EIS 759

AB019421

Environmental impact statement for proposed titanium minerals mining, MLA 1 Coffs Harbour, 10km southeast of Nabiac, New South Wales

RZM

RZM PTY. LTD.

Prepared by Resource Planning Pty. Limited

RZM PTY. LTD

ENVIRONMENTAL IMPACT STATEMENT FOR PROPOSED TITANIUM MINERALS MINING, MLA 1 COFFS HARBOUR, 10KM SOUTHEAST OF NABIAC, NEW SOUTH WALES

PREPARED BY:

RESOURCE PLANNING
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May 1993

Form 4.

ENVIRONMENTAL PLANNING AND ASSESSMENT ACT, 1979 (SECTION 77 (3) (d)).

ENVIRONMENTAL IMPACT STATEMENT.

This Statement has been prepared by or on behalf of RZM Pty. Ltd..... ..... being the applicant making the development application referred to below.

The Statement accompanies the development application made in respect of the development described as follows:—

Titanium Minerals Mining, Wang Wauk

The development application relates to the land described as follows:—

No. ..... Street .....

Locality/suburb Wang Wauk

Real property description Portions 52, 89, Part Portion 238, Part Lots 260, 261, DP 39953, Lot 2, DP 518234, Pt ML1 and Part ML4.

(e.g. Lot, D.P./M.P.S., vol./fol., Parish, Portion)

The contents of this statement, as required by clause 34 of the Environmental Planning and Assessment Regulation, 1980, are set forth in the accompanying pages.

Name, Qualifications and Address of person who prepared Environmental Impact Statement

Valerie Smith, B.Sc., M.Sc., Hort.Cert.
Resource Planning Pty Limited
PO Box 388
EAST MAITLAND NSW 2323

Certificate.

I, Valerie Smith , of Resource Planning Pty Limited hereby certify that I have prepared the contents of this Statement in accordance with clauses 34 and 35 of the Environmental Planning and Assessment Regulation, 1980.

Signature

20th May, 1993.

Date

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SUMMARY

1.0 SUMMARY

RZM Pty Ltd seeks development consent from Great Lakes Shire Council to mine titanium minerals from an area of approximately 21.5 hectares in MLA 1 Coffs Harbour, 10km southeast of Nabiac.

The area to be mined comprises a central ore body of 19.7 hectares and two smaller leads covering an area of 6,500m^2 southwest and 8,000m^2 northwest of the central ore body. A smaller former titanium minerals stockpile area covering 3,700m^2 east of the main ore body will also be mined as part of this proposal.

The maximum total area to be disturbed including ancillary operations such as topsoil stockpiles, plant and dams is approximately 28 hectares or 9% of the total area of MLA 1 Coffs Harbour.

The proposed mining area is one of a number of residual ore bodies in the Wang Wauk area identified by RZM Pty Ltd. The Company is currently mining titanium minerals from an area approximately 4km south of this proposal near McClymonts Creek for which consent to mine was granted in 1990 (Plant 10 operations). Reserves in this area are nearing exhaustion and mining is expected to be completed in mid 1993. RZM Pty. Ltd. urgently seeks access to new reserve areas in order to ensure continuity of mineral supply and employment for existing personnel.

The Company has lodged a Development Application and accompanying Environmental Impact Statement for mining titanium minerals stockpile areas in the Wang Wauk area resulting from previous mining operations conducted in the late 1970's and early 1980's by Mineral Deposits Limited (Resource Planning Pty Limited 1993a). High concentrations of titanium minerals occur in these areas but mining of these residual stockpiles will take only one month to complete.

The Company urgently seeks access to the ore bodies identified in MLA 1 to ensure continuing supplies and personnel employment. Investigations have identified reserves in the order of 5850 tonnes of titanium minerals comprising rutile (27%), zircon (26%), and other (47%), the latter comprising a suite of less economically important heavy minerals.

Objectives of the proposal are to:

1. *Recover in the order of 5850 tonnes of titanium minerals from four separate areas covering approximately 21.5 hectares.*

2. *Provide continued employment for RZM Pty. Ltd. personnel in the area.*

3. *Provide a continuing supply of titanium minerals to the Company's operations.*

4. *Leave the mining site in a condition suitable for subsequent land use.*

The operations will be the same as those conducted in the McClymonts Creek area by RZM Pty Ltd. Dry mining methods utilising a front-end loader and dozer excavating to a maximum depth of 4m will be utilised to recover the mineral which will be concentrated in an adjoining plant and hauled to the Company's

Tomago mill for further refining. The residue will be returned as sand tailings to the excavation, where it will be shaped to a similar landform to the pre-mining landform and revegetated.

Operations will be conducted over a 24 hour period Monday to Friday and provide employment for 12 on-site personnel. Up to 3 trucks each weekday will haul concentrate from the site between the hours of 7:00am and 6:00pm daily on weekdays.

Mining will commence on the western side in the two smaller ore bodies and then progressively proceed from west to east over a period of some 14.5 weeks. The mining path width and depth determines the rate of progress of mining and hence the total area disturbed at any one time. Ancillary equipment and facilities are usually located as close as possible to the mining path to minimise total areas of disturbance. These ancillary operations will include topsoil stockpiling, access roads, feeder and plant sites, plant route, concentrate and tailings stockpiles, loader routes, and dam sites.

Rehabilitation follows progressively behind mining and not all of the total disturbed area is exposed at any one time. The frontal edge of rehabilitated ground is expected to be approximately 11 weeks behind the mining face, depending on the rate of fines produced and drying time. The majority of other disturbances will be rehabilitated immediately upon termination of their use.

The operation is a replacement for the Company's existing mining operations 4km to the south near McClymonts Swamp which utilises Old Aerodrome and Glen Ora Roads for the haulage of concentrate. The proposed development will replace this existing mining operation with no increase in traffic levels.

The proposed operations will not encroach upon nor disrupt flow in existing drainage lines. The permeability characteristics of the sand mass returned to the mined area will be similar to the pre-mining permeability conditions allowing infiltration of rainfall direct to groundwater and hence subsurface flows. Runoff from bedrock areas will not be altered.

Groundwater studies have shown that the water table is generally high except during prolonged dry periods and that dewatering will normally be necessary to permit dry mining operations. Proposals for dewatering, and management of seasonally wet areas will ensure that changes to groundwater levels will be temporary and short-term, minimising any potential deleterious effects on nearby plant communities. Initially it is expected that there will be a drawdown of the groundwater table in the immediate vicinity of the mining area, water supply bores and dams. However, water returned with the tailings will infiltrate the porous sands to recharge the groundwater table.

Soil studies have shown that no acid sulphate soils (catclays) occur in the areas to be mined by the Company. Consequently, the large scale release of acids and the consequent mobilisation of iron and aluminium as a result of oxidation of acid sulphate soils will not occur or affect nearby vegetation communities. Previous studies of the effect of titanium minerals mining on groundwater quality in the Tomago Sandbeds (Viswanathan 1987, Warne et al, 1989) indicate that there may be some initial change in soluble iron and sulphate levels but the mechanism for these changes cannot be defined, nor is there any evidence that

these levels are maintained over an extended period or have a detrimental effect on regenerating or adjacent undisturbed native vegetation.

Air quality controls will ensure that dust from traffic on gravel access roads and stockpiles will not be a nuisance at nearest residences.

Within the proposed mine path approximately 21 ha of vegetation will be cleared. It is expected that an extra 20% to 30% of surface clearing will be associated with services. Of the mine path 9.3 ha is swamp sclerophyll communities and 6.8 ha of wet heath and sedgelands. These communities are represented within some of the nature reserves along the mid north coast of New South Wales. They also occur throughout the Forster – Tuncurry region. Within the immediate local area these communities have been modified by titanium minerals mining activities.

Revegetation of the mine path will mitigate the effects of clearing in the long term. Due to changes in microtopography and species diversity of the area, post mining vegetation communities will be expected to possess somewhat different properties to those occurring premining.

It is proposed that bedrock area and areas adjoining the bedrock within the private lands on Portions 52 and 89 will be established with pasture grasses. The area to be established as pasture will not have a significant impact on vegetation and fauna values of the area post mining. In the long term the pasture will potentially introduce weed species to the edges of the regenerating mine path and this could be controlled through management of weeds within the regenerating area.

The proposed haul route is an existing four wheel drive track traversing previously mined area to the northeast of the mine path. This section of the haul route will require minimal to no clearance of vegetation. Where the haul route adjoins the mine path there will be disturbance of forested communities 4, 6, 9, 10 and 11 (see ***Figure 8****).*

Records of ***Allocasuarina defungens*** *are restricted to the Nabiac area in dry shrub and heath communities.* ***Allocasuarina defungens*** *has been assigned a 2E category by CSIRO ie. occurs over a range of less than 100km and is at serious risk of disappearing (Cleland et al, 1992). Any specimens of* ***Allocasuarina defungens*** *located during works will be fenced and a 20m wide buffer of natural vegetation retained.*

In 1985, State Environmental Planning Policy 14 (SEPP 14) – Coastal Wetlands was gazetted with the aim of ensuring that the environmental values of coastal wetlands are preserved and protected.

One hundred and twenty five metres (125m) to the north, northwest of the proposed mine path is located a small SEPP 14 Wetland No. 594 of 1.3 hectares (see ***Figure 8****). The wetland is classified as a sedgeland community dominated by* ***Baumea articulata****.*

The SEPP 14 wetland will not be directly disturbed by clearing or access road construction. A buffer of Swamp Sclerophyll communities between the wetland and mine path will lessen indirect impacts. There is a potential for indirect impacts through short term changes in depth of the water table during mining

operations. It is unlikely that there will be any long term impact on the ecology of the SEPP 14 wetland.

Impacts on the fauna of proposed mining in the MLA include loss of habitat, loss of foraging habitat, loss of diurnal roosts for bats, noise and disruption of wildlife corridors. Clearance of natural vegetation will occur over a period of 14.5 weeks. All fauna habitats associated with the mine path will be disturbed resulting in potential localised loss of protected fauna species.

The proposed haul route is an existing four wheel drive track traversing mined areas and natural forested and wet heath communities. The track is an existing potential barrier to the free movement of small mammals. Upgrading of the road will increase the impact of the road as a barrier to the movement of small mammals for the duration of the operation. Rehabilitation of the haul road within the MLA would in the long term ameliorate this impact. The risk of road kills of larger animals will be increased by increased usage of the road during mining period between the hours of 7am and 6pm. To minimise this impact it is recommended that vehicular speed is limited to 60km/hr.

The likely impact of the proposed mining operations on endangered and protected fauna of the area was assessed based on the seven point test of significance as established in Section 4A of the Environmental Planning and Assessment Act 1979.

From assessment of the seven point test of significance it appears that the proposed mining activity will not significantly affect the environment of endangered species. Accordingly, a fauna impact statement will not be required for the proposed mining activity.

INTRODUCTION

2.0 INTRODUCTION

2.1 OBJECTIVES AND OUTLINE OF THE PROPOSAL

RZM Pty Ltd seeks development consent from Great Lakes Shire Council to mine titanium minerals from an area of approximately 21.5 hectares in MLA 1 Coffs Harbour, 10km southeast of Nabiac. The location of the site is shown on **Figure 1**.

The area to be mined comprises a central ore body of 19.7 hectares and two smaller leads covering an area of 6,500m^2 southwest and 8,000m^2 northwest of the central ore body. A smaller former titanium minerals stockpile area covering 3,700m^2 east of the main ore body will also be mined as part of this proposal.

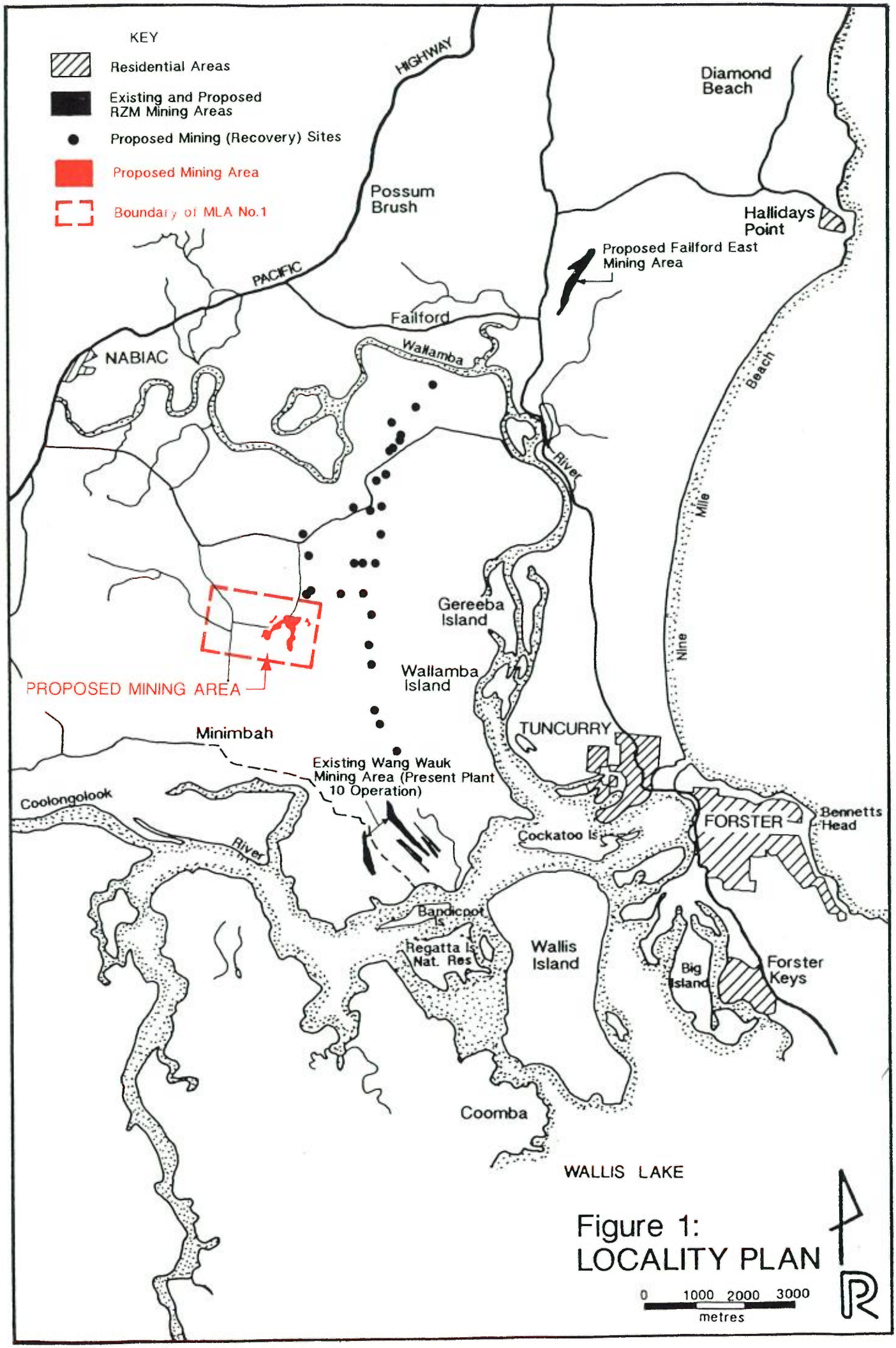
The maximum total area to be disturbed including ancillary operations such as topsoil stockpiles, plant and dams is approximately 28 hectares or 9% of the total area of MLA 1 Coffs Harbour.

The proposed mining area is one of a number of residual ore bodies in the Wang Wauk area identified by RZM Pty Ltd. The Company is currently mining titanium minerals from an area approximately 4km south of this proposal near McClymonts Creek for which consent to mine was granted in 1990 (Plant 10 operations). Reserves in this area are nearing exhaustion and mining is expected to be completed in mid 1993. RZM urgently seeks access to new reserve areas in order to ensure continuity of mineral supply and employment for existing personnel.

The Company has lodged a Development Application and accompanying Environmental Impact Statement for mining titanium minerals stockpile areas in the Wang Wauk area resultant from previous mining operations conducted in the 1970's early 1980's by Mineral Deposits Limited (Resource Planning Pty Limited 1993a). High concentrations of titanium minerals occur in these areas but mining of these residual stockpiles will take only one month to complete.

The Company urgently seeks access to the ore bodies identified in MLA 1 to ensure continuing supplies and personnel employment. Investigations have identified reserves in the order of 5850 tonnes of titanium minerals comprising rutile (27%), zircon (26%), and other (47%). The latter comprising a suite of less economically important heavy minerals.

The operations will be the same as those conducted in the McClymonts Creek area by RZM Pty Ltd. Dry mining methods utilising a front-end loader and dozer excavating to a maximum depth of 4m will be utilised to recover the mineral which will be concentrated in an adjoining plant and hauled to the Company's Tomago mill for further refining. The residue will be returned as sand tailings to the excavation, where it will be shaped to a similar landform to the pre-mining landform and revegetated.


KEY
Residential Areas
Existing and Proposed RZM Mining Areas
Proposed Mining (Recovery) Sites
Proposed Mining Area
Boundary of MLA No.1
HIGHWAY
Diamond Beach
Possum Brush
Hallidays Point
Proposed Failford East Mining Area
PACIFIC
Failford
NABIAC
Wallamba
River
Mile
Nine
Beach
Gereeba Island
PROPOSED MINING AREA
Wallamba Island
TUNCURRY
Minimbah
Existing Wang Wauk Mining Area (Present Plant 10 Operation)
Coolongolook
River
Cockatoo Is
FORSTER
Bennetts Head
Bandicoot Is
Regatta Is Nat. Res
Wallis Island
Big Island
Forster Keys
Coomba
WALLIS LAKE
Figure 1:
LOCALITY PLAN
0 1000 2000 3000
metres

1008/92502

Operations will be conducted over a 24 hour period Monday to Friday and provide employment for 12 on-site personnel. Up to 3 trucks each weekday will haul concentrate from the site.

Objectives of the proposal are to:

1. Recover in the order of 5850 tonnes of titanium minerals from four separate areas covering approximately 21.5 hectares.

2. Provide continued employment for RZM personnel in the area.

3. Provide a continuing supply of titanium minerals to the Company's operations.

4. Leave the mining site in a condition suitable for subsequent land use.

2.2 BACKGROUND

RZM Pty Ltd identified the ore bodies in this area during reconnaissance drilling within Exploration Licence 3066 in June 1992. Further more detailed drilling and resource evaluation were undertaken in February 1993 and Mining Lease Application No. 1 Coffs Harbour was lodged on 25th November 1992 under the Mining Act, 1992. MLA 1 covers a total area of 308 hectares.

2.3 LAYOUT OF THE IMPACT STATEMENT

Mining operations are listed in Schedule 3 of the Environmental Planning and Assessment Regulation, 1980 and as such, constitute 'designated development', as defined in the Environmental Planning and Assessment Act, 1979. Development consent for the proposal is necessary and being a designated development, an Environmental Impact Statement must accompany the development application. Resource Planning Pty Limited has been commissioned by RZM Pty Ltd to prepare the Statement on its behalf. Pursuant to Clause 35 of the Regulation, the Department of Planning has been informed of the proposed development and advice regarding the form, content and specific matters to be addressed in the Statement is provided in **Appendix 1**.

The impact statement has been divided into a number of sections to facilitate reading of the document. The sections are inter-related and basic data to support statements or conclusions made in one section of the statement may be found in other parts of the document. The reader is advised to read the Table of Contents carefully to locate all information of interest. As a further aid to locating information in the statement, the following notes outline for the reader the layout adopted for the impact statement.

SECTION 1.0 SUMMARY

Section 1.0 summarises the findings of the environmental investigations.

SECTION 2.0 INTRODUCTION

The introduction presents the objectives and brief outline of the proposed development as required under **Clause 34b** of the Regulations. It also describes the background to the development, statutory requirements and layout of the impact statement.

SECTION 3.0 JUSTIFICATION FOR THE DEVELOPMENT

This section describes the Company's activities, demand and use of titanium minerals; and describes the Company's need for access to the new area based on economic, environmental and social considerations in accordance with **Clause 34f** of the Regulations.

SECTION 4.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

Base-line investigations were carried out to establish the characteristics of the existing environment of the site and its surrounds. This information was used in the design of the mining operation and in assessing the impacts of the proposal.

This section presents a description of the natural, physical and man-made features of the site together with social and economic factors (**Clause 34c** of the Regulations).

Supporting data are found in the accompanying appendices.

SECTION 5.0 DESCRIPTION OF THE PROPOSED DEVELOPMENT

This section provides full details of the proposed development including mining and processing operations, operator facilities, services, haulage, workforce and other operational considerations including a programme for rehabilitation of the areas disturbed by the mining operation (**Clause 34a** of the Regulations).

SECTION 6.0 ENVIRONMENTAL MANAGEMENT PROCEDURES

The management and planning measures required to protect the environment and to mitigate adverse impacts of the project are described in this section. These include measures for the protection of water quality, control of dust and noise, protection of archaeological sites, habitat management and rehabilitation procedures. Details of the measures to be taken to conserve energy and to maximise the resource yield are also described (**Clauses 34g** and **34g1** of the Regulations).

SECTION 7.0 ANALYSIS OF ENVIRONMENTAL INTERACTIONS AND IMPACTS

This section examines the effectiveness of the measures outlined in **Section 6.0** to protect the environment and provides an assessment of the residual environmental effects. Both adverse and beneficial aspects are described in accordance with **Clauses 34d** and **34e** of the Regulations. **Sections 2.0** to **6.0** provide and describe the basic data to be considered in the assessment of impacts.

SECTION 8.0 ALTERNATIVES

This section describes the alternatives to the proposed development as required under **Clauses 34h** and **34i** of the Regulations. These include alternative mining methods, haul routes and other operational details as well as the alternative of not proceeding with the development.

2.4 STATUTORY REQUIREMENTS

Department of Planning

As indicated above, the Department of Planning was consulted in accordance with the requirements of the Environmental Planning and Assessment Act 1979 and Regulations 1980. Specific issues advised by the Department to be addressed in the impact statement are outlined below and the sections of the document in which those matters are addressed are noted:

* An overview of past and current sand mining operations in the vicinity of this proposal (**Sections 2.1** and **4.17.5**).

* Description of the stages of development, with a clear synopsis of the resources proposed to be extracted, the potential for the occurrence of these resources particularly within the wetland regions, and the justification for the proposal in terms of supply of, and demand for sand resources (**Sections 3.0** and **4.4**).

* Description of the existing environment clearly identifying areas mapped under SEPP 14 provisions; evaluation of the existing flora and fauna including an analysis of the habitat values present, survey to identify any rare or endangered plants and animals including:

    1. A vegetation survey and map (preferably at a scale of 1:4,000) to particularly indicate the occurrence of any rare or threatened plant species, their values and the extent of any weed infestation (**Section 4.9** and **Figure 8**).

    2. A faunal survey describing the birds (both indigenous and migratory), reptiles, amphibians and mammals (including bats) of

the area and the occurrence of any rare or threatened and protected species (**Section 4.10**).

* Discussion of the direct and indirect environmental implications of the proposal including but not limited to the following:

  1. An assessment of the changes in the distribution and abundance of plant and animal species (**Sections 7.7**, **7.8**, and **7.9**).

  2. A description of measures proposed to be taken to guard against actual and potential disturbances to the vegetation, fauna, water quality and hydrological regime during the construction and operation of the proposal. It should include consideration of possible effects on SEPP 14 wetlands not included in the development proposal (**Sections 6.1.1**, **6.5** and **6.6**).

* An analysis of the surface and groundwater quality and hydrological regime; description of measures proposed to be taken to preserve water quality in both surface and groundwater, including sediment control management (**Sections 4.6** and **6.1**).

* Description of proposed site and access rehabilitation plans with methods of reformation and revegetation, including plans of the final landform (**Sections 4.0** and **6.6**, **Figure 13**)

* Identification of potential acid sulphate soils; if located on the site, description of proposed management measures (**Section 4.5**).

* Flooding issues (**Section 4.6.3**).

* Road and traffic impacts (**Sections 4.19** and **7.18**).

* Results of consultation.

  - Department of Mineral Resources
  - National Parks and Wildlife Service
  - Environment Protection Authority
  - Department of Conservation and Land Management
  - NSW Agriculture
  - NSW Fisheries
  - Roads and Traffic Authority
  - Department of Public Works (**Appendix 1**).

In accordance with the Department of Planning's requirements all relevant Government authorities were consulted regarding the proposed development. All responses received are provided in **Appendix 1** and summarised below. No response was received from either the Roads and Traffic Authority or Great Lakes Shire Council.

Department of Mineral Resources

The Department advised that it fully supported the proposals for mining in the Parish of Wang Wauk and sought an Environmental Impact Statement of a similar standard as previously prepared for mining proposals in the Waug Wauk area. The Department requested examination of a draft prior to distribution to other organisations.

National Parks and Wildlife Service

The Service required consideration to be given to rare and endangered plants, rare and endangered animals, Aboriginal sites, and European historic sites. The Service advised that a rare **Allocasuarina sp.** exists in the general locality and surveys should pay particular attention to this plant. The possibility of the presence of Koalas was also raised and investigated during the field surveys (**Section 4.9** and **4.10**).

The service provided details of comments made during a site inspection and these are provided in **Appendix 1**.

Environment Protection Authority

The Environment Protection Authority required that the Environmental Impact Statement address those matters relating to the statutory responsibilities of the Environmental Planning and Assessment Act under the Clean Waters, Clean Air, and Noise Control Acts.

Specific comments made were:

* Possibility of pollution of waters both surface and underground should be considered (**Sections 6.1**, **7.4** and **7.5**).

* If discharge of wastewater, methods proposed to detain or treat such wastewater (**Section 6.1**).

* If dredging, the Environment Protection Authority's formal approval would be required. (No dredging to be undertaken).

* Potential for impinging on Wetlands designated under SEPP 14 (**Section 7.8**).

* Methods for control of dust from stockpiles, access roads, exposed areas, etc., (**Section 6.4**).

* If sand separated by dry methods then the process will require the Environment Protection Authority's approval.

* Approval from the Environment Protection Authority under the Noise Control Act supported by an acoustic study (**Appendix 4**).

* Predicted future noise levels, and noise level increase, to be set out in the Environmental Impact Statement in accordance with the Environment

Protection Authority guidelines (i.e., no greater than 5dB(A) above the background level L_{A90} when measured at nearest affected residence) (**Appendix 4**).

Department of Conservation and Land Management

The Department advised that it sought the following to be addressed in the Environmental Impact Statement.

1. Description of the Mining Proposal

Part of the area under consideration is Crown Land. Therefore, the Department requested that the Environmental Impact Statement should explain, in full detail, the nature of the proposed mining activity. This explanation should include where relevant:

* An outline of the project objectives. (**Section 1.0**).

* A full, detailed description of the mining process to be used, including equipment, project dimensions, the size of the areas affected by direct mining, stockpiles, road, etc. (**Section 5.0**).

* A description of the time scale of operations, i.e., how long the project is expected to last; what rate the mining plant will move through the area, what is the ratio of land directly affected by mining plant at any given time as opposed to the overall size of the MLA area; what is the expected daily timetable of operations, etc., (**Section 5.0**).

* A full description of the effects of the project on the site, including physical presence; aesthetics; atmospheric emissions; dust; liquid/solid releases; the presence of tailings; slurry, etc; noise; light; heat; transport movements and other human activity (**Section 7.0**).

* A description of likely off site impacts – traffic/transport densities; road damage; noise; dust; changes to watertable, water supply, etc., (**Section 7.0**).

* An estimation of the social and economic changes expected to be wrought by the project. This should include both positive and negative aspects, e.g., income generation, employment opportunities, cost of damage to roads, pollution, etc., (**Sections 3.2** and **7.0**).

2. A Description of the Existing Environment

The Environmental Impact Statement should provide an accurate and comprehensive description of the existing (pre-mining) environs. This will establish 'baseline' information against which impacts can be predicted, measured and evaluated. This section should include a detailed inventory of the biophysical characteristics of the site (land type, soil, hydrology, flora and fauna) as well as socio-economic factors (land use, existing services, etc). (**Section 4.0**).

3. Impact Identification, Evaluation and Mitigation

On the basis of the information provided in the two sections above, the Environmental Impact Statement should then list clearly (and quantify, if possible) the environmental changes likely to be caused by the mining activity, and describe accurately the expected site conditions that will prevail after mining is complete. Off site impacts in connection with the project should also be documented (**Sections 6.0** and **7.0**).

Issues to be addressed/considered would include:

* Impacts on the surrounding community (**Sections 7.10**, **7.11**, **7.14**, **7.15**, **7.17**, **7.18**, **7.19**, **7.20**, **7.21**).

* Impacts on the natural environment (**Sections 7.1**, **7.2**, **7.3**, **7.4**, **7.5**, **7.6**).

* Impacts on items of aesthetic, recreational, archaeological, historic, scientific or social significance (**Sections 7.12**).

* Possible endangering of flora and fauna species (**Sections 7.7**, **7.8**, and **7.9**).

* Long term effects on the environment (**Section 7.0**).

* Possible sterilisation or negative effects on future land use options (**Section 7.14**).

* Possible pollution of the environment (both on and off site) (**Section 6.0**), and

* Problems associated with disposal of wastes and transport of materials (**Section 6.1** and **6.3**).

With regard to mitigation of possible undesirable impacts, the Department requests that specific plans and explanations be included for:

* Erosion and sedimentation control (in the construction, mining and decommissioning phases of the project) (**Sections 6.1** and **6.6**).

* Restoration control plans – vegetation, fauna, landscape, weeds, soils. Where possible, these plans should be adaptive and progressive (i.e., designed to operate throughout the life of the project) rather than reactive in nature (**Section 6.6**).

* A protection plan/strategy relating to flora and fauna (**Section 6.5**).

4. Other Departmental Requirements

The land in question is considered a valuable Crown resource which is in close proximity to existing human habitation and development. The Department has a responsibility to ensure that the area will be restored to a condition that will leave

it capable of accepting a range of suitable uses in the future. In this regard, the following points are made:

* The site must be left free of any toxic residues, chemicals or other substances or conditions that will affect future land use options (including the possibility of use for residential purposes).

* The Department would expect that the Environmental Impact Statement includes provisions whereby RZM acknowledges its responsibility to institute, monitor and make public necessary impact amelioration and restoration processes (**Section 5.0**).

* The Environmental Impact Statement should attempt to incorporate a measure of public participation and consultation, in particular, input from local residents who will be affected by the proposal.

* The Environmental Impact Statement should address the major aspects of soil conservation (**Sections 5.3** and **6.1**).

* The potential for wind erosion of stockpiles and other disturbed areas will require close attention due to the sandy nature of the soil (**Sections 4.5.3** and **6.6**).

* Any clays encountered during sampling should be assessed as to their acid sulphate potential (**Section 4.5.2**).

NSW Agriculture

The Department requires a full description of the agricultural potential of the area and surrounding lands. Specific matters raised by the Department were:

* That the operation of the site should not disadvantage primary producers through increased dust, noise, vehicle movements or other adverse factors (**Sections 7.6, 7.10** and **7.18**).

* That appropriate erosion control structures/practices are implemented (**Sections 5.4** and **6.1**).

* That the quality of surface and subsurface waters are not compromised (**Section 7.4**).

* That appropriate weed control practices are implemented (**Section 6.6.3**), and

* That, after extraction, the site should be rehabilitated to achieve at least its former agricultural productive potential (**Section 6.6**).

NSW Fisheries

The NSW Fisheries required the following matters to be addressed in the Environmental Impact Statement.

* The vegetation of the site (**Section 4.9**).

* The likely presence of aquatic fauna (**Section 4.10**).

* The possible impact of mining and ancillary activities on water quality (**Section 7.5**).

* Methods to ameliorate these impacts (**Section 6.1**).

Department of Public Works

The Department sought the following:

* Restoration of the site as close as possible to its natural contours and revegetated to the satisfaction of the Department of Conservation and Land Management (**Section 6.6** and **Figure 13**).

* Advised that the subject land is low lying and sections of the proposed access routes would be flood liable. The Department advised that the peak water level for 1% Annual Exceedance Probability Flood conditions in the Wallamba River adjacent to the subject land is estimated to be approximately 2.5m AHD.

* Any proposed extraction and/or stockpiling of overburden material and sand to have regard to the floodplain management policy of Great Lakes Shire Council and Government's "Floodplain Development Manual".

2.5 RZM PTY LIMITED

RZM Pty Ltd was formed in 1962 by the merging of two established titanium minerals mining companies, National Minerals Ltd and Coffs Harbour Rutile N.L. These were owned respectively by Peko Wallsend Operations Ltd and Kathleen Investments Ltd. In 1989, the transfer of Peko's equity to Coffs Harbour Rutile N.L. ended this joint venture. In early 1990 RZM Pty Limited became a wholly owned subsidiary company of Nissho Iwai Corporation.

The Company's operational headquarters and processing mill are located at Tomago, north of Newcastle. Approximately 190 people are employed by RZM Pty Ltd with mining currently being undertaken at four sites located at Tomago, Williamtown and Medowie in Port Stephens Shire, and at Nabiac in Great Lakes Shire. Approximately 10 million tonnes of sand are mined each year, recovering in the order of 35,000 tonnes each of rutile and zircon.

2.6 PROJECT MANAGEMENT

The Environmental Impact Statement was prepared by Resource Planning Pty Limited in conjunction with RZM Pty Limited. The study team comprised:

Resource Planning Pty Limited

Valerie Smith **B.Sc.(Hons), M.Sc., Hort.Cert.**	– Project Management – Report Writing & Editing
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RZM Pty Ltd

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JUSTIFICATION FOR THE PROPOSED DEVELOPMENT

3.0 JUSTIFICATION FOR THE PROPOSED DEVELOPMENT

3.1 ECONOMIC CONSIDERATIONS

3.1.1 Production

In recent years improved markets for titanium minerals have instigated a resurgence in exploration and mining on the eastern seaboard.

More recently increased production from some overseas countries has caused a relative reduction in Australia's market share in most titanium minerals. Australia's relative market share has been steadily decreasing since the 1970's under the effects of this type of competition. However, Australian titanium minerals product derives its market standing from the exceptional metallurgical quality of both rutile and zircon compared to US and African concentrates.

In 1984 Australian production accounted for about 55% of world production for rutile, 70% for zircon, 60% for monazite and 25% for ilmenite. The decline in the Australian market share to this time was primarily due to reduced production in New South Wales resulting from sterilisation of many deposits by imposed land use constraints and depressed overseas markets (Department of Mineral Resources, 1985).

On a national basis in 1990/91, the east coast (New South Wales and Queensland), accounted for 68% of rutile, 34% or zircon, and 7% of the ilmenite production in Australia. The remainder of Australian production came from Western Australia (Australian Bureau of Statistics, 1992). RZM Pty. Ltd. produced approximately 60,000 tonnes of product in that financial year which comprised 40% of New South Wales rutile production and 60% of zircon production for the 1991/92 financial year.

3.1.2 Uses

Rutile and zircon will be the main products with monazite and ilmenite being of little importance in the products from the proposed mining site. These minerals are used in a wide range of general applications as well as in highly specialised areas ranging from the paint and steel industries, ceramics and refractories through to the aerospace industry. They are of considerable economic and technological importance to developing Australian and international industries. Some of these uses are outlined below.

Rutile – TiO_2 (Titanium Dioxide)

Rutile is primarily used for the production of "titanium white", the most efficient, non–toxic white pigment. This pigment is used in most white based paints, paper, plastics and a variety of other products.

Another major use of rutile is flux coating for steel welding rods, while a lesser, but probably more publicised use is in the smelting of titanium metal for the aerospace industry and medical uses.

A modern passenger jet aircraft for example, may contain in excess of 25 tonnes of titanium and its structure is highly dependent on the metal for overall stability. Titanium has a high strength to weight ratio, is heat stable and has good resistance to prolonged cycles of fatigue.

Titanium is used in internal body implants (pacemakers, pins and many other prosthesis applications) as it is relatively biochemically inert and does not react adversely within the human body.

There are many exotic uses in other new technology areas due to the various physical and chemical properties of both rutile and titanium metal.

Zircon – $ZrO_2.SiO_2$

An important use of zircon is as moulding material in the manufacture of metal castings. Because of zircon's chemical and temperature stability, volume stability, good bonding and high thermal diffusivity, it is used extensively as a casting medium and as furnace and ladle linings in the steel and nonferrous metal industries. Zirconia, produced from the primary zircon, is used for the smelting of zirconium metal.

Zircon and zirconia are highly refractory, erosion and corrosion resistant and quite inert in most high temperature environments. They are found extensively in the three main types of refractories: slip cast (1800°C), zircon–alumina (glass applications) and zirconia refractories (2000°C).

The various ceramics industries are also major users of zircon where it is used both as a pigment base (white) and in the manufacture of the ceramics themselves. The white base pigment is used in quality sanitary ware, dinner sets, wall tiles and white wares. Refined zirconia is the basis for the new ceramics used in engines, cutting edges, piezo–electric devices, metal grinding wheels and wire drawing dies.

Various zirconium compounds are produced for use in leather tanning, textiles, pharmaceuticals and pigment fixing agents.

Ilmenite – $FeO.TiO_2$ (Iron Titanium Oxide)

Ilmenite is commonly used for the manufacture of white pigment. However, as East Coast ilmenite has a high chromite content it is presently unsuitable for this purpose. This material is used as a sandblasting abrasive whilst further use is made of it as an additive in iron smelting.

Monazite – $(Ce,La,Th)PO_4$ and Xenotime YPO_4

These are classified as phosphates of the rare earths and are produced as concentrates for the refinement of rare earth metals and compounds. The compounds find application in lighter flints, polishing powders, ceramic rare earth magnets, sunglasses colouring and television phosphor coatings.

3.1.3 Locational Factors

Titanium minerals originate in rocks of the coastal ranges and are washed to the coast during favourable periods of high runoff. Because of their extremely high resistance to abrasion and chemical attack, the minerals have accumulated over time in the dunes and the ancient strandlines of the coast.

Due to the changes in the configuration of the coastline over geological time (in plan as well as elevation) economically viable deposits of titanium minerals sands can occur up to 15km inland from the present coastline in the old dunes and prior strandlines.

The New South Wales coast is, because of geographical and social considerations, the most densely populated section of the state. Consequently, there are social pressures and competition between alternate land uses such as housing, recreation, conservation and tourism. Many large economic deposits occur within National Parks and on present beaches where mining is prohibited. Elsewhere, most of the higher grade coastal deposits have already been mined and mining is now confined to lower grade deposits further inland.

Due to increasing land use constraints associated with titanium minerals mining it is essential to utilise any remaining deposits which are still accessible and can be worked without causing unacceptable environmental damage. The proposed recovery of remnant titanium minerals from MLA 1 will ensure utilisation of a valuable resource which may in the future be sterilised by land use constraints. The relatively small reserves of titanium minerals within the site necessitates that the material be recovered in conjunction with other operations in the area to be economically viable. Approval of the proposed operation within the mining life of other operations in the area will ensure maximisation of resource utilisation.

3.1.4 Future Demand

The market for titanium dioxide (pigment grade rutile) is currently returning in the order of $500/tonne FOB in Australia. Zircon is also attracting interest from zirconia manufacturers for use in high temperature ceramics and other areas of new technology. Zircon is currently returning in the order of $170/tonne FOB in Australia. The prices for these commodities are subject to the realities of international markets and available stockpiles, with considerable fluctuation possible over a twelve month period.

3.1.5 Flow On and Multiplier Effects

Flow on effects in local manufacturing and wholesale operations are of considerable importance. Within the mining industry, indirect employment in allied service industries can be of the order of 3–4 times that of the direct mining enterprise. With this in mind the value of the proposal to the local and regional economy can be readily appreciated.

