assumed between L_{10} and L_{eq}. Calculations include traffic on both the proposed by-pass and, where relevant, on Grange Rd.

In predicting night-time noise levels, it was assumed that the distribution of traffic volume and mix with time of day on the new by-pass and on Grange Rd will be the same as for the existing highway, with the overall traffic volume scaled up to represent the higher volumes predicted for the future.

Calculated night-time noise levels are shown in Table V. The calculated values assume that the noise control measures recommended above for the control of general traffic noise will be implemented.

TABLE V
CALCULATED L_{eq} NOISE LEVELS FOR THE PERIOD 10pm - 6am

LOCATION	NIGHT-TIME L_{eq} NOISE LEVEL, dB(A)
1	53
2	51
3	52
4	52
5	54
6	48
7	57
8	52
9	53
10	54
11	54
12	53
13	50
14	50
15	50
16	44
17	49
CRITERION	**55**

From Table V it is clear that night-time noise levels will be within the criterion of 55 dB(A) L_{eq} at all residences except residence 7, where the criterion is exceeded by 2 dB. This exceedance is considered acceptable, given that the calculated existing night-time noise level at this residence is 60 dB(A) L_{eq}, or 3 dB higher than the new level shown in Table V.

We conclude that if noise control measures are introduced to control the L_{10}(18hr) noise level to within the recommended criterion at all residences, night-time noise levels will also be acceptable.

7.0 CONSTRUCTION NOISE

Construction will proceed in several phases.

Initial clearing of the ground will be performed by bulldozers and scrapers. Graders and rollers will then prepare the surface for paving. A construction unit will typically consist of three scrapers, two large dozers, one small dozer, a grader, two rollers and a watercart. However, all this equipment would not operate near an individual residence simultaneously. At some locations, blasting may be required, we understand that such locations will be no closer than 800m to residences.

Construction will be carried out only between 7 am and 6 pm, Monday to Saturday.

The equipment which is assumed to be in operation during each phase of construction is shown in Table VI. In calculations, all the equipment listed was assumed to be operating at the point on the roadway which is closest to the residence in question, at the centre of the nearest carriageway. The effect of any possible barriers has not been included.

For clearing of ground and laying of pavement, all equpiment listed is assumed to be operating simultaneously. However, for laying of concrete, the equipment listed operates at different times, and the levels of the loudest item, the concrete leveler, is used.

Table VII shows calculated noise levels due to construction equipment at representative residential locations along the freeway route.

TABLE VI
ASSUMED CONSTRUCTION EQUIPMENT AND NOISE LEVELS

CONSTRUCTION PHASE	EQUIPMENT	NOISE LEVEL,dB(A) @ 7m
Clearing of ground	Large Bulldozer	85
	Grader	85
Earthworks	Large bulldozer	85
	Grader	85
	Scraper	85
	Roller	80
	Watercart	80
Laying of pavement	Asphalt truck	88
	Excavator	85
	2 x asphalt rollers	80 ea.
	Watercart	80
	Backhoe	85

TABLE VII
CALCULATED NOISE LEVELS DUE TO CONSTRUCTION ACTIVITIES

LOCATION	CALCULATED NOISE LEVEL, dB(A)			
	CLEARING	EARTHWORKS	LAYING PAVEMENT	CRITERION
1	72	76	77	60
2	65	69	70	60
3	65	69	70	60
4	70	74	75	60
5	71	76	77	60
6	64	68	69	71
7	78	82	83	71
8	69	73	74	71
9	70	74	75	69
10	72	76	77	67
11	72	76	77	65
12	69	73	74	63
13	62	66	67	60
14	56	60	61	60
15	59	63	64	60
16	59	63	64	60
17	65	69	70	60

From the above table, it is clear that construction noise levels exceed the recommended criterion at almost the all residences. The exceedances are up to 17 dB at residences 1 and 5. Noise levels are within the criterion at residence 6, and at residence 14 the exceedence is only 1 dB, which is not considered significant.

