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Proposed mineral sands mining, Tomago sandbeds water  
supply catchment area : environmental impact assessment

NSW DEPT PRIMARY INDUSTRIES



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NSW DEPARTMENT OF  
MINERALS AND ENERGY

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# Proposed Mineral Sands Mining Tomago Sandbeds Water Supply Catchment Area

ENVIRONMENTAL IMPACT  
ASSESSMENT

ENVIRONMENTAL GEOLOGY SECTION  
GEOLOGICAL SURVEY OF N.S.W.

EIS  
737

DEPARTMENT OF ENVIRONMENT & PLANNING  
SYDNEY, 1983

**ENVIRONMENTAL GEOLOGY SECTION  
GEOLOGICAL SURVEY OF N.S.W.**

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## FOREWORD

The assessment of proposed mineral sands mining by Rutile and Zircon Mines (Newcastle) Limited within the Tomago Sandbeds Catchment Area north of Newcastle, has been prepared in response to the environmental impact statement submitted by the Company. In carrying out the assessment, due consideration has been given to all written submissions received.

The proposed development requires the approval of the consent authority, Port Stephens Shire Council and the concurrence of the Director of Environment and Planning pursuant to Clauses XII(2) I.D.O. No. 23, Shire of Port Stephens. This is a deemed environmental planning instrument under the Environmental Planning and Assessment Act, 1979.

This assessment report has been prepared by the Department of Environment and Planning and constitutes the Director's concurrence to the development. The report will be forwarded to the Council for consideration prior to Council determining the development application. The applicant or any objector from whom a submission has been received is entitled to appeal to the Land and Environment Court against a decision by Council, in accordance with Sections 97 and 98 respectively of the Environmental Planning and Assessment Act, 1979.

R.B. SMYTH  
Director of Environment  
and Planning

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## LIST OF ABBREVIATIONS

A.H.D.	Australian Height Datum
dB(A)	decibel ("A" weighted scale)
ha	hectare
kL	kilolitre
km	kilometre
kw	kilowatt
L	litre
M.L.A.	Mining Lease Application
ML	megalitre
PM	Permanent Mark
s	second
t	tonne
y	year
The Board	Hunter District Water Board
NPWS	National Parks and Wildlife Service
PWD	Department of Public Works
SPCC	State Pollution Control Commission

## 1. INTRODUCTION

Rutile and Zircon Mines (Newcastle) Limited has prepared an environmental impact statement for the proposal to continue its present mineral sands mining operation in the Tomago Sandbeds Water Supply Catchment Area, north of Newcastle. Mining leases within the sandbeds cover a total of 1900 hectares and are encompassed by Raymond Terrace, Williamtown, Salt Ash and Medowie. Figure 1 indicates the location of the mining lease applications held by the Company in the area.

The Tomago Sandbeds Catchment covering an area of approximately 106 km<sup>2</sup> represents one of three major sources of water for the Newcastle Region and was first brought into use in 1939. The other main sources of domestic water are Chichester Dam and Grahamstown Reservoir.

The quantity of water stored in the sandbeds is variable and generally related to rainfall patterns, recharge and use. In 1977-78 16 percent of the total domestic water requirements of the Newcastle area were delivered from the Tomago Sandbeds. In 1980 during a prolonged dry spell up to 40 percent of the Hunter District Water Board's domestic supply was being extracted from the sandbeds.

The Company has been mining this groundwater reserve for the past nine years. The operations have been carried out under controls imposed by State laws administered by the Department of Mineral Resources, the Hunter District Water Board and the State Pollution Control Commission.

Approval to continue mining will permit an annual extraction of approximately 25000 t of rutile and 30000 t of zircon over a period of 15-20 years. These reserves stretch over a narrow band for 25 kms, some 10km inland from the present shoreline, and represent 85% of the Company's anticipated regional production.

Approximately 500-600 hectares of open forest, heath and wetland are proposed to be progressively cleared over a 15-20 year period. This represents 5.7 percent of the Tomago Water Supply Catchment Area.

Following the granting of prospecting titles in 1965, the Company received approval from the Board and began to mine a non productive portion of the aquifer on a trial basis during the period of July 1967 - June 1971.

Investigations were undertaken by the Board's consultant, Ercon Australia Ltd. to assess the effects of the operation on yield and water quality of the aquifer. These investigations indicated that there was an increase in iron content of the water approximately 12 months after mining and this was considered to possibly be associated with slimes which accumulate at the bottom of the dredge pond. As a result the Company was required to treat the dredge pond water for the removal of slimes.

In January 1979, Port Stephens Shire Council approved the Company's development application in respect of a proposed mining operation within the sandbed area, in M.L.A's 1048 and 263, subject to the concurrence of the Board and the then Minister for Mines.

Mining commenced in December 1972 and is continuing under the monitoring of the Board and its consultant.

Subsequently the company sought and gained approval to mine within M.L.'s 594, 744 and 785 with the concurrence of the Planning and Environment Commission in June 1978 and March 1979.

In addition the Department of Mineral Resources referred the remaining M.L.A.'s within the sandbeds to the Commission. The Commission recommended in February 1979 that the Company make only one application for development consent for all the remaining areas to be mined in the locality. The Commission further recommended that the Company submit an environmental impact statement covering such a submission.

The environmental impact statement was prepared by Croft and Associates Pty. Limited on behalf of the applicant. The company submitted the statement with the development application to Port Stephens Shire Council on the 15th April, 1982.

The environmental impact statement was advertised and placed on display by Council for a period of 30 days ending on June 4, 1982. The statement was also put on display during this period at the Department's Sydney and Newcastle offices, the N.S.W. Government Information Centre, the N.S.W. Environment Centre and at the Head Office of Rutilite and Zircon Mines (Newcastle) Limited.

As a result of the public exhibition, one submission was received by Council from the public. The Department sought advice and received additional responses from eleven relevant public authorities, the Government's Mineral Sands Mining Committee and Port Stephens Shire Council.

A summary of these submissions is included in Section 5 of this report.

To assist in the Department's review of the proposal, the Company was invited to comment on the various items of concern raised in the submissions.

The Department's Assessment Report constitutes the Director's concurrence and will be forwarded to Council for consideration prior to Council determining the development application.

## 2. THE PROPOSAL

### 2.1 The Proponent Company

Rutile and Zircon Mines (Newcastle) Limited is a joint venture company formed in 1962 by Coffs Harbour Rutile NL (the subsidiary of Kathleen Investments (Australia) Ltd) and National Minerals Pty Ltd (a subsidiary of Peko-Wallsend Investments Ltd). The joint venture was formed principally to secure a major contract to furnish rutile for the Du Pont company's new chlorination plant in the USA for the production of titanium pigment. The joint venture has operated on a large scale to the present time, purchasing leases and plant of Clutha Development Pty Ltd in 1963 in the Harrington district and entering a joint venture to mine further leases at Harrington in 1967. This latter joint venture was terminated in December 1980. (Morley, I.W. 1981).

The major mining operation and new dry plant at Tomago was established in the early 1970's following negotiations and agreement with the Water Board to mine the area under very rigid conditions. The Company now has separation plants at Tomago and Harrington. A presently dormant subsidiary of the company is Chlorine Technology Ltd which has developed a process to make synthetic rutile from ilmenite. Since 1974, the operating agent of the joint venturers, Peko-Wallsend and Coffs Harbour Rutile, has been their company, R.Z. Mines (Newcastle) Pty Ltd.

### 2.2 Processing and Use of the Mineral

The mineral sand industry in Australia in recent