The "multiplier effect" is an economic term which relates to the changes in spending patterns in the community which may arise from a change in investment. In times of recession an increase in investment can give rise to increased employment and consumer confidence and a general increased level

of spending in the community. This will, in turn, result in secondary increases in employment levels and further increases in the level of spending and so on accumulating to a multiplied increase in the overall economic well-being of the community (Jackson and McConnell, 1980).

Depending on the attitude of the community towards saving or consumption the multiplier may be in the order of 2-10 times the value of the initial investment spending.

In todays recessionary economic climate, it is therefore a valid strategy to sustain levels of investment in industry as a valuable buffer against the overcontraction of the economy. In view of the damage that could be caused to the local and regional economies by disinvestment in this industry there is ample economic justification for proceeding with the project on the assumption that no major externalities occur (eg. environmental or social costs).

3.2 SOCIAL CONSIDERATIONS

The proposed operation by RZM Pty. Ltd. will have no detrimental effect on population growth, distribution or structure in the area. The new operation will constitute a continuation of work for the current employees.

The mining operation will provide continued direct employment for 12 full-time employees and various contractors in this area for a period of about 14.5 weeks on an individual basis, but a longer period when considered as part of the overall mining project in the Nabiac area. These employees are currently dependent upon existing operations in the area which will be completed towards the end of 1993. Continuity of operation will also indirectly ensure the economic efficiency of the Company's processing mill at Tomago and hence the job security of personnel at this operation.

The Company purchases most of its spares, tyres, fuel and other supplies from outlets in the local community. In this respect, the new operation will also provide a minor but useful positive impact on the local community and economy in the current period of recession.

3.3 ENVIRONMENTAL CONSIDERATIONS

The environmental issues raised by the Department of Planning, other Government authorities, and those issues required to be addressed under the Environmental Planning and Assessment Act (1979) and Regulations (1980) have been addressed in this document.

Potential adverse environmental impacts on the natural and made environments caused by the proposed development will be mitigated by the mine planning, operational procedures and environmental controls which will be applied to this project.

DESCRIPTION OF THE EXISTING ENVIRONMENT

4.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 LOCATION AND LAND OWNERSHIP

MLA 1 Coffs Harbour covers an area of 308 hectares, 10km southeast of Nabiac as shown on **Figure 1**. The area is partly Crown Land and partly in private ownership as shown on **Figure 2**.

Mining activities are primarily located within Portion 52 owned by V.M. Weller and on the Crown land portions ML 1 and ML 4. Only a small area of Portion 89 owned by J.J. and C.I. Sultana will be subject to mining.

4.2 TOPOGRAPHY

The area to be mined is generally low lying with an average elevation of 7m AHD. It abuts a bedrock high on the western margin which rises to an elevation of 13m AHD and which forms an elongated ridge extending from more western bedrock areas.

4.3 GEOLOGY AND GEOMORPHOLOGY

4.3.1 Regional Setting

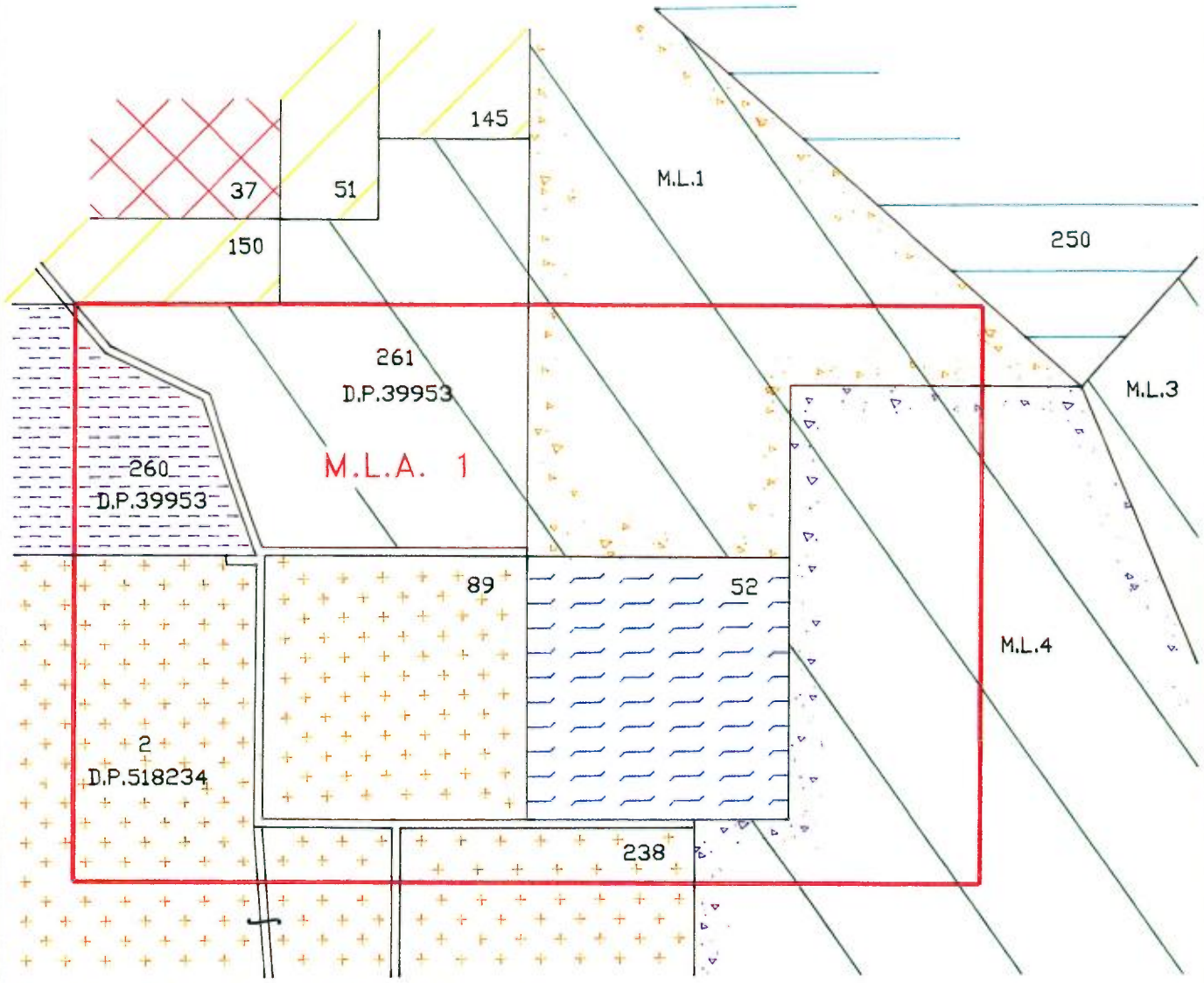
Figure 3 shows the location of the proposed mining area within the coastal sand barrier between Forster and Hallidays Point.

Bedrock areas comprise moderately hard undifferentiated sequences of Devonian mudstone, sandstone, conglomerate, greywacke, chert and tuff north of the Coolongolook River, and Carboniferous sandstones, siltstones, claystones, shales and lavas to the south. Sequences are structurally transverse to the coastline.

Along this section of the coast, coastal relief is moderate, river estuaries are medium to large, and coastal embankments large and broad. Devonian metasediments are unconformably overlain by unconsolidated marine and aeolian sands of Pleistocene and Holocene age.

Melville (1984) described and analysed the sediments and morphology of the barrier systems in the area. The Wallamba River separates a series of three Pleistocene barriers 120,000 to 140,000 years old to the west from the Holocene barrier to the east. The latter has accreted within the last 6,000 years and had continued to prograde up until about 1,000 years ago. (Chapman et al, 1982).

A mature suite of titanium minerals occur in marine and aeolian deposits along the east coast north of Broken Bay. Concentrations vary according to the geology of the local sediment compartment and sorting processes operating at the time of deposition. Highest concentrations are generally associated with beach ridges because of the efficiency of hydraulic sorting in swash deposits.



Crown Land.

R.G. and J.R. Aylett.

J.J. and C.I. Sultana.

V.M. Weller.

Central North Coast Sporting Car Club Ltd.

E.D. and M.E. Carrier.

G.A. Mallinson.

Aboriginal Land Claim No. 3207 over Crown Land.

Aboriginal Land Claim No. 3209 over Crown Land.

Figure 2
LAND OWNERSHIP AND MINING TENEMENTS

RZM

0 200 400 600 800
metres

A4-1113

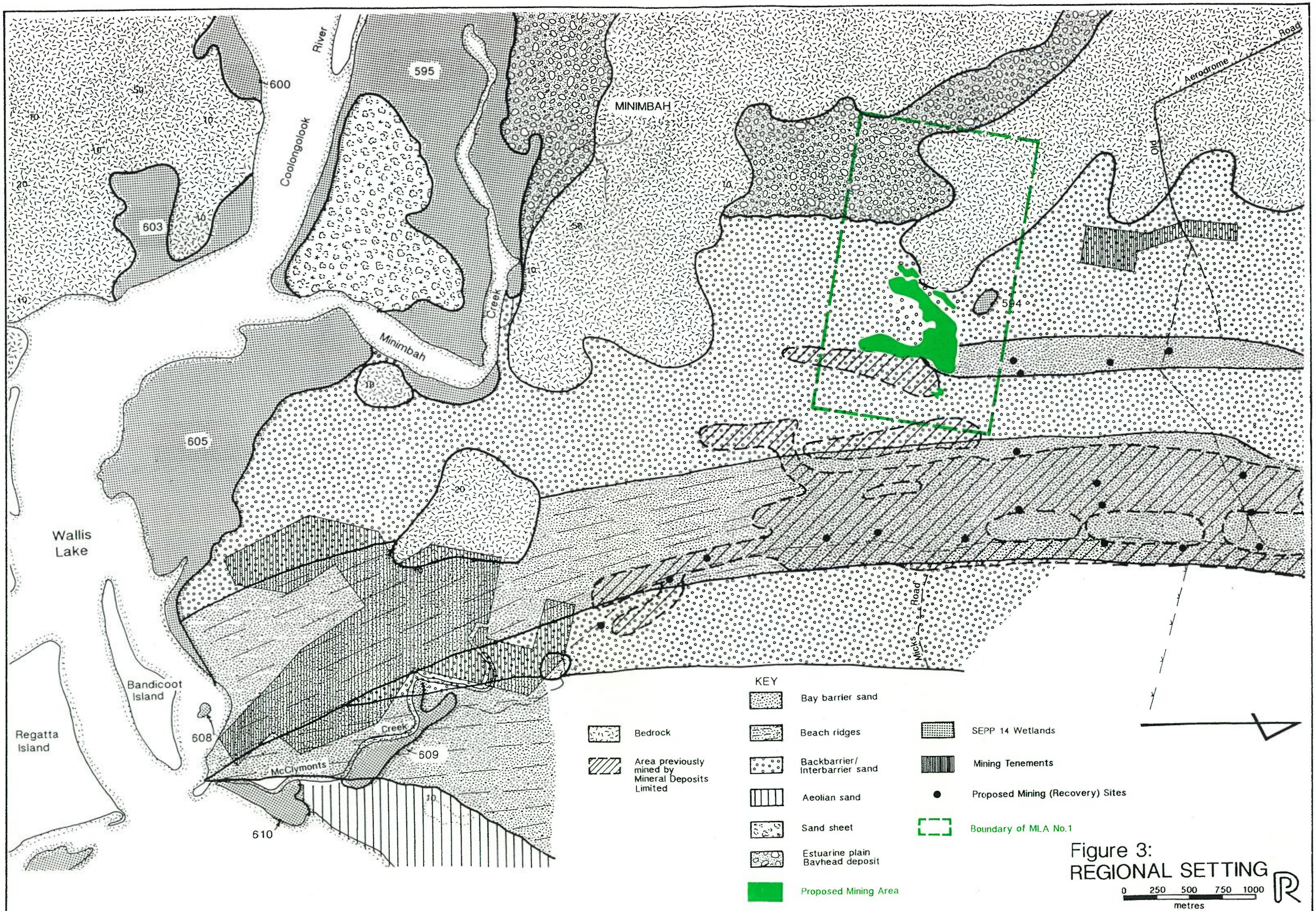


Figure 3:
REGIONAL SETTING

1008/92502

4.3.2 Local Setting

The proposed mining area occurs within an area of back barrier/interbarrier sand sheet that comprises flat to gently undulating topography as shown on **Figure 3**. The ore bodies are tied to the bedrock high which abuts the western side of the mining area. Colluvial clay derived from the bedrock high partly overlies the ore bodies as shown on **Figures 4** to **5**. Estuarine clay and clayey sands occur beneath the sand sheet sequences at depths ranging from 3.5m to 7m.

Bedrock areas are underlain by the Booti Booti Sandstone of Carboniferous age comprising white siltstone with coal-rich beds, crossbedded sandstone with white siltstone, and parallel-laminated quartz sandstone with sorted brachiopod valves.

4.4 ORE DEPOSITS

4.4.1 Distribution

RZM Pty Ltd have drilled over 200 exploration holes in the area to depths of up 16m and have delineated three separate ore bodies and a former stockpile area. Exploration was mainly conducted in the period June 1992 and February 1993.

The mineralisation occurs in narrow elongate or pod-like bodies, representing former strandline deposits oriented in the northeast-southwest direction generally parallel with the beach ridges or former Pleistocene shoreline. **Figures 4** and **5** shown in section the distribution of ore bodies in the sand mass.

An area with high titanium minerals concentration was located east of the main ore bodies during exploration. This is a former stockpile area of titanium minerals concentrate remnant from the 1970's when Mineral Deposits Limited mined the areas adjacent the eastern margin of MLA 1.

4.4.2 Reserves

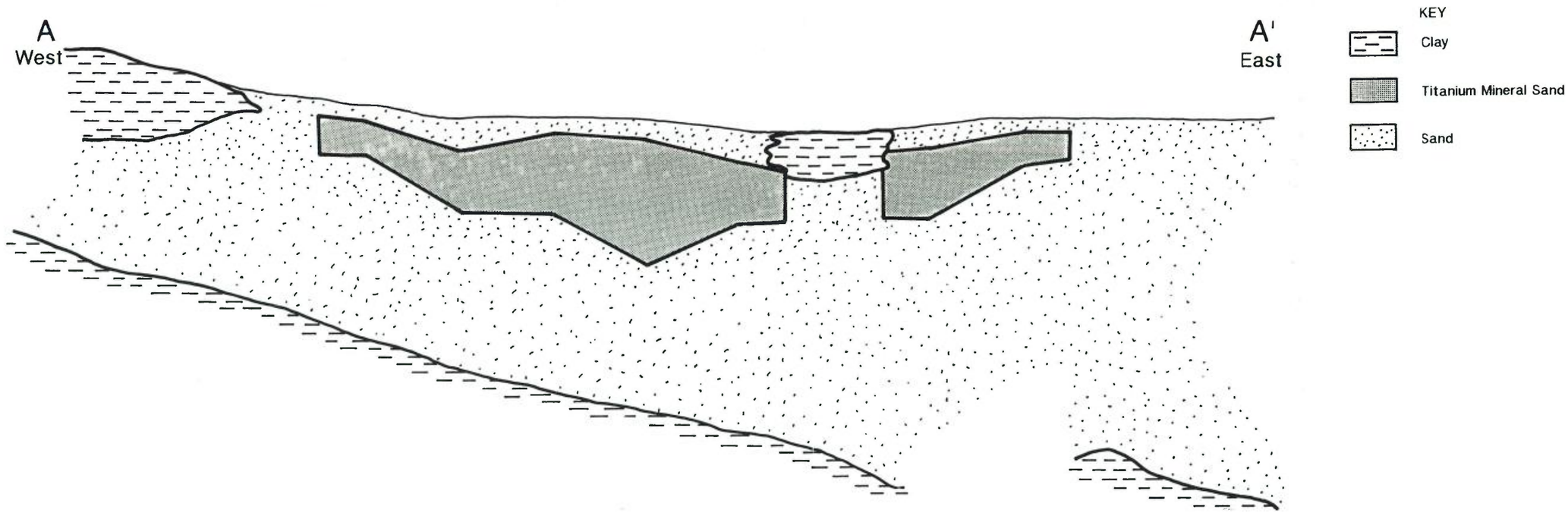
Total proven or indicated reserves in the mining area are 5,850 tonne of titanium minerals comprising 27% rutile and 26% zircon. The balance of the titanium mineral suite comprises mainly ilmenite and monazite which will be recovered during the mining operation but do not represent the principal economic minerals.

4.5 SOILS

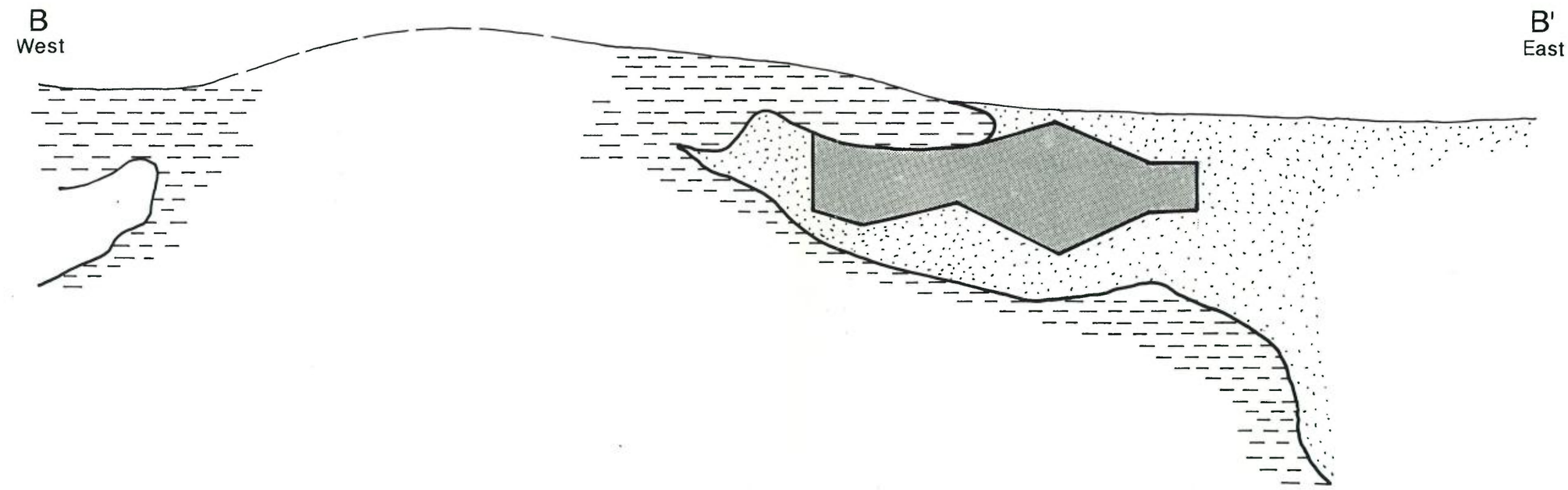
4.5.1 Soil Distribution

Four soil profiles were sampled by auger and described in detail at the locations shown in **Figure 6** and profile description are provided in **Appendix 2**.

The profiles described at Sites S2 and S4 are representative of the proposed mining area. The soils are typically sandy with considerable accumulation of decomposed organic matter (peat), on the surface. The topsoil generally varies between 12cm to 40cm in depth while the pH is between 5.5 and 6.0. The water table at the time of survey was consistently at 1m depth.



LINE 160 SOUTH



LINE 240 SOUTH

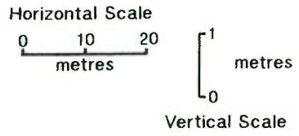


Figure 4:
CROSS SECTIONS

1008/92502

KEY

Clay

Titanium Mineral Sand

Sand

C
West

C'
East

LINE 320 SOUTH

Horizontal Scale

0 10 20
metres

1
metres
0
Vertical Scale

Figure 5:
CROSS SECTION

1008/92502

Profile S3 is representative of the previously mined area to the east of the proposed mining area. The vegetation density is low compared to the adjacent undisturbed area and no peat accumulations are present. The topsoil extends to only 10cm and contains few plant roots.

The profile at Site S1 would appear to be limited to the depression in the vicinity of the bedrock outcrop. The clay soils are up to 1.7m deep overlying mineral bearing sands. These clay soils have a considerable accumulation of peat near the surface. The peat accumulation and the dark clay subsoil extend to a depth of about 25cm. The pH of these two layers ranges between 5.5 and 6.0. A water table was not observed at S1, but if present it is likely to be below the clay layers.

4.5.2 Acid-Sulphate Potential

Soil sampling and analyses were undertaken in conjunction with establishment of groundwater bores to determine whether potential acid sulphate soils occur on the site. Acid sulphate soils contain a high proportion of pyritic sulphur (FeS_2) which oxidise on exposure to air, resulting in formation of sulphuric acid as one product of this process. When sulphuric acid production exceeds the neutralising capacity of the soil to the extent that the pH decreases to less than 3.5, these soils are termed 'acid sulphate soils'. Prior to aeration these soils are referred to as 'potential acid sulphate soils'. Identification of potential acid sulphate soils is essential to ensure that titanium mining does not result in aeration of these soils, potentially causing a serious reduction in water quality.

The sampling and analysis showed that the area has a very low potential to form acid sulphate soils upon oxidation. Results of analyses and assessment of acid sulphate potential are outlined in the following sections.

Sampling and Analysis Methodology

Samples were taken by RZM Pty Ltd at 0.5m intervals during establishment of the four groundwater bores in the locations shown on **Figure 6**. Samples were selected for analyses with the aim of determining acid sulphate potential for a range of soil characteristics, sample depths and spatial locations.

The groundwater table depth varied from 0.1m to 1.0m below the ground surface at Sites PW01 to PW04 during the sampling programme. Samples selected for analysis were recovered from just below the water table in the zone where seasonal groundwater variation may have oxidised any potential acid sulphate soils and well below the water table, in the zone where potential acid sulphate soils may be encountered.

Groundwater bores were established and samples collected using a hand auger. Drilling was undertaken by RZM field staff and supervised by a RZM geologist who logged the boreholes and collected soil samples.

Soil samples were placed in sealed plastic bags, with the time of soil exposure limited to minimise potential oxidisation effects of the atmosphere. Samples were transported to the laboratory and refrigerated as soon as possible following collection.

Laboratory analyses were undertaken in accordance with procedures recommended by Dr Ian Willett of CSIRO, Division of Soils (Willett, 1989).

Measurements of soluble sulphate before and after oxidisation of the samples by hydrogen peroxide provides a rapid indication of the acid sulphate potential of the soils by determination of the oxidisable sulphur (pyrite).

All analyses were undertaken prior to and following hydrogen peroxide oxidation and included:

* pH.
* Soluble sulphate.
* Electrical conductivity.

Results of Analyses

The results showed that the soils have very low potential to form acid sulphate soils on oxidation.

Sample descriptions, groundwater depths during sampling and results of laboratory analyses are summarised in **Table 4.1**.

TABLE 4.1
SAMPLE DESCRIPTIONS AND LABORATORY ANALYSES RESULTS

Borehole No.	Ground Water Depth (m)	Sample Interval (m)	Sample Desc.	pH		Sol. SO_4 (mg/kg)		Elect. Conduct.		Oxid. S. (% S)
				Pre Oxid.	Post Oxid.	Pre Oxid.	Post Oxid.	Pre Oxid.	Post Oxid.	
PW01	1.0	2.0–2.5	Hard Indur. Sand	5.5	2.7	24	620	220	1400	0.02
		4.5–5.0	Sand	5.0	2.4	50	560	130	1900	0.02
PW02	1.0	1.0–1.5	Clay	4.5	3.7	140	200	510	740	0.00
		4.0–5.0	Gravelly Sand	4.1	2.4	41	480	150	1800	0.01
PW03	0.1	0.0–0.5	Topsoil & Clay	4.6	3.3	51	150	120	880	0.00
	0.1	4.5–5.0	Sand	3.8	2.5	65	450	160	1200	0.01
PW04	0.3	1.0–1.5	Sand Tailings	4.6	3.1	25	90	50	350	0.00
		3.5–4.0	Sand	4.1	2.7	61	350	120	1000	0.01

TABLE 4.1 (CONT'D)
SAMPLE DESCRIPTIONS AND
LABORATORY ANALYSES RESULTS

Note: The oxidisable sulphur results were calculated from the pre and post-oxidation soluble sulphate results utilising the following relationship.

Oxidisable sulphur (%S) = $(SO_4 \text{ post} - SO_4 \text{ pre}) \times 3.3 \times 10^{-5}$.

Assessment of Results

There are no standard criteria of assessment of potential acid sulphate soils in Australia. Golder Associates Pty Limited (1992) applied the criteria given in **Table 4.2** for categorisation of the potential risk of formation of acid sulphate soils at a site near Saltwater, Taree and it is considered that these levels are appropriate for this site.

TABLE 4.2
CATEGORISATION OF SOIL ANALYSES RESULTS

Category	% Sulphur
Low	<0.15
Low–Moderate	0.15 to 0.4
Moderate–High	0.4 to 0.75
High	>0.75

Using the criteria given in **Table 4.2** the soils within the area have very low potential to form acid sulphate soils upon oxidisation.

Calculated oxidisation sulphur results indicate that there is negligible risk of acid-sulphate soil production for the upper samples at borehole numbers PW02, PW03, and PW04. All other samples are within the low risk category. Highest soluble sulphate results of oxidation were measured in the hard indurated sand and sand at depths below 2m at borehole number PW01.

Conclusion

Analysis of soils sampled at varying depth intervals at four locations within and adjacent to the proposed mining area indicates that site soils have very low

potential for acid sulphate soil production. There appears no necessity for additional soil analyses or implementation of control measures for the management of potential acid sulphate soils, but it is recommended that the environmental management plan for the operation incorporate a water quality monitoring programme.

4.5.3 Soil Erodibility

The clay soil described at S1 would not be subject to wind erosion due to the heavy soil textures. Water erosion would be a low hazard at this location due to the low slope of the depression. The sand layers below the clays described at S1 have the potential to be subject to wind erosion during the mining operation and before rehabilitation.

The soils on the bedrock on the western side of the main ore body were investigated without description. This area will be subject to moderate water erosion and nil wind erosion on clearing. Wind erosion will not be a hazard as the soil is moderately textured and the site is surrounded by mature trees.

The soils described at S2 and S4 are typical of the proposed mining area and have the potential to be subject to wind erosion on clearing. The previously mined areas as described at S3 will have a similar erosion hazard. To minimise potential wind erosion, progressive backfilling and rehabilitation will be undertaken to limit the exposed area.

4.5.4 Suitability of Soils for Post Mining Rehabilitation

The clay topsoils and their associated peat and litter layers as described in S1 will be most suitable for rehabilitation purposes.

The more typical profiles on the site such as described at S2 and S4 (**Appendix 2**) have considerable depths of peat (8–10cm) and topsoil (12–40cm) all of which are suitable for rehabilitation purposes. These layers contain the bulk of the nutrients, organic matter and seed available on site.

The previously mined areas, as typified by the S3 profile, have no surface layers which are suitable for rehabilitation purposes. The organic matter and seed content is too low and the topsoil is structureless. The poor state of these previously mined areas would appear to be due to the failure to replace topsoil, peat and litter in sequence after the previous mining activity.

4.6 HYDROLOGY

4.6.1 Surface Drainage

The area lies within a low relief sand mass of Pleistocene age with an average elevation of 7m AHD. The sand has high permeability; incident rainfall infiltrates to the water table and surface runoff is minimal. The bedrock high to the west of the mining area contributes runoff to the sand mass. This runoff infiltrates the sand mass to the groundwater table.

4.6.2 Groundwater

Because of the low lying topography, groundwater levels within the area are subject to considerable fluctuation depending on rainfall and drought.

Four groundwater bores have been established in the area to monitor both fluctuations in groundwater levels and groundwater quality. As discussed in **Section 4.5.2** soil samples were taken from these bores for analysis of acid–sulphate potential. Groundwater levels in these bores ranged from 0.1m in PW03 to 1.0m depth in PW01 and PW02 at the time of establishment and levels have remained consistently high during the survey period.

Clay occurring at or near the surface results in ponding of water for periods. Such areas generally support wet heath and sedgeland vegetation types.

During prolonged periods of wet weather, the groundwater table within the sand mass rises and may be above the surface in swales and low lying areas. During drought conditions the water table would be considerably lower.

The Company noted groundwater depths within each hole drilled for exploration purposes and will continue to monitor groundwater levels in the four piezometers installed in the site.

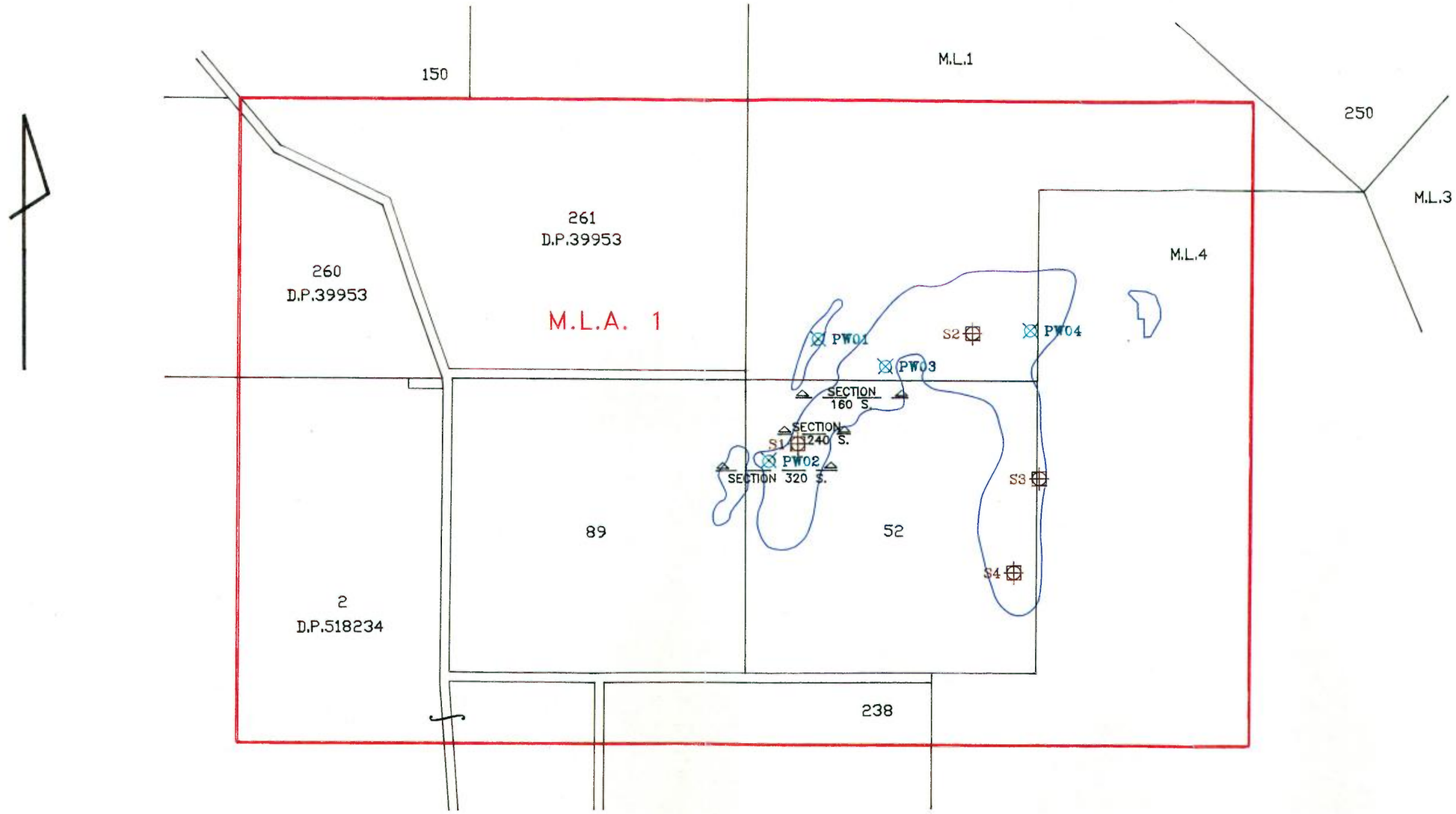
4.6.3 Flooding

Flooding of the Wallis Lakes estuary, occurs when flood waters from the Wallamba, Coolongolook, Wallingat and Wang Wauk Rivers are held in Wallis Lake. The Department of Public Works has advised that the peak water level for 1% Annual Exceedance Probability flood conditions in the Wallamba River is estimated to be approximately 2.5m AHD (**Appendix 1**)..

The proposed mining areas are at an average of 7m AHD and well above flooding influences.

4.7 WATER QUALITY

There are no permanent standing water bodies on the site. Groundwater samples from the four locations shown on **Figure 6** have been analysed and results presented in **Table 4.3**.



LEGEND:

- Mining Path.
- Mining Tenements.
- S3 Soil Sampling Site.
- PW01 Groundwater Monitoring Site.

RZM

Figure 6
MONITORING SITES

0 100 200 300 400 500
metres

A3-1119

TABLE 4.3
GROUNDWATER QUALITY

Site No.	Date Samp.	Water Table Depth (m)	pH	Dissol. Iron mg/L	Chlor. (as Cl) mg/L	Sulph. (as SO4) mg/L	Susp. Solids mg/L	TDS mg/L	Turb. NTU	Conduct. mS/cm
PW01	25/3/93	1.46	5.8	22.7	660	<0.5	630	1130	540	2.01
	15/4/93	1.75	6.0	23.0	680	5	7	1250	10	2.13
	30/4/93	1.86	6.1	20.3	660	<1	120	1280	8	1.99
PW02	25/3/93	1.71	6.1	1.6	440	22	1505	840	980	1.46
	15/4/93	2.06	6.1	2.1	360	15	340	830	300	1.40
	30/4/93	2.23	6.4	0.5	580	15	80	840	21	1.35
PW03	25/3/93	0.93	5.6	11.9	100	5	60	220	80	0.399
	15/4/93	1.22	5.9	0.4	100	5	20	240	40	0.408
	30/4/93	1.36	5.8	0.3	100	2	10	300	6	0.365
PW04	25/3/93	0.62	5.7	37.2	70	47	245	220	260	0.412
	15/4/93	0.98	5.1	0.2	80	55	70	250	110	0.434
	30/4/93	1.11	4.7	0.3	100	55	30	280	2	0.430

Note:

1. Spear PW02 was sampled via a suction pump, with Numbers PW01, PW03 and PW04 which were bailed.

2. Tubidities were carried out on settled samples.

The analysis show that the groundwater is mildly acidic with moderate to high levels of dissolved iron, low sulphate and salinity. The suspended solid and turbidity level in PW02 is likely to be due to the method of sampling.

Over the period of sampling, dissolved iron, suspended solids and turbidity have reduced.

4.8 CLIMATIC FACTORS

The area is located on the lower north coast and experience a mild maritime climate with high rainfall and humidity and warm temperatures with no large seasonal or daily contrasts. The nearest official meteorological stations that record a full range of climatic parameters are located at Taree and Williamtown.

Forster Post Office maintains rainfall records which would be indicative of the site.

Temperature and humidity readings for Williamtown and Taree are similar. The generally subdued coastal relief of Taree, although 50km to the north and about 4km further inland from the coast than the area, would indicate that wind speed and direction conditions of the two areas would be similar with a difference only in the timing of summer northeast breezes. The Great Lakes district experiences hot summers, characteristic of a hot subtropical climate similar to Taree. The area lies in a zone of interaction of two major air masses; the subtropical high pressure cells which form over the continent and the subpolar low pressure cells originating over the southern ocean. The movement of these cells often results in unpredictable climatic change.

4.8.1 Rainfall

Records for mean monthly rainfall at Forster are given in **Table 4.4**. The highest monthly rainfall is experienced in March (144mm) with high rainfalls (greater than 100mm) from January to June. Rainfall decreases through late winter and spring with lowest falls between September and November.

TABLE 4.4
MONTHLY RAINFALL

Month	Mean (mm)	Median (mm)	No. of Raindays
January	123	91	11
February	136	99	11
March	149	118	13
April	118	79	10
May	94	64	9
June	97	68	8
July	76	47	8
August	64	37	8
September	63	45	8
October	78	62	10
November	78	60	10
December	102	81	10

Based on the Bureau of Meteorology data shown in **Table 4.5**, the average monthly pan evaporation ranges from 57 to 195mm. As could be expected, highest evaporation rates are experienced during summer months.

TABLE 4.5
MEAN DAILY PAN EVAPORATION
(1970–1989) (mm)

Month	Mean Pan Evaporation (mm)
January	180
February	151
March	136
April	99
May	68
June	57
July	65
August	87
September	114
October	149
November	159
December	195

TABLE 4.6
TEMPERATURE DATA

Month	Maximum °C	Minimum °C
January	28.9	17.7
February	28.6	18.1
March	27.5	16.1
April	25.1	12.8
May	21.6	9.4
June	19.0	7.2
July	18.6	5.3
August	20.1	5.8
September	22.5	8.2
October	24.6	11.7
November	26.5	14.2
December	28.3	16.4

4.8.2 Temperature

Mean daily maximum and minimum temperatures for Taree are summarised in **Table 4.6.** Daily maxima are between 26°C and 28°C from November to March, declining to 19°C in June and July. The coldest daily minimum temperatures, 4°C to 7°C, are experienced in June, July, and August, rising to 17°C in January and February. Relative humidity is 70% to 80% for all months except August through to December. Low humidity readings correspond with the high number of dry westerly winds and low rainfall through the spring months.

4.8.3 Wind Speed and Direction

Wind speed data based on 17 years of records for Taree are presented in **Figure 7.** This figure summarises morning and afternoon wind speed and direction data for four months which are representative of seasonal variation.

The most significant features of the wind pattern are:

1. Brisk northeast to southeast winds on summer afternoons, with calm to light variable breezes on summer mornings.

2. Autumn winds are light and variable, tending to switch from morning westerlies to afternoon easterlies.

3. Winter winds are predominantly from the southwest and west, with greater strength in the mornings. This pattern continues throughout the early spring.