To control noise during construction of the proposed by-pass, we recommend that temporary barriers or hoardings be positioned between the roadway and all nearby residences. The barriers should consist of one sheet of 9mm compressed fibre cement. Their height should be at least 3m for residences 1-5, and 2.5m for the remaining residences. The barriers should extend for at least 100m on each side of the residences.

If permanent barriers are to be constructed adjacent to Grange Rd, these could be constructed before the by-pass, and would obviate the need for temporary barriers near residences 8-13.

With the barriers as recommended above, the noise levels from construction activities will be reduced to within the recommended criterion levels at all residences.

In relation to blasting, calculations indicate that with normal blasting practice, the SPCC criteria for both airblast overpressure and ground vibration will be met at a distance of 800m if the maximum instantaneous charge is less than 200 kg. We therefore recommend that charges be limited to this value. We also recommend that all blasts carried out within 2 km of residences be maintained to ensure that the SPCC criteria are met.

Before commencing construction activity in an area, it is recommended that public notification should be given by way of media release or letter drop to all potentially-affected residents.

8.0 RECOMMENDATIONS AND CONCLUSION

To control noise levels from the proposed Tomerong By-pass to within the recommended criterion levels, the following noise control measures are recommended:

- open graded asphaltic concrete, or similar noise-reducing road surface, should be used within 300 m of residences 1, 4 and 5 (shown on Figure 1), and from 300 m north of residence 9 to 300m south of residence 12.
- a solid barrier at least 2.5 m high should be constructed on the eastern side of Grange Rd, from the corner of the existing Highway to 100 m south of residence 12. The barrier would need to be designed to allow access to residences from Grange Rd, but without allowing line-of-sight to the road. It could be constructed of any suitable material, such as solid timber, which has a transmission loss greater than approximately 15 dB at 125 Hz.
- To control noise from construction activities, we recommend temporary barriers or hoardings be located near certain residences before construction begins. The barriers should be constructed from 9mm compressed fibre cement sheet or equivalent material, and should be 2.5-3m high, depending on the location. The permanent barriers described above could be used in place of these temporary barriers in some cases, provided they are installed before the construction of the roadway begins.
- To control noise and vibration from blasting, we recommend that the maximum instantaneous charge be limited to 200 kg, and that the noise and vibration from all blasts carried out within 2 km of residences be maintained to ensure compliance with SPCC criteria.

An alternative to the second measure listed above would be to re-design the by-pass to divert through traffic on Grange Rd onto the by-pass before residence 12.

With the above control measures, noise levels from traffic movements on the proposed by-pass during both daytime and night-time, as well as noise from construction activities, will be within the recommended criteria at all nearby residences. These noise levels are therefore considered acceptable.

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2. Robert Wilkinson and Ken B. Campbell, 1984. Effects of traffic noise on quality of sleep: Assessment by EEG, subjective report, or performance the next day. Jnl. Acoust. Soc. Am. 75(2)
3. R.D. Leach and M.L. Limb, 1985. The effect of road surface type on traffic noise. Aust. Road Research Board Jnl. Vol. 13, Pt. 4.