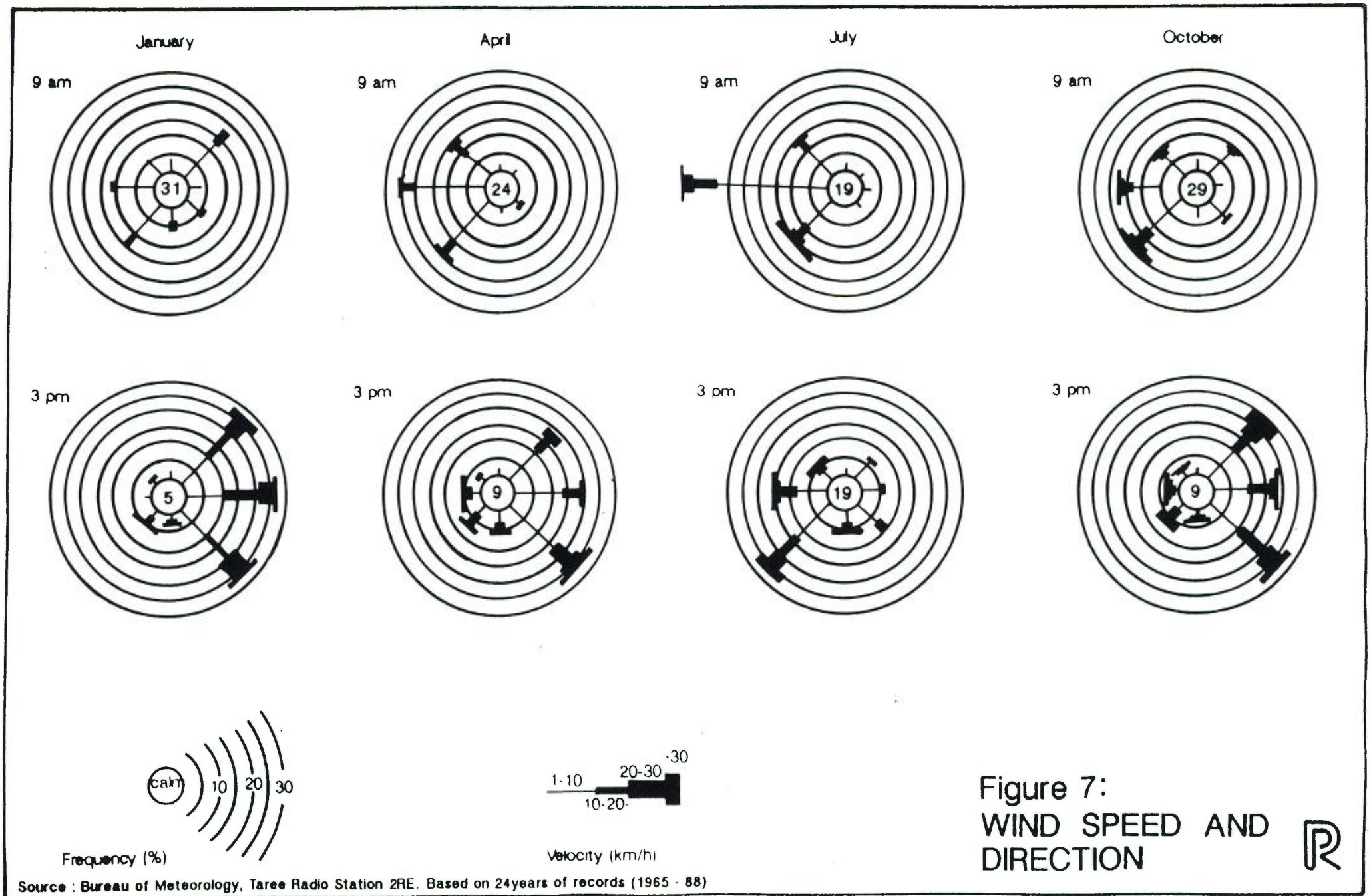
4. By late spring, the strong westerlies have reduced in velocity, and are replaced by southeast to northeast afternoon breezes.

The climatic data indicate a potential wind erosion hazard for mining operations during winter mornings (strong west-southwest winds) and summer afternoons (brisk, often gusty northeast and east winds). Wind strengths at these times would be sufficient to entrain sand grains from dry, bare ground surfaces exposed during the mining process and during the early stages of rehabilitation. Management techniques to overcome this potential hazard are discussed in **Section 6.4.**

4.8.4 Air Quality

The air quality around the site would be similar to that found in rural areas and would vary throughout the year depending on the activities on the surrounding land. Typical dust deposition rates in rural areas have been measured in the range 1.17 to 1.96g/m^2/month (Senate Select Committee on Air Pollution, 1969).

It is expected that, except in periods of extended drought, the area around the proposed sites would fall into the lower end of the typical levels given by the Environment Protection Authority for rural areas i.e., up to 2g/m^2/month.



Source : Bureau of Meteorology, Taree Radio Station 2RE. Based on 24years of records (1965 - 88)

Figure 7:
WIND SPEED AND DIRECTION

1008/92502

4.9 VEGETATION

4.9.1 Introduction

Flora surveys of MLA 1 were undertaken over two days in March 1993.

The primary objectives of the study were:

* To map and describe the vegetation communities in accordance with the classification system of Specht et al (1974) which identifies structural classes.

* To compile a list of the flora in the area, identifying any rare, threatened, regionally or locally significant species.

* Assess the impacts of the proposed development on the flora of the area.

* Propose amelioration measures to lessen impacts of the proposed development on the flora of the area.

An area to the east of the MLA was mined by Mineral Deposits Limited in the 1970s. The vegetation of the mine path is dominated by regenerating heath communities.

A significant area of the proposed mine path is in a natural condition with the only disturbances being track construction and bush fires, the last in 1991. SEPP 14 Wetland No. 594 is located 125m to the northwest of the proposed mine path. Within the mine path land ownership is private (55%) and crown (45%). Private land on the bedrock has been grazed in the past.

4.9.2 Vegetation Communities

Vegetation analysis involved a general description of the plant communities using qualitative field observations and aerial photograph interpretation. Delineation of plant communities was constrained by the scale of the aerial photograph (NSW 3508/79 Run 4 19.4.86 1:25,000; NSW 4032 Run 4 31.8.91 1:25,000). Major plant communities were identified and mapped (see **Figure 8**) following the classification system of Specht et al. (1974) which identifies structural classes.

Field surveys concentrated on the communities to be affected directly by the proposed mining activity. All vascular plant species observed within the area were recorded and a list of species occurring on the site is presented in **Appendix 3A.**

There are 21 vegetation communities in the area. A full description of each community detailing structure and species composition of each strata, is provided in **Appendix 3B**. The distribution of the vegetation is shown in **Figure 8**. Vegetation communities are as listed below:

1. **Spotted Gum Open-forest**. Dry sclerophyll open-forest community on bedrock. To the west of the mine path. This community occurs on privately owned land and has been partially cleared and grazed in the past.

1. Spotted Gum Open–forest.
2. Open–forest Ecotone.
3. Paperbark/Forest Red Gum Forest.
4. Scribbly Gum Open–forest.
5. Scribbly Gum Woodland.
6. Smooth–barked Apple Woodland.
7. Paperbark Low Closed–forest.
8. Paperbark Open–forest.
9. Paperbark/Swamp Mahogany Forest.
10. Paperbark/Swamp Mahogany Woodland.
11. Broad–leaved Paperbark. Swamp Mahogany Woodland.
12. Broad–leaved Paperbark. Swamp Mahogany Open–woodland.
13. Wet Heath with Emergents.
14. Heathland. (Regenerating.)
15. Open Heathland. (Regenerating.)
16. Heathland/Sedgeland with Emergents.
17. Heath/Sedgeland. (Regenerating.)
18. Baumea Sedgeland. S.E.P.P.14 Wetland No. 594.
19. Sedgeland.
20. Eleocharis Sedgeland.
21. Cleared.

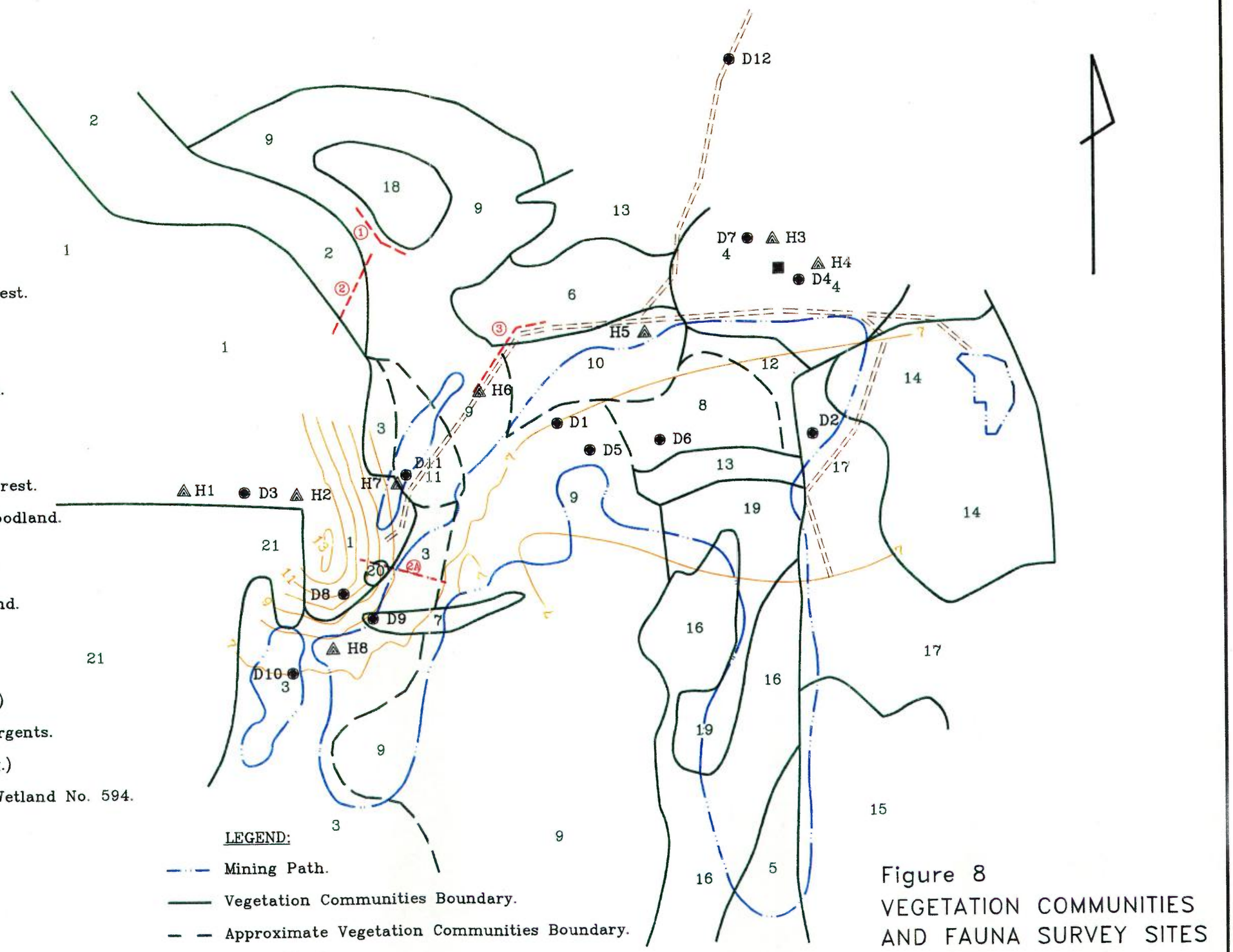


Figure 8
VEGETATION COMMUNITIES AND FAUNA SURVEY SITES

RZM

A3–1114

2. **Open-forest Ecotone**. Ecotone community between dry sclerophyll open-forest and the swamp sclerophyll communities. Dense mid-understorey dominated by Melaleuca species.

3. **Paperbark/Forest Red Gum Forest**. An ecotone community between dry sclerophyll open-forest and the swamp sclerophyll communities.

4. **Scribbly Gum Open-forest**. Occurs on the northern edge of the mine path. Proposed haul road passes through community.

5. **Scribbly Gum Woodland**. Occurs on the eastern edge of the mine path. Remains undisturbed from earlier mining activity which occurred immediately to the east.

6. **Smooth-barked Apple Woodland**. Bisected by the access track.

7. **Paperbark Low closed-forest**. Community occurs in a narrow strip, approximately 20 metres wide, bordered by Paperbark/Swamp Mahogany Forest. There is little to no understorey with sparse groundcover.

8. **Paperbark Open-forest**. Community dominated by Paperbarks with scattered Swamp Mahoganies. Shrub understorey is sparse dominated by wetland species, cyperaceous and restionaceous. Sandy soil damp.

9. **Paperbark/Swamp Mahogany Forest**. Fringes Baumea sedgeland (SEPP 14 Wetland). Ecotone community between Open-forest ecotone (Community 3) and Baumea sedgeland (Community 18). Also occurs to the east of the Paperbark/Forest Red Gum community where the understorey is dominated by dryland monocotyledons.

10. **Paperbark/Swamp Mahogany Woodland**. Occurs between the Smooth-barked Apple Woodland (Community 6) and Paperbark Open-forest (Community 8). Wet heath understorey. Sandy soil damp.

11. **Broad-leaved Paperbark/Swamp Mahogany Woodland**. Occurs along the access track between the Paperbark/Forest Red Gum Forest (Community 3) and the Smooth-barked Apple Woodland (Community 6). Understorey cyperaceous, restionaceous and wet heath shrub species.

12. **Broad-leaved Paperbark/Swamp Mahogany Open-woodland**. Open swamp sclerophyll woodland with heath understorey.

13. **Heath with emergents**. Ecotone community between the sedgeland (Community 19) and Paperbark Open-forest (Community 8). Dominated by wet heath shrub species with cyperaceous and restionaceous species. Emergent Broad-leaved Paperbarks scattered throughout.

14. **Heathland. (Regenerating)**. Occurs on the edge of the proposed mine path and was previously disturbed by mining. Heath species with juvenile Scribbly Gums. Adjoins the Scribbly Gum Open-forest (Community 4).

15. **Open heathland (Regenerating)**. Previously disturbed by mining. Sandy soil disturbed with no distinct organic layer.

16. **Heathland/sedgeland with emergents**. Community intermediate between wet heath and sedgeland. Dominated by cyperaceous and restionaceous species with shrub species. Scattered emergent Paperbarks and Swamp Mahoganies.

17. **Heath/sedgeland. (Regenerating)**. Community regenerating from past mining activity dominated by cyperaceous and restionaceous species with wet heath shrubs. Sandy damp to wet soil with no distinct organic layer.

18. **Baumea sedgeland**. SEPP 14 Wetland No. 594. Occurs to the northwest of the mine path and proposed haul route.

19. **Sedgeland**. Occurs on low lying ground in the mine path. Water on the surface at the time of inspection.

20. **Eleocharis sedgeland**. Dominates a constructed dam on the edge of the bedrock.

21. **Cleared**. Private land previously cleared and is regenerating. Not described.

4.9.3 Floristics

A total of 128 plant species were identified during field work. The list of species is comparable to the species lists from other studies undertaken within the region (Bartrim and Martin 1990, Resource Planning, 1993). These species are representative of heathland and sedgeland communities on sandy soils throughout the north coast of New South Wales.

The dominance of **Melaleuca** species, **Eucalyptus robusta**, cyperaceous and restionaceous species are indicative of the water logged conditions characterising the areas where these communities occur.

The regenerating heath and sedgeland communities to the east of the mine path have been previously mined and are of low conservation significance.

The majority of communities are represented within reserve systems along the coastal strip north of Newcastle in particular on the Pleistocene sands of the Eurunderee Sand Mass in the Myall Lakes National Park (Myerscough and Carolin, 1986). Community 6 is similar in structure and species composition to the wet heath forest of Myall Lakes National Park, dominated by **Angophora costata, Eucalyptus robusta** and **Melaleuca quinquenervia** (Myerscough and Carolin, 1986). Swamp Forest in Myall Lakes National Park is dominated by **Eucalyptus robusta** and **Melaleuca quinquenervia** in differing proportions (Myerscough and Carolin, 1986), and is equivalent to communities 7, 8, 9, 10, 11 and 12. Wet heath and Swamp communities of Myall Lakes National Park (Myerscough and Carolin, 1986) bare some similarity in structure and floristics to communities 13, 16 and the regenerating communities of this site. The sedgeland community is also represented within Myall Lakes National Park (Myerscough and Carolin, 1986).

According to Briggs and Leigh (1988) none of the species recorded on the site are considered to be rare or threatened. Christmas Bells (**Blandifordia**

grandiflora) are a protected species and occur throughout the heath/sedgeland communities in the area.

A number of threatened species or locally significant species have been recorded on the sand communities at Nabiac (Bartim and Martin, 1990; Resource Planning, 1993). These include **Allocasuarina defungens**, **A. simulans**, **Acacia quadrilateralis**, **A. bauerl** and **Leptospermum semibaccatum**. None of these species were observed within the mine path.

Records of **Allocasuarina defungens** are restricted to the Nabiac area in dry shrub and heath communities and to Wallum Banksia dry open-shrubland at Saltwater (Cleland et al, 1992).

4.10 FAUNA

Fauna surveys of MLA 1 were undertaken in February 1993. As specified in the Endangered Fauna (Interim Protection) Act 1991, the fauna survey seeks to establish if the proposed works will have a significant effect on the environment of endangered fauna.

The primary objectives of the study were:

* To survey vertebrate fauna species utilising the area.
* To identify any locally significant fauna species.
* To identify any endangered fauna (vulnerable and rare or threatened) as listed in Schedule 12 of the National Park and Wildlife Act 1974.
* To identify wildlife habitats within the area.
* Assess the impacts of the proposed development on fauna.
* Propose amelioration measures to lessen impacts of the proposed development on fauna.
* If endangered species are present or are known to occur in the area, address the seven point test of significance as detailed in Section 4A of the amended Environmental Planning and Assessment Act 1979.

4.10.1 Methodology

All fauna species observed during field work undertaken in February and during vegetation surveys undertaken in March 1993 were recorded. Specific survey methods used were:

* Trapping for small terrestrial mammal with Elliot Type A traps baited with a mixture of rolled oats, peanut butter and honey. Small mammal trapping was conducted (GLE/E 277) over four nights 12th to 15th February 1993. Seventy (70) type A Elliot traps were set giving 280 trap nights. Traps were set along transects at approximately 10 metre intervals. They were checked and set each morning.

* Birds and frogs were identified by direct sightings and or identification of calls.

* Stagwatching and spotlighting for nocturnally active arboreal and terrestrial mammals, birds and frogs.

* Indirect searches for the presence of species. This includes identification of scats found at the bases of tree trunks and throughout the area; identification of diggings and tracks; searches of tree trunks for scratch marks.

A specialist bat survey was undertaken by FBN Bat Surveys over four night period from 13th to 16th April, 1993 (see **Appendix 3F**). Bats were surveyed within the area using Harp traps (8 sites), Mistnetting (1 site) and bat echolation call analysis from twelve detection sites (see **Figure 8**).

Survey data was supplemented with existing information for the area from published reports (Bartrim and Martin 1990; Bartrim and Martin 1991).

The weather was a major constraint to the availability of data for the fauna survey. Fauna surveys were undertaken in the preferred warmer months of the year however, several of the days and nights were rainy and could have affected bird observations, trapping success and observation of arboreal mammals. Waning moon could have affected spotlighting observations of arboreal animals. Weather conditions at the time of the bat survey were a constraint to survey results as again there were heavy rainfalls (see **Appendix 3F**).

4.10.2 Faunal Assemblages

Avifauna

A list of the birds observed during field work and expected to occur in the area is provided in **Appendix 3C**. The list also details birds known to occur in the local area (Bartim and Martin, 1990). A total of 27 bird species were observed during field work.

None of the birds observed in the MLA are listed as endangered (threatened or vulnerable and rare) by New South Wales National Parks and Wildlife Service (1992). The Glossy Black Cookatoo is known to occur in the general locality and is scheduled as vulnerable and rare by the New South Wales National Parks and Wildlife Service.

The majority of the species are common to abundant in New South Wales (Morris et al, 1981). Records of the Grey Goshawk, White-bellied Sea-eagle, Lewin's Rail and Barking Owl are uncommon (Morris et al, 1981). All of these birds are expected to occur within the general area and were not observed in the MLA.

Mammals

Appendix 3D presents mammal species known to occur in the area, excluding Bat species. Species listed include those mammals recorded during field surveys and those expected to occur in the area from recent studies in the region

(Bartrim and Martin, 1990; Bartrim and Martin, 1991) and from local residents reports. A total of 17 native species and 9 introduced species have been recorded in the area. Of these 6 species were observed during field work.

Small mammal trapping was undertaken over four consecutive nights in February 1993 with 280 trap nights. Four trap lines were set in habitats representative of the area to be disturbed and adjacent habitats. All traps were set within easy access of tracks in the area. Location of the trap lines are shown in **Figure 8** and descriptions of the habitats where each trap line was set are provided in **Table 4.7**

TABLE 4.7
CHARACTERISTICS OF TRAPPING SITES

Trap Site/Habitat	Characteristics	Comments
1. Paperbark/ Swamp Mahogany Forest	Swamp Sclerophyll Forest. Dense understorey of restiads,sedges **Blechnum** and **Pseudoraphis spinscens**.	Undisturbed Fringes Baumea sedgeland. SEPP 14 Wetland No. 594 40 trap nights. No captures.
2. Swamp Sclerophyll to Dry sclerophyll ecotone	Understorey changes from wet heath to grasses on bedrock. Fallen timber provide microhabitats.	Disturbed by tracks and clearing of understorey on bedrock. 80 trap nights. No captures.
3. Dry sclerophyll through **Eleocharis** sedgeland to Swamp sclerophyll forest.	As above. Sedgeland with standing water.	Constructed wetland 80 trap nights. 1 x **Mus musculus**.
4. Swamp sclerophyll Forest	Wet heath. Dense understorey of sedges, restiads and shrubs.	Along access track. 80 trap nights. 5 x **Mus musculus**.

As detailed in **Table 4.7** the only species trapped was the introduced House Mouse (**Mus musculus**). Other small ground dwelling mammals that would be expected to occur in the area are the Swamp Rat (**Rattus lutreolus**), Black Rat (**Rattus rattus**), Brown Antechinus (**Antechinus stuartii**), New Holland Mouse (**Pseudomys novaehollandiae**) and possibly the Eastern Chestnut Mouse (**Pseudomys gracilicaudatus**).

The Swamp Rat prefers moist conditions tending to burrow in dense undergrowth. It has been trapped within the region in regenerating scrub near swamp sclerophyll community (Bartrim and Martin 1991).

Neither the New Holland Mouse (**Pseudomys novaehollandiae**) or Eastern Chestnut Mouse (**Pseudomys gracilicaudatus**) were trapped in the heath communities. Both of these species have been recorded as expected to occur within the Foster – Taree region in wet and dry heath in natural and regenerating states (Bartrim and Martin 1991). The New Holland Mouse was listed as Fauna of Special Concern by the New South Wales National Parks and Wildlife Service but is no longer scheduled. New Holland Mouse has been recorded to the south of the area. Eastern Chestnut Mouse is listed as vulnerable and rare by the New South Wales National Parks and Wildlife Service. It has not been trapped during studies in the Nabiac area (Bartrim and Martin, 1990).

Spotlighting was successful in verifying the presence of arboreal mammal species. Common Ringtail Possum (**Pseudocheirus peregrinus**) and Sugar Glider were observed in the dry sclerophyll community on the bedrock. Other arboreal species expected to occur in the area are Brush-tail Possums (**Trichosurus vulpecula**).

The Brush-tailed Phascogale (**Phascogale tapoatafa**) is an arboreal dasyurid which has been trapped to the southwest of the MLA (Bartrim and Martin, 1990). Preferred habitat is open dry sclerophyll forest with grassy understorey (Strahan, 1983) as such it is unlikely to occur within the mine path. The Brush-tailed Phascogale is listed as vulnerable and rare by the New South Wales National Parks and Wildlife Service.

No macropod tracks or scats were observed during field work. Macropods reported by residents and observed in earlier studies in the general area (Bartrim and Martin, 1990) are the Red-necked wallaby (**Wallabia rufogrisea**), Swamp wallaby (**Wallabia bicolor**) and Eastern Grey Kangaroo (**Macropus giganteus**).

There are no records of Koalas (**Phascolarctos cinereus**) in the local area from earlier studies (Bartrim and Martin, 1990) or local residents. Koalas are known to occur along the mid north coast between Bulahdelah and Taree (Reed et al. 1991). They have been recorded by the Forestry Commission in Wang Wauk State Forest, Batchelor State Forest, Bulahdelah State Forest and Wallingat State Forest to the south, southwest and by National Park Rangers at Booti Booti National Park to the south of Forster (Reed et al. 1991).

Specialist bat survey has identified eleven bat species within the proposed mine path: White-striped Mastiff Bat (**Tadarida australis**), Little Free-tail Bat (**Mormopterus loriae**), Gould's Wattled Bat (**Chalinolobus gouldii**), Chocolate Wattled Bat (**Chalinolobus morio**), Little Bent-wing Bat (**Miniopterus australis**), Common Bent-wing Bat (**Miniopterus schreibersii**), Lesser Long-eared Bat (**Nyctophilus geoffroyi**), Gould's Long-eared Bat (**Nyctophilus gouldi**), Little Forest Bat (**Vespadelus vulturnus**), Eastern Forest Bat (**Vespadelus pumilus**) and Grey-headed Flying fox (**Pteropus poliocephalus**) (see **Appendix 3F**).

Other species considered to have a medium to high likelihood of occurring in the area, based on regional records and preferred habitat, include the following species: Eastern Blossom Bat (**Syconycteris australis**), Little Reddish Flying-

fox (**Pteropus scapulatus**), Yellow-bellied Sheathtail Bat (**Saccolaimus flaviventris**), Eastern Broad-nosed Bat (**Scotorepens orion**) and Greater Broad-nosed Bat (**Scotorepens rueppellii**) (see **Appendix 3F**).

Of the eleven bat species, confirmed as occurring in the area, the Common Bent-wing Bat and Little Bent-wing Bat are listed as vulnerable and rare by the New South Wales National Parks and Wildlife Service. A further three bat species - Eastern Blossom Bat, Yellow-bellied Sheathtail Bat and Greater Broad-nosed Bat - are considered to have medium likelihood of occurring in the area and are also listed as vulnerable and rare by the New South Wales National Parks and Wildlife Service.

Reptiles and Amphibians

Reptile and Amphibian species known and expected to occur in the area are listed in **Appendix 3E**.

A total of 16 reptiles are listed as observed, expected to occur (Bartrim and Martin 1990) or reported by local residents in the area. None of these species are listed as endangered in New South Wales (National Parks and Wildlife Service, 1992).

A total of 20 amphibians were recorded as observed or expected to occur in the area. The identification of many of the species was confirmed by capture. All of the species are widely distributed in a variety of coastal swamp sclerophyll and heath habitats. None of the species are listed as endangered in New South Wales (National Parks and Wildlife Service, 1992). The high relative number of amphibians reflects the habitat types. Prevailing weather conditions at the time of the survey favoured amphibian observations.

4.11 BACKGROUND NOISE ENVIRONMENT

A survey of the existing background noise environment was undertaken at two locations shown on **Figure 9** on 5th March 1993. Survey methods and results have been combined with data obtained during a 1989 survey in the area obtained by Resource Planning Pty Ltd (1990) for the existing Nabiac operations. The survey methods and results are presented in detail in **Appendix 4**. For the purpose of this development the following two survey sites were chosen.

N1 - Closest northern residents to proposed mining area.

N2 - Junction Glen Ora Road and Old Aerodrome Road to established background noise levels for residences close to the proposed haul route.

The combined survey results are summarised in **Table 4.8** in which existing background noise levels are expressed as LA_{90} noise levels (ie, noise levels exceeded for 90% of the time).

TABLE 4.8
BACKGROUND NOISE LEVELS

Site	Time	Date	LA90 Background Noise Levels (dB(A))
N1	9:15am	5/3/93	34.3
N1	10:09am	5/3/93	29.8
N1	7:00am	7/12/89(1)	31.0
N2	9:45am	5/3/93	34.8
N2	10:31am	5/3/93	29.3
N2	7:30am	1/12/89(1)	38.0

Note: (1) Resource Planning Pty Ltd (1990)

Measured background noise levels listed in **Table 4.8** average 32.0 dB(A) at N2. Major noise sources at N2 were passing trucks, cars and tractors whereas at N1, birds, cicadas and cars were the major noise sources.

Noise levels recorded at the 1989 and 1993 surveys are generally consistent although levels at N2 are lower than the 1989 survey and possibly due to the later survey time after a 'peak' associated with early morning travellers to work and school.

4.12 VISUAL ASPECTS

4.12.1 Relative Scenic Quality

Great Lakes Shire Rural Lands Study (1986) identified broad landscape character types on the basis of landform and waterform. Each of these were then divided into landscape units, which showed an identifiable visual character.

The mining area occurs within the Nabiac Aerodrome Plains Landscape Character Type (P2). It adjoins the more elevated Minimbah Road Landscape Unit (P3) and the Minimbah Creek Unit (P4).

The study concluded 'The Nabiac Aerodrome unit (P2) and Minimbah Creek unit (P4) are less attractive (than the Minimbah Road unit P3) except for the riverside areas and the forest adjoining the Highway. Taken overall, the units have a 'medium' visual value. Casuarina swamp forest around Minimbah Creek has been roughly cleared, leaving a 'blitzed' look. The tree cover provides the only vertical element in these flat landscapes and therefore takes on an exaggerated visual importance. Roadside trees are especially important. Planning tree

clearing can retain the attractiveness and the ability of these areas to absorb further development. The view from the waterway requires special consideration in any development approvals, with the preservation of the tree line and the blending of development the essential requirements'. (Page 17, Great Lakes Rural Lands Study, 1986).

4.12.2 Visibility

The mining area occurs on flat to gently undulating land and is surrounded by similar landform to the south, east and north. The elevated bedrock area to the west provides limited views to the mining area but is generally not accessible as a public viewing point.

The main ore body is only visible from the existing access tracks. However the site is not visible from nearby residences due to a combination of distance and screening by surrounding vegetation. The area is not visible from the Wallis Lake System.

4.13 ABORIGINAL PREHISTORY

An archaeological survey of the area was undertaken in February 1993 by archaeologist, Noeleen Steel, accompanied by a representative of Foster Local Aboriginal Land Council.

No archaeological sites were identified and no objections were made to the mining operations.

The archaeologists report is presented in **Appendix 5.**

4.14 EUROPEAN HISTORY

European settlement in the Nabiac–Forster district dates to the mid nineteenth century. The whole district was included in the AA Company's grant in 1827 of 1 million acres extending from Port Stephens to the Manning River. However, as much of the area was poor quality agricultural land, it was allowed to revert to the Crown. Browne and Scott (1985) noted that fishermen from the AA Company's headquarters at Stroud visited Wallis Lake during the 1830's. It appears that most of the navigable river systems – the Wang Wauk, Coolongolook, Wallingat and Wallamba had been visited by Europeans at that time.

Land in the Nabiac area was first taken up and settled by small holders in the 1850's. Gallager (1987) notes that the first settlers in the Wang Wauk area officially arrived in 1865. Several of these had lived in the area for some time before acquiring land.

In the 1860's the area was known generally as the Cape Hawke settlement, with most landholders engaged in timber cutting, agriculture or fishing.

Throughout the latter part of the nineteenth century, and into the twentieth century, the forests along the Wank Wauk River were logged for mill logs, piles, sleepers, girders, piles and transoms. The timber was shipped to Sydney.

Dairying began in the district early in the twentieth century, and cream was collected by boat and taken to a butter factory at Tuncurry.

At Minimbah, the nearest property to the south of the mining area, dairying was the dominant land use up until about fifteen years ago. Beef cattle grazing is currently undertaken on this property.

Low agricultural potential, woodland/heath vegetation, rather than loggable forest have prevented development of the mining areas for these purposes. Some logging has taken place on more accessible parts of the site.

4.15 ZONING

The entire region is zoned Rural 1(a) with the exception of a 400m strip along the Pacific Highway which is zoned Rural 1(b) in Manning Local Environmental Plan No. 1. A minimum subdivision size of 40 hectares applies.

Proposals for more intensive settlement in the Nabiac Candidate area, as shown on **Figure 9** may result in rezoning of some land to 1(c) Rural 'C' (Small Holdings) with a minimum subdivision size of 4 hectares. Mining is a permitted use only with Council consent in the Rural 1 (a) zone.

4.16 PLANNING PROPOSALS

Several planning studies of relevance to the current proposal have been completed in Great Lakes Shire.

The Great Lakes Shire Rural Lands Study (1986) identified several areas within the Shire which were considered appropriate for closer rural subdivision within a series of natural, scenic and heritage constraints. One of these candidate areas is situated between Nabiac and Minimbah and is shown on **Figure 9**. The total area is approximately 2,000 hectares, and includes both undulating hills and steep ridges south of Bundacree Creek. The boundary of the Nabiac candidate area follows Glen Ora Road, Old Aerodrome Road, and Minimbah Road.

Bennett (1989) recommends that the northern part of the Nabiac Candidate area, immediately south of Glen Ora Road, should be developed before the remainder of the area. This portion of the candidate area could yield approximately 80 new rural-residential allotments over the next five years or more, depending on demand.

Traffic servicing these rural-residential allotments will use Glen Ora Road and Old Aerodrome Road and a series of smaller link roads through the Candidate area.

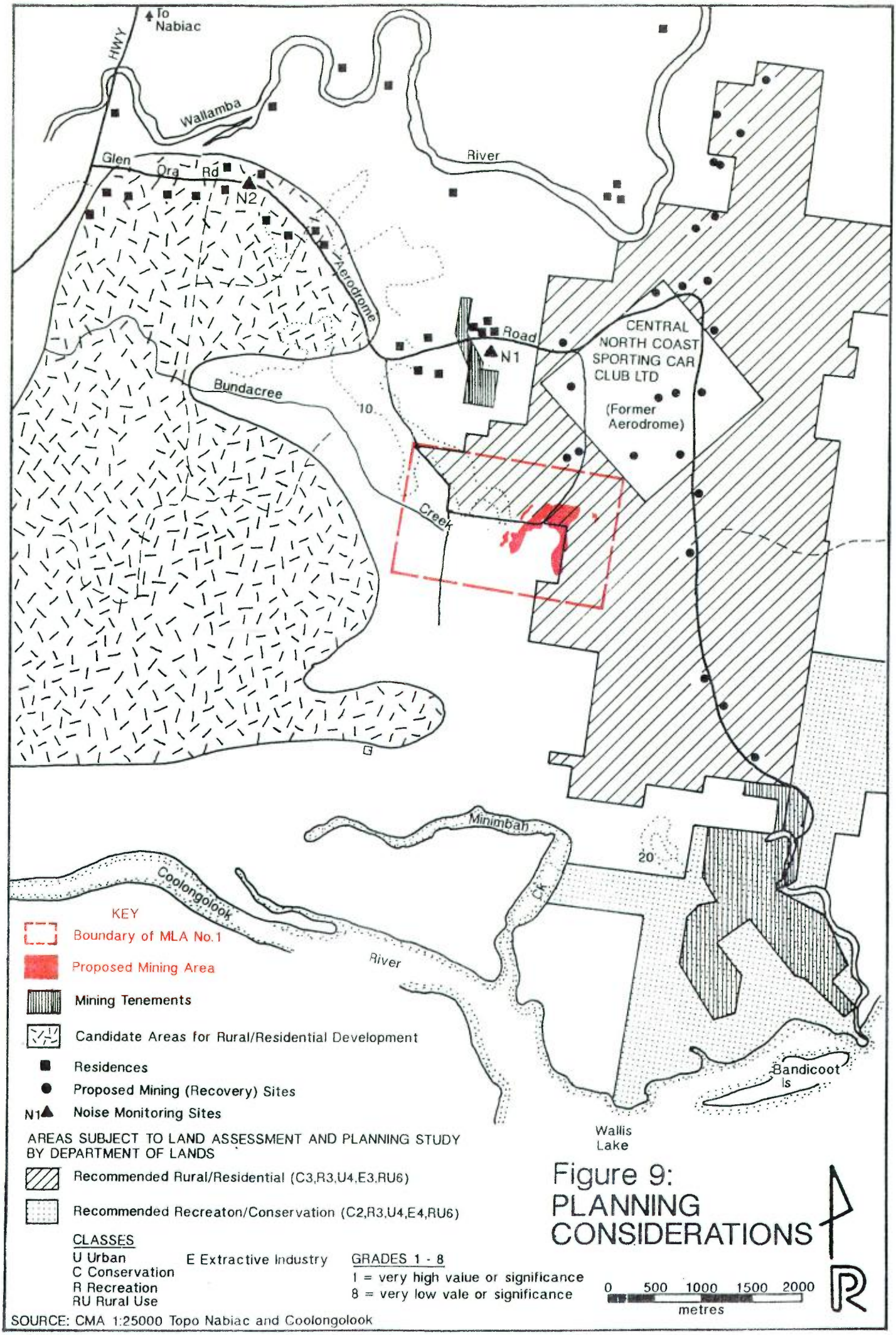


Figure 9: PLANNING CONSIDERATIONS

SOURCE: CMA 1:25000 Topo Nabiac and Coolongolook

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The Department of Lands undertook a Land Assessment and Planning Process study of Crown Land within Great Lakes Shire. Potential land uses considered include conservation, rural-residential, recreation, agriculture, and extractive industries. Areas of Crown Land were attributed rankings for these land uses, and general recommendations for each area derived. Land uses and rankings for the study area and adjacent lands are shown on **Figure 9**.

Aboriginal Land Claims have also been lodged over most of the Crown Land in this area. Crown Land on which the site is located is subject to Aboriginal Land Claim Numbers 3207 and 3209 covering ML1 and ML4 in the proposed mining area.

Subject to the determination of the land claims, the recommended land use for Crown Land is rural-residential. This is based on assessments of moderate value for conservation, recreation and urban development, moderate extractive industry value, and low value as agricultural land.

4.17 LAND USE

4.17.1 Residential

Nearest residences to the mining sites are shown on **Figure 9.**

Generally the area is remote from residential areas. Nearest residences are associated with agricultural enterprises 3km to the south at Minimbah and 2km to the north on Old Aerodrome Road.

Rural-residential development occurs along Glen Ora Road and Old Aerodrome Road and a number of new homes have been completed or are under construction. Further rural-residential development in this area can be expected in the future as land is rezoned to permit closer settlement in accordance with planning proposals.

4.17.2 Agricultural

The Great Lakes Shire Rural Lands Study (1986) identified timber as the most important primary industry in the Shire, with poultry production being the second most important rural land use. Other agricultural uses include beef cattle, dairying, pigs, pasture production and a variety of other crops.

Dairying is carried out close to Nabiac, and the rural properties along Glen Ora Road and Old Aerodrome Road carry beef, dairy cattle, and pigs. 'Minimbah' to the south was formerly a dairying property, and now carries beef cattle.

There has been minor selective logging of timber in the area and some areas further to the west on bedrock have been cleared for grazing.

Other rural/residential land uses include nurseries and a sawmill located adjacent to Old Aerodrome Road.

4.17.3 Recreational

One of the most important sources of income in Great Lakes Shire is water based recreational activities. The proposed mining area does not have water frontage and will not be visible from Wallis Lake. Land based recreational activities in the vicinity of the haul road include a racing track operated by the Central North Coast Sporting Car Club Limited on the old aerodrome site, which holds functions intermittently throughout the year. Tourism is a major industry within the Shire but there are no tourism venues located in close proximity to the proposed mining site.

4.17.4 Extractive Industry

A small sand pit was operated intermittently on the northern side of Old Aerodrome Road. Quantities of sand previously removed are small. Two gravel quarries are operated, also on an intermittent basis, in the Bundacree Creek area to supply roadbase and shoulder gravel.

4.17.5 Mineral Sand Mining

The proposed mining area adjoins an area previously mined for titanium minerals by Mineral Deposits Limited in the mid 1970's-early 1980's. The approximate extent of previous mining is shown on **Figure 3.**

These areas have been rehabilitated or have naturally regenerated and the majority support heath vegetation similar to the pre-mining communities. Parts of the former mining area have been previously used by the Central North Coast Sporting Car Club Limited as described in **Section 4.17.3.**

As discussed previously, RZM Pty Limited is currently mining within an area near McClymonts Creek south of the proposed site (refer to **Figure 1**) and has mined an area adjoining Old Aerodrome Road. Operations commenced within this area in October 1991 and are expected to be completed in mid 1993.

4.17.6 Future Land Use

RZM Pty Ltd has submitted a Development Application and accompanying Environmental Impact Statement for mining of remnant titanium minerals stockpile areas east of MLA 1 over a period of one month while the existing plant is located in the McClymonts Creek area. Following completion of mining in this area, operations will be relocated to MLA 1.

It is planned that following completion of mining in MLA 1, operations will relocate to Failford East (see **Figure 1**). An Environmental Impact Statement is currently being finalised for mining proposals in the Failford area.

Crown Lands in the area have been identified as potentially suitable for rural residential land uses and recreation. Great Lakes Shire Council has identified the Nabiac-Minimbah area as also suitable for rural-residential development. It is likely that there will be significant growth in the development of smaller acreage subdivisions throughout the area over the next 5 to 10 years particularly in the Glen Ora Road area. However, more eastern areas near the former aerodrome on Crown Land are unlikely to be developed over the next 5 years for this purpose.

As stated in **Section 4.16**, Aboriginal Land Claims have been lodged over most of the Crown Land in the area.

4.18 PUBLIC UTILITIES

There are no public utilities servicing the proposed site. Residences along Glen Ora Road have access to power and telephone only. Water is derived from bores or tank water and sewage disposed of on-site.

4.19 ROADS AND TRAFFIC

Roads servicing the mining site to be used as access are shown on **Figure 9**.

These include Glen Ora and Old Aerodrome Roads which are gravelled public roads from the intersection of the Pacific Highway near Nabiac. This section of the road is under the care and control of Great Lakes Shire Council.

Thereafter a Right of Way (which was granted in 1990 under Section 175 of the Mining Act 1973) continues through land owned by the Car Club and unoccupied Crown Land to the existing southern mining site. This part of the road, a distance of 7.5km, comprises the former mine haul road constructed by Mineral Deposits Limited in the mid 1970's. The road is currently used by RZM as their mine haul road for operations in the McClymonts Creek area.

A traffic count conducted at the corner of Old Aerodrome and Glen Ora Roads in 1990 was presented in Resource Planning Pty Ltd (1990), for the existing mining operations in the McClymonts Creek area to the south.

It showed that a total of 34 vehicles used Glen Ora Road between 6:00am and 10:00am and 49 between 2:00pm and 6:00pm. More than 82% of vehicles turned into old Aerodrome Road, the balance continued along Glen Ora Road. Heavy vehicles comprise 19% of morning and 10% of afternoon traffic using both Glen Ora and Old Aerodrome Roads. Total heavy vehicles were 6 in the morning and 4 in the afternoon, i.e., a total of 10 movements.

Since that time, RZM Pty Ltd has commenced mining operations in the McClymonts Creek area with a maximum of 38 additional vehicle movements daily of which 6 movements are associated with trucks carrying concentrate haulage.

Access to the new site will be via existing roads used by the Company. Upgrading of an existing track from the formed Right of Way for a distance of 2.5km will be necessary to access the new mining operations in MLA 1.

4.20 SOCIO-ECONOMIC ENVIRONMENT

Great Lakes Shire is one of the highest non-metropolitan population growth areas in New South Wales and Foster is the main growth centre in the Shire. The rising population has had a beneficial effect on the socio-economic environment of the area due to associated development of community services and use and development of commercial and industrial services.

The basis of urban growth is generally provided by employment opportunities. Browne and Great Lakes Shire Town Planning Department (1984) recognise that in Forster the large proportion of in-migration of retirees provide added population. This, together with the growth in the tourist sector, has produced a high growth rate and increased employment opportunities in the area.

Relatively high proportions of the Shire labour force are employed in the construction industry and the recreation and entertainment industry. An increased sector of the labour force has been employed in the manufacturing and finance/property/business services since 1976. These changes reflect the wider range of economic activities supported by the larger population size of the Shire (Browne and Great Lakes Shire Council Town Planning Department 1984).

DESCRIPTION OF THE PROPOSED DEVELOPMENT

5.0 DESCRIPTION OF THE PROPOSED DEVELOPMENT

Proposed operations in MLA 1 are identical to those currently being conducted further to the south in the McClymonts Creek area.

5.1 MINING TENEMENT

The proposed mining operations will be located within MLA 1 Coffs Harbour covering a total area of 308 hectares. Within this area, approximately 25 to 28 hectares will be disturbed by mining and ancillary operations, ie. 8% to 9% of the MLA.

5.2 CONSTRUCTION PHASE

RZM Pty Ltd is currently mining in the McClymonts Creek area further to the south (see **Figure 1**). Reserves in this area are nearing depletion and mining is expected to be finished in 1993.

The Company seeks to transfer to the new areas as soon as consents are obtained to ensure continuity of operations and employment for personnel. A Development Application has been lodged for mining former titanium minerals stockpiles areas in the Wang Wauk area which will provide the Company with an additional one month of reserves while the plant is located in the McClymonts Creek area.

Construction procedures will involve:

1. Construction of access (subject to conditions).
2. Clearing for plant and ancillary equipment.
3. Relocation of the plant from the McClymonts Creek to MLA 1.
4. Reconstruction of the plant.

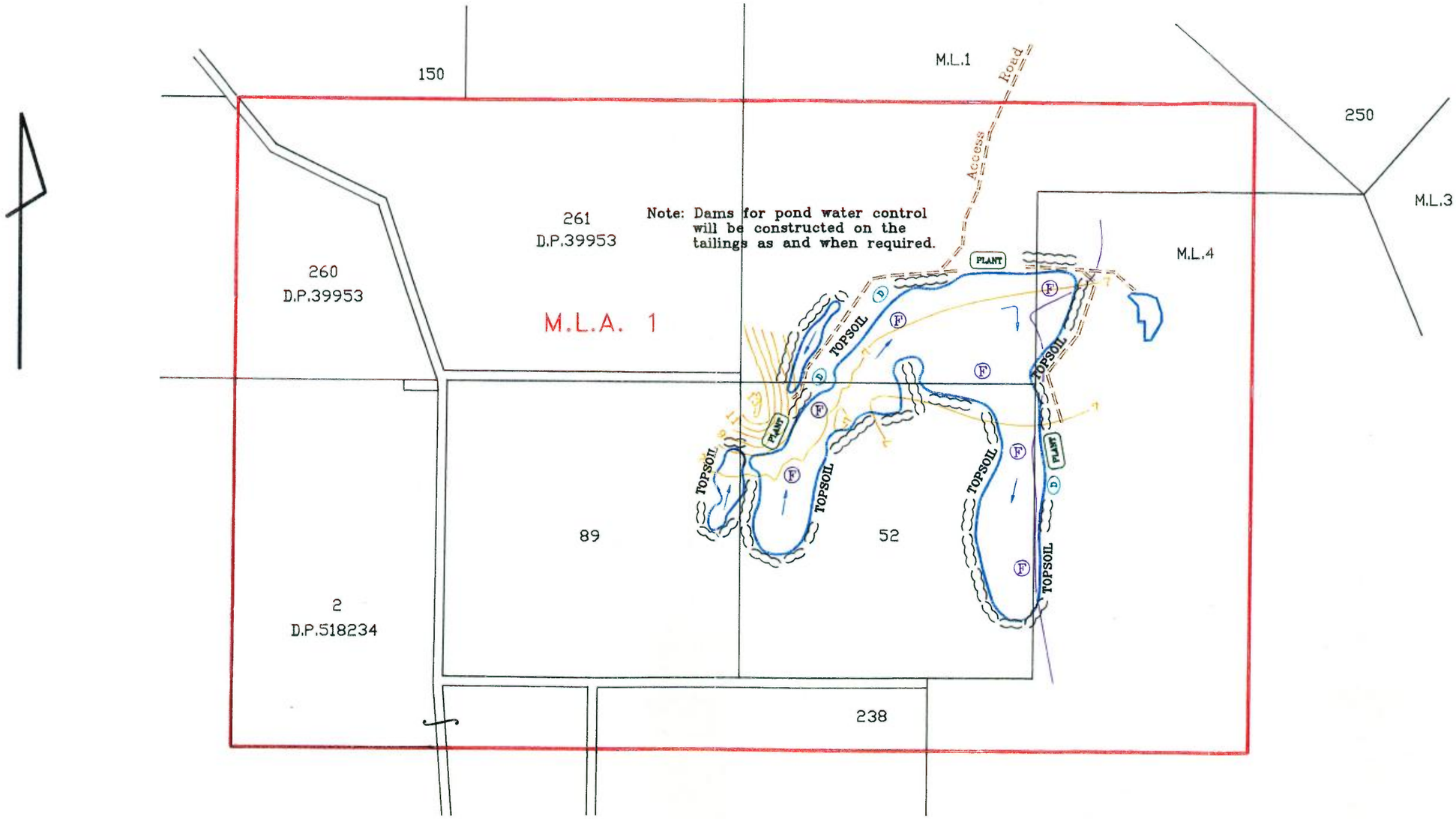
These procedures are expected to take 12 working days.

5.3 OUTLINE OF THE MINING OPERATION

The ore bodies to be mined occur in distinct linear bodies or pods within the mining areas as shown on **Figure 10**.

These ore bodies are to be progressively mined and rehabilitated in 'paths' with all ancillary processing and servicing equipment moving progressively with the mining operation.

Mining procedures involve:



LEGEND:

- RZM Access Roads.
- PLANT Plant Sites.
- Mining Path.
- Mining Tenements.
- (D) RZM Dams.
- (F) Feeder Unit Sites.
- Edge Previous Mining.

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Figure 10
MINING PLAN

0 100 200 300 400 500
metres

1. Surveying and pegging of the mine path.

2. Pre-mining vegetation survey.

3. Clearing of any vegetation cover up to 200m in advance of the mining face to the width of the mining path (50m to 100m).

4. Clearing of sufficient adjacent areas for topsoil stockpiling and provision of mining services.

5. 'Disposal' of timber either by burning or stockpiling for later respreading on the reformed areas. Stockpiling is preferred.

6. Stripping generally to a depth of 300mm and stockpiling of topsoil in windrows on the sides of the mining path for later respreading.

7. Dry mining using a front-end loader and dozer to a maximum depth of 4m.

8. Wet processing to separate heavy minerals from the sand and fines.

9. Return of sand tailings to the excavation and fines to settling dams.

10. Drying out of the returned tailings and fines.

11. Reshaping of the ground surface to a landform similar to the pre-mining situation.

12. Respreading of topsoil.

13. Spreading of stacked timber (where retained).

14. Revegetation of the disturbed areas using native endemic species or grass, depending on the pre-mining land use, agreements with landowners, and conditions of consent.

Figure 11 shows in sketch form the mining and processing procedures.

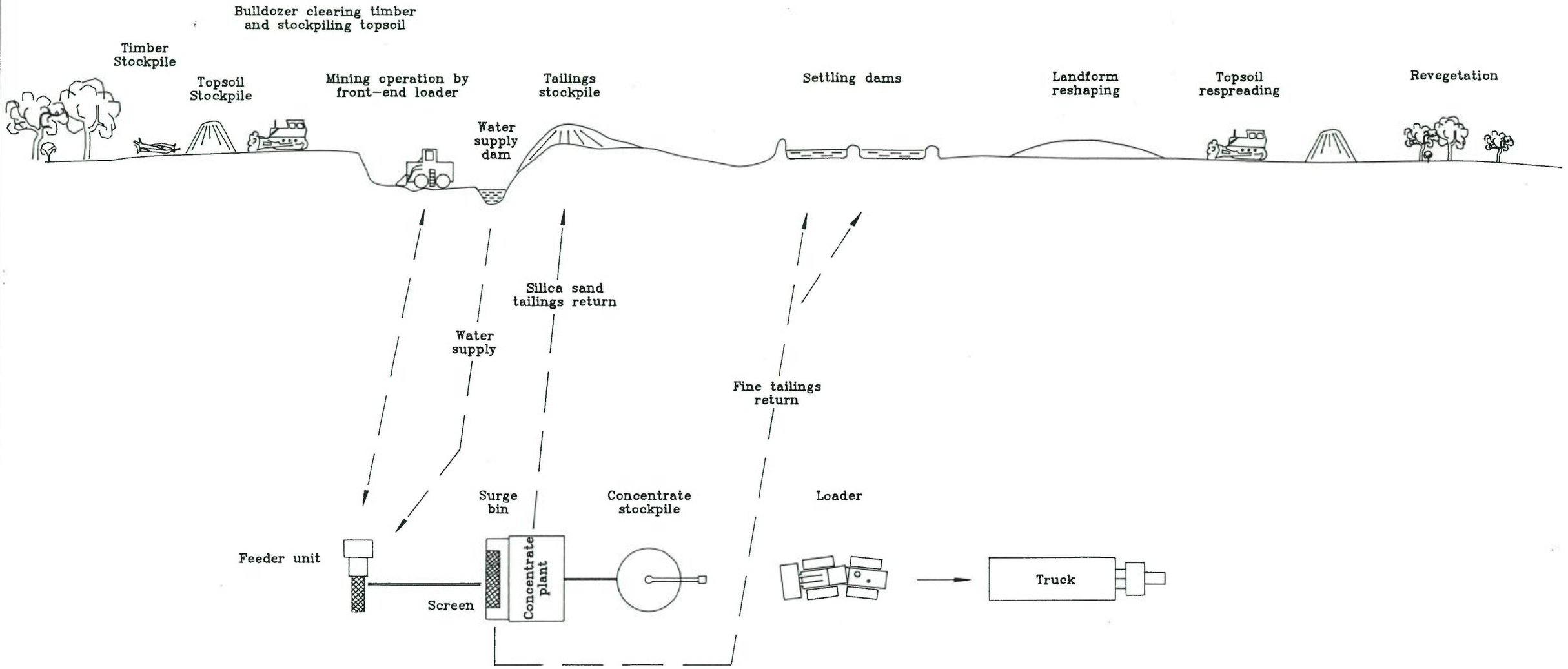
5.4 SITE PREPARATION

5.4.1 Pre-Mining Assessment

Following planning of the mine paths and prior to any disturbance, topographic and detailed botanical surveys will be undertaken by the Company.

Large-scale contour plans of the mine paths and adjoining areas will be drawn as a pre-mining record and to facilitate post-mining landform shaping.

Transects will be made across the mining path to record the diversity and abundance of all vegetation. This information is used to formulate a revegetation strategy, as a record of the pre-mining conditions, and to monitor the longer term



RZM

FIGURE 11:
SCHEMATIC OF MINING PROGRESSION

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re-establishment of native species post-mining so that areas can be reassessed according to the rehabilitation objectives.

5.4.2 Vegetation Clearing

Naturally occurring areas on the mining path will be cleared for a distance up to 200m ahead of the mining face and to the width of the mining path which varies from 50m to 150m depending on the width of the ore body. An area 10m to 20m wide immediately adjacent to the path will also be cleared to allow for topsoil and vegetation storage and provision of mining services.

Only large overstorey species will be removed by the dozer and disposed of according to the logistics of the operation and rehabilitation design. The owner of Portion 52 has requested that any large paperbark trees felled on this property be sent to a local timber mill for processing.

Options for disposal include stacking and burning, or storage on the sides of the mine path behind the topsoil storage areas in zones of extra clearing for this purpose. The timing of timber clearing and burning will be planned to avoid high bushfire risk conditions and an appropriate permit will be obtained from Council's Fire Control Officer.

In areas which have either been previously cleared or support heath only, the vegetation will be removed with the topsoil.

Areas of lower mineralisation which are not part of the mining path will be retained as natural vegetation islands to minimise disturbance and to act as natural seed sources during revegetation.

5.4.3 Topsoil Stockpiling

Topsoil will be removed by a dozer and stockpiled in windrows on the sides of the mine path. Depth is determined by relative relief and the type of plant community but would generally be approximately 300mm.

The understorey and herbaceous vegetation remaining in forested areas after clearing will be removed with the topsoil to preserve plant propagules and organic matter for the purposes of site rehabilitation.

Soil will be stockpiled in windrows on the sides of the mining path with storage time governed by the logistics of the operation. Every endeavour will be made to keep soil storage duration to a minimum and it is anticipated that respreading would be completed within 3 to 6 months of mining and sooner if possible.

5.4.4 Clay Removal

In places, clay up to a depth of 1.7m overlies the orebody. This clay will be stripped and stockpiled in a similar manner to the topsoil and replaced progressively in a similar topographic and geomorphological position.

5.5 MINING OPERATIONS

5.5.1 Mining Method

Because of the shallow occurrence of economic grades of heavy mineral at or above the water table, it is proposed to adopt a dry mining method using dozers and front-end loaders operating in a shallow pit (maximum depth of 4m). This is as opposed to a dredging method which is more effective where significant volumes of mineralised sands exist below the water table.

Sand will be progressively mined from a pit face using a 4.1m^3 wheeled loader to excavate and transfer material to the plant's feeder unit. At times, the wheeled loader will be assisted by a dozer to excavate harder materials and to maintain a consistent throughput.

5.5.2 Progressive Mining and Rehabilitation

Mining will commence on the western side in the two smaller ore bodies and these progressively proceed from west to east over a period of some 14.5 weeks.

The mining path width and depth determines the rate of progress of mining and hence the total area disturbed at any one time. Ancillary equipment and facilities are usually located as close as possible to the mining path to minimise total areas of disturbance. These ancillary operations will include topsoil stockpiling, access roads, feeder and plant sites, plant route, concentrate and tailings stockpiles, loader routes, and dam sites.

Rehabilitation follows progressively behind mining and not all of the total disturbed area is exposed at any one time. The frontal edge of rehabilitated ground is expected to be approximately 11 weeks behind the mining face, depending on the rate of fines produced and drying time. The majority of other disturbances will be rehabilitated immediately upon termination of their use.

5.6 MINING EQUIPMENT

Equipment to be used in the mining operation is listed in **Table 5.1** together with its functions. This equipment is currently used by the Company in its McClymonts Creek operation (Plant 10).

TABLE 5.1
MOBILE MINING EQUIPMENT

1 Komatsu D65/8 Swamp Dozer	– Vegetation and topsoil removal, assistance to front-end loader, topsoil/vegetation respreading, tailings contouring, dam construction and rehabilitation, etc.
1 Komatsu D65 Dozer (Contract)	– As above, if Swamp Dozer not available or not required.
1 Volvo L150 Front-end Loader ($4.1m^3$ capacity)	– Excavation of sand, loading of feeder unit, disposal of trash, loading of concentrate.
1 Volvo ($2.5m^3$ capacity)	– As above as required, to cover maintenance and breakdowns and occasionally for mining.
1 4 x 4 Utility	– Transport of employees and equipment.

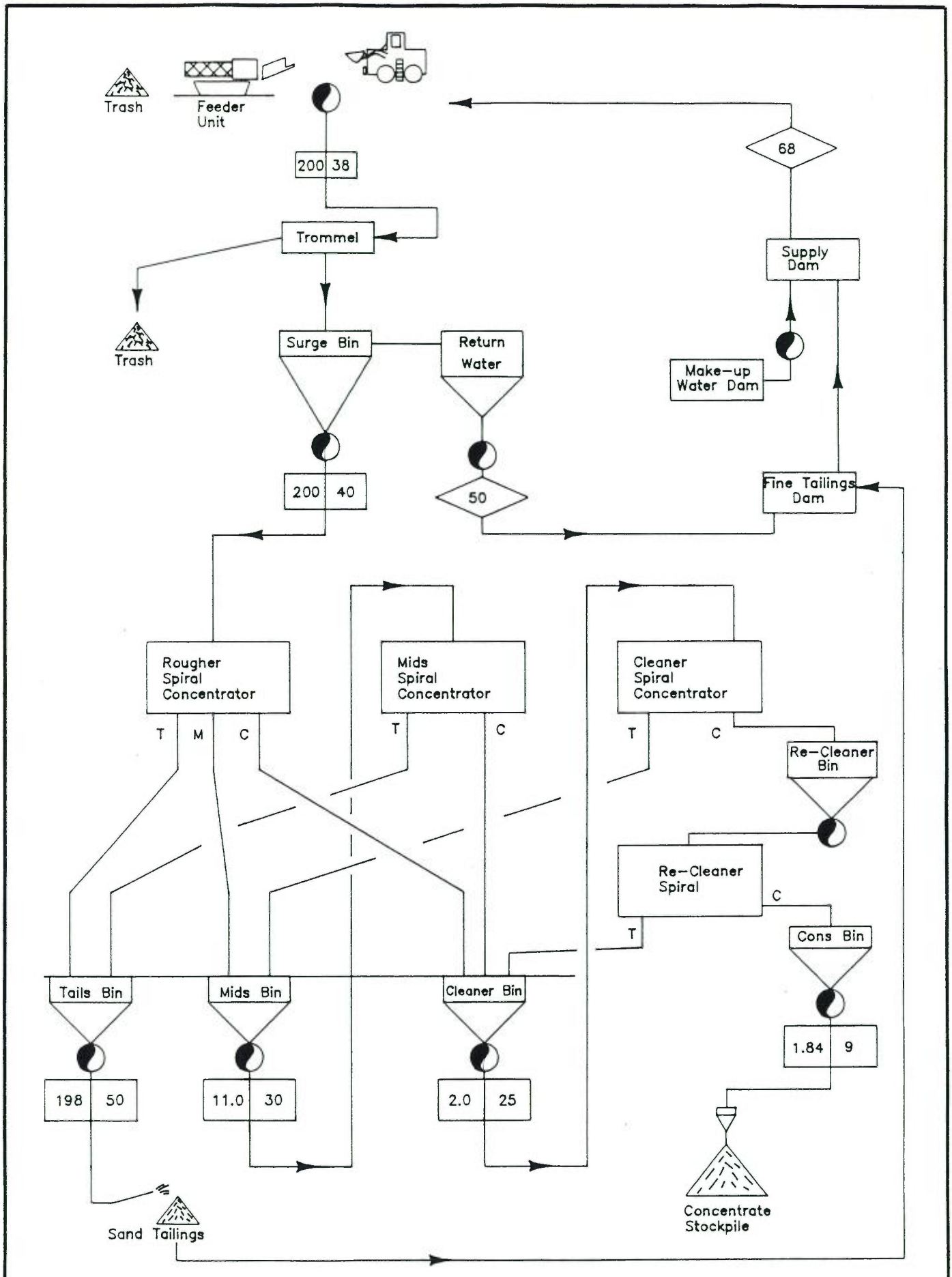
5.7 PROCESSING OPERATIONS

Figure 11 shows the components of the processing operations and **Figure 12** a flow chart. It is proposed to utilise the existing plant currently operating in the McClymonts Creek area.

The plant has a throughput of 200 tonnes per hour and comprises 3 major units; the feeder, surge bin, and concentrator plant.

5.7.1 Feeder Unit

The feeder unit measures 9.3m by 4.5m and consists of a receival bin, trommel screen and collection tank. Sand mined from the excavation will be deposited into the receival hopper where it will be sluiced with the assistance of water to the trommel screen. The trommel is a revolving screen designed to separate coarse refuse such as stones, concretions, any lumps, and sticks from the sand. The 'trash' will be discharged to a stockpile at the end of the screen while the sand fraction, now in slurry form, will be pumped from the collection tank to the surge bin.



KEY

Bin — Recieving Bin

Plant Process

Tonne/hr 200 38 Pulp density

50 Litres/sec

Figure 12
FLOW CHART OF PLANT OPERATION

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5.7.2 Surge Bin

The sand slurry will be further screened at the surge bin section of the plant, with the oversize and trash discharged to the ground. The sand slurry drops into the surge bin and will be pumped to pressure distributors mounted above the rougher spiral concentrators in the concentrator plant.

5.7.3 Concentrator Plant

The concentrator plant separates the heavy minerals from the sand slurry and comprises a two storey unit measuring 16m by 9m, housing the spiral concentrators.

The sand slurry passes down the spiral concentrators under gravitational forces. The heavy minerals are retained on the inside of the spirals and separated from the lighter silica sand which moves to the outside of the spiral. The heavy mineral is further upgraded by two other stages of pumps and spirals before being pumped to a cyclone on a boom to discharge onto a stockpile for later removal.

Further refining of the heavy mineral will be undertaken at the Company's existing Tomago processing plant.

The sand tailings which comprise approximately 98% by weight of the material mined will be returned to the mining excavation.

Fine tailings from the processing operation containing silt and clay will be pumped to settling dams on the mining path for settlement. Clean water overflow will be returned to the supply dam and reused in the circuit.

5.7.4 Production Rate

The plant has a throughput of 200 tonnes per hour. Production of concentrate depends on the grade of heavy minerals within the ore body which may range from 1% to 3.3%. Hence production of concentrate may range from 2 to 6.6 tonnes per hour or 240 to 792 tonnes per week with three shifts operating.

5.8 LIFE OF THE MINING OPERATION

Based on expected production rates, the Company expects to complete mining in the area in approximately 14.5 weeks.

5.9 ANCILLARY EQUIPMENT

All equipment including the plant and feeder unit will be mounted on skids and relocated as mining proceeds. Ancillary supporting equipment for the plant include 2 small workshops (each 4.7m x 2.6m), generator (6.6m x 3.2m), diesel fuel tank for the 2 generators (each 2.6m x 4.5m), two storage buildings (2.6m x 2.3m, 2.6m x 4.8m) and three smaller fuel tanks for machinery, (each measuring 3.2m x 2.0).

5.10 WATER SUPPLY

5.10.1 Process Water

Process water will be obtained initially from a dam or spear point constructed to intersect the groundwater and pumped to the processing operations at a rate of 34L/second.

Once the normal sequence of operations is established, water will be obtained from the supply dam on the mining path which is fed from decanted water from the fines settling dam and tailings overflow to create a closed circuit. Make-up water is required to compensate for the normal operating loss of approximately 20% from evaporation and permeation from settling dams and returned tailings. In areas of high groundwater, flows into the pit from groundwater sources compensate for the 20% loss, eliminating the need to secure make-up water from external sources.

Figure 12 shows on-site water management which is described in more detail in **Section 6.1**.

5.10.2 Domestic Water

Water for drinking and washing will be derived from tanks on the concentrator plant which will collect normal roof water or be replenished by an outside contractor during dry weather conditions.

5.11 EMPLOYEE FACILITIES

A meal room, shower and toilet facilities will be contained on the plant in accordance with the requirements of the Mines Inspection Act 1901.

5.12 SERVICES

5.12.1 Power

Power for plant processes and pumps will be derived from one 330 kVA and one 200 kVA diesel alternating sets which will be mounted on skids and enclosed in a silencing canopy.

5.12.2 Telecommunications

Portable telecommunication facilities will be provided to the site.

5.13 ROADS AND TRAFFIC

5.13.1 Access Road

It is proposed to use part of the existing haul road currently used by the Company's vehicles accessing the McClymonts Creek operations. This route follows Glen Ora Road from the Pacific Highway, and Old Aerodrome Road. From the end of Old Aerodrome Road at the boundary of the private land comprised in Portion 250 where the right-of-way granted under Section 175 of the Mining Act (1973) commences, the route will deviate at this intersection to the south along a partly formed road utilised by Mineral Deposits Limited in 1970's - early 1980's to access mining operations. This former road and access track to MLA 1 which passes through both private land and Crown land will need to be upgraded and reconstructed for the proposed traffic. It is intended that upon the grant of a mining lease in satisfaction of MLA 1 that an application will be made to the Mining Warden for grant of a right-of-way under Section 164 of the Mining Act 1992 for part of the access route from Old Aerodrome Road to the northern boundary of the mining lease.

RZM Pty. Ltd. has upgraded part of Glen Ora and Old Aerodrome Road as part of its existing operations.

5.13.2 Traffic

Mining in MLA 1 will replace the Company's existing operations in the McClymotts Creek area and hence there will be no increase in existing traffic levels as a result of the new operations. **Section 4.19** describes existing traffic levels.

5.13.3 Construction Vehicles

Ten semi-trailer loads (3 wide loads) will be required to relocate the mining plant from the McClymonts Creek area and 2 cranes will be used to dismantle and reassemble and plant over a period of 12 working days.

5.13.4 Concentrate Haulage

Concentrate is hauled by up to 3 tri-axle tipping trucks carrying up to 27 tonnes of concentrate per load.

5.13.5 Service Vehicles

Other service vehicles include two loads of 7,000 litres of diesel fuel per week, one 2,000 litre tanker of sewage removed from the site approximately once per month and one tri-axle low loader at an average of 2 trips per month transporting the contract equipment to and from the site. A truck carrying nursery plants and personnel would be in attendance at least once during the mining operations.

5.13.6 Employee Vehicles

Normal daily employee vehicle movements number 14 (trips x 2), with an additional 2 movements on three days per week for service and maintenance duties, and 4 movements on weekends on maintenance and security services.

5.13.7 Summary

Table 5.2 summarises expected total vehicle movements per day for three shifts and the worst case situation of all service trucks and personnel in attendance, and the plant requiring repairs.

TABLE 5.2
DAILY VEHICLE MOVEMENTS

	Normal 3 Shift Operation	* Peak 3 Shift Operation
Concentrate Haulage	6	6
* Maintenance/ Repair Vehicles	–	2
Nursery Vehicles	–	2
Fuel Delivery	–	2
Sewage Tanker	–	2
Low Loader	–	4
Employee Vehicles	14	20
	20	**38**

* **Worst-case situation of plant breakdown and all service vehicles in attendance.**

* **1 trip = 2 vehicle movements.**

The table shows a maximum of 18 truck movements and 20 vehicle movements daily during worst case operational conditions.

5.14 HOURS OF OPERATION

5.14.1 Mining and Processing

Mining and processing operations are conducted 24 hours a day, 5 days a week.

5.14.2 Truck Haulage

Haulage of concentrate and fuel, and other heavy vehicle activities are carried out during the hours of 7:00am and 6:00pm daily on weekdays.

5.14.3 Maintenance

Maintenance is carried out progressively during mining and processing or on Saturdays.

5.15 EMPLOYEES

The mining and processing operation provides on-site employment for 12 personnel. These persons are currently employed at the Company's McClymonts Creek operation and will relocate to MLA 1 when operations commence.

ENVIRONMENTAL MANAGEMENT PROCEDURES

6.0 ENVIRONMENTAL MANAGEMENT PROCEDURES

6.1 WATER MANAGEMENT

Protection of existing surface and groundwater supplies in the area is essential to maintain the viability of adjoining vegetation and agricultural enterprises, and water quality in creeks and groundwater sources. This section describes procedures to safeguard these water supplies.

6.1.1 Water Supply

Section 5.10 outlined procedures for the supply of process water to the plant and these are briefly reviewed. **Figures 11** and **12** show details of the water management procedures.

At the commencement of operations, process water for the plant will be obtained from a dam or spear points constructed adjacent to the mining path. The excavated dam and associated stockpiled excavated material will occupy approximately 3,600m^2.

Once the normal sequence of operations is established, a sump on the floor of the excavation will serve as a water supply and will be fed from decanted water from the fines settling dams and sand tailings; creating a closed system. In dry conditions, make-up water will be obtained from the initial water supply dam or spear points.

Process water (dredge pond and pond make-up water) will be monitored and from the results, the Department of Mineral Resources will determine whether an ongoing programme will be required.

6.1.2 Dewatering Procedures

In wet conditions with a high water table, water will be pumped from the excavation to the water supply dam via the fines settling dams if settlement is required. As the mining progresses, groundwater flowing into the excavation will be retained in the floor sump and used in plant processes. Under normal circumstances the volume of groundwater will compensate for the loss of approximately 20% of water due to evaporation or permeation from the floor of settling dams and returned tailings.

On occasions when excess water occurs in the system, water will be pumped to additional settling dams on the mining path until it is of suitable quality for release to the ground or required to balance normal losses in the water supply system.

There will be no discharge to waterways.

6.1.3 Tailings Disposal

Two types of tailings will be produced by the processing operation. These include a dense sand slurry, and suspended silt and clay.

Sand tailings from the initial excavation will be stockpiled behind a bund wall constructed of topsoil stripped from the stockpile pad. The bund contains runoff and acts as a visual buffer until the material is required for filling of the final pit void. Once the normal sequence of operations is established, the tailings comprising approximately 98% sand by weight, will be pumped directly back to the mining area for final landform shaping. Decanted water drains to the pit sump for recycling in the system.

The suspended silt and clay, known as fine tailings, will be pumped to sedimentation dams for settling of the fines and decanting of clean water back to the water supply system. These dams will be constructed on the mining path and will be designed to contain fines from 4 weeks production. The dams are progressively relocated with the mining operation, dried out, and the fine tailings mixed with the sand tailings and contoured. Drying may take up to 5 weeks to complete before shaping is possible.

6.1.4 Erosion Controls

To minimise wind erosion, progressive rehabilitation follows mining, involving the return of stockpiled topsoil to mined areas and contouring to the pre-mining landform. A surface vegetation cover is re-established as soon as practicable. The final landform will be stable and of similar topography to the pre-mining terrain.

6.1.5 Domestic Waste Water Disposal

Waste water from employee facilities will be collected in tanks on the concentrator plant, and removed by a contractor on a regular basis, and disposed of off-site in an approved Council disposal area.

6.2 CONTAINMENT OF FUELS AND OILS

Waste oils and greases from plant maintenance operations will be collected and removed from the sites in drums to approved Council disposal areas.

The fuel tanks will be bunded and sited on an impervious surface to contain any spillages from ruptures and escape through the pervious sand surface.

6.3 SOLID WASTE MANAGEMENT

The trash from the screening units comprising stones, hard indurated clumps and tree roots, will be picked up by the front-end loader and placed back on the sand tailings before being covered and mixed with the topsoil.

Domestic waste products will be removed regularly from the site.

6.4 AIR QUALITY CONTROLS

Air quality will be protected by preventing or minimising dust at generation points to levels below those that cause inconvenience to employees and surrounding residences.

The main potential sources of dust generation will be:

1. Traffic on the access route, including Glen Ora Road and Old Aerodrome Road.

2. Areas of exposed topsoil and dried tailings, i.e., immediately after vegetation stripping, topsoil stockpiles, and respread topsoil prior to revegetation.

The balance of the operation involves working with damp sand, damp product and saturated tailings. The processing of the sand to yield the titanium minerals concentrate is a wet process, using water at all stages of processing. Therefore, the extraction and processing operations will not be significant dust generators.

Stripped upper storey vegetation will generally not be burnt, but will be stockpiled for use during rehabilitation.

To minimise dust generation, the following control measures will apply:

1. Only a small number of vehicles travel the access route daily and a speed limit will be imposed by the Company and Council.

2. The area of exposed topsoil or dried tailings will be minimised at all times. Stockpiling of the topsoil will occur immediately after the stripping of the vegetation, and conversely after mining, the respread topsoil will be progressively revegetated.

3. After respreading of the topsoil, the stockpiled timber will be spread over the topsoil to aid in reducing wind speeds and minimising the occurrence of wind blown dust.

All residences along the access route are well set back from the road alignment and any dust generated by trucks will not significantly increase dust levels beyond those already experienced by residents.

6.5 MANAGEMENT OF WETLAND AREAS

No SEPP 14 Wetlands will be disturbed by the mining operations. Some seasonally wet swamp sclerophyll communities and heath/sedgelands will be mined. Practices to be adopted in these areas are those outlined by Brooks (1988a and b) and include:

1. Accurate establishment of ground levels because significant alterations to water levels can have a major impact on vegetated recovery.

2. Areas will be drained before mining to maintain topsoil structure and viability of plant propagules when handled.

3. Topsoil will be handled in large clumps, and stored for the minimal time.

4. Rehabilitation will be carried out progressively following mining.

The depositional history of titanium mineral concentrations, and associated ground surface morphology mean that mining for titanium minerals sands frequently has occurred in seasonally wet low lying swampy areas. There was a misconception that rehabilitation of these areas in mining paths was not feasible, but advances in rehabilitation technology and research by mining companies and others have shown that with responsible management of peaty topsoil and plant propagules, and control of post mining water levels, rehabilitation of seasonally wet areas can be achieved.

Monitoring of vegetation rehabilitation in seasonally wet areas indicates that the greatest success has been achieved where mining occurs along narrow strand lines separated by zones of natural vegetation, and where post mining water levels are maintained close to, or just below the ground surface by drainage control. Regenerating vegetation should not be inundated, but drains can be removed once vegetation has become established.

The extraction technique proposed for MLA 1 is dry mining, using dozers and front-end loaders. Because the water table in the mining area is generally high, the dry mining technique may necessitate disposal of groundwater. Disposal of groundwater is governed by seasonal conditions and may not be necessary in dry conditions. When seasonal conditions affect the mining programme a rearrangement in the mining sequence may be required with operations commencing when the groundwater table is lower and proceeding later into low lying areas when the groundwater table has lowered. The effects of such short term water table lowering on adjacent natural vegetation units, particularly wet areas, suggest that the method is not expected to have any deleterious effects on nearby plant communities. This is because:

* Groundwater will be pumped principally from the mining path, and only the section currently being mined will be kept dry at any one time.

* Groundwater pumped from the mining path will be redistributed on the sand mass for infiltration to the groundwater table. Consequently, any alteration to groundwater levels during mining will be minimal and within normal climatic cycles and variations which the existing plant communities are adapted to.

6.6 REHABILITATION PROCEDURES

The Company's rehabilitation procedures have evolved over some 30 years and are constantly being refined in line with technology changes and research. The rehabilitation of mined areas is an integral part of the mining operation and therefore, given important consideration during the mine planning process.

The planned post mining programme forms part of the conditions under which the Company operates and a substantial bond is posted with the Department of Mineral Resources as a guarantee that the work will be carried out satisfactorily. The bond is held until the conditions of the lease have been met and the area considered satisfactory for release.

6.6.1 Landform Reshaping

Tailings will be returned to the excavation and contoured to create a topography similar to that which was present before mining. Contours will be sympathetically merged in with the existing ground on the sides of the mine path in a plan based on pre-mining contour surveys. This normally follows within 300m behind the mining face and final contouring is carried out by a dozer. Post-mining landforms would be expected to be in place 4 to 8 weeks after mining depending on the rate of advance of the mining face. The logistics of the operation or erratic weather patterns may, however, alter this practice where the construction of water control dams may be necessitated on the tailings (which is usually the best place to locate them in order to minimise disturbance) which may delay final landform contouring for up to 11 weeks.

6.6.2 Topsoil Replacement

A post mining rehabilitation programme designed to ensure progressive site rehabilitation will be undertaken by the Company in order to minimise potential soil erosion and to successfully re-establish surface vegetation cover as soon as practicable after mining. It is anticipated that this process would be completed within 3 to 6 months of mining and sooner where possible. Topsoil will be returned to the contoured tailings by front-end loader and/or dozer by the reverse of the topsoil removal process.

6.6.3 Revegetation Procedures

After respreading of topsoil, a planned revegetation programme will follow involving the re-establishment of those major species which existed prior to mining and in similar proportions, unless alternative agreement is reached with the landowner. This would normally entail either the planting out of nursery grown endemic stock or the re-establishment of pasture cover. Revegetation will generally follow soon after topsoil replacement. However, if the process is delayed for any reason, interim soil conservation measures such as cover cropping or brush matting are employed.

The detailed botanical survey which is conducted prior to mining to accurately identify the floristic elements present on the mine path will be used to plan the revegetation strategy so that similar plant communities to those existing pre-mining may be re-established post-mining.

Seedlings are grown in the Company's nursery from seed collected on-site at the clearing stage and during the operation (when available). Collection of local seed for revegetation ensures the conservation of species provenances, but some seed may be purchased from commercial suppliers if in short supply.

Nursery stock will be grown according to rehabilitation demands and will be planted out based on the predetermined strategy of species composition and density.

The owners of the freehold properties have requested that land which is to be affected by mining operations be revegetated by seeding with suitable species of grasses and legumes to establish an acceptable pasture, where applicable. Rehabilitation arrangements will be planned by the Company's officers in consultation with the landowner and the Department of Mineral Resources. The programme will include periodic applications of fertilisers, slashing and reseeding, if necessary, for a period of up to three years at which time it is expected that the Company will be released from its maintenance obligations. In those parts of the private lands which are subject to seasonal flooding and which are not generally suited to grazing, the planned native revegetation programme outlined above will be adhered to.