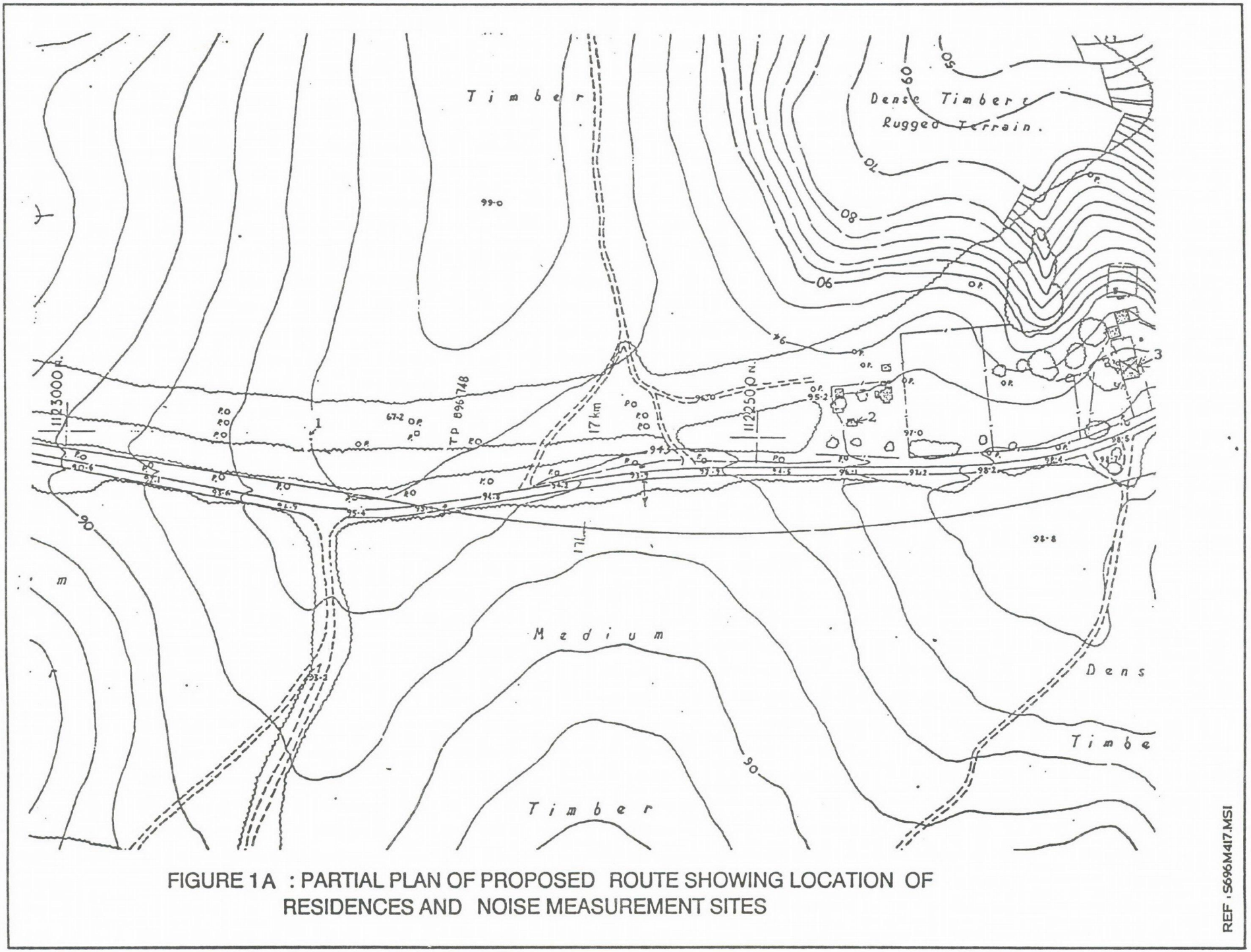

FIGURE 1A : PARTIAL PLAN OF PROPOSED ROUTE SHOWING LOCATION OF RESIDENCES AND NOISE MEASUREMENT SITES