The Company will monitor re-establishment of rehabilitated lands including species replacement and weed control as required.

All plant and equipment will be removed at the completion of mining operations and the sites progressively rehabilitated If required, the access road will also be removed and revegetated.

6.7 NOISE CONTROLS

Safeguards will be incorporated in the project to reduce noise impacts. Potential sources of noise are the mobile equipment (front-end loaders and dozers), feeder unit, processing plant and generators, portable pumps and trucks transporting the concentrate from the site.

All mobile equipment (front-end loaders and dozers) will be fitted with appropriate noise reduction equipment, e.g., 'residential' type mufflers on exhausts, shielding around motors, etc., and maintained in good working order.

The generators for the plant will be fully enclosed within acoustic enclosures and appropriate silencing equipment will be fitted to the exhaust of the diesel motors.

Portable pumps driven by diesel motors will have suitable silencing equipment fitted to the exhaust of the motor.

Trucks transporting the concentrate from the site will be normal roadworthy highway vehicles and the loading and dispatch of the concentrate will be restricted to daylight hours, normally occuring between 7:00am and 6:00pm weekdays. Only a small number of truck movements will occur each day and trucks will be required to adhere to Statutory and Company imposed speed limits.

No special measures will be necessary on the processing plant because of the nature of the operation and the enclosure of the plant within a transportable building.

6.8 VISUAL CONTROLS

Because of the relatively flat terrain, the mining operation will be seen only from access roads and the bedrock area to the west. The retention where possible of vegetation along the road verge, and vegetation islands will minimise visual impacts.

ANALYSIS OF ENVIRONMENTAL INTERACTIONS AND IMPACTS

7.0 ANALYSIS OF ENVIRONMENTAL INTERACTIONS AND IMPACTS

7.1 TOPOGRAPHY

The existing landform is gently undulating with low relief. The mining operation will return up to 98% daily by weight of sand mined to the excavation which is shaped to a similar landform to the pre-mining terrain. Detailed topographic surveys conducted prior to mining as outlined in **Section 5.3** guide the post-mining shaping to ensure landform similarity. **Figure 13** shows the final landform for the site.

7.2 GEOMORPHOLOGY AND GEOLOGY

As discussed in **Section 7.1**, the post mining surface morphology will be very similar to the natural pre-mining terrain. The mining operation will rework the stratigraphic units in the upper 4m of the Pleistocene sand mass, and remove the titanium minerals content using efficient mining methods. The geomorphic history of this barrier system has been intensively studied and is well understood (Melville, 1984).

Export of titanium minerals mined from this site provides financial benefits to the Company, State and Nation.

7.3 SOILS AND EROSION

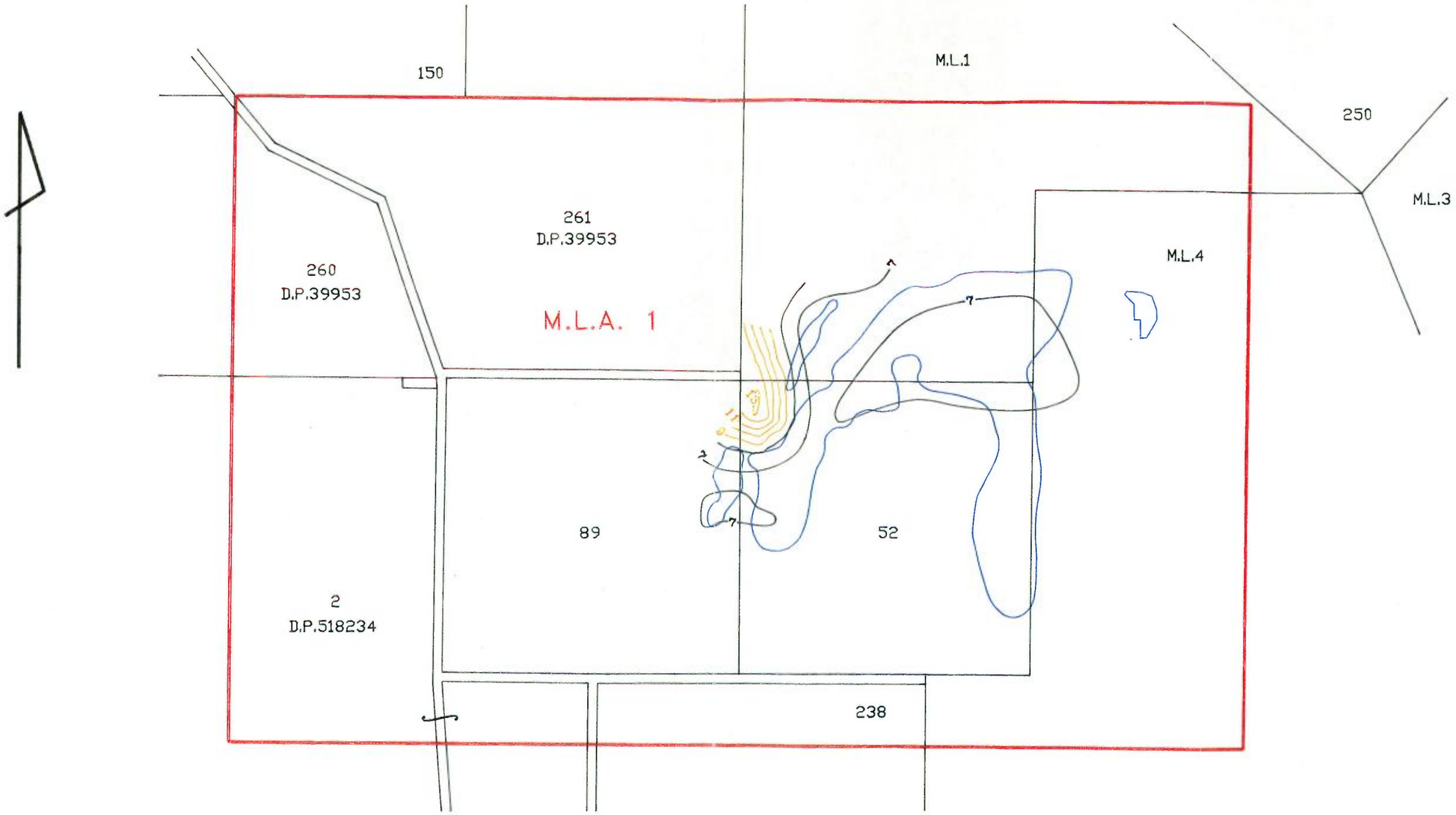
The Company's proposals for soil stripping, stockpiling, respreading and revegetation as outlined in **Sections 5.4** and **6.6** will ensure that soil resources are retained and maximised in rehabilitation procedures.

The soil is susceptible to wind erosion but not subject to significant sheet and rill erosion (**Section 4.5.3**). Minimising the areas to be disturbed and undertaking progressive rehabilitation of the mined areas, as outlined in **Section 5.4** and **6.6** will ensure that wind erosion is minimised and that there are no significant wind erosion impacts.

7.4 SURFACE AND GROUNDWATER HYDROLOGY

The proposed operations will not encroach upon nor disrupt flow in existing drainage lines. The permeability characteristics of the sand mass returned to the mined area will be similar to the pre-mining permeability conditions allowing infiltration of rainfall direct to groundwater and hence subsurface flows. Runoff from bedrock areas will not be altered.

Groundwater studies have shown that the water table is generally high except during prolonged dry periods and that dewatering will normally be necessary to



LEGEND:

Edge of proposed mining activity.

—7— Approximate post mining contours.

—7— Existing contours.

NOTE:
Contours shown are in metres
on Australian Height Datum.
Contour interval 0.5m.

Figure 13
FINAL LANDFORM

0 100 200 300 400 500
metres

RZM

A3—1116

permit dry mining operations. Proposals outlined in **Sections 6.1.2** and **6.5** for dewatering, and management of seasonally wet areas will ensure that changes to groundwater levels will be temporary and short-term, minimising any potential deleterious effects on nearby plant communities. Initially it is expected that there will be a drawdown of the groundwater table in the immediate vicinity of the mining area, water supply bores and dams. However, water returned with the tailings will infiltrate the porous sands to recharge the groundwater table.

Evidence given and accepted by the Land and Environment Court hearing in Ballina in late 1989 for titanium mineral mining, showed that groundwater flow and discharge before and after mining would be similar, that destruction of the indurated B layer would not affect overall water levels, and that the prime watertable would continue to fluctuate within the same range post-mining as it had pre-mining.

Extensive titanium minerals sand mining has been carried out previously by Mineral Deposits (late 1970's-early 1980's) in the adjoining area. No adverse long-term effects on groundwater have been noted in these areas from the mining operation and it could be expected that similar negligible effects will result from the proposed mining operation of RZM Pty Ltd.

7.5 WATER QUALITY

Soil studies have shown that no acid sulphate soils (catclays) occur in the areas to be mined by the Company. Consequently, the large scale release of acids and the consequent mobilisation of iron and aluminium as a result of oxidation of acid sulphate soils will not occur or affect nearby vegetation communities. Previous studies of the effect of titanium minerals sand mining on groundwater quality in the Tomago Sandbeds (Viswanathan 1987, Warne et al, 1989) indicate that there may be some initial change in soluble iron and sulphate levels but the mechanism for these changes cannot be defined, nor is there any evidence that these levels are maintained over an extended period or have a detrimental effect on regenerating or adjacent undisturbed native vegetation.

The groundwater in the proposed mining area already has a low pH and moderate to high iron content, common to podzol soils in coastal sand dune systems (see **Section 4.7**). Past mining activities in adjacent areas have shown that any changes to groundwater chemistry have not detrimentally affected vegetation re-establishment or existing nearby natural vegetation communities.

Process water (dredge pond and pond make-up water) will be monitored. From the results obtained, the Department of Mineral Resources will determine if an ongoing monitoring programme will be necessary.

Operational procedures adopted by the Company to contain any accidental spillages of oil and lubricants will ensure that no pollutants come in contact with the porous soils or groundwater table (**Sections 6.1** and **6.2**).

7.6 AIR QUALITY

Since the mining and processing operation involves the handling of wet sand, the potential for dust from these activities is low.

The main potential source of dust nuisance is the movement of traffic along the gravel access route. Because of the low traffic volumes, set back of residences from the road, and the adoption of control measures given in **Section 6.4**, it is expected that the development will not result in a significant increase in dust levels currently being experienced at nearest residences.

It is expected that with the control measures proposed in **Section 6.4** dust emissions from the exposed or stockpiled topsoil can be adequately controlled and the potential for dust nuisance is low. The distance from the mining operation to residences will provide an adequate buffer minimising dust impacts on nearest residences.

Any burning of vegetation will take place during suitable weather conditions and when wind directions blow away from nearest residences.

7.7 IMPACT ON VEGETATION

Within the proposed mine path approximately 21 ha of vegetation will be cleared. An extra 20 to 30% surface clearing will be associated with services. Of the mine path 9.3 ha is swamp sclerophyll communities and 6.8 ha of wet heath and sedgelands. These communities are represented within some of the nature reserves along the mid north coast of New South Wales. They also occur throughout the Forster – Tuncurry region. Within the immediate local area, part of these communities have been modified by titanium minerals mining activities.

Revegetation of the mine path will mitigate the effects of clearing in the long term and is discussed in **Section 6.5 and 6.6.** Due to changes in microtopography and species diversity of the area, post mining vegetation communities will be expected to possess somewhat different properties to those occurring premining.

It is proposed that bedrock area and areas adjoining the bedrock within the private lands on Portions 52 and 89 will be established with pasture grasses. The area to be established as pasture will not have a significant impact on vegetation and fauna (see **Section 7.9**) values of the area post mining. In the long term the pasture will potentially introduce weed species to the edges of the regenerating mine path. This could be controlled through management of weeds within the regenerating area.

The proposed haul route is an existing four wheel drive track traversing previously mined area to the northeast of the mine path. This section of the haul route will require minimal to no clearance of vegetation. Where the haul route adjoins the mine path there will be disturbance of forested communities 4, 6, 9, 10 and 11 (see **Figure 8**).

Records of **Allocasuarina defungens** are restricted to the Nabiac area in dry shrub and heath communities. **Allocasuarina defungens** has been assigned a

2E category by CSIRO ie. occurs over a range of less than 100km and is at serious risk of disappearing (Cleland et al, 1992). Any specimens of **Allocasuarina defungens** located during works will be fenced and a 20m wide buffer of natural vegetation retained.

7.8 IMPACT ON WETLAND

In 1985, State Environmental Planning Policy 14 (SEPP 14) – Coastal Wetlands was gazetted with the aim of ensuring that the environmental values of coastal wetlands are preserved and protected.

One hundred and twenty five metres (125m) to the north, northwest of the proposed mine path is located a small SEPP 14 Wetland No. 594 of 1.3 hectares (see **Figure 8**). The wetland is classified as a sedgeland community dominated by **Baumea articulata** (see **Section 4.9.2**, Community 19).

SEPP 14 Wetland No. 594 is located in the Pleistocene sand barrier. The associated poorly drained swales are dominated by Swamp Sclerophyll communities and wet heath which are excluded from SEPP 14 wetland communities. The SEPP 14 wetland is isolated from other protected estuarine wetlands which occur 3.5km to the south, southwest along the Coolongolook River and Minimbah Creek.

Wetlands in old coastal country are generally of low habitat value for waterfowl (Goodrick, 1970). The majority of the amphibians were not observed within the vicinity of the SEPP 14 wetland but at the constructed dam dominated by **Eleocharis** and the sedgeland (Community 20).

The SEPP 14 wetland will not be directly disturbed by clearing or access road construction. A buffer of Swamp Sclerophyll communities between the wetland and mine path will lessen indirect impacts. There is a potential for indirect impacts through short term changes in depth of the water table during mining operations. It is unlikely that there will be any long term impact on the ecology of the SEPP 14 wetland.

7.9 IMPACT ON FAUNA

Impacts on the fauna of proposed mining in the MLA include loss of habitat, loss of foraging habitat, loss of diurnal roosts for bats, noise and disruption of wildlife corridors. Clearance of natural vegetation will occur over a period of 14.5 weeks. All fauna habitats associated with the mine path will be disturbed resulting in potential localised loss of protected fauna species.

The proposed haul route is an existing four wheel drive track traversing mined areas and natural forested and wet heath communities. The track is an existing potential barrier to the free movement of small mammals. Upgrading of the road will increase the impact of the road as a barrier to the movement of small mammals for the duration of the mining operation. Rehabilitation of the haul road within the MLA would in the long term ameliorate this impact. The risk of road kills of larger animals will be increased by increased usage of the road during

mining period between the hours of 7am and 6pm. To minimise this impact it is recommended that vehicular speed is limited to 60km/hr.

The likely impact of the proposed mining operations on endangered fauna of the area was assessed based on the seven point test of significance as established in Section 4A of the Environmental Planning and Assessment Act 1979.

Endangered fauna, as listed in the revised Schedule 12 of the National Park and Wildlife Act 1974, which may occur in the MLA are the Glossy Black Cockatoo, Eastern Chestnut Mouse, Brush-tailed Phascogale, Common Bent-wing Bat, Little Bent-wing Bat, Eastem Blossom Bat, Yellow-bellied Sheathtail Bat and Greater Broad-nosed Bat .

As mentioned in **Section 4.9.2** the Brush-tailed Phascogale if it occurs in the MLA would favour the open dry sclerophyll forest with a grassy understorey. The Glossy Black Cockatoo favours dry sclerophyll habitat with stands of Casuarinas. **Allocasuarina littoralis** and **A. torulosa** are the favoured seed sources for the Glossy Black Cockatoo and both species occur in large numbers in the understorey of the dry sclerophyll open-forest on the bedrock to the west of the mine path.

Of the endangered ground dwelling fauna recorded within the region the Eastern Chestnut Mouse will potentially be affected. There are no recorded trappings within the local area and potential occurrence of the Eastern Chestnut Mouse is based on the occurrence of its preferred dense wet heath habitat.

Endangered bat fauna recorded within the area are the Common Bent-wing Bat and Little Bent-wing Bat. The Eastem Blossom Bat, Yellow-bellied Sheathtail Bat and Greater Broad-nosed Bat are considered to have medium likelihood of occurring in the area.

Both the Common Bent-wing Bat and Little Bent-wing Bat were recorded in the area. These species are cave roosting and it is considered unlikely that they are roosting in the mine path or adjoining area due to the sand-based nature of the site and lack of rock outcrops or suitable alternative roosts such as culverts or buildings.

The Eastern Blossom Bat is considered likely to occur in the area due to the presence of preferred nectar sources such as paperbarks and banksias. Mistnetting failed to confirm the presence of this species. The lack of rainforest in the vicinity may exclude the Eastern Blossom Bat from the area as it normally roosts in the rainforest (see **Appendix 3F**).

Yellow-bellied Sheathtail Bat prefers open eucalypt woodland habitats and therefore may occur in the areas adjoining the mine path. These habitats are available in the local area.

The Greater Broad-nosed Bat occurs in a range of habitats from rainforests and moist forests foraging in open areas on the edges of forests or along tree-lined creeks (Strahan, 1983). Preferred habitat is available within the region.

The following assessment of significance is based principally on the likely affects on the Eastern Chestnut Mouse, Common Bent-wing Bat and Little Bent-wing Bat.

(a) Extent of Modification or Removal of Habitat.

Proposed mining operation involves the recovery of minerals from an area of 9.3ha of swamp sclerophyll and 6.8ha of wet heath and sedgeland habitats in a natural condition.

The Eastern Chestnut Mouse favours habitat which will be modified by mining operations. Seven hectares of wet heath and sedgeland communities is a minimal area for disturbance in relation to the occurrence of similar habitat in the locality as interpreted from aerial photograph (NSW 4032 Run 4 31.8.91 1:25,000).

As outlined above, critical habitat of the Brush-tailed Phascogale and Glossy Black Cockatoo will not be affected by mining operations.

Mining operations will result in the loss of foraging habitat for the Common Bent-wing Bat and Little Bent-wing Bat.

(b) Impact of Habitat Modification on Fauna

The operation will result in the removal of existing vegetation and associated habitat. Sedentary species such as the Eastern Chestnut Mouse are sensitive to habitat removal and there is the potential for loss of individuals, however none have been trapped during studies in the area.

Mining operations will disturb foraging habitat of the Common Bent-wing Bat and Little Bent-wing Bat. As both species will travel long distances from their roosts to forage, the area of disturbance is not likely to be a significant loss.

Diurnal roosts occupied by tree roosting bat species and arboreal mammals will be removed. This will increase competition for remaining roosts.

(c) Regeneration of Habitat

The aim of the revegetation programme (see **Section 6.6**) is to restore the sites to a native ecosystem, as far as practicable resembling that originally present. It will take many years for the swamp sclerophyll forest habitats to regenerate. Sedgeland and wet heathland habitats will regenerate over a relatively shorter time period.

Revegetation of the area should provide habitat for species such as the New Holland Mouse which appear to favour areas of regenerating heath where there is a diversity of flora species.

As part of the clearing and subsequent regeneration of the area, habitat could be enhanced by replacing brush and logs in the area to provide cover and shelter for recolonising species of fauna. Provision of brush cover will also enhance the success of flora regeneration by stabilising the sand.

(d) Recovery of Fauna Populations

The population of Eastern Chestnut Mouse is unknown as it has not been trapped in the local area.

Fauna will return in the long term to the mined areas from adjacent refuges as the vegetation communities regenerate.

(e) Impact Amelioration Proposals

Rehabilitation of the mine path will provide similar fauna habitat in the long term.

To minimise mortality of tree roosting bats, clearing of vegetation prior to mining, should be undertaken during the months of September, October, March, April and May.

(f) Wilderness Assessment

The National Parks and Wildlife Service has not indicated that the area is being assessed for wilderness.

(g) Effect on Species Survival

The proposed activity could potentially have an adverse effect on the survival of a local population of Eastern Chestnut Mouse. This affect is unlikely to be significant as preferred habitat is available within the local area. It is difficult to assess whether the operation will significantly affect the conservation status of the Eastern Chestnut Mouse on a regional or statewide basis.

The proposed activity will have a minimal impact on foraging habitat of the Common Bent-wing Bat and Little Bent-wing Bat as these species are likely to be foraging over a wider area.

From assessment of the seven point test of significance it appears that the proposed mining activity will not significantly affect the environment of endangered species. Accordingly, a fauna impact statement will not be required for the proposed mining activity.

7.10 NOISE IMPACTS

A detailed analysis of potential noise impacts from proposed mining, processing and transportation operations has been undertaken as part of this study. A full description of noise monitoring data, noise levels used for the assessment purposes, and calculated noise levels are given in **Appendix 4**. The following sections summarise the relevant assessment criteria, noise impact analysis and assessment for the proposed development.

7.10.1 Mining and Processing Operations

Assessment Criteria

In assessing noise impacts of new projects, the Environment Protection Authority has two broad objectives.

1. That noise from any single source does not intrude greatly above the prevailing background noise level.

2. That the background noise level does not exceed the level appropriate for the particular locality and land use.

The Environment Protection Authority has proposed a schedule of recommended background noise levels for various land use categories to assist in balancing the individual and community effects and benefits from particular development. Details of the relevant category is given in **Table 7.1**.

TABLE 7.1
RECOMMENDED OUTDOOR BACKGROUND NOISE LEVELS

Receiver Area	Time Period	L_{A90} Background Noise Level (dB(A)) Acceptable Limit	Extreme Limit
Residential in Rural Area	Day	45	50
	Night	35	40

Note:

From Monday to Saturday, daytime is defined as 7:00am to 10:00pm and on Sundays and Public Holidays, daytime is 8:00am to 10:00pm.

It is generally considered that noise from a particular continuous noise source will not be annoying if it does not exceed the background noise level by more than 5dB(A) at the boundary of the nearest residence. Based on measured minimum background noise levels (refer to **Section 4.11**) and consideration of the Environment Protection Authority recommended outdoor background noise levels (refer to **Table 7.1**), the average background noise level to be used for noise impact assessment of daytime operations at the nearest residence is 32dB(A) (R1) and 34dB(A) (R2) for residences at the junctions of Glen Ora Road and Old Aerodrome Road. A night-time noise survey was not undertaken but a background noise levels of 30dB(A) has been adopted for both receiver localities.

Utilising the above criteria, design goals at R1 and R2 are 37dB(A) and 39dB(A) respectively, during daytime and 35dB(A) for both during night-time operations.

Adoption of the 37dB(A) daytime design goal is conservative in reference to the recommended outdoor background noise levels listed in **Table 7.1**, but is appropriate considering the rural land use designation of the area.

7.10.2 Major Noise Sources

Most of the on-site noise sources during mining and processing operations will operate on a 24 hour basis except for the dozers and fuel pumps which operate only during day shifts. Equipment will include the processing plant, D65 dozer,

diesel pumps, feeder unit, electrical generator (diesel enclosed) fuel tank pump, D6518 swamp dozer and a front-end loader.

The plant and mobile equipment to be used will be moved from the current operation 4km south of the proposed development. Noise levels for this equipment have been obtained during previous studies (refer to **Table 4** in **Appendix 4**). Equipment noise sources used for assessment purposes and measured noise levels are presented in **Table 7.2**.

TABLE 7.2
EQUIPMENT NOISE LEVELS

Equipment	Sound Pressure Level dB(A)
D65 Dozer	111.7
Hanson Sykes Pump - Quieter	98.4
Feeder Unit	98.2
Electric Generator - Diesel Enclosed	104.5
Fuel Tank Pump	101.2
Processing Plant 10	94.6
Swamp Dozer Komatsu D65/8	109.9
Volvo Front-end Loader	109.5

7.10.3 Impact Analysis

A computer model, incorporating all proposed noise sources and surrounding terrain features, was used to calculate maximum noise emission levels at surrounding residences due to mining and processing operations. The model used was the RTA Software's Environmental Noise Model which is a commercially available software system developed in conjunction with the Environment Protection Authority.

Noise levels were calculated for 'normal' and 'worst-case' meteorological conditions. For 'normal' meteorological conditions assume 20°C and 70% relative humidity. Temperature inversions may occur during early morning periods and, in some situations, significantly enhance noise propagation over a considerable distance. Consequently a temperature inversion of 3°C per 100m, in addition to the temperature and humidity parameters outlined above were adopted as the 'worst-case' meteorological condition.

The model calculated the maximum noise emission levels from the plant and mobile equipment to the following potentially affected residential receiver locations (refer to **Figures 14** to **17**).

R1 – Closest single northern resident.
R2 – Group of four residences to the north.
R3 – Minimbah.

It was assumed for the calculation that all items of equipment will be operating simultaneously. Noise contours were generated with the processing plant and associated equipment at two localities (P1 and P2) and mobile mining equipment at the single northern most locality (S1) as shown on **Figures 14** to **17**. Processing equipment located at P1 and P2 include, processing plant, electrical generator and fuel tank pump. Mining equipment located at S1 include front-end loader, swamp dozer, D65 dozer, feeder unit and pump.

The contour plots are shown on **Figures 14** to **17**. Predicted noise levels at nearest surrounding residences from continuous mining and processing operations are given in **Table 3** in **Appendix 4** for both weather scenarios and during daytime and night-time operations.

7.10.4 Impacts Assessment

Predicted continuous mining and processing noise levels calculated under 'normal' and 'worst-case' weather scenarios during daytime and night-time operations are all below the design goals set in **Section 7.10.1**.

It is considered that there will be no noise impact on surrounding residences or land use from both continuous daytime and night-time operations.

7.10.5 Transportation Noise Impacts

In assessing noise impacts for road traffic, the Environment Protection Authority has adopted the following criteria:

1. Where traffic flows are low or intermittent $L_{Aeq,T}$ noise level of 55dB(A) should be adopted for new developments. A $L_{Aeq,T}$ level of 50dB(A) in rural areas is also considered appropriate.

Therefore, haul truck noise emissions should not exceed an $L_{Aeq,T}$ noise level of 50dB(A) at rural residences adjacent to the haulage route.

Calculation of the $L_{Aeq,T}$ for truck movements is based on a noise level of 82dB(A) at 10m from passing trucks (based on previous measurement of passing trucks), passing at an average speed of 60km/hour over a ten second period. This results in an $L_{Aeq,T,1sec}$ noise level of 84dB(A) at 10m from the road.

To obtain an hourly L_{Aeq} the $L_{Aeq,1sec}$ noise level is adjusted for traffic flow per hour by the following equation:

$$L_{Aeq,T} = L_{Aeq,1sec} + 10 \log N - 10 \log 3600$$

Where N = Number of truck movements.

Normally only a small number of truck movements will occur each day, i.e., between 2 and 6 movements, (Trip x 2).

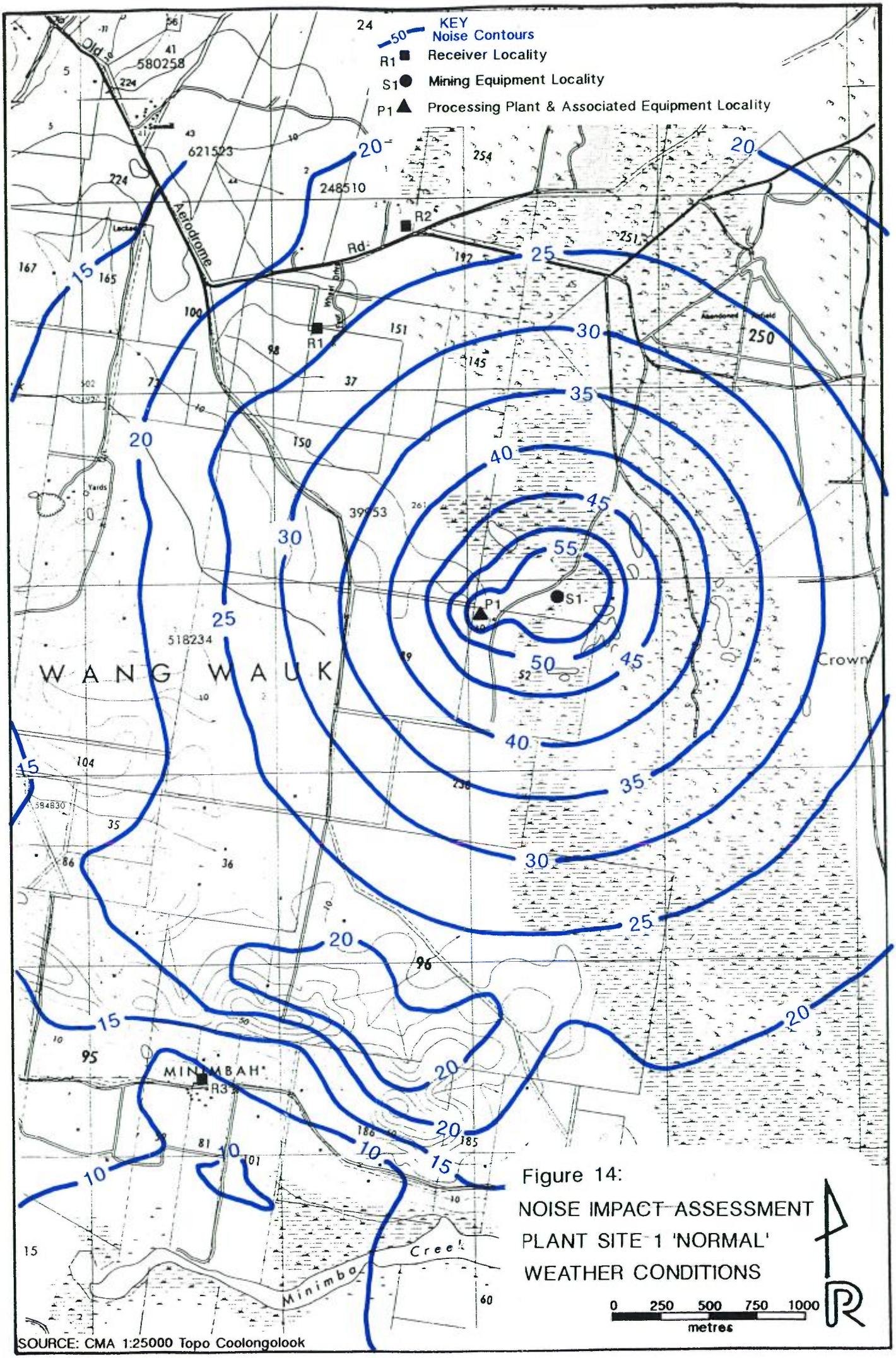


Figure 14:
NOISE IMPACT ASSESSMENT
PLANT SITE 1 'NORMAL'
WEATHER CONDITIONS

1008/92502

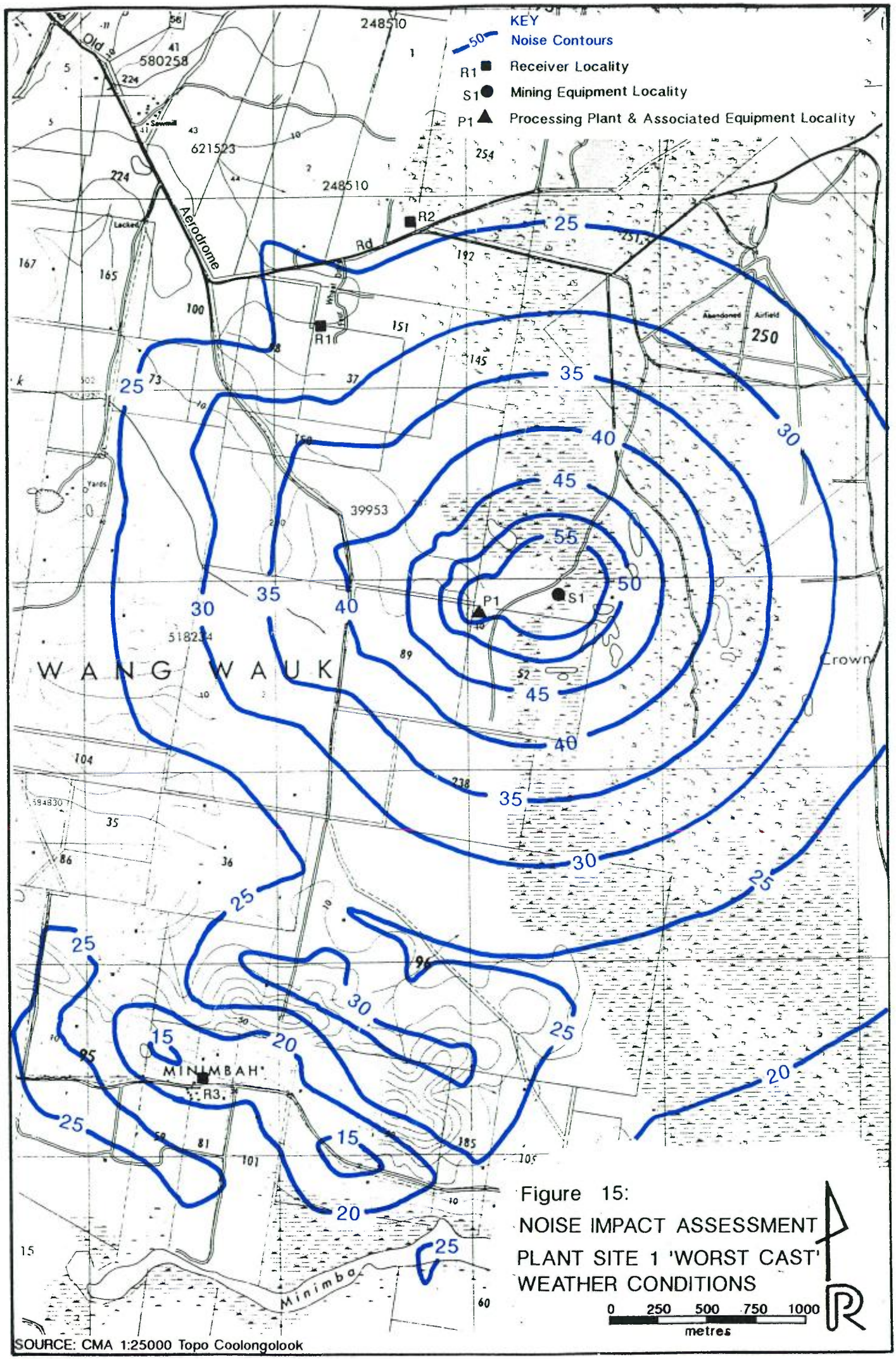


Figure 15:
NOISE IMPACT ASSESSMENT
PLANT SITE 1 'WORST CAST' WEATHER CONDITIONS

SOURCE: CMA 1:25000 Topo Coolongolook

1008/92502

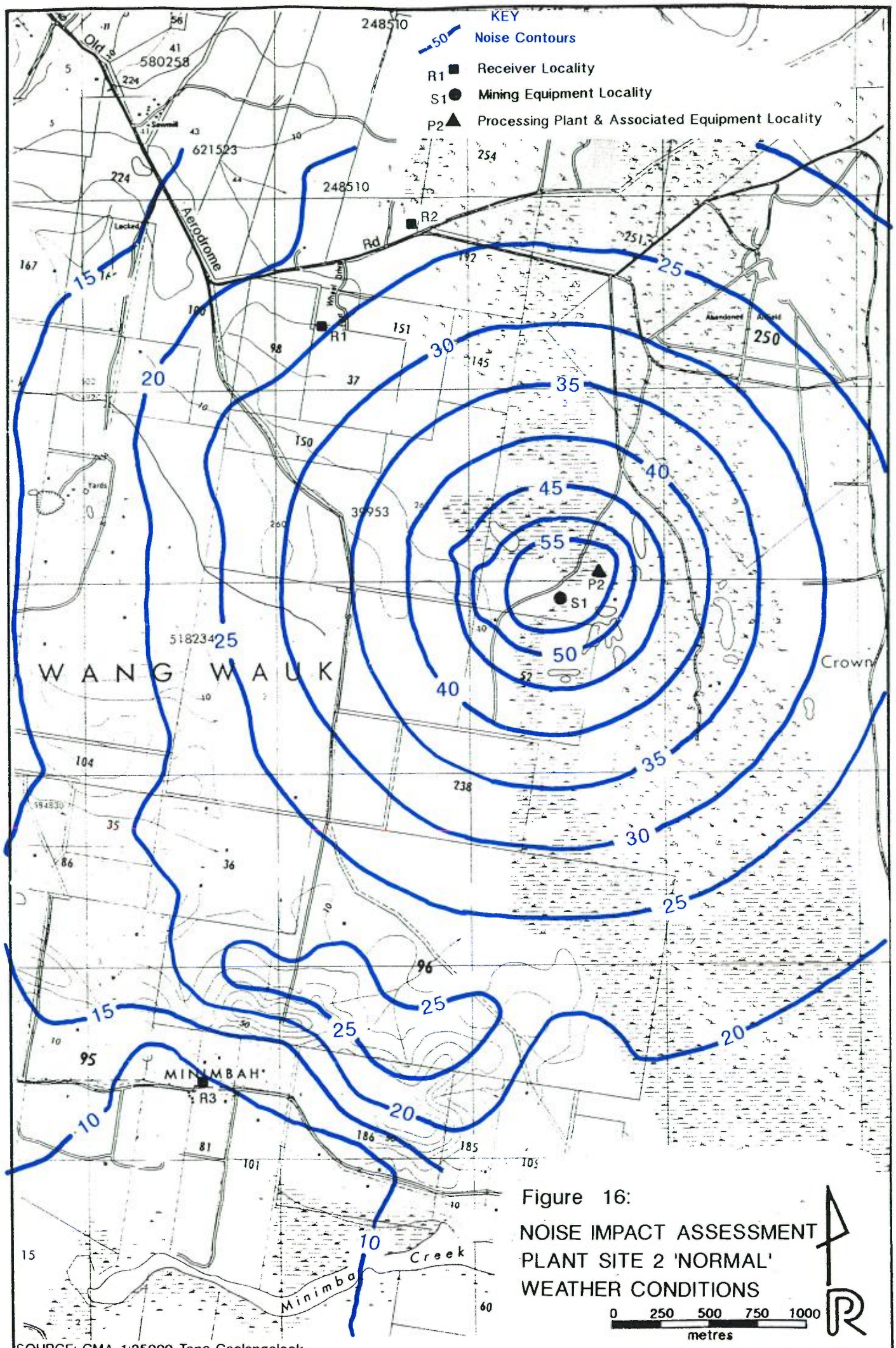


Figure 16:

NOISE IMPACT ASSESSMENT
PLANT SITE 2 'NORMAL'
WEATHER CONDITIONS

1008/92502

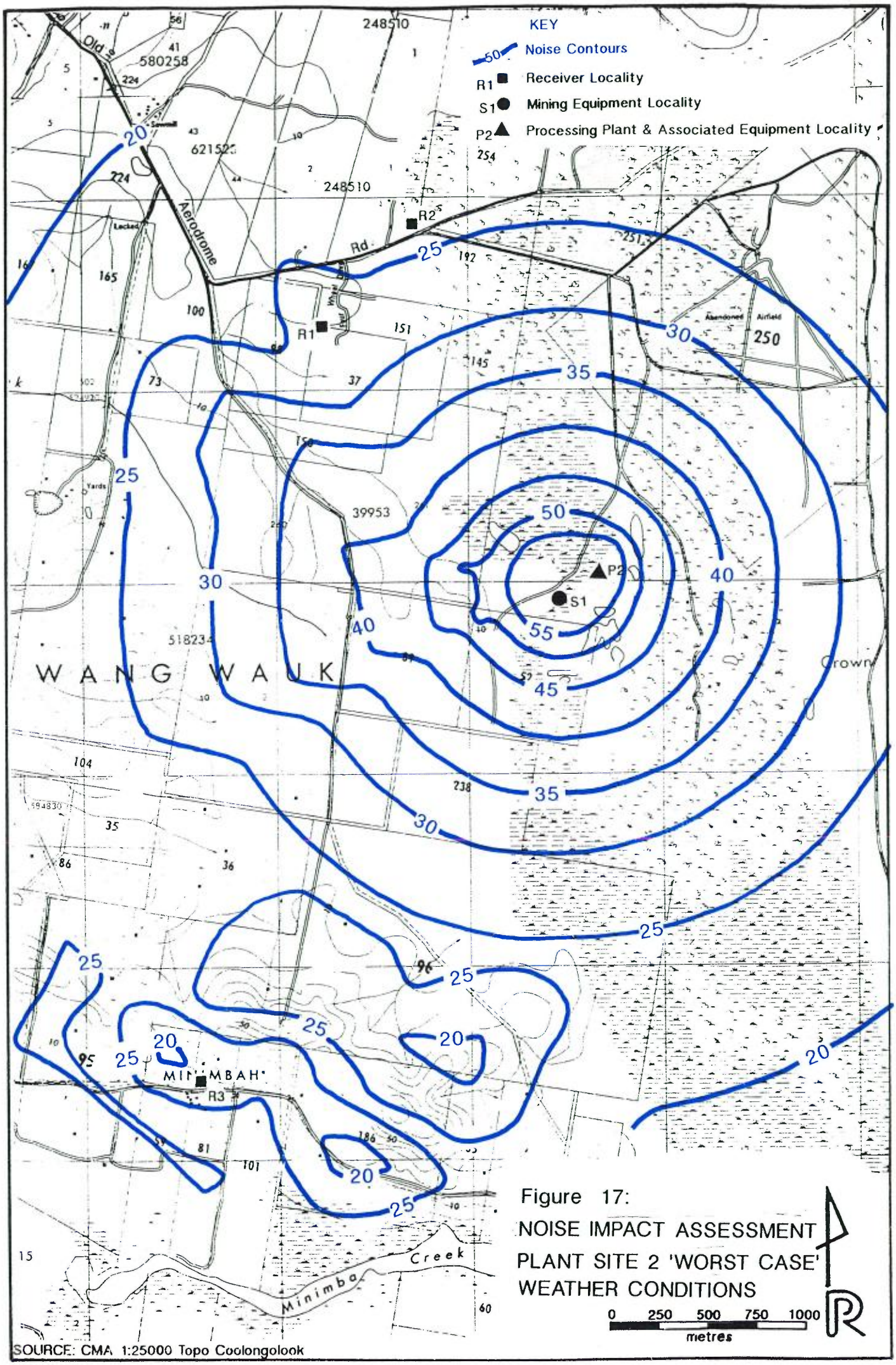


Figure 17:
NOISE IMPACT ASSESSMENT
PLANT SITE 2 'WORST CASE'
WEATHER CONDITIONS

SOURCE: CMA 1:25000 Topo Coolongolook

1008/92502

Using a 'worst-case' scenario with three shifts operating, a plant breakdown and all service vehicles attending during the day, up to 22 truck movements will occur over a period of eleven hours, i.e., on average, 2 truck movements per hour.

Calculated noise emission levels from these truck movements are shown in **Table 7.3.**

TABLE 7.3
PREDICTED NOISE FROM TRANSPORTATION

	Distance From Road (m)	Truck Movement/ Hour	Resultant $L_{Aeq,T}$ dB(A)	EPA Design Goal $L_{Aeq,T}$	Exceedance
'Normal' Truck Movements	15	1	45	50	Nil
'Worst-case' Truck Movements	15	2	48	50	Nil

The predicted noise levels were below the 50 $L_{Aeq,T}$ dB(A) design goal set by the Environment Protection Authority. Since the residences along Glen Ora and Old Aerodrome Roads are located further away than 15m from these roads, the predicted noise levels will be even less. It is considered that there will be no transportation noise impact upon residences along Glen Ora and Old Aerodrome Roads from the development.

7.11 VISUAL IMPACTS

The proposed mining area is well shielded from public viewing points. Operations will be seen only from the access road to the site and the more elevated ridgeline on private land to the west. The operation has a life of only 14.5 weeks and hence visual impacts will be low.

7.12 ABORIGINAL RELICS AND EUROPEAN SITE

An archaeological survey of the site did not identify any archaeological or european sites. There will be no impacts on archaeological relics or historical sites (see **Appendix 5**).

7.13 ZONING

No rezoning of the site will be necessary to permit the proposed development.

7.14 PLANNING PROPOSALS

It is proposed that over the next five years there will be a significant increase in rural/residential development along Glen Ora Road and areas to the south identified as the Nabiac Candidate area (see **Section 4.17**). This rural/residential development will result in increased traffic levels along this route comprising both construction and residential traffic. The rural/residential development is also likely to increase the number of residences which have views of Glen Ora Road and passing traffic.

The proposed future rural–residential areas will not be affected by the proposed mining operations. Residences will not have views nor will they be affected by noise or dust from mining operations. The mining operation is a replacement of the Company's existing operations in the McClymonts Creek area and will not result in increased traffic on local roads beyond that already generated by the existing development.

Any proposals for future rural/residential or recreation/conservation in areas identified by the Department of Lands in the Land Assessment and Planning report (see **Figure 9**) are long–term and likely to be beyond the 14.5 week life of the mining operations.

Mining will temporarily delay any proposals in the mining area to be used for recreation/conservation purposes as proposed by the Department of Conservation and Land Management planning study. In the longer term, rehabilitation of the site in the Crown Lands will return the land to similar vegetation cover to that existing and the land will be available for the proposed future land use.

7.15 LAND USE

7.15.1 Residential

The mining operations will not directly affect residential land. The mining will be completed in 14.5 weeks and the land will be rehabilitated to its former land use.

Impacts from dust and noise are discussed in **Sections 7.6** and **7.10** respectively.

7.15.2 Agriculture

Intermittent agricultural activities such as logging and cattle grazing in the area will be temporarily halted for the life of the mining operation. Any timber suitable for logging will be identified prior to clearing and provision made for this timber to

be made available for milling purposes. Past logging has, however, removed most millable timber from this area.

7.16 RADIATION LEVELS

The mining operation will not have any effects on radiation levels in the area. Monazite, the only mineral to be mined with mild radiation levels is a minor component of the heavy mineral suite and will be concentrated at the Company's Tomago mill. All tailings have radiation levels at or below acceptable levels. Evidence given by the Department of Health at the CASM versus Australmin hearing indicated that titanium minerals mining can be carried out without exceeding acceptable levels of radiation.

7.17 PUBLIC UTILITIES

The proposed operation will not need access to normal public utilities and no augmentation will be necessary. Power will be derived from generators, potable water from roof tanks or water tanker, and sewage will be collected in tanks. Portable telecommunication services will be used.

7.18 ROADS AND TRAFFIC

The Company will upgrade part of the existing road and access track through private and Crown land which leads to the site from the intersection of Old Aerodrome Road and the existing right-of-way granted under Mining Act 1973. Both Aerodrome Road and the former mine haul road within the right-of-way have been upgraded by RZM Pty. Ltd. as access to the existing McClymonts Creek mining area. The existing access road and track will be rehabilitated or left in at least their current condition on completion of mining activities.

Trucks from the existing McClymonts Creek area currently utilise Old Aerodrome and Glen Ora Roads. The proposed development will replace this existing mining operation and there will be no increase in traffic as a result of this development.

7.19 CUMULATIVE EFFECTS

The proposed mining operation will follow on from the McClymonts Creek and stockpile mining activities (Resource Planning 1990, 1993a). It will not be conducted concurrently and hence there will be no cumulative effects.

7.20 SOCIO-ECONOMIC IMPACTS

The proposed mining operation will provide continued secure employment for personnel currently employed in the McClymonts Creek operation, and indirectly assure continued employment for service firms throughout the region. The Company purchases most of its spares, tyres, and fuel in the local region. In this regard, the mining operation will continue to provide a positive and beneficial impact on the local community and economic base.

7.21 ENERGY IMPACTS

The proposed mine will utilise dozers and front-end loaders for mining and generators to provide power to the concentrator plant and other amenities.

Expected weekly fuel usage is presented in **Table 7.4.**

TABLE 7.4
ENERGY USE

Equipment	Number	Fuel Use (Weekly Average)
Dozer (50 hours)	1	750
Dozer (40 hours)	1	600
Front-end Loader (120 hours)	1	3000
Front-end Loader (8 hours)	1	120
330 kVA Generator (120 hours)	1	6600
200 kVA Generator (120 hours)	1	3000
Sykes Water Pump (80 hours)	1	320
Concentrate Trucks	2	300
Utility	1	60
		14,750 L/week
	Over 14.5 weeks	**213,875 L/year**

This equates with a primary energy use of 8.2×10^{12} joules per annum. This is a negligible use of energy in comparison with the expected total demand for energy by the mining industry in New South Wales in 1986-87 of 4.4×10^{15} joules (Department of National Development, 1978).

Procedures to be adopted to minimise energy use include:

1. Regular maintenance and servicing of mobile and fixed equipment.

2. Operating machinery only as required and in an efficient manner to eliminate unnecessary use.

3. Educating employees in the need to conserve energy in everyday practices, e.g., use of light and power, etc.

ALTERNATIVES

8.0 ALTERNATIVES

8.1 MINING METHOD

The proposed dry mining method using dozers and front-end loaders is considered the most cost effective and environmentally suitable method for the mining of economic grades of titanium minerals at or above the water table at shallow depths from the surface.

The alternative is to use a floating dredge in a pond of water. A suction/cutter head on the dredge head removes sand from below the water table which is then pumped to the concentrator plant floating on the pond or on land adjoining the pond. The plant moves progressively with the mining operations.

The dredge method is the most effective when significant volumes of mineralised sands occur at depth below the water table. It is, of course, dependent on water for its operation.

Given the shallow depths of mineralised sands generally at or above the water table in the proposed mining area, dry mining is the preferred and optimum mining method, and will be used.

8.2 ALTERNATIVE HAULAGE ROUTE

An alternative haulage route is to utilise the public road known locally as Nursery Road which deviates to the south from Old Aerodrome Road to service private landholdings on the western side of the proposed mining area. This public road would need significant upgrading and access provided through either private land or Crown land to the mining site. The Company has already extensively upgraded the access road through Portion 250 being private land owned by Central North Coast Sporting Car Club Limited and this route is used by existing traffic access in the McClymonts Creek mining area. Utilising the existing route for truck traffic was seen as a more desirable alternative than upgrading and utilising a new route.

8.3 ALTERNATIVE OF NOT PROCEEDING WITH THE DEVELOPMENT

The deposits of titanium minerals occurring in the area southeast of Nabiac are considered to be important mineral resources. These deposits represent one of the few remaining viable resources of heavy mineral accessible for development along the east coast of New South Wales. Should the operations not proceed these deposits will not be made available to benefit the State and Nation.

No mining on these sites would induce more mining overseas probably at a much higher world environmental cost, due to the demand for the minerals. This situation would lead to higher costs for the Australian consumer and

unnecessarily upset our balance or payments. Australia imposes some of the highest environmental safeguards in the world on mining.

Should the project not proceed, the 12 persons employed at the Company's existing operations would need to seek alternative employment and closure would lead to indirect detrimental effects on the local business community who provide services to the operations.

The deposits represent valuable economic minerals that can be mined with minimal impact on the environment. The environmental investigations outlined in this document have shown that mining of these resources with appropriate controls and safeguards will minimise potential environmental effects.

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APPENDICES

APPENDIX 1

CORRESPONDENCE FROM GOVERNMENT AUTHORITIES

New South Wales Government

Department of Planning

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

Telephone : (02) 391 2000 Ext: 2081
Fax No : (02) 391 2111
Contact : Y. Stone
Our reference : N90/00642
Your reference :

Mr T L Barnard
RZM Pty Ltd
Locked Bag 32
HUNTER REGION MAIL CENTRE NSW 2310

Dear Sir,

Proposed Mineral Sand Mining, Nabiac, Parish of Wang Wauk

Thank you for your letters of 3 February and 10 March, 1993 with additional information in regard to the preparation of an environmental impact statement (EIS) for the above development.

2. As development consent is required for the proposal and it is a designated development within the meaning of Schedule 3 of the Environmental Planning and Assessment Regulation, 1980, as amended, an EIS must accompany the development application to the Great Lakes Shire Council. The EIS shall be prepared in accordance with clause 34 of the Regulation and shall bear a certificate required by clause 26(1)(b) of the Regulation (see Attachment No. 1).

3. In addition, pursuant to clause 35 of the Regulation, the Director requires that the following matters be specifically addressed in the EIS, revising those directions issued on 23 December, 1992:

- an overview of past and current sand mining operations in the vicinity of the proposal;
- description of the stages of development, with a clear synopsis of the resources proposed to be extracted; the potential for the occurrence of these resources particularly within the wetland regions; and the justification for the proposal in terms of supply of, and demand for sand resources;
- description of the existing environment clearly identifying areas mapped under SEPP 14 provisions; evaluation of the existing flora and fauna including an analysis of the habitat values present; survey to identify any rare or endangered plants and animals including:

(1) a vegetation survey and map (preferably at a scale of 1:4 000) to particularly indicate the occurrence of any rare or threatened plant species, their values and the extent of any weed infestation;

(2) a faunal survey describing the birds (both indigenous and migratory), reptiles, amphibians and mammals (including bats) of the area and the occurrence of any rare or threatened and protected species;

- discussion of the direct and indirect environmental implications of the proposal including but not limited to the following:

(1) an assessment of the changes in the distribution and abundance of plant and animal species;

(2) a description of measures proposed to be taken to guard against actual and potential disturbances to the vegetation, fauna, water quality and hydrological regime during the construction and operation of the proposal. It should include consideration of possible effects on SEPP 14 wetlands not included in the development proposal;

- an analysis of the surface and groundwater quality and hydrological regime; description of measures proposed to be taken to preserve water quality in both surface and groundwater, including sediment control management;

- description of proposed site and access rehabilitation plans with methods of reformation and revegetation including plans of the final landform;

- identification of potential acid sulphate soils; if located on the site, description of proposed management measures;

- flooding issues;

- road and traffic impacts;

- results of consultation with:

  - Department of Mineral Resources
  - National Parks and Wildlife Service
  - Environment Protection Authority
  - Department of Conservation and Land Management
  - NSW Agriculture
  - NSW Fisheries
  - Roads and Traffic Authority
  - Department of Public Works

4. 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.

5. In preparing your EIS you should approach the Great Lakes Shire Council and take into account any comments Council considers may apply to the determination of the proposal. Additionally you should discuss the procedures related to endangered fauna with Council and the Director of National Parks and Wildlife.

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

Yours faithfully

B Adams 6/4/93

B. Adams
Manager
Assessments and Major Hazards Branch
As Delegate for the Director

DEPARTMENT OF PLANNING
ATTACHMENT NO. 1

STATUTORY REQUIREMENTS FOR ENVIRONMENTAL IMPACT STATEMENTS

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

Pursuant to clause 34 of the Environmental Planning and Assessment Regulation, 1980, as amended, the contents of an EIS shall include the following matters:

(a) full description of the designated development proposed by the development application;

(b) a statement of the objectives of the proposed designated development;

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

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

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

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

(g) measures to be taken in conjunction with the proposed designated development 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 designated development and reasons for choosing the latter; and

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

The EIS must also take into account any matters required by the Director of Planning pursuant to clause 35 of the Regulation, which may be included in the attached letter.

The EIS must bear a certificate as required by clause 26(1)(b) of the Regulation.

DEPARTMENT OF PLANNING

ATTACHMENT NO. 2

ADVICE ON THE PREPARATION OF AN ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR A MINING AND PROCESSING OPERATION

The purpose of this paper is to outline various issues relevant to the preparation and consideration of an EIS for a mining and processing operation. It is intended to assist preparation of the EIS. However, 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 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 a mining and processing operation. 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 consent authority (usually the Council) and the Department of Planning to properly understand the environmental consequences of the proposed development.

1. Description of the proposal.

The description of the proposal should provide general background information on the location and extent of the works proposed, an indication of adjacent developments, and details of the site, land tenure, zonings and relevant forward planning proposals any any other land use constraints.

This section should provide specific information on the nature, intent and form of the development. It should, as far as possible, include such details as the processes involved highlighting any proposed crushing or blasting, water management and treatment, chemical processing disposal of wastes, landscaping and rehabilitation. A description should also be provided of associated operations such as the transport of materials.

Particular details that may be relevant include:

- Characteristics and economic significance of the resource.
- Quantity of materials to be mined.
- Methods of extraction/plans of operations.
- Details of treatment process.
- Type of machinery and equipment to be used.
- Expected life of the operation.
- Number of persons to be employed.
- Hours of operation.
- Details of necessary stockpiling.

- Access arrangement - truck routes, truck numbers etc.
- Site drainage and erosion controls.
- Recycling of waste water.
- Disposal of tailings and hazardous waste materials.
- Storage of chemicals and associated safety measures.
- Proposals for rehabilitation.

2. Description of the Environment.

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

3. Analysis of Environmental Impacts.

Environmental impacts usually associated with the mining are listed below. Where relevant to the specific proposal, these should be addressed in the EIS and suitably quantified, taking into account the adequacy of safeguards proposed to minimise them.

- Any possible siltation, sedimentation or downstream effects of the operation.
- Any likely cumulative effects of the proposed operation when considered together with other operations in the vicinity.
- Effects on flora a fauna.
- The effects on the agricultural viability of the adjoining land holdings.
- Likely noise/vibration disturbance caused by the operations, including transport operations, on nearby residences.
- Other impacts of trucking movements, including access over railways and on highways.
- Dust nuisance likely to be caused.
- Effects on water quality of nearby watercourses.
- Disposal of waste material including tailings.
- Effects on the visual environment.
- Any likely affectation of sites of Aboriginal archaeological or European heritage value (including Industrial Heritage) if located in vicinity of operations.
- The proposed end use of the site.

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

4. 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 Environment Protection Authority in regard to air, water and noise impacts and relevant pollution control legislation requirements;
- The Department of Mineral Resources in regard to requirements under the Mining Act.
- The Department of Conservation and Land Management regarding appropriate erosion control and rehabilitation procedures;
- The Department of Agriculture if prime agricultural land may be affected by the proposal; and
- The Heritage Council of NSW if the proposal is likely to affect any place or building having heritage significance if Aboriginal places or relics are likely to be affected.

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

*** END OF DOCUMENT ***

DEPARTMENT OF PLANNING
ATTACHMENT NO. 1

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

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

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

(g) measures to be taken in conjunction with the proposed designated development 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 designated development and reasons for choosing the latter; and

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

The EIS must also take into account any matters required by the Director of Planning pursuant to clause 35 of the Regulation, which may be included in the attached letter.

The EIS must bear a certificate as required by clause 26(1)(b) of the Regulation.

DEPARTMENT OF PLANNING

ATTACHMENT NO. 2

ADVICE ON THE PREPARATION OF AN ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR A MINING AND PROCESSING OPERATION

The purpose of this paper is to outline various issues relevant to the preparation and consideration of an EIS for a mining and processing operation. It is intended to assist preparation of the EIS. However, 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 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 a mining and processing operation. 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 consent authority (usually the Council) and the Department of Planning to properly understand the environmental consequences of the proposed development.

1. Description of the proposal.

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Particular details that may be relevant include:

- Characteristics and economic significance of the resource.
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- Type of machinery and equipment to be used.
- Expected life of the operation.
- Number of persons to be employed.
- Hours of operation.
- Details of necessary stockpiling.

- Access arrangement - truck routes, truck numbers etc.
- Site drainage and erosion controls.
- Recycling of waste water.
- Disposal of tailings and hazardous waste materials.
- Storage of chemicals and associated safety measures.
- Proposals for rehabilitation.

2. Description of the Environment.

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

3. Analysis of Environmental Impacts.

Environmental impacts usually associated with the mining are listed below. Where relevant to the specific proposal, these should be addressed in the EIS and suitably quantified, taking into account the adequacy of safeguards proposed to minimise them.

- Any possible siltation, sedimentation or downstream effects of the operation.
- Any likely cumulative effects of the proposed operation when considered together with other operations in the vicinity.
- Effects on flora a fauna.
- The effects on the agricultural viability of the adjoining land holdings.
- Likely noise/vibration disturbance caused by the operations, including transport operations, on nearby residences.
- Other impacts of trucking movements, including access over railways and on highways.
- Dust nuisance likely to be caused.
- Effects on water quality of nearby watercourses.
- Disposal of waste material including tailings.
- Effects on the visual environment.
- Any likely affectation of sites of Aboriginal archaeological or European heritage value (including Industrial Heritage) if located in vicinity of operations.
- The proposed end use of the site.

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

4. 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 Environment Protection Authority in regard to air, water and noise impacts and relevant pollution control legislation requirements;
- The Department of Mineral Resources in regard to requirements under the Mining Act.
- The Department of Conservation and Land Management regarding appropriate erosion control and rehabilitation procedures;
- The Department of Agriculture if prime agricultural land may be affected by the proposal; and
- The Heritage Council of NSW if the proposal is likely to affect any place or building having heritage significance if Aboriginal places or relics are likely to be affected.

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

Department of Mineral Resources

NEW SOUTH WALES GOVERNMENT

85 FAULKNER STREET
ARMIDALE NSW 2350
PO BOX 65
ARMIDALE NSW 2350
TELEPHONE (067) 737 122
FACSIMILE (067) 741 387
067-702107.

FILE 292-0665

Ms V Smith
Director
Resource Planning Pty Ltd
P O Box 388
EAST MAITLAND NSW 2323

January 19, 1993

Dear Ms Smith

ENVIRONMENTAL IMPACT STATEMENT
MINERAL SAND MINING - WANG WAWK

The Department fully supports the companies proposals for mining within the Parish of Wang Wawk. The Department has been pleased with the standard of EIS previously prepared for RZM in respect of Moffats Swamp and Big Swan Bay, by your company. We request that a similar high standard should be undertaken for the two (2) EIS's for Wang Wawk as well as for Clybucca near Kempsey and Failford near Tuncurry.

Please forward initial drafts for comment prior to going to any other organization.

Yours faithfully

Greg Unwin.

New South Wales Government

National Parks and Wildlife Service

HUNTER DISTRICT

Bourke Street
P.O. Box 270
Raymond Terrace, N.S.W. 2324
Telephone: (049) 87 3108
Facsimile: (049) 83 1031

Our reference: HD:EIS2/40
DT:SC
Your reference: 1008/92502

Director
Resource Planning Pty Ltd
PO Box 388
EAST MAITLAND 2323

Dear Madam,

Re: Environmental Impact Statement
Mineral Sand Mining - Wang Wauk RZM Pty Ltd

Thank you for your letter dated 15/12/92. I apologise for the delay in answering.

The Service requires that consideration be given to the following;

* rare and endangered plants
* rare and endangered animals
* Aboriginal sites, and
* European historic sites

From other surveys carried out in the general locality, it is known that rare Allocasuarina sp. exist. Whilst carrying out flora surveys particular attention should be made for these plants.

It is also possible that koala exist in the area. If this is the situation consideration will need to be given to a Fauna Impact Statement.

The Service will make further comments when more detailed information on the proposal is made available.

Yours faithfully,

I. Nowacki
District Manager
for Director

February 26, 1993

Site Inspection Comments
Proposed Sand Mining - Nabiac

1) Western Access

* May need road improvements near junction of haulage route and Aerodrome Road.

* Generally and forested area - some of it open, some with good shrub level.

2) Eastern Access

* Haulage route through elevated area of swamp then forest. - what upgrading will be needed therefore E.I.S to cover this work also!

* No rare or endangered plants/animals seen

* Forest varies from recovering from bush fires to forest that has not seen fire for many years.

* Along northern boundary of portion 89 forest has a grassy understorey.

* Possible koala country.

Birds seen

White-cheek H/E	Superb Blue-wren
Yellow-face H/E	Red-brow finch
Grey Fantail	Bronze-wing pigeon
Welcome Swallow	Noisy Friar bird

David Turner
Senior Ranger North

February 26, 1993

EPA

Environment
Protection
Authority
New South Wales

NSW Government Offices
117 Bull Street Newcastle West NSW 2302
PO Box 488G Newcastle NSW 2300
Tel .049. 26 9971 Fax .049. 29 6712

Ms V Smith
The Director
Resource Planning Pty Ltd
PO Box 388
EAST MAITLAND NSW 2323

Our Reference: 270022A2 CH:YA

Your Reference:

Dear Ms Smith

ENVIRONMENTAL IMPACT STATEMENT
MINERAL SAND MINING, WANG WAUK - RZM PTY LTD

I refer to your correspondence dated 15 December 1992 requesting comment and requirements from the Environment Protection Authority (EPA) for an Environmental Impact Statement (EIS) for mineral sand mining at Failford East.

The EPA requires that the EIS address those matters related to the statutory responsibilities of the EPA under the Clean Waters, Clean Air and Noise Control Acts. The following comments are offered to assist you in preparing this document;

Water Pollution

The possibility of pollution of waters, both surface and underground should be considered.

If the sand mining operation will involve the discharge of wastewaters, details should be given of any methods proposed to detain or treat such wastewaters. (The EPA would generally permit a maximum non-filtrable residue of 50 mg/L in the discharge.)

If the mineral sand will be obtained by dredging the proponent will require the EPA's formal approval for the operation.

A further point to be considered in relation to water is whether or not the operation will impinge on any wetlands designated under SEPP 14.

Air Pollution

The EIS should discuss methods proposed to control dust from stockpiles, access roads, exposed areas, etc.

If the sand is to be separated by dry methods the process will require the EPA's approval under the Clean Air Act, 1961.

Noise Pollution

Sand mining is an extractive industry for the purposes of the Noise Control Act and approval in writing will have to be obtained from the EPA prior to the any work being carried out.

The EPA will expect that such an application be supported by an acoustic study that identifies the principal noise sources, estimates their effect on any residential premises in the vicinity, proposes any necessary or practical remedial measures and specifics any residual impacts. It is appropriate that such a study be included in the EIS for the information of persons likely to be affected by the proposal. The study should include the impact of transport noise from the development.

The predicted future noise level, and noise level increase, should be set out in the EIS in accordance with the EPA guidelines.

The EPA would generally permit a maximum noise level LA_{10} of no greater than 5 dB(A) above the background level LA_{90}, when measured at the nearest affected residence.

General

These comments should be regarded as a guide only and are by no means exclusive. The EIS should address any matter arising from the proposal that is likely to impact on the natural environment.

I trust that these comments assist you in this matter but, if you have any verbal queries please contact Colin Halverson telephone (049) 26 9071.

Yours faithfully,

Brian Gilligan. 12.2.93.

BRIAN GILLIGAN
Regional Director, Hunter
for Director-General

OUR REF TE92 H 341
YOUR REF 1008/92502
CONTACT OFFICER C J ATCHISON (E)

EISLET

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT
Valley Fair Building
102 - 112 Victoria St
PO Box 440
Taree NSW 2430
Phone (065) 52 2788
Fax (065) 52 2816

Ms Valerie Smith
Director
Resource Planning Pty Ltd
PO Box 388
EAST MAITLAND 2323

Dear Ms Smith

Environmental Impact Statement - Mineral Sand Mining
South West of Old Nabiac Aerodrome - RZM Pty Limited

I refer to your letter of 15th December 1992 concerning input into the proposed E.I.S. mentioned above. Please note that the Soil Conservation Service and the Department of Lands have joined to form a new Department known as Conservation and Land Management. The following letter addresses the range of issues considered significant with respect to the new organisation.

This submission has been structured under four main headings which together summarise the main factors the Department would like to see addressed in the E.I.S.

1. Description of the Mining Proposal

The area under consideration is Crown land. Therefore, the Department requests that the E.I.S. should ex plain, in full detail, the nature of the proposed mining activity. This explanation should include where relevant:

* an outline of the project objectives;

* a full, detailed description of the mining process to be used, including equipment, project dimensions, the size of the areas affected by direct mining, stockpiles, roads, etc;

* a description of the time scale of operations, i.e. how long the project is expected to last; what rate the mining plant will move through the area; what is the ratio of land directly affected by mining plant at any given time as opposed to the overall size of the MLA area; what is the expected daily timetable of operations, etc;

* a full description of the effects of the project on the site, including physical presence; aesthetics; atmospheric emissions; dust; liquid/solid releases; the presence of tailings; slurry, etc; noise; light; heat; transport movements and other human activity;

* a description of likely off site impacts - traffic/transport denisites; road damage; noise; dust; changes to watertable, water supply, etc;

* an estimation of the social and economic changes expected to be wrought by the project. This should include both positive and negative aspects, e.g. income generation, employment opportunities, cost of damage to roads, pollution, etc.

2. A Description of the Existing Environment

The E.I.S. should provide an accurate and comprehensive description of the existing (pre-mining) environs. This will establish "baseline" information against which impacts can be predicted, measured and evaluated. This section should include a detailed inventory of the biophysical characteristics of the site (land type, soil, hydrology, flora and fauna) as well as socio-economic factors (land use, existing services, etc).

3. Impact Identification, Evaluation and Mitigation

On the basis of the information provided in the two sections above the E.I.S. should then list clearly (and quantify, if possible) the environmental changes likely to be caused by the mining activity, and describe accurately the expected site conditions that will prevail after mining is complete. Off site impacts in connection with the project should also be documented.

Issues to be addressed/considered would include:

* impacts on the surrounding community;
* impacts on the natural environment;
* impacts on items of aesthetic, recreational, archaeological, historic, scientific or social significance;
* possibel endangering of flora and fauna species;
* long term effects on the environment;
* possible sterilisation or negative effects on future land use options;
* possible pollution of the environment (both on and off site); and
* problems associated with disposal of wastes and transport of materials.

With regard to mitigation of possible undesirable impacts, the Department requests that specific plans and explanations be included for:

* erosion and sedimentation control (in the construction, mining and decommissioning phases of the project);

* restoration control plans - vegetation, fauna, landscape, weeds, soils. Where possible, these plans should be adaptive and progressive (i.e. designed to operate throughout the life of the project) rather than reactive in nature.

* a protection plan/strategy relating to flora and fauna.

4. Other Departmental Requirements

The land in question is a valuable Crown resource which is in close proximity to existing human habitation and development. The Department has a responsibility to ensure that the area will be restored to a condition that will leave it capable of accepting a range of suitable uses in the future. In this regard, the following points are made:

* the site must be left free of any toxic residues, chemicals or other substances or conditions that will affect future land use options (including the possibility of use for residential purposes);

* the Department would expect that the E.I.S. includes provisions whereby RZM acknowledges its responsibility to institute, monitor and make public necessary impact amelioration and restoration processes;

* the E.I.S. should attempt to incorporate a measure of public participation and consultation; in particular, input from local residents who will be affected by the proposal;

* the E.I.S. should address the major aspects of soil conservation as listed and highlighted in Appendix "A" attached;

* the potential for wind erosion of stockpiles and other disturbed areas will require close attention due to the sandy nature of the soil;

* any clays encountered during sampling should be assessed as to their acid sulphate potential;

Conclusion

The Department is required to manage Crown land in accordance with the requirements of the Crown Lands Act, 1989. The objects of the Act, together with the principles of Crown land management, are listed in Appendix "B". It is important that these objects and principles are recognised in the E.I.S., together with the soil conservation requirements mentioned above, so that potential problems relating to future use and enjoyment of the land are avoided from the outset.

Thank you for the opportunity to contribute.

Yours sincerely

A E Wiseman
District Manager
Sydney/Hunter Region

APPENDIX "A"

It is not the purpose of these guidelines to specify stability measures for proposed projects, but rather cover major aspects of soil conservation which need to be addressed by an Impact Statement. Additional information relevant to each individual project should be included where directly applicable to the operation under consideration. Officers of the Soil Conservation Service are available to advise on matters, which arise periodically, concerning individual sites.

Dept of Env CALM.

The guidelines cover the following checklist of items to be covered in environmentally based investigations :

* soil and overburden material
* earthworks
* out of pit emplacements
* end landuse
* reshaping
* vegetation establishment
* reject material
* mine facilities.

[redacted]

1. CHARACTERISATION OF SOIL MATERIAL

The frequency of sampling for soil, overburden and/or waste rock analyses is determined by the size of the area to be investigated and its pedological and geological complexity. Sampling density should be sufficient to be representative of each soil and rock type or mapping unit within the area.

The frequency of sampling in situ overburden should be sufficient to ensure that each distinctly different lithological unit is sampled. Sampling and analyses conducted prior to mining should be regarded as base line information which will be supplemented by further work when mining is in progress.

Information on the following is generally required and will assist in assessing the potential for erosion and applicability of various control measures.

1.1 Topsoil

- soil type and classification (Northcote code and/or Great Soil Group)
- suitability for topdressing purposes
- suitability for stockpiling
- location and depth of areas to be stripped
- planned stripping, stockpiling and respreading methods

- physical and chemical properties affecting erodibility and revegetation potential
- any other relevant information (e.g. salinity, extent of existing erosion, dispersibility)

1.2 Subsoil

- physical and chemical properties
- suitability for topdressing purposes
- location and depth of areas to be stripped
- planned stripping, stockpiling and respreading methods, where applicable (e.g. in arable situations, the soil profile may need to be reconstituted. In these circumstances the A and B horizons must be stripped and replaced separately as two distinct layers; or where B horizon material is to be used for topdressing)
- erosion potential
- any other relevant information

1.3 Overburden/Interburden Materials

- location and configuration of spoil heaps
- sediment control measures to be employed prior to reshaping
- physical and chemical properties
- the need for any selective handling and placement of individual layers, either for burial of unsuitable materials or salvage of materials useful in the rehabilitation programme
- proposed selective handling and placement methods (if applicable)
- methods to overcome excessive surface compaction
- rehabilitation schedule
- any other relevant information

2. STOCKPILES

2.1 Temporary Overburden, Ore and Waste Rock Stockpiles

- location and configuration of stockpiles
- clearing and other site preparation requirements
- proposed depth of stockpiled materials
- protection from erosion and sedimentation
- effects of stockpiled material on adjacent land uses
- likelihood of leachates from stockpiles and their effect on surrounding land and watercourses
- characteristics of stockpiled material
- any potential toxicity or instability problems and proposed control measures
- proposed life of stockpiles
- any other relevant information

2.2 Topsoil/Subsoil Stockpiles

- location and configuration of stockpiles
- clearing and other site preparation requirements
- proposed depth of stockpiled material
- quantity, quality and characteristics of material in each stockpile
- protection from erosion and sedimentation
- protection from deterioration in quality
- feasibility and schedule for reclaiming material for later use in rehabilitation
- proposed life of stockpiles
- any other relevant information

3. EROSION CONTROL AND DRAINAGE EARTHWORKS

Information on the following will assist in assessing the potential for erosion problems and the applicability of various control measures.

3.1 General Design Criteria

The following design data must be provided for each significant component of erosion control and drainage schemes :

- nominated storm return period
- storm intensity
- catchment size
- time of concentration of flow in the catchment
- co-efficient of runoff
- anticipated discharge
- any other relevant information

Where a development will affect land lower in the catchment, the impact of that development on downstream stability conditions must be considered.

3.2 Diversion Banks and Channels

The above Design Criteria to apply plus information on the following :

- channel gradient
- maximum permissible flow velocity for long term stability of the system
- batter gradients
- cross-sectional shape
- cross-sectional area
- design flow depth in structure
- freeboard
- capacity of structure
- soil physical properties affecting stability (e.g. dispersibility, structure, pedality), and methods of control

- outlet type, design and location
- treatment of outlet for long-term stability
- any other relevant information

3.3 Dams (Sediment Traps, Retardation Structures)

The following information is generally required in addition to the Design Criteria in 3.1 above :

- purpose (e.g. water storage, sediment control, etc.)
- location
- batter gradients of excavation and embankment
- freeboard
- crest width
- soil physical properties affecting stability (e.g. dispersibility, structure, pedality) and methods of control
- spillway channel and outlet (refer to points under 3.2 above)
- storage capacity and method of emptying (if applicable)
- provision for removal of sediment
- provision for emergency spillway, its type and capacity
- revegetation and stabilization techniques after construction
- maintenance works
- any other relevant information

3.4 Specialised Erosion Control and Drainage Works

- nature of specialised works (e.g. waterways, flumes, drop-inlets, pipe spillways, trickle pipes)
- location and design of each structure
- construction materials (e.g. concrete, stone-pitching, etc.)
- whether structure is to be permanent or temporary
- any other relevant information

3.5 Cuttings, Embankments

- properties of materials to be used
- slope length and gradient
- topdressing procedures (e.g. keying and respreading techniques)
- stabilization methods (e.g. location and design of drop-down drains, table drains, etc.)
- revegetation methods
- any other relevant information

4. REHABILITATION PROGRAMME

The following aspects apply generally to the planning and implementation of rehabilitation works for all extensively disturbed areas :

4.1 End Land Use

- pre-mine land capability classification (S.C.S.)
- proposals for and justification of intended land use and supporting information for any proposed uses which are appreciably different from the pre-mining use
- location of fences, dams, stock shelter tree lots, etc. (where applicable)
- any other relevant information

4.2 Reshaping

- slope shapes, angles and lengths
- any requirements for selective handling to place undesirable overburden materials well below the root zone
- drainage patterns
- allowance for settlement
- erosion control and stabilization methods
- any other relevant information

4.3 Permanent Out-of-Pit Emplacements

In addition to the above general requirements, the following additional information should be supplied :

- location and configuration of emplacements
- means of avoiding or controlling excessive compaction of the root zone
- any effects on surrounding land uses
- runoff diversion and erosion control on surrounding land
- any specialised revegetation, stabilization, erosion control and drainage techniques
- any other relevant information

[redacted]

- method of disposal of coarse and fine rejects
- chemical and physical characterisation of rejects
- location and configuration of surface emplacements
- long-term stability measures
- any other relevant information

5. VEGETATION ESTABLISHMENT

The following aspects need to be considered in the preparation for and implementation of revegetation measures on the site :

- procedures for topdressing or respreading of spoil dump surfaces with topsoil or alternative materials
- vegetation species selection (attention should be given to current S.C.S. recommendations)
- surface preparation and cultivation methods

- sowing techniques and timing
- fertilizer application (types, rates, timing)
- the need for any specialised revegetation methods (e.g. mulching, cover crops, jute meshing, etc.) and the need for specialised equipment
- maintenance treatments (oversowing, fertilizer applications, etc.)
- short-term erosion protection (cover crops, etc. - depending upon seasonal conditions and whether native or introduced species are to be used)
- if irrigating - the source, amount and timing
- any other relevant information

6. MINE INFRASTRUCTURE

Environmental Impact Statements should include provision of the following information in respect of the design of appropriate erosion and sediment control measures associated with office complexes, workshops, preparation plants, coal loading facilities, hard stand areas, roads and access tracks, etc.

6.1 Land Reshaping

- existing land surface gradients and slopes
- properties of soil materials
- slope gradients (on completion of construction)
- provision for surface drainage
- topdressing replacement procedures
- revegetation methods
- any other relevant information

6.2 Cut and Fill Embankments, Steep Slopes

- properties of exposed materials
- slope lengths and gradients
- topdressing procedures
- specialised stabilization and/or revegetation methods to be used
- any other relevant information

6.3 Sediment Traps

Temporary sediment control measures, e.g. gravel weirs, hay bales, sandbags, etc.