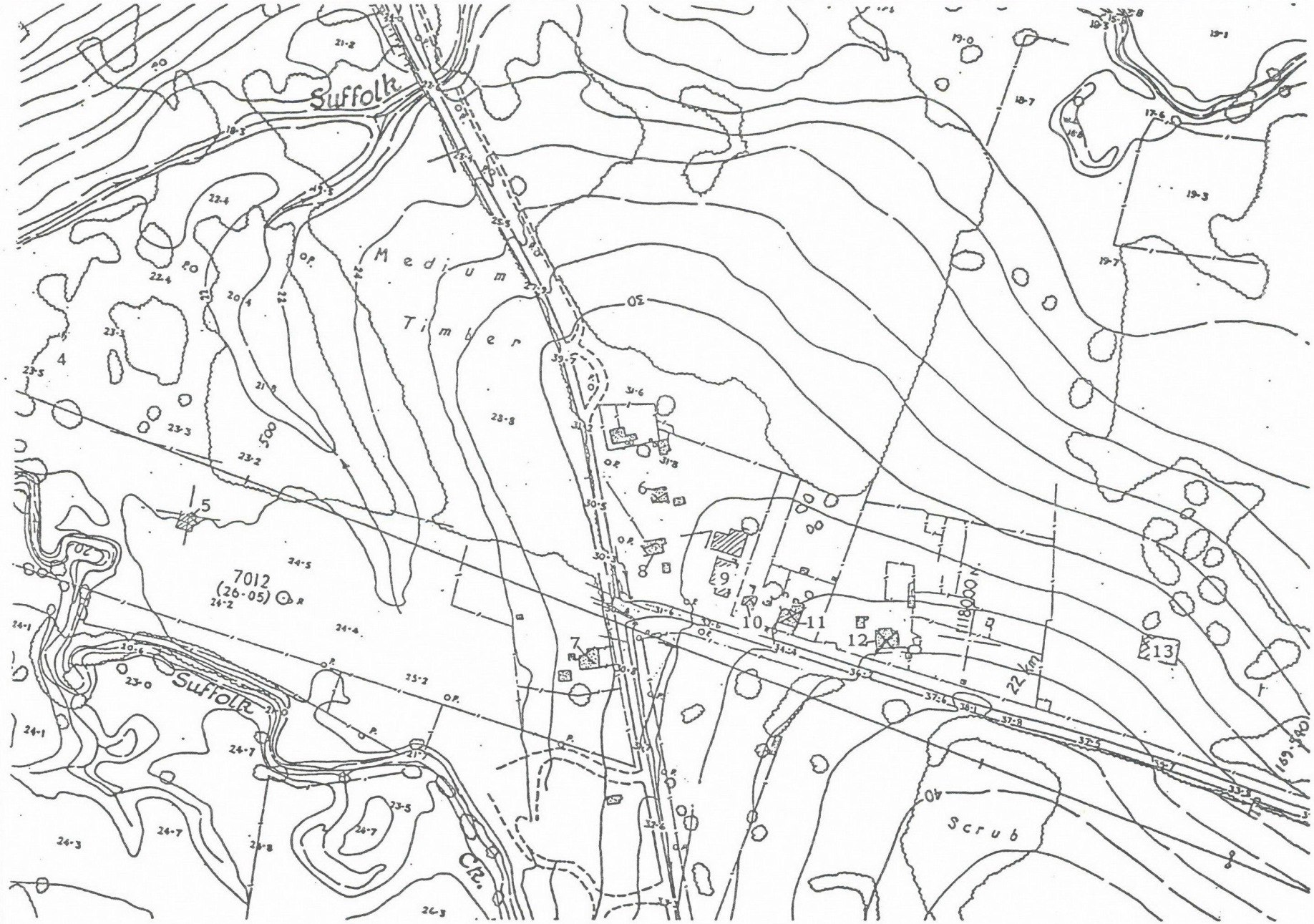

FIGURE 1B

REF : S696M418.MSI

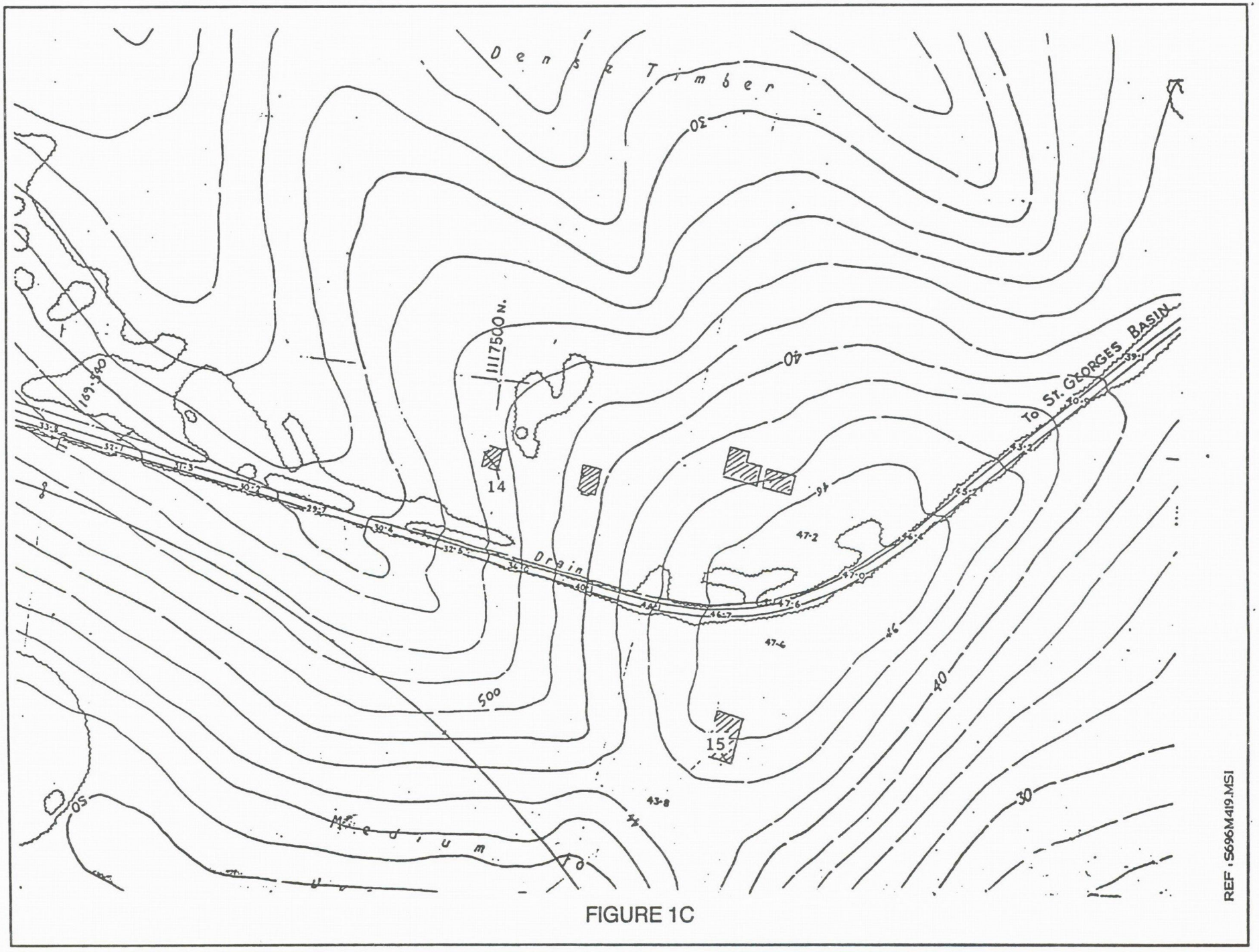
Dense Timber
30
40
46
500
1117500 N.
169.540
14
15
Drain
To St. GEORGES BASIN
Medium
47-2
47-6
43-8
REF : S696M419.MSI

FIGURE 1C

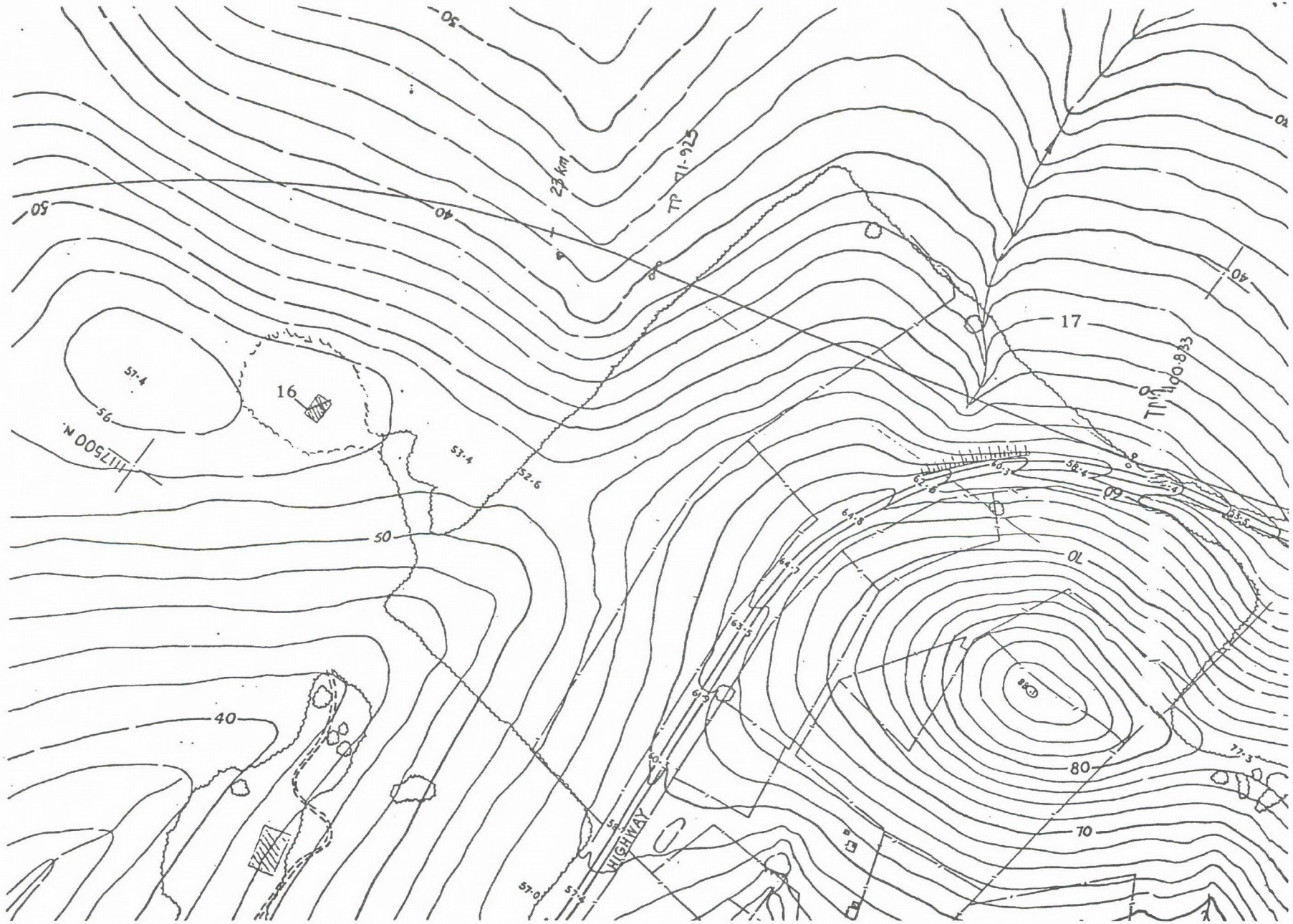

FIGURE 1D

REF : S696M420.MSI

8.6 STUDY TEAM

STUDY TEAM

This Environmental Impact Statement was prepared for the Roads and Traffic Authority of NSW by the following project team:

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