- appropriate design criteria outlined in 3.1 and 3.3 applies
- any other relevant information

6.4 Roadside Erosion Control Measures

[redacted]

APPENDIX "B"

(2) The Minister may, by notification in the Gazette, alter or abolish existing land districts or establish and define new land districts.

Cities, towns and villages

9. The Minister may, by notification in the Gazette—

(a) declare Crown land to be set apart as sites for cities, towns or villages; or

(b) correct or alter the design, plan or boundaries of any city, town or village set apart under the Crown Lands Acts.

Objects of Act

10. The objects of this Act are to ensure that Crown land is managed for the benefit of the people of New South Wales and in particular to provide for—

(a) a proper assessment of Crown land;

(b) the management of Crown land having regard to the principles of Crown land management contained in this Act;

(c) the proper development and conservation of Crown land having regard to those principles;

(d) the regulation of the conditions under which Crown land is permitted to be occupied, used, sold, leased, licensed or otherwise dealt with;

(e) the reservation or dedication of Crown land for public purposes and the management and use of the reserved or dedicated land; and

(f) the collection, recording and dissemination of information in relation to Crown land.

Principles of Crown land management

11. For the purposes of this Act, the principles of Crown land management are—

(a) that environmental protection principles be observed in relation to the management and administration of Crown land;

(b) that the natural resources of Crown land (including water, soil, flora, fauna and scenic quality) be conserved wherever possible;

(c) that public use and enjoyment of appropriate Crown land be encouraged;

(d) that, where appropriate, multiple use of Crown land be encouraged;

(e) that, where appropriate, Crown land should be used and managed in such a way that both the land and its resources are sustained in perpetuity; and

(f) that Crown land be occupied, used, sold, leased, licensed or otherwise dealt with in the best interests of the State consistent with the above principles.

5th February, 1993.
TAG

New England,
Hunter and
Metropolitan Region

NSW Agriculture

35-37 Abbott Street
PO Box 546
GUNNEDAH NSW 2380

Telephone (067) 42 9277
Facsimile (067) 42 4018

Resource Planning Pty Ltd
P O Box 388
EAST MAITLAND 2323

Dear Madam,

EIS Preparation for Mineral Sand Mining, Wang Wauk

I refer to your letter of the 15th December, 1992, which sought the opinion of NSW Agriculture on the preparation of an Environmental Impact Statement (EIS) for this development proposal.

The Department considers that a full description of the agricultural potential of the area and of surrounding lands would be a vital component of any EIS.

Furthermore, the general concerns held by the Department on extractive industry operations include:

* that the operation of the site should not disadvantage primary producers through increased dust, noise, vehicle movements or other adverse factors;

* that appropriate erosion control structures/practices are implemented;

* that the quality of surface and subsurface waters are not compromised;

* that appropriate weed control practices are implemented; and,

* that, after extraction, the site should be rehabilitated to achieve at least its former agricultural productive potential.

Naturally, many of these concerns are also held by other government agencies, such as the Department of Water Resources and the Soil Conservation Service from which advice should also be sought.

Thank you for the opportunity to comment on this proposal.

Yours faithfully,

D.J. Hartley,
Regional Director of Agriculture,
NEW ENGLAND, HUNTER & METROPOLITAN REGION

NSW FISHERIES

CC/BD
2 February 1993

The Director
Resource Planning Pty Ltd.
PO Box 388
EAST MAITLAND NSW 2323

Dear Ms Smith,

re: ENVIRONMENTAL IMPACT STATEMENT -
MINERAL SAND MINING; WANG WAUK RZM PTY LTD.

Thank you for your letter of 15 December 1992, requesting advice from NSW Fisheries in regard to the above proposal.

It would be appreciated if the following information could be considered in the preparation of the Environmental Impact Statement :

a. the vegetation of the site;

b. The likely presence of aquatic fauna;

c. the possible impact of mining and ancillary activities on water quality;

d. methods to ameliorate these impacts

If you have further questions, please contact me again.

Yours sincerely,

CRAIG COPELAND
for
R CLAXTON
Director
NSW FISHERIES

Public Works Department
Hunter-New England Region
117 Bull Street, Newcastle West, 2302
PO Box 5177, Newcastle West, 2302
Tel: (049) 26 9920
Fax: (049) 26 9954

The Director
Resource Planning Pty Ltd
P.O. Box 388
East Maitland, NSW 2323

Our Ref: 140-D SH:sh
Your Ref: 1008/92502

Contact : Syed Hasan
Telephone : (049)269937

Dear Sir/Madam,

-2 FEB 1993

Re: Environmental Impact Statement
Mineral Sand Mining - Wang Wauk
RZM Pty Ltd

Reference is made to your letter of 15 December, 1992. The Department wishes to make the following comments:

General Issues :

After mining land surface should be restored as closely as possible to its natural contours and revegetated to the satisfaction of Soil Conservation Division of the Department of Conservation and Land Management.

Floodplain Management Issues:

Available topographic information indicates that the subject land are low lying and sections of the proposed access routes may be flood liable.

The peak water level for 1% Annual Exceedance Probability Flood conditions in the Wallamba River adjacent to the subject land is estimated to be approximately 2.5m AHD. This flood level is based on information contained in the "Forster Tuncurry Flood Study, September 1989" which was prepared for Great Lakes Shire Council. Refinement of the model for this study would be required to determine whether this flood level would apply to the subject land.

Any proposed extraction and/or stockpiling of overburden material and sand should have regard to both the floodplain management policy of Great Lakes Shire Council and the

Government's "Floodplain Development Manual". As indicated in the manual, the local council is responsible for setting the flood standard and development control conditions for the area.

for R. Gray
Government Programs Manager

APPENDIX 2

SOIL PROFILE DESCRIPTIONS

APPENDIX 2
SOIL PROFILE DESCRIPTIONS

S1, 240S, 160E

Profile occurs in the mine path but the upper 1 m would not appear to be mineral bearing material. Groundcover is 100% with the dominant vegetation being **Melaleuca quinquenervia**. Erosion hazard is low and the top layers are suitable for rehabilitation purposes. This profile cannot be allocated a Northcote soil classification due to its texture changes, but it can be considered a uniform clay for management purposes.

Surface

O_1 0–1cm, leaf litter.

O_2 2–8cm, peat layer, pH 5.5.

Topsoil

A 8–25cm, 2.5 YR 1/1, black, medium clay, pH 6.0. Very strong consistence and plastic shear. Apedal massive, roots common. No pans, concretions, inclusions or stones.

Subsoil

B_2 25–50cm, 7.5 YR 3/2, pH 6.5. Sandy clay, normal plastic, moderate consistence, no change in shearing.

B_3 50cm+, 10 YR 4/3, mottled light clay, pH 6.0. Normal plastic, strong consistence, plastic shearing. Apedal massive, few roots. No stones, pans, concretions or inclusions. No water table observed.

S2, 40S, 580N

Sand, Uc 5.11

Profile occurs in Melaleuca Open Forest. No bedrock outcrops are nearby. Slope 0%, groundcover 100%, consisting of leaf litter and live sedges. The leaf litter, peat and the A horizon are all suitable for rehabilitation purposes.

Surface

O_1 0–1cm, leaf litter.

O_2 1–10cm, peat, pH 4.5.

Topsoil

A 10–40cm, 10 YR 4/6, pH 6.0. Coarse loamy sand, very weak consistence and brittle shear. Apedal single grained with sandy fabric, and many roots. No stones, pans, concretions or inclusions.

Subsoil

B 40cm+, 10 YR 5/8, pH 6.0. Coarse sand, very weak consistence and brittle shear. Apedal single grained with sandy fabric. Roots common. No stones, pans, concretions or inclusions. Water table evident at 1m.

S3, 680E, 320S

Sand, Uc 1.23

Profile occurs in the eastern edge of the proposed mine path on an area previously mined. No litter or peat. The topsoil is poorly structured and is not suitable for rehabilitation purposes.

Topsoil

0–10cm, 7.5 YR 3/3, pH 5.5. Loamy sand, very weak consistence with brittle shear. Apedal single grained with sandy fabric, few roots. No stones, pans, concretions or inclusions.

Subsoil

10–25cm, 7.5 YR 3/4, pH 6.0. Loamy sand, very weak consistence with brittle shear. Apedal single grained with sandy fabric. No roots, stones, pans, concretions or inclusions.

25cm–1m, 7.5 YR 3/3, pH 6.5. Sand, very weak consistence with brittle shear. Apedal single grained with sandy fabric. No roots, stones, pans, concretions or inclusions. No water table observed.

S4, 600E, 480S

Sand, Uc 5.11

Profile occurs on the southern portion of the mine path. The surface and topsoil layers are similar to S2.

The leaf litter, peat and topsoil can all be used for rehabilitation purposes.

Surface

O_1 0–1cm, leaf litter.

O_2 1–8cm, peat, pH 4.5.

Topsoil

A 8–12cm, 7.5 YR 3/4, pH 5.5. Sand, very weak consistence, brittle shear. Apedal single grained with sandy fabric. Abundant roots. No stones, pans, concretions or inclusions.

Subsoil

B — 12–25cm, 10 YR 6/4, pH 5.0. Sand, very weak consistence, brittle shear. Apedal single grained with sandy fabric. Many roots. No stones, pans, concretions or inclusions.

C — 25cm–1m, 10 YR 7/3, pH 6.0. Sand, very weak consistence, brittle shear. Apedal single grained with sandy fabric. No stones, pans, concretions or inclusions. Water table at 1m.

APPENDIX 3

FLORA AND FAUNA INVESTIGATIONS

APPENDICES 3(A) - 3(E)
- Flora and Fauna Species Lists (Resource Planning)

APPENDIX 3F - FBN Bat Surveys

APPENDIX 3A
PLANT SPECIES OBSERVED IN THE STUDY AREA.

The following list includes all vascular plant species observed within MLA 1, near Nabiac, New South Wales. It should be noted that such a list is not complete because of the nature of the survey, resulting in some species being inadvertently omitted.

Scientific names follow Jacobs and Pickard (1981), Jacobs and Lapinpuro (1984), and Harden (1990, 1991 & 1992).

Introduced species are indicated by an asterisk (*).

LYCOPSIDA	
SELAGINELLACEAE	
Selaginella uliginosa	Swamp Selaginella
FILICOPSIDA	
ADIANTACEAE	
Adiantum hispidulum	Rough Maidenhair
BLECHNACEAE	
Blechnum indicum	Swamp Water Fern
DENNSTAEDTIACEAE	
Pteridium esculentum	Bracken
POLYPODIACEAE	
Platycerium bifurcatum subsp. bifurcatum	Elkhorn
SINOPTERIDACEAE	
Cheilanthes tenuifolia	Rock Fern
MAGNOLIOPSIDA	
Magnoliidae	
ACANTHACEAE	
Pseuderanthemum variabile	Pastel Flower
APOCYNACEAE	
Parsonia straminea	Common Silkpod
ASCLEPIADACEAE	
* Gomphocarpus fruticosus	Cotton bush
ASTERACEAE	
Senecio spp.	

CASUARINACEAE	
Allocasuarina littoralis	Black Sheoak
Allocasuarina torulosa	Forest Oak
Casuarina glauca	Swamp Oak
CONVOLVULACEAE	
Convolvulus erubescens	Australian Bindweed
DROSERACEAE	
Drosera auriculata	Sundew
Drosera spathulata	Common Sundew
EPACRIDACEAE	
Epacris pulchella	
Leucopogon juniperinus	Prickly Beard-heath
EUPHORBIACEAE	
Amperea xiphoclada	Broom Spurge
Breynia oblongifolia	Coffee Bush
Glochidion ferdinandi	Cheese Tree
FABACEAE	
Acacia brownei	
Acacia elongata var. elongata	Wallum Wattle
Acacia falcata	Sickle Wattle
Acacia floribunda	
Acacia linifolia	Flax Wattle
Acacia longifolia var. longifolia	Sydney Golden Wattle
Acacia longissima	
Acacia terminalis	Sunshine Wattle
Glycine clandestina	Twining Glycine
Hardenbergia violacea	Purple Twining-pea
Indigofera australis	Wild Indigo
Jacksonia scoparia	Dogwood
Kennedia rubicunda	Dusky Coral Pea
Pultenaea villosa	
Viminaria juncea	Native Broom
GOODENIACEAE	
Dampiera stricta	
Goodenia hederacea	Ivy Goodenia
Goodenia heterophylla	
Goodenia paniculata	
Goodenia stelligera	
Scaevola ramosissima	Purple Fan-flower
HALORAGACEAE	
Gonocarpus micranthus subsp. ramosissimus	Creeping Raspwort
LOBELIACEAE	
Pratia purpurascens	White Root
MENYANTHACEAE	
Villarsia exaltata	Yellow Marsh Flower

MYRTACEAE	
Angophora costata	Smooth-barked Apple
Baeckea imbricata	
Baeckea ramosissima subsp. ramosissima	Rosy Heath-myrtle
Callistemon pachyphyllus	Wallum Bottle Brush
Eucalyptus globoidea	White Stringybark
Eucalyptus gummifera	Red Bloodwood
Eucalyptus intermedia	Pink Bloodwood
Eucalyptus maculata	Spotted Gum
Eucalyptus microcorys	Tallowwood
Eucalyptus pilularis	Blackbutt
Eucalyptus propinqua	Small-fruited Grey Gum
Eucalyptus punctata	Grey Gum
Eucalyptus robusta	Swamp Mahogany
Eucalyptus siderophloia	Grey Ironbark
Eucalyptus signata	Nothern Scribbly Gum
Eucalyptus tereticornis	Forest Red Gum
Leptospermum juniperinum	
Leptospermum polygalifolium	Yellow Tea-tree
Melaleuca linariifolia	Snow-in-Summer
Melaleuca nodosa	Prickly Leaved Paperbark
Melaleuca quinquenervia	Broad-leaved Paperbark
Melaleuca sieberi	
Melaleuca styphelioides	Prickly Leaved Paperbark
Melaleuca thymifolia	Thyme Honey-myrtle
POLYGONACEAE	
Persicaria ? praetermissa	Knotweed
PROTEACEAE	
Banksia aemula	Wallum Banksia
Banksia ericifolia var. macrantha	Heath Banksia
Banksia oblongifolia	
Banksia robur	Swamp Banksia
Banksia spinulosa var collina	Hill Banksia
Hakea teretifolia	
Persoonia lanceolata	Lance-leaf Geebung
Persoonia levis	Broad-leaf Geebung
RUTACEAE	
Boronia (?) parviflora	Swamp Boronia
SAPINDACEAE	
Dodonaea triquetra	Common Hopbush
STACKHOUSIACEAE	
Stackhousia nuda	Leafless Stackhousia
STYLIDIACEAE	
Stylidium graminifolium	Grass-leaf Trigger Plant
VIOLACEAE	
Viola hederacea	Ivy-leaved Violet

Liliidae

ARECACEAE	
Livistona australis	Cabbage Tree Palm
BLANDFORDIACEAE	
Blandfordia grandiflora	Northern Christmas Bell
CYPERACEAE	
Baumea articulata	Jointed Twig-rush
Baumea teretifolia	Wrinkle-nut Twig-rush
Caustis recurvata var. recurvata	
Chorizandra cymbaria	Bristle-rush
Chorizandra sphaerocephala	Round-headed Bristle-rush
Cyperus spp.	
Eleocharis sphacelata	Tall Spike-rush
Gahnia clarkei	Tall Saw-sedge
Gahnia sieberana	Sword Grass
Lepidosperma lineare	
Lepidosperma longitudinale	
Lepidosperma (?) neesii	
Lepironia articulata	
Ptilanthelium deustum	
Schoenus brevifolius	Zig-zag Bog-rush
HAEMODORACEAE	
Haemodorum spp.	Bloodroot
IRIDACEAE	
Patersonia fragilis	
Patersonia glabrata	
JUNCAGINACEAE	
Triglochin procera	Water Ribbons
LILIACEAE	
Anguillaria dioica	Early Nancy
Arthropodium minus	Vanilla Lily
LOMANDRACEAE	
Lomandra longifolia	Mat-rush
LUZURIAGACEAE	
Eustrephus latifolius	Wombat Berry
PHILYDRACEAE	
Philydrum lanuginosum	Wooly Frogmouth
PHORMIACEAE	
Dianella spp.	

POACEAE	
* Andropogon virginicus	Whiskey Grass
Digitaria spp.	
Echinopogon spp.	
Entolasia stricta	Wiry Panic Grass
Imperta cylindrica var. major	Blady Grass
Leersia hexandra	Swamp Ricegrass
Pseudoraphis spinscens	
Themeda australis	Kangaroo Grass
RESTIONACEAE	
Empodisma minus	
Hypolaena fastigiata	Tassel Rope-rush
Leptocarpus tenax	Slender Twine-rush
Lepyrodia (?) interrupta	
Lepyrodia muelleri	Scale rush
Restio pallens	
Restio tetraphyllus subsp. meiostachyus	Tassel Cord-rush
TYPHACEAE	
Typha orientalis	Broadleaf Cumbungi
XANTHORRHOEACEAE	
Xanthorrhoea resinosa subsp. fulva	
XYRIDACEAE	
Xyris spp.	

APPENDIX 3B
VEGETATION COMMUNITIES
MLA 1, NEAR NABIAC, NSW

COMMUNITY	TREES			TALL SHRUBS			LOW SHRUBS			HERBS/GROUNDCOVER		
	Species	Ht m	Cvr %	Species	Ht m	Cvr %	Species	Ht m	Cvr %	Species	Ht m	Cvr %
1. Spotted Gum open-forest. Dry sclerophyll	Eucalyptus maculata E. punctata E. intermedia E. siderophloia E. gummifera	20	50	Allocasuarina littoralis	6	5	Acacia brownei Melaleuca nodosa Acacia falcata Jacksonia scoparia Dodonaea triquetra Indigofera australis	3	5	Themeda australis Imperata cylindrica Pseuderanthemum variabile Viola hederacea Kennedia rubicunda Hardenbergia violacea	0.5	50
2. Open-forest ecotone. Abuts bedrock	Eucalyptus punctata Melaleuca quinquenervia Eucalyptus tereticornis E. intermedia E. siderophloia	20 –25	40 –50	Melaleuca nodosa M. linariifolia M. styphelioides Glochidion ferdinandi	5	80	Breynia oblongofolia Livistonia australis Leucopogon juniperinus juvenile Melaleucas	1		Imperata cylindrica Echinopogon spp. Viola hederaceae Lomandra longifolia Glycine clandestine Arthropodim minus Pratia purpurascens	0.5	30
3. Paperbark/ Forest Red Gum Forest	Melaleuca quinquenervia Eucalyptus tereticornis Casuarina glauca Platycerium bifurcatum (epiphyte)	25	50 –60	Melaleuca linariifolia Casuarina glauca M. styphelioides	8	30	Glochidion ferdinandi	2	5	Digitaria spp. Entolasia stricta Imperata cylindrica Pteridium esculentum Viola hederacea Lomandra longifolia Gahnia sieberana Echinopogon spp.	1	80
4. Scribbly Gum Open-forest	Eucalyptus signata Angophora costata	15	50	Banksia aemula Melaleuca sieberi	4	30	Leptospermum polygalifolium Melaleuca sieberi M. nodosa Banksia oblongifolia Acacia terminalis Pultenaea villosa	2	80	Restio tetraphyllus Leptocarpus tenax Selaginella uliginosa Drosera spathulata Pteridium esculentum Epacris pulchella Gahnia sieberana Cassytha pubescens	1	70

COMMUNITY	TREES			TALL SHRUBS			LOW SHRUBS			HERBS/GROUNDCOVER		
	Species	Ht m	Cvr %	Species	Ht m	Cvr %	Species	Ht m	Cvr %	Species	Ht m	Cvr %
5. Scribbly Gum Woodland	Eucalyptus signata	15	30	Banksia aemula Melaleuca sieberi	6	40	Leptospermum polygalifolium Banksia oblongifolia	1.5	40	Leptocarpus tenax Restio pallens Baeckea ramosissima Baeckea imbricata Xanthorrhoea resinosa Blandfordia grandiflora Hypolaena fastigata Lepyrodia muelleri	0.5	80
6. Smooth barked Apple Woodland	Angophora costata Eucalyptus robusta	10	30	Melaleuca sieberi	8		Melaleuca nodosa M. sieberi M. linariifolia Banksia collina Leptospermum polygalifolium Acacia longifolia Pultenaea villosa	3	50	Baumea juncea Schoenus brevifolius Restio tetraphyllus Gonocarpus micranthus Leptocarpus tenax Gahnia sieberana Goodenia heterophylla	0.5	70
7. Paperbark Low-closed Forest	Melaleuca quinquenervia M. linariifolia Eucalyptus robusta	10	80							Villarsia exaltata Gahnia seiberana		
8. Paperbark Open-forest	Melaleuca quinquenervia M. sieberi Eucalyptus robusta	20	30 -50	Melaleuca sieberi	3	5	Viminaria juncea Pultenaea villosa Banksia collina B. robur Hakea teretifolia	1.5	10	Leptocarpus tenax Baumea juncea Schoenus brevifolius Selaginella uliginosa Restio pallens Villarsia exaltata Xanthorrhoea resinosa Gonocarpus micranthus Stackhousia nuda	0.5	100

COMMUNITY	TREES			TALL SHRUBS			LOW SHRUBS			HERBS/GROUNDCOVER		
	Species	Ht m	Cvr %	Species	Ht m	Cvr %	Species	Ht m	Cvr %	Species	Ht m	Cvr %
9. Paperbark/ Swamp Mahogany Forest	Melaleuca quinquenervia Eucalyptus robusta Melaleuca linariifolia	20 –25	50 –70	Melaleuca linariifolia Glochidion ferdinandi	4 –3	20	Viminaria juncea Acacia longifolia Acacia elongata Livistonia australis	2		Blechnum indicum Baumea teretifolia Lepironia articulata Pseudoraphis spinscens Restio tetraphyllus Villarsia exaltata Gahnia sieberana Persicaria ? praetermissa	1	80
10. Paperbark/ Swamp Mahogany Woodland	Melaleuca sieberi Eucalyptus robusta	15 –20	20 –30	Melaleuca sieberi	8		Leptospermum polygalifolium Melaleuca nodosa Acacia longifolia Acacia elongata Pultenaea villosa Banksia collina B. oblongifolia	4	50	Baumea teretifolia Schoenus brevifolius Leptocarpus tenax Restio tetraphyllus Gahnia sieberana Gonocarpus micranthus Restio pallens	0.5	70
11. Broad –leaved Paperbark/ Swamp Mahogany Woodland	Melaleuca quinquenervia Eucalyptus robusta	15 –20	20 –30	Melaleuca nodosa M. quinquenervia M. linariifolia M. sieberi	4	20 –50	Acacia longifolia A. elongata Pultenaea villosa	1.5	30	Baumea teretifolia Schoenus brevifolius Lepidosperma ? neesii Baumea juncea Leptocarpus tenax Restio pallens Xanthorrhoea resinosa Imperata cylindrica Themeda australis Gonocarpus micranthus	0.5	100
12. Broad –leaved Paperbark/ Swamp Mahogany Open–woodland	Melaleuca quinquenervia Eucalyptus robusta	15	10	M. quinquenervia	6	10	Melaleuca sieberi Callistemon pachyphyllus Pultenaea villosa Banksia collina B. oblongifolia Acacia longissima	2	40	Leptocarpus tenax Schoenus brevifolius Chorizandra cymbaria Baumea juncea Lepidosperma longitudinale Xanthorrhoea resinosa Baeckea imbricata	0.5	80

COMMUNITY	TREES			TALL SHRUBS			LOW SHRUBS			HERBS/GROUNDCOVER		
	Species	Ht m	Cvr %	Species	Ht m	Cvr %	Species	Ht m	Cvr %	Species	Ht m	Cvr %
13. Heath with emergents				Melaleuca quinquenervia	3	<5	Viminaria juncea Callistemon pachyphyllus Leptospermum juniperinum	1	100	Leptocarpus tenax Restio pallens Villarsia exaltata Selaginella uliginosa	1	100
14. Heathland (Regenerating)				Leptospermum polygalifollium Melaleuca sierberi Persoonia levis Banksia ericifolia (seedlings) Eucalyptus signata (juvenile)	2	50				Restio pallens Schoenus brevifolius Selaginella uliginosa Gahnia sieberana Andropogon virginicus Drosera spathulata Baeckea imbricata	1	80
15. Open heath (Regenerating)							Melaleuca nodosa M. quinquenervia M. thymifolia Banksia ericifolia (seedlings) Leptospermum polygalifolium Acacia elongata	<1	40	Ptilanthelium deustum Empodisma minus Baumea juncea Baumea teretifolia Leptocarpus tenax Baeckea imbricata Lepidosperma ? neesii Schoenus brevifolius Haemodorum spp.	0.5	80
16. Heathland/ sedgeland with emergents				Melaleuca sieberi Eucalyptus robusta	6	5 –10	Banksia oblongifolia Leptospermum polygalifolium Melaleuca thymifolia	1.5	30	Lepyrodia muelleri Ptilanthelium deustum Leptocarpus tenax Xanthorrhoea resinosa Gonocarpus micranthus Goodenia stelligera Blandfordia grandiflora Drosera spathulata	0.5	100

COMMUNITY	TREES			TALL SHRUBS			LOW SHRUBS			HERBS/GROUNDCOVER		
	Species	Ht m	Cvr %	Species	Ht m	Cvr %	Species	Ht m	Cvr %	Species	Ht m	Cvr %
17. Heath/ sedgeland (Regenerating)							Melaleuca thymifolia	0.5	60	Restio pallens Leptocarpus tenax Schoenus brevifolius Villarsia exaltata Xyris spp. Goodenia stelligera Baeckea imbricata Drosera species Haemodorum spp.	0.5	60
18. Baumea Sedgeland (SEPP 14 Wetland)										Baumea articulata Philydrum lanuginosum Triglochin procera	1.5	100
19. Sedgeland										Baumea articulata Philydrum langinosum Villarsia exaltata Lepironia articulata Chorizandra cymbaria Leptocarpus tenax	1.5	100
20. Eleocharis Sedgeland (constucted)										Eleocharis sphacelata Philydrum lanuginosum Pseudoraphis spinscens Villarsia exaltata	2	100

APPENDIX 3C
BIRDS OBSERVED IN THE STUDY AREA.

Common name	Scientific name	Status in N.S.W.	Conserv. Status N.S.W.	Record in Area	Recorded in General Locality
ARDEIDAE					
White-faced Heron	Ardea novaehollandiae	A.N		E	+
Great Egret	Egretta alba	C.PN	J.C		+
ANATIDAE					
Pacific Black Duck	Anas superciliosa	A.PN		E	+
Grey Teal	Anas gracilis	A.N			+
Wood Duck	Chenonetta jubata	A.PN		E	+
ACCIPITRIDAE					
Whistling Kite	Haliastur sphenurus	MC.PN		O	+
Brown Goshawk	Accipiter fasciatus	MC.?PM		E	+
Collared Sparrowhawk	Accipiter cirrhocephalus	MC.R		E	+
Grey Goshawk	Accipiter novaehollandiae	U.R		E	+
White-bellied Sea-eagle	Haliaeetus leucogaster	U.PN	C	E	+
Wedge-tailed Eagle	Aquila audax	MC.PN		E	+
PHASIANIDAE					
Brown Quail	Coturnix australis	C.PN		O	+
King Quail	Coturnix chinensis	MC.N		E	+
TURNICIDAE					
Painted Button Quail	Turnix varia	MC.R			+
RALLIDAE					
Buff-banded Rail	Rallus philippensis	MC.PN			+
Lewin's Rail	Rallus pectoralis	U.?R			+

Common name	Scientific name	Status in N.S.W.	Conserv. Status N.S.W.	Record in Area	Recorded in General Locality
CHARADRIIDAE					
Masked Lapwing	Vanellus miles	A.PN			+
COLUMBIDAE					
Peaceful Dove	Geopelia placida	A.R		O	+
Bar-shouldered Dove	Geopelia humeralis	C.R		E	+
Common Bronzewing	Phaps chalcoptera	A.PN			+
Brush Bronzewing	Phaps elegans	MC.?R		E	+
PSITTACIDAE					
Glossy Black-Cockatoo	Calyptorhynchus lathami	MC.PN	VR	E	+
Yellow-tailed Black Cockatoo	Calyptorhynchus funereus	MC.PN		O	+
Galah	Cacatua roseicapilla	A.PN		E	+
Sulphur-crested Cockatoo	Cacatua galerita	C.PN			+
Rainbow Lorikeet	Trichoglossus haematodus	C.N		E	+
Scaly-breasted Lorikeet	Trichoglossus chlorolepidotus	MC.N		E	+
Little Lorikeet	Glossopsitta pusilla	C.N			+
King Parrot	Alisterus scapularis	C.PN			+
Eastern Rosella	Platycerus eximius	A.R		C	+
CUCULIDAE					
Pallid Cuckoo	Cuculus pallidus	C.M		E	+
Brush Cuckoo	Cuculus variolosus	MC.M			+
Fan-tailed Cuckoo	Cuculus pyrrhophanus	C.PN		E	+
Golden Bronze Cuckoo	Chrysococcyx lucidus plagosus	C.PM		E	+
Common Koel	Eudynamis scolopacea	MC.M		O	+
Channel-billed Cuckoo	Scythrops novaehollandiae	U.M			+
Pheasant Coucal	Centropus phasianinus	MC.R		C	+
STRIGIDAE					
Southern Boobook	Ninox novaeseelandiae	C.?R		E	+
Barking Owl	Ninox connivens	U.R		E	+

Common name	Scientific name	Status in N.S.W.	Conserv. Status N.S.W.	Record in Area	Recorded in General Locality
PODARGIDAE					
Tawny Frogmouth	Podargus strigoides	A.R		E	+
AEGOTHELIDAE					
Australian Owlet-Nightjar	Aegotheles cristatus	A.R		E	+
CAPRIMULGIDAE					
White-throated Nightjar	Eurostopodus mystacalis	MC.M			+
APODIDAE					
White-throated Needletail	Hirundapus caudacutus	A.MV.V	J.C	E	+
Fork-tailed Swift	Apus pacificus	MC-S.V	J.C	E	+
ALCEDINIDAE					
Azure Kingfisher	Ceyx azurea	MC.?R			+
Laughing Kookaburra	Dacelo novaeguineae	A.R		O	+
Sacred Kingfisher	Halcyon sancta	A.PM		E	+
CORACIIDAE					
Dollarbird	Eurystomus orientalis	MC.M		E	+
HIRUNDINIDAE					
Welcome Swallow	Hirundo neoxena	A.PM&V		E	+
Tree Martin	Cecropis nigricans	A.PN		E	+
Fairy Martin	Cecropis ariel	A.PM			+
MOTACILLIDAE					
Richard's Pipit	Anthus novaeseelandiae	A.R		E	+

Common name	Scientific name	Status in N.S.W.	Conserv. Status N.S.W.	Record in Area	Recorded in General Locality
CAMPEPHAGIDAE					
Black-faced Cuckoo-shrike	Coracina novaehollandiae	A.PM		O	+
White-bellied Cuckoo-shrike	Coracina papuensis	MC.PN			+
Cicadabird	Coracina tenuirostris	MC.M		E	+
MUSCICAPIDAE					
Rose Robin	Petroica rosea	C.PN		O	+
Eastern Yellow Robin	Eopsaltria australis	A.R		O	+
Brown Flycatcher	Microeca leucophaea	A.?PN		E	+
Crested Shrike-tit	Falcunculus frontatus	C.R		E	+
Golden Whistler	Pachycephala pectoralis	A.PN		E	+
Rufous Whistler	Pachycephala rufiventris	A.PM		E	+
Grey Shrike-thrush	Colluricincla harmonica	A.R		E	+
Leaden Flycatcher	Myiagra rubecula	C.M		E	+
Satin Flycatcher	Myiagra cyanoleuca	MC.M		E	+
Restless Flycatcher	Myiagra inquieta	A.PN			+
Rufous Fantail	Rhipidura rufifrons	C.M			+
Grey Fantail	Rhipidura fuliginosa	A.PN		O	+
Willie Wagtail	Rhipidura leucophrys	A.R		O	+
ORTHONYCHIDAE					
Eastern Whipbird	Psophodes olivaceus	A.R		O	+
MALURIDAE					
Superb Fairy-wren	Malurus cyaneus	A.R		O	+
Variegated Fairy-wren	Malurus assimilis	C.R		E	+
Southern Emu-wren	Stipiturus malachurus	MC.R		E	+
ACANTHIZADEA					
White-browed Scrubwren	Sericornis frontalis	A.R		E	+
Chestnut-rumped Heathwren	Hylacola pyrrhopygia	MC.R		E	+
White-throated Warbler	Gerygone olivacea	A.PM			+

Common name	Scientific name	Status in N.S.W.	Conserv. Status N.S.W.	Record in Area	Recorded in General Locality
ACANTHIZADEA cont'd					
Brown Thornbill	Acanthiza pusilla	A.R		O	+
Yellow Thornbill	Acanthiza nana	A.R		E	+
Striated Thornbill	Acanthiza lineata	A.R		E	+
NEOSITTIDAE					
Varied Sitella	Neositta chrysoptera	C.R		E	+
CLIMACTERIDAE					
White-throated Treecreeper	Climacteris leucophaea	A.R		O	+
MELIPHAGIDAE					
Red Wattlebird	Anthochaera carunculata	A.PN		C?	+
Little Wattlebird	Anthochaera chrysoptera	C.R		O,C	+
Striped Honeyeater	Plectorhyncha lanceolata	A.R		E	+
Noisy Friarbird	Philemon corniculatus	A.PN		O	+
Blue-faced Honeyeater	Entomyzon cyanotis	C.R			+
Noisy Miner	Manorina melanocephala	A.R		E	+
Lewin's Honeyeater	Meliphaga lewinii	A.R			+
Yellow-faced Honeyeater	Lichenostomus chrysops	A.PM		E	+
White-eared Honeyeater	Lichenostomus leucotis	A.R		O	+
Fuscous Honeyeater	Lichenostomus fuscus	A.PN		E	+
Brown-headed Honeyeater	Melithreptus brevirostris	A.R		E	+
White-naped Honeyeater	Melithreptus lunatus	A.PM		E	+
Brown Honeyeater	Lichmera indistincta	C.PN		E	+
New Holland Honeyeater	Phylidonyris novaehollandiae	A.PN		O	+
White-cheeked Honeyeater	Phylidonyris nigra	A.PN		O	+
Tawny-crowned Honeyeater	Phylidonyris melanops	MC.R		E	+
Eastern Spinebill	Acanthorhynchus tenuirostris	A.PN		O	+
Scarlet Honeyeater	Myzomela sanguinolenta	C.N		E	+

Common name	Scientific name	Status in N.S.W.	Conserv. Status N.S.W.	Record in Area	Recorded in General Locality
DICAEIDAE					
Mistletoebird	Dicaeum hirundinaceum	A.N		E	+
PARDALOTIDAE					
Spotted Pardalote	Pardalotus punctatus	A.PN		E	+
Striated Pardalote	Pardalotus striatus	MC-U.V		E	+
ZOSTEROPIDAE					
Silvereye	Zosterops lateralis	A.PN&V		E	+
ESTRILDIDAE					
Red-browed Firetail	Aegintha temporalis	A.PN		O	+
Double-barred Finch	Poephila bichenovii	A.R		E	+
Chestnut-breasted Mannikin	Lonchura castaneothorax	MC.R		E	+
STURNIDAE					
Common Starling	Sturnus vulgaris	A	*		+
ORIOLIDAE					
Olive-backed Oriole	Oriolus sagittatus	C.N		O	+
DICRURIDAE					
Spangled Drongo	Dicrurus megarhynchus	MC.PN		E	+
CORCORACIDAE					
White-winged Chough	Corcorax melanorhamphos	C.R		E	+
GRALLINIDAE					
Magpie-Lark	Grallina cyanoleuca	A.PN		E	+

Common name	Scientific name	Status in N.S.W.	Conserv. Status N.S.W.	Record in Area	Recorded in General Locality
ARTAMIDAE					
White-breasted Woodswallow	Artamus leucorhychus	MC.PM		E	+
Masked Woodswallow	Artamus personatus	C.N		E	+
White-browed Woodswallow	Artamus superciliosus	A.N		E	+
Dusky Woodswallow	Artamus cyanopterus	A.PM		E	+
CRACTICIDAE					
Grey Butcherbird	Cracticus torquatus	A.?R		O	+
Australian Magpie	Gymnorhina tibicen	A.R		O	
Pied Currawong	Strepera graculina	A.PN		E	+
CORVIDAE					
Australian Raven	Corvus coronoides	A.R		O	+
Torresian Crow	Corvus orru	MC.R			+

Key:

Record:

O – Observed
E – Expected to occur.
\+ – Record for general locality from stiudies undertaken to the north and south of the area (Bartrim and Martin, 1990)

Conservation Status:

* – Introduced Species
J – Listed in the Japan Australia Migratory Birds Agreement (JAMBA).
C – Listed in the China Australia Migratory Birds Agreement (CAMBA).

Conservation Status in NSW as listed in Schedule 12 (Endangered Fauna)
New South Wales National Parks and Wildlife Act 1974:

T	–	Part 1 Threatened
VR	–	Part 2 Vulnerable and Rare

Status in N.S.W (Morris et al 1981)

A	–	Very Common
C	–	Common
MC	–	Moderately Common
U	–	Uncommon
S	–	Scarce
Ra	–	Rare
?E	–	Possibly extinct

R	–	Resident
Se	–	Sedentary
B	–	Breeding
RB	–	Resident Breeder
N	–	Nomad
P	–	Partial
M	–	Migrant
SM	–	Summer Migrant
WM	–	Winter Migrant
V	–	Visitor
SV	–	Summer Visitor
WV	–	Winter Visitor

APPENDIX 3D
MAMMALS OBSERVED AND EXPECTED IN THE STUDY AREA AND ENVIRONS (EXCLUDING BAT SPECIES)

Common Name	Scientific Name	Status	Record Observed	Expected.
BURRAMYIDAE				
Feather–tail Glider	Acrobates pygmaeus	C		L
DASYURIDAE				
Brown Antechinus	Antechinus stuartii	A		E
Dusky Antechinus	Antechinus swainsonii	A		E
Brush–tailed Phascogale	Phascogale tapoatafa	VR		E
MACROPODIDAE				
Eastern Grey Kangaroo	Macropus giganteus	A		E
Red–necked Wallaby	Macropus rufogriseus	C		E,L
Swamp Wallaby	Wallabia bicolor	C		E
MURIDAE				
Eastern Chestnut Mouse	Pseudomys gracilicaudatus	VR		E
New Holland Mouse	Pseudomys novaehollandiae	C,I		E
Bush Rat	Rattus fuscipes	A		E,L
Swamp Rat	Rattus lutreolus	C		E
PERAMELIDAE				
Northern Bandicoot	Isoodon macrourus	C–A		E
Long–nosed Bandicoot	Perameles nasuta	C		E
PETAURIDAE				
Sugar Glider	Petaurus breviceps	C	O	E,L
Common Ringtail Possum	Pseudocheirus peregrinus	C	O	E

Common Name	Scientific Name	Status	Record Observed	Expected.
PHALANGERIDAE				
Common Brushtail Possum	Trichosurus vulpecula	A	O	E,L
TACHYGLOSSIDAE				
Short-beaked Echidna	Tachyglossus aculeatus	C		E
INTRODUCED MAMMALS				
Dog (feral)	Canis familaris	C		E
Horse	Equus caballus	C	O	E
Cattle	Bos taurus	A	O	E
Cat (feral)	Felis catus	A		E,L
Brown Hare	Lepus capensis	C		E,L
House Mouse	Mus musculus	A	T	E
European Rabbit	Oryctolagus cuniculus	A		E,L
Black Rat	Rattus rattus	A		E,L
Fox	Vulpes vulpes	A		E,L

Key:

STATUS

Conservation Status as listed in Schedule 12 (Endangered Fauna)
New South Wales National Parks and Wildlife Act:

T – Part 1 Threatened
VR – Part 2 Vulnerable and Rare

Australian status from Strahan (1983)

A	–	Abundant
C	–	Common
I	–	Limited
U	–	Uncommon

RECORD

E	–	Expected or likely to occur in region
O	–	Observed during field surveys
T	–	Trapped
Ev	–	Identified from evidence of the presence of species (scats, tracks, marks)
L	–	Observed by locals

APPENDIX 3E
HERPETOFAUNA OBSERVED AND EXPECTED TO OCCUR IN THE STUDY AREA AND ENVIRONS

Common Name	Scientific Name	Record Observed	Expected.
A. REPTILES			
AGAMIDAE			
Bearded Dragon	Amphibolurus barbatus		E
Eastern Water Dragon	Physignathus lesueurii		E
BOIDAE			
Diamond Python	Morelia spilota subsp. spilota	R	E
CHELIDAE			
Long-necked Tortoise	Chelodina longicollis		E
COLUBRIDAE			
Green Tree Snake	Dendralaphis punctulatus		E
ELAPIDAE			
Death Adder	Acanthophis antarcticus		E,L
Yellow-faced Whip Snake	Demansia psammophis ssp. psammophis		E,L
Swamp Snake	Hemiapis signata		E,L
Red-bellied Black Snake	Pseudechis porphyriacus	O	E,L
Eastern Brown Snake	Pseudonaja textilis		E,L
SCINCIDAE			
Striped Skink	Ctenotus robustus		E
Tree Skink	Egernia striolata		E
	Lampropholis delicata	O	
Weasel Skink	Lampropholis mustelina	O	
Eastern Blue-tongued Lizard	Tiliqua scincoides ssp. scincoides		E,L

Common Name	Scientific Name	Record Observed	Expected.
VARANIDAE			
Lace Monitor	Varanus varius	O	E
B. AMPHIBIANS			
HYLIDAE			
Green Tree Frog	Litoria caerulea	O	E
Red Eyed Tree Frog	Litoria chloris	O	
Bleating Tree Frog	Litoria dentata	O	
Dwarf Tree Frog	Litoria fallax	O	E
Freycinet's Frog	Litoria freycineti		E
Dainty Tree Frog	Litoria gracilenta		E
Broad Palmed Frog	Litoria latopalmata		E
Lesueur's Frog	Litoria lesueuri		E
Rocket Frog	Litoria nasuta	O?	E
Peron's Tree Frog	Litoria peronii	O	
Leaf Green Tree Frog	Litoia phyllochroa		E
Tyler's Tree Frog	Litoria tyleri	C	
MYOBATRACHIDAE			
Tusked Frog	Adelotus brevis		E
Common Eastern Froglet	Crinia signifera		E
Eastern Banjo Frog	Limnodynastes dumerilii		E
Brown–striped Frog	Limnodynastes peronii	O	E
Spotted Grass Frog	Limnodynastes tasmaniensis		E
	Pseudophryne spp.	C	

Key:

RECORD

O – Observed during field surveys
C – Identified from call
R – Observed by RZM
E – Expected to occur
L – Observed by locals/ranger

APPENDIX 3F

A SURVEY OF THE BAT FAUNA OF THE AREA PROPOSED FOR MINERAL SANDS EXTRACTION AT MLA1 NEAR NABIAC, NEW SOUTH WALES.

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16 May 1993

1 INTRODUCTION

The consultant was requested by Resource Planning Pty Ltd to survey the bat fauna of an area proposed for titanium minerals extraction at MLA1 near Nabiac, New South Wales. Field work was undertaken from the 13- 16 April 1993.

2 METHODS

2.1 Mistnetting

On 15 April 1993 3 mistnets were placed around ***Banksia aemula*** blossum in scribbly gum forest at the northern end of the proposed mine path(M1 on figure 1). This was primarily to sample for the Eastern Blossum Bat ***Syconycteris australis*** which is nectivorous, as well as for Flying-foxes which also forage on blossum.

2.2 Harp Traps

Harp traps were placed in suitable flyways at eight(8) sites in and around the proposed mine path. (H1-H8 on figure 1) .
Sites H1-H4 were sampled for two nights on 13 and 14 April 1993 while sites H5-H8 were sampled for one night on the 15 April 1993.

2.3 Echolocation Call Analysis

Calls of Microchiropteran bats were recorded at twelve(12) sites (D1-D12 on figure 1) for a duration of forty five minutes each via Anabat II bat detectors onto audio cassettes for subsequent computer analysis.

2.4 Spotlighting and Audible Calls

Flying-foxes were surveyed by spotlighting of potential food trees and by identification of their characteristic social calls. This was done during other aspects of field work.

1. Spotted Gum Open–forest.
2. Open–forest Ecotone.
3. Paperbark/Forest Red Gum Forest.
4. Scribbly Gum Open–forest.
5. Scribbly Gum Woodland.
6. Smooth–barked Apple Woodland.
7. Paperbark Low Closed–forest.
8. Paperbark Open–forest.
9. Paperbark/Swamp Mahogany Forest.
10. Paperbark/Swamp Mahogany Woodland.
11. Broad–leaved Paperbark. Swamp Mahogany Woodland.
12. Broad–leaved Paperbark. Swamp Mahogany Open–woodland.
13. Wet Heath with Emergents.
14. Heathland. (Regenerating.)
15. Open Heathland. (Regenerating.)
16. Heathland/Sedgeland with Emergents.
17. Heath/Sedgeland. (Regenerating.)
18. Baumea Sedgeland. S.E.P.P.14 Wetland No. 594.
19. Sedgeland.
20. Eleocharis Sedgeland.
21. Cleared.

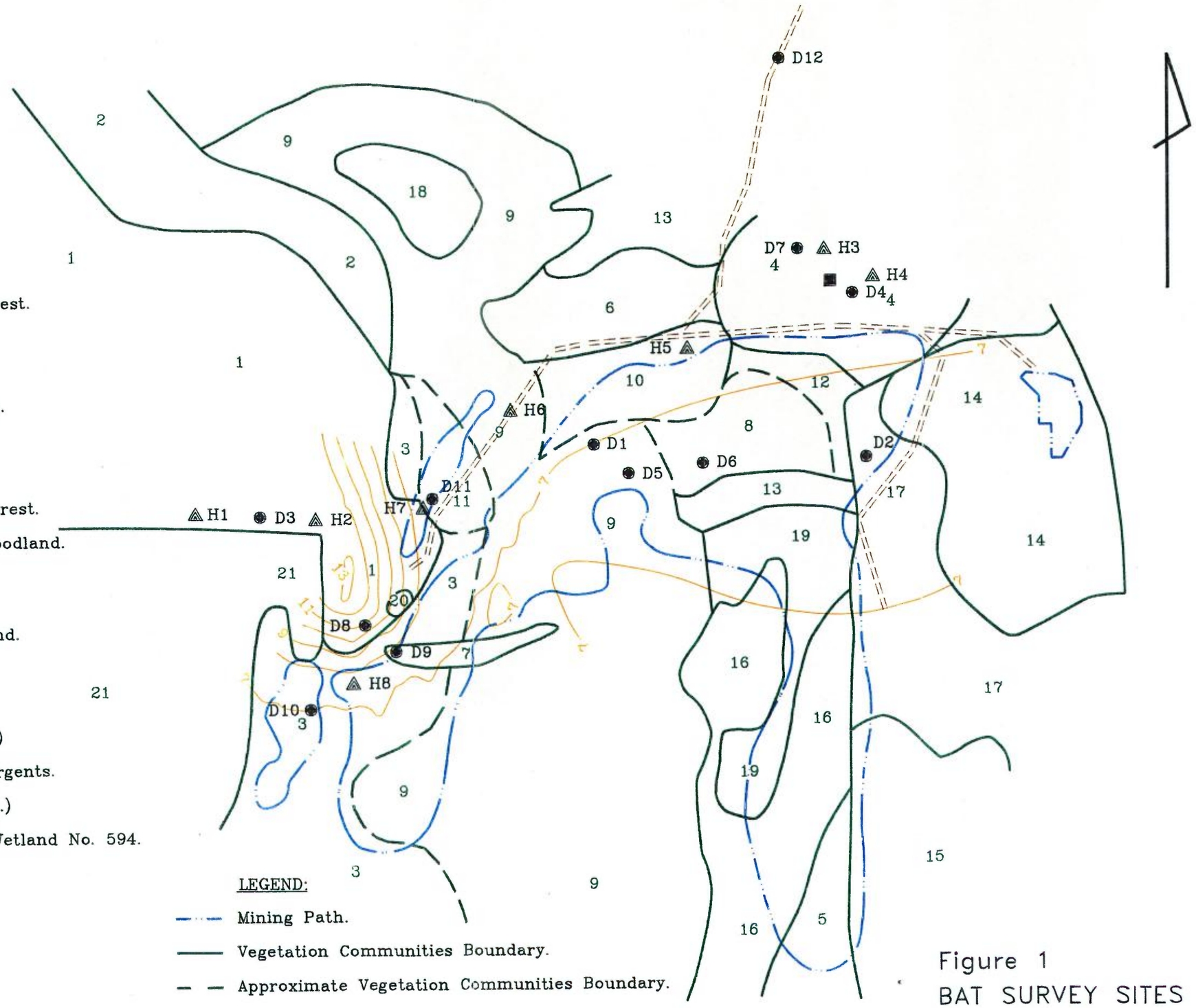

Figure 1
BAT SURVEY SITES

RZM

A3–1156

3 RESULTS

3.1 Mistnetting

No bats were caught in mistnets around the *Banksia* blossum. Constant rain during the period following nightfall on the 15 April attributed to a lack of captures.

3.2 Harp Traps

Nine bats of four species were caught in harp traps during the course of the survey. Rain and cool temperatures hampered survey of bats, particularly on the nights of 14 and 15 April 1993. Most of the captures(6) occured on the first night.

TABLE 1
BAT SPECIES CAPTURED DURING SURVEY

SPECIES	COMMON NAME	NO. OF CAPTURES	NO. OF SITES
Nyctophilus geoffroyi	Lesser Long-eared Bat	1	1
Nyctophilus gouldi	Gould's Long-eared Bat	1	1
Vespadelus pumilus	Eastern Forest Bat	4	1
Vespadelus vulturnus	Little Forest Bat	3	2

Three of the bat species, the Lesser Long-eared Bat *Nyctophilus geoffroyi*, Gould's Long-eared Bat *Nyctophilus gouldi* and the Little Forest Bat *Vespadelus vulturnus* are widespread species in eastern New South Wales occuring in a wide range of habitats. The Eastern Forest Bat *Vespadelus pumilus* is more limited in it's habitat preferences being restricted largely to rainforests and Melaleuca swamp forests.

A low number of captures due largely to rain on the 15 and 16 April make estimates of abundance based on captures unfeasible.

3.3 Echolocation Call Analysis

One hundred and fifty six(156) passes of ten species of bat were recorded during the survey.

TABLE 2

BATS IDENTIFIED FROM ECHOLOCATION CALLS DURING SURVEY

SPECIES	COMMON NAME	NO. OF PASSES	% OF TOTAL PASSES	NO. OF SITES
Tadarida australis	White-striped Mastiff Bat	1	0.6	1
Mormopterus loriae	Little Free-tail Bat	19	11.9	5
Chalinolobus gouldii	Gould's Wattled Bat	26	16.3	5
Chalinolobus morio	Chocolate Wattled Bat	8	5.0	2
*Miniopterus australis**	Little Bent-wing Bat	14	8.5	2
*Miniopterus schreibersii**	Common Bent-wing Bat	3	1.9	2
Nyctophilus geoffroyi	Lesser Long-eared Bat	9	5.7	3
Nyctophilus gouldi	Gould's Long-eared Bat	14	8.5	2
Vespadelus pumilus	Eastern Forest Bat	21	13.2	3
Vespadelus vulturnus	Little Forest Bat	44	27.8	4

* Schedule 12 species

As seen in Table 2, ten bat species were identified from call. Four species can be regarded as reasonably common in the study area; the Little Free-tail Bat *Mormopterus loriae*, Gould's Wattled Bat *Chalinolobus gouldii*, the Eastern Forest Bat *Vespadelus pumilus* and the Little Forest Bat *Vespadelus vulturnus*. These species each accounted for more than ten per cent of total echolocation calls and were recorded from more than three sites. They appear to be widespread throughout the study area.

Two Schedule 12 species, the Common Bent-wing Bat *Miniopterus schreibersii* and the Little Bent-wing Bat *Miniopterus australis* were recorded from the study area. Each of these species represented less than ten percent of total echolocation passes of bats and were recorded from less than three sites.

The few records of the two Long-eared Bats *Nyctophilus geoffroyi* and *N. gouldi* is not unexpected as these soft calling bats are not readily detected by call. The trapping results give a better indication of their abundance.

The White-striped Mastiff Bat *Tadarida australis* was recorded from a single call at one site and appears to be sparsely distributed in the study area.

3.4 Spotlighting and Audible Calls

Grey-headed Flying-foxes *Pteropus poliocephalus* were heard and seen feeding in Broad-leaved Paperbark *Melaleuca quinquinervia* blossum at sites H8 and D1. They appeared to be quite common in these areas at the time of survey.

4 DISCUSSION

4.1 General

The area proposed for titanium minerals mining has a relatively rich bat fauna of at least eleven species. Of these, only two, the Common Bent-wing Bat *Miniopterus schreibersii* and the Little Bent-wing Bat *Miniopterus australis* are listed on Schedule 12 as endangered.

The remaining nine species are not regarded as threatened or endangered on a national or state level but are becoming less common largely through loss of habitat.

4.2 Bat Species of Conservation Significance

Two Schedule 12 bat species were recorded from the study area;

Little Bent-wing Bat	*Miniopterus australis*
Common Bent-wing Bat	*Miniopterus schreibersii*

The Common Bent-wing Bat *Miniopterus schreibersii* was recorded in dry sclerophyll forest immediately to the west of the proposed mine path. Although it may also forage in the proposed mine path it is unlikely to roost within the study area as it roosts in caves, mines, tunnels and culvets. The lack of rocky areas in the study area suggest it is roosting in locations out of the proposed mine path.
Loss of foraging habitat through clearance prior to mining may have a minor effect on this species.

As it is also cave-roosting, the Little Bent-wing Bat *Miniopterus australis* will be effected in a similar manner to *M.schreibersii*.
This species also is unlikely to be roosting in the study area due to the sand-based nature of the site and a lack of rock outcrops. It will be impacted to a minor extent through loss of foraging habitat.

4.3 Bat Species Not Recorded But Possibly Occuring on the Site

TABLE 4
BAT SPECIES NOT RECORDED THAT COULD OCCUR IN STUDY AREA

COMMON NAME	SPECIFIC NAME	LIKELYHOOD OF OCCURENCE
PTEROPODIDAE		
Eastern Blossum Bat	*Syconycteris australis**	M
Little Reddish Flying-fox	*Pteropus scapulatus*	H
EMBALLONEURIDAE		
Yellow-bellied Sheathtail Bat	*Saccolaimus flaviventris**	M
RHINOLOPHIDAE		
Eastern Horseshoe Bat	*Rhinolophus megaphyllus*	L
MOLLOSIDAE		
Eastern Free-tail Bat	*Mormopterus norfolkensis**	L
VESPERTILIONIDAE		
Eastern Broad-nosed Bat	*Scotorepens orion*	H
Greater Broad-nosed Bat	*Scoteanax rueppellii**	M

KEY: SPECIFIC NAME * - Schedule 12 species

LIKELYHOOD OF OCCURENCE L -Low
M -Medium
H -High

Table 4 lists bat species not recorded during the survey but which may occur in the area based on previous records and available habitat.

The presence of suitable food plants for the Eastern Blossum Bat *Syconycteris australis* indicate that this nectivorous species may occur in the study area. Records exist of this bat from Crowdy Head to the north and Booti Booti to the south. *Banksia* and *Melaleuca* species would

be included in the diet of this specialised bat. The absence of rainforest in the vicinity of the study area may exclude this bat as it normally roosts in rainforest in order to regulate body temperature.

Two flying-foxes are likely to occur in the forest at varying times of the year, the Little Reddish Flying-fox *Pteropus scapulatus* as well as the Grey-headed Flying-fox *Pteropus poliocephalus*. These large bats would utilise flowering trees within the proposed mine path for food and their presence would be dependent on when the different eucalypts, Melaleucas, Banksias and other trees are in blossum.

Coastal records of the Eastern Free-tail Bat *Mormopterus norfolkensis* are few, therefore this bat has a low probability of occuring in the study area.

Yellow-bellied Sheath-tail Bats *Saccolaimus flaviventris* prefer woodland/dry eucalypt habitats and on this basis may occur in the study area.

Eastern Horeshoe Bats *Rhinolophus megaphyllus* prefer moister habitats and there is only a low probability of this species occuring in the study area.

Records exist of the Greater Broad-nosed Bat *Scoteanax rueppellii* in similar coastal sites to south and north of the study area and it has a moderate possibilty of occuring.

The Eastern Broad-nosed Bat *Scotorepens orion* has a high possibility of occuring in the study area.

4.4 Impacts of the Proposed Development on Bat Species Recorded

The two Flying-foxes, *Pteropus poliocephalus* and *P.scapulatus* will be affected by the proposed development through loss of feeding resources. Clearing of native vegetation prior to mining will remove an area of diverse food plants for these bats. No camps of either species were detected in the study area at the time of survey. As both species move camps throughout the year to follow flowering and fruiting trees, they may use the study area at other times.

With the exception of the Common Bent-wing Bat *Miniopterus schreibersii* and the Little Bent-wing Bat *Miniopterus australis*, all the Microchiropteran bat species recorded from the proposed mine path are tree roosting, sheltering during the day in the hollow limbs and trunks of trees or under bark. They tend to roost communally in groups of a few individuals to hundreds of bats. These roosts can vary seasonly depending on climate and the requirements of the bats. During summer, females congregate at maternity roosts to give birth.

Clearing prior to mining will destroy diurnal roosts for these species with a percentage of bats being killed outright and much of the remainder being taken by predatory birds or succumbing to stress. Some individuals may find roosts in the remaining forest, but these are likely to be few. Clearing will also lead to a loss of foraging habitat for all species including the two flying-foxes.

Regeneration of the site following mining will alleviate these effects in the long term, but as tree hollows do not generally develop in trees until a minimum of eighty years of age, few roosts will exist in the study area during this period.

5 CONCLUSIONS AND RECOMMENDATIONS

1. Mining of the proposed area will impact the eleven bat species present through loss of roosting and\or foraging habitat. This impact will largely be confined to the mine path and due to the presence of similar habitat outside the mine path should not impact the bat species present on a regional level.

2. If extraction of titanium minerals proceeds, the site should be rehabilitated to a degree that the habitats currently represented on the site are reestablished.

3. To minimise mortality of bats during clearing of vegetation prior to mining, clearing of forest should not be undertaken in the periods November-February as births occur during this period and maternity roosts are in use. Similarly, bats are vulnerable during winter when they hibernate, so clearing of forest should not be undertaken during the months June-August.
Clearing of vegetation prior to mining should thus be undertaken during the months of September,October, March, April and May.

Glenn Hoye

16 May 1993

APPENDIX 4

NOISE DATA

APPENDIX 4
NOISE DATA

1.0 PROCEDURES AND EQUIPMENT USED DURING BACKGROUND NOISE MONITORING

Bruel and Kjaer Type 2231 Precision Sound Level Meter
Bruel and Kjaer Type 4155 Microphone
Bruel and Kjaer Type UA0207 Windshield
Bruel and Kjaer Type BZ7101 Statistical Analysis Module
Bruel and Kjaer Type 2318 Graphics Printer
Bruel and Kjaer Type 4230 Sound Level Calibrator

The microphone was located at approximately 1.2m above the ground and away from reflecting surfaces The calibration was checked before and after each series of readings, and did not fluctuate by more than +/- 0.1dB(A).

The meter was set on fast response, A weighting, with the Sound Incidence Correction set on Random.

Noise levels were recorded over a fifteen minute period, analysed into the percentile noise level (LN) and equivalent continuous noise level (Leq) and recorded on the graphics printer. Prominent noise sources were also noted.

2.0 MONITORING EQUIPMENT AND SURVEY PROCEDURES USED TO ASSESS PROCESSING AND MOBILE EQUIPMENT.

Bruel and Kjaer Type 2231 Precision Sound Level Meter
Bruel and Kjaer Type 4155 Microphone
Bruel and Kjaer Type UA0207 Windshield
Bruel and Kjaer Type BZ7101 Statistical Analysis Module
Bruel and Kjaer Type 2318 Graphics Printer
Bruel and Kjaer Type 4230 Sound Level Calibrator
Bruel and Kjaer Type 1625 1/3-1/1 Octave Filter Set
Bruel and Kjaer Type BZ7103 Frequency Analysis Module

The meter was set on fast response, linear "all pass" and a preset number of sprecta of 2.

The microphone was located at approximately 1.2m above the ground and away from reflecting surfaces The calibration was checked before and after each series of readings, and did not fluctuate by more than +/- 0.1dB(A).

3.0 BACKGROUND NOISE SURVEY RESULTS

TABLE 1
NOISE SURVEY RESULTS

Site	Date	Time	EPA Time	L_{10}	L_{50}	L_{90}	L_{eq}	Source
N1	1/12/89	7:00am	Day	45.0	35.0	31.0	50.0	1,5
N1	5/3/93	9:15am	Day	42.3	36.8	34.3	40.5	1,2,3
N1	5/3/93	10:09am	Day	40.8	35.3	29.8	44.3	1,2,5
N2	1/12/89	7:30am	Day	51.0	42.0	38.0	51.0	1,3,5,8,9
N2	5/3/93	9:45am	Day	43.8	43.3	34.8	57.9	1,2,3,4,5,6
N2	5/3/93	10:31am	Day	46.8	32.8	29.3	48.2	1,2,3,5,7,8

Note:

1 – Birds
2 – Cicadas
3 – Overhead Plane
4 – 25 Tonne Trucks
5 – Cars
6 – Tractor
7 – Motor Bike in Distance
8 – Dog Barking
9 – Rooster

TABLE 2
METEOROLOGICAL CONDITIONS DURING SURVEY

Date	Time	Temp.	Air Pressure	Cloud Cover	Wind Speed	Wind Direction
1/12/89	7:00am	25°C	–	Nil	Nil	–
1/12/89	7:30am	25°C	–	Nil	Nil	–
5/3/93	9:15am	20°C	1018	5%	Nil	–
5/3/93	10:09am	20°C	1018	60%	1m/s	South
5/3/93	9:45am	20°C	1018	10%	Nil	–
5/3/93	10:31am	20°C	1018	80%	Nil	–

TABLE 3
PREDICTED MINING AND PROCESSING NOISE LEVELS DURING NORMAL WEATHER CONDITIONS

Receiver	Equipment Locality	dB(A)	Daytime Design Goal	Night-time Design Goal	Exceedance
R1	P1 + S1*	25.1	37	35	-
R2	P1 + S1	22.9	37	35	-
R3	P1 + S1	7.8	37	35	-
R1	P2 + S1**	24.5	37	35	-
R2	P2 + S1	22.9	37	35	-
R3	P2 + S1	7.6	37	35	-

Note:

Predicted mining and processing noise levels during 'worst-case' weather conditions.

Receiver	Equipment Locality	dB(A)	Daytime Design Goal	Night-time Design Goal	Exceedance
R1	P1 + S1	26.5	37	35	-
R2	P1 + S1	24.0	37	35	-
R3	P1 + S1	15.7	37	35	-
R1	P2 + S1	25.8	37	35	-
R2	P2 + S1	23.9	37	35	-
R3	P2 + S1	15.6	37	35	-

Note:

*P1 + S1 – Processing Plant 10 and associated equipment located at P1 and mining equipment is located at S1 (e.g., Dozer, Front-end Loader, Feeder Unit, Pumps).

**P2 + S1 – Processing Plant 10 and associated equipment located at P2 and mining equipment are located at S1.

TABLE 4
SOUND POWER LEVELS OF EQUIPMENT USED FOR MODELLING PURPOSES OCTAVE (HERTZ)

	31.5	63	125	250	500	1000	2000	4000	8000	16000	Awt
Komatsu D60 Swamp Dozer	-	80.0	82.0	90.0	108.0	104.0	105.0	88.0	80.0	-	109.9
Volvo Front-end Loader	121.3	112.9	113.4	108.6	106.1	103.9	101.8	97.9	91.3	-	109.5
Feeder Unit for Processing Plant	94.5	99.7	100.6	91.5	96.8	93.0	89.1	87.3	79.5	-	98.2
Hanson Sykes Pump	113.4	114.2	108.9	91.9	87.8	91.4	90.3	88.4	84.7	82.5	98.4
D65P Dozer	104.1	111.6	114.0	106.9	104.8	107.7	105.6	99.5	95.4	87.5	111.7
Processing Plant	96.9	100.4	96.6	92.0	91.8	88.9	96.3	85.0	79.3	72.5	94.6
Fuel Tank Pump	84.9	95.2	104.6	98.8	97.9	96.2	93.0	89.6	87.6	78.2	101.2
Generator	103.9	103.4	99.6	102.7	106.2	93.3	93.7	82.8	78.2	69.7	104.8

APPENDIX 5

ARCHAEOLOGICAL SURVEY

RZM PTY. LTD

ARCHAEOLOGICAL SURVEY FOR PROPOSED TITANIUM MINERALS MINING, MLA 1 COFFS HARBOUR, 10KM SOUTHEAST OF NABIAC, NEW SOUTH WALES

PREPARED BY:

RESOURCE PLANNING
PTY LIMITED

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1.0 INTRODUCTION

1.1 BACKGROUND TO THE STUDY

This report presents the results an archaeological survey conducted on Portion 52, part of Portion 89, and ML1 and ML4 near Nabiac, approximately 5km west of the Wallamba River, Tuncurry, New South Wales. ML1 and ML4 are presently comprising Crown Land. The aim of the survey was to assess the likely impact of the proposed mining on the archaeological resource in the area.

The archaeological survey included an investigation of the mining operations sites and all associated vehicular tracks around and through the boundaries of the site area. The survey was undertaken as part of an Environmental Impact Statement being prepared by Resource Planning Pty Limited. The survey was designed to determine the presence or otherwise of Aboriginal cultural remains and to make recommendations for future action to meet with the requirements of the National Parks and Wildlife Act (1974) and with the approval of the Forster Local Aboriginal Land Council.

The archaeological survey and report was completed by Noeleen Steel for Resource Planning Pty Limited.

1.2 THE STUDY AREA

The study area (**Figure 1**) is located on the eastern side of the Pacific Highway, approximately 5km west of the Wallamba River, Tuncurry. The site comprises part of Portions 52 and 89 and two independent Aboriginal Land Claims on Crown Land (ML1 and ML4). The approximate area of proposed site disturbance is 28 hectares.

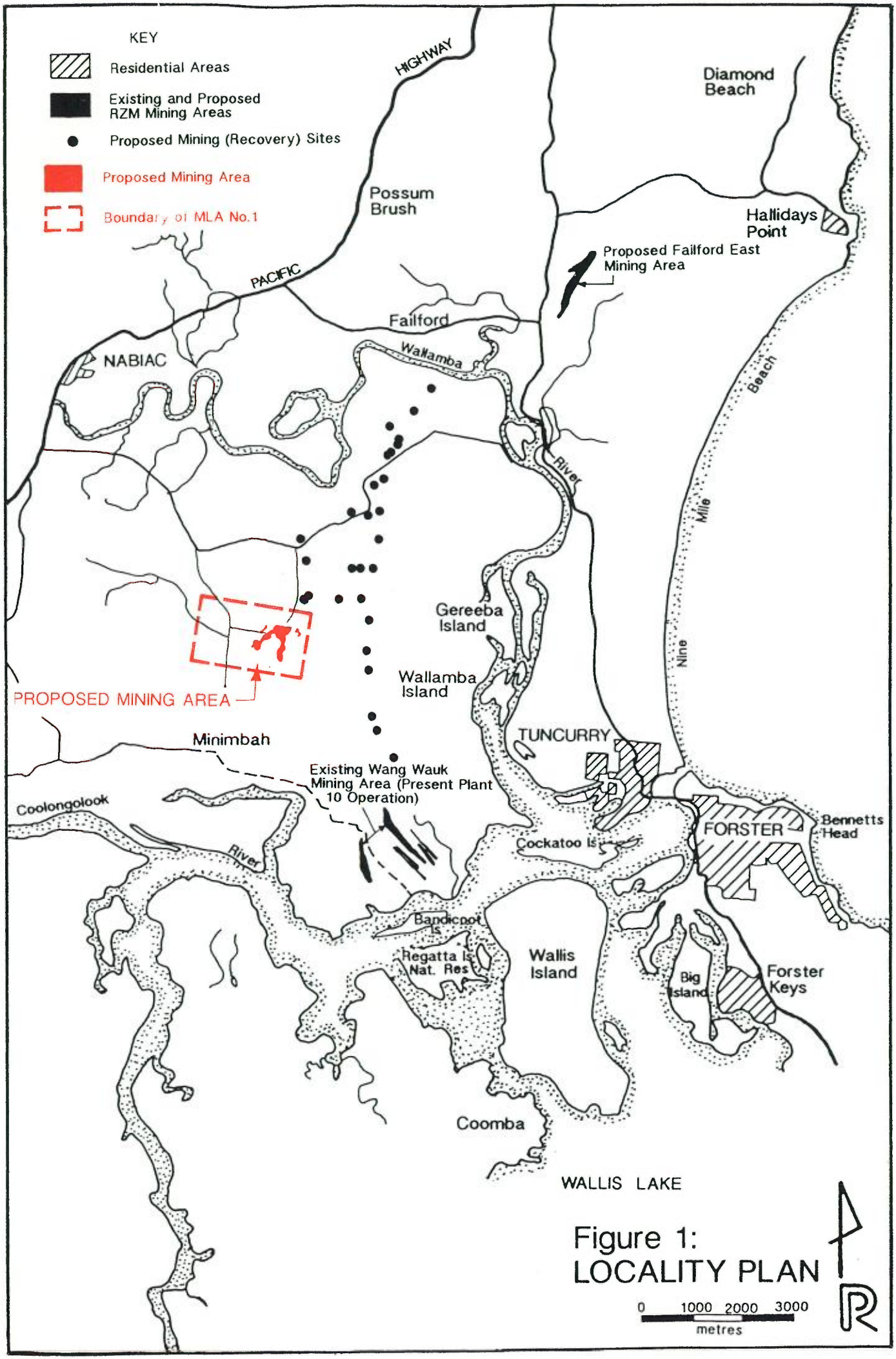
1.3 SUMMARY OF RESULTS

No archaeological sites were located in the study area during the survey. Dense vegetation cover obscured clear view of the ground, making surface visibility 0%. The possibility of sites occurring in this area was marginal, as much of the land intended for mining is subject to inundation by water.

No objections are made against the mining operations continuing in Portions 52 and 89, however, as there are two Aboriginal Land Claims on the Crown Land surrounding Portion 52 where the proposed mining is to operate, mining should not commence until such a time as ownership of the land is decided.

2.0 ABORIGINAL CONSULTATION

The study area falls within the bounds of the Forster Local Aboriginal Land Council. The Council were advised of the survey and the proposed development


KEY
Residential Areas
Existing and Proposed RZM Mining Areas
Proposed Mining (Recovery) Sites
Proposed Mining Area
Boundary of MLA No.1
HIGHWAY
PACIFIC
Possum Brush
Diamond Beach
Hallidays Point
Proposed Failford East Mining Area
Failford
NABIAC
Wallamba
River
Beach
Mile
Nine
Gereeba Island
Wallamba Island
PROPOSED MINING AREA
Minimbah
TUNCURRY
Existing Wang Wauk Mining Area (Present Plant 10 Operation)
Coolongolook
River
Cockatoo Is
FORSTER
Bennetts Head
Bandicoot Is
Regatta Is Nat. Res
Wallis Island
Big Island
Forster Keys
Coomba
WALLIS LAKE
Figure 1:
LOCALITY PLAN
0 1000 2000 3000
metres

1008/92502

prior to commencement of the survey. The Council Co-ordinator, Mr Cal Davis, assisted with the survey on the 3rd February 1993. A fieldwork statement has been sought from the Local Aboriginal Land Council but was not available at the time of finalisation of this document. This correspondence will be included in the reports to be sent to the National Parks and Wildlife Service in accordance with the National Parks and Wildlife Act (1974). A copy of this report will be forwarded to the Forster Local Aboriginal Land Council for their records.

3.0 ENVIRONMENTAL CONTEXT

The study area is located within the coastal sand barrier between Forster and Hallidays Point. North of the Coolongolook River there are bedrock areas which comprise moderately hard undifferentiated sequences of Devonian mudstone, sandstone, conglomerate, greywacke, chert and tuff. South of the Coolongolook River consists of Carboniferous sandstones, siltstones, claystones, shales and lavas. Those materials north of the river would have been readily utilised by Aborigines and manufactured into implements used in hunting and gathering activities.

There were 21 vegetation communities identified in the study area as follows (Buchhorn 1993). The description below are similarly reflected in the Environmental Impact Statement.

1. Spotted Gum Open-forest.
2. Open-forest Ecotone.
3. Paperbark/Forest Red Gum Forest.
4. Scribbly Gum Open-forest.
5. Scribbly Gum Woodland.
6. Smooth-barked Apple Woodland.
7. Paperbark Low closed-forest.
8. Paperbark Open-forest.
9. Paperbark/Swamp Mahogany Forest.
10. Paperbark/Swamp Mahogany Woodland.
11. Broad-leaved Paperbark/Swamp Mahogany Woodland.
12. Broad-leaved Paperbark/Swamp Mahogany Open-woodland.
13. Heath with emergents.
14. Heathland. (Regenerating).
15. Open heathland (Regenerating).

16. Heathland/sedgeland with emergents.

17. Heath/sedgeland. (Regenerating).

18. Baumea sedgeland.

19. Sedgeland.

20. Eleocharis sedgeland.

21. Cleared.

The use of Australia native plant species for their medicinal properties, and as bushtucker, is well documented for both Aboriginal and Europeans (Low 1989, 1990). Eucalyptus trees, tea-trees, and wattle trees characterise the abovementioned vegetation communities which were exploited for their leaves, stems, rhizomes, seeds, fruits and bark. Some plant parts were used in beverages, made into flour for food, as cigarettes, and used in medicines as bandages, therapeutic oils and sponge paths for fevers. More functional uses were as bark walls, baskets, string and bowls. Introduced species are mostly recognised as weeds, however some in fact were used for their medicinal properties.

4.0 ARCHAEOLOGICAL CONTEXT

A search of the National Parks and Wildlife Sites Register revealed that there are no archaeological sites recorded in the study area. Within a radius of 20km however, there are many site types recorded. Such sites include: middens, open sites, bora/ceremonial sites, stone arrangements, quarry sites, burials and carved trees. Such a variety of site types in the area is an indication that this may have been a densely settled area. Archaeological evidence on the mid to lower north coast supports this theory. Information about Aboriginal occupation has been condensed by Dean-Jones (1988) and is highlighted below.

Coleman (1982, from Dean-Jones 1988), made an analysis of ethnographic descriptions for the area and suggested that the Aboriginal population of the New South Wales north coast at the time of European contact was high, with densities of as much as three persons per square kilometre, and a relatively sedentary pattern of occupation. At contact, the high population was supported principally by exploitation of oceanic and outer estuarine fish resources. The extent of exploitation is not certain, not is it clear whether the pattern was replicated on the mid-lower north coast, such as in the Tuncurry area.

The most common site types to occur on the mid-north coast of New South Wales is midden deposit. Middens have been recorded along the shores of the Wallamba/Coolonglook River system, which feeds into Wallis Lake, around Wallis Lake itself, and on Yahoo Island and Wallis Island, within the estuary (Dean-Jones 1988). These sites appear to predominantly exploit estuarine shellfish and fish resources.

Open sites have been recorded at Minimbah, on the western side of Wallis Lake, and at Booti Booti and Elizabeth Bay, south of Forster.

Bonhomme (1988) conducted a survey at Tuncurry and found three shell middens containing both estuarine and open shellfish remains, and also stone artefacts. Stone artefacts are more common in middens located to exploit a variety of resource zones – often in coastal dunes, or along the upstream portion of estuaries. Dean-Jones suggests that if only shellfish remains are found in near coastal middens, such as appears to be the case at Tuncurry, then we must assume that either the remains of other food sources have been lost from the site by taphonomic processes, or they are located elsewhere. Data from sites in the Tuncurry area are still not yet sufficient to ascertain which of these options is most likely.

Of the remaining site types recorded in the Forster/Tuncurry area, carved trees, ceremonial grounds and stone arrangements are known to have occurred, but appear to have been destroyed. At Forster, at least thirty Aboriginal burials are known to have taken place at the Mission cemetery. No prehistoric burials have yet been discovered in the area.

5.0 FIELD INVESTIGATION

5.1 SURVEY STRATEGY

Groundcover in the survey area was very high, consequently surface visibility was low. Consequently, all vehicular tracks, walking tracks, and exposed and eroded areas were investigated for archaeological material. The study area was surveyed on foot on the 3rd of February 1993. The survey was undertaken with the assistance of Cal Davis from the Forster Local Aboriginal Land Council.

5.2 RECORDING TECHNIQUES

A log book was maintained in the field to record immediate observations such as topographic features, vegetation cover, surface visibility and any problems with interpretation that were encountered. Prepared recording forms were to be used for efficient site recording. The degree of detail on these forms was determined by the recording requirements of the National Parks and Wildlife Service (NSW). A 1:25,000 topographic map (Coolongolook) was used to locate the study area.

6.0 RESULTS OF THE ARCHAEOLOGICAL SURVEY

No archaeological sites were located in the study area.

7.0 RECOMMENDATIONS

The following recommendations are made on the basis of:

1. The legal requirements of Section 90 of the National Parks and Wildlife Act (1974) which states that it is illegal to deface, damage to destroy an Aboriginal relic without the prior consent of the Director of the National Parks and Wildlife Service (NSW).

2. A field inspection of the proposed mining site for archaeological material.

3. A search of the National Parks and Wildlife Service Sites Register for archaeological sites in the survey area and its immediate surrounds.

4. Consultation with the Forster Local Aboriginal Land Council.

Subject to the considerations of the Forster Local Aboriginal Land Council, it is recommended that:

1. In the absence of archaeological sites in the survey area, there is no objection to the development proceeding as planned.

2. In the event that any archaeological material is found during mining, operations in the area should cease immediately and the National Parks and Wildlife Service (NSW) be contacted to expedite an assessment of the situation.

3. Three copies of the report should be forwarded with a cover sheet to the National Parks and Wildlife Service (NSW) Regional Archaeologist for review.

4. A copy should also be forwarded to the Forster Local Aboriginal Land Council.

8.0 REFERENCES

Bonhomme, T., 1988. Archaeological Sites on the North Tuncurry.

Buchhorn, N., 1993. Flora and Fauna Investigations, Environmental Impact Statement for Titanium Mineral Mining on MLA1, Coffs Harbour, Parish of Wang Wauk.

Dean-Jones, P., 1988. An Archaeological Survey of Part of Portion 100, Parish of Tuncurry, New South Wales.

National Parks and Wildlife Act, 1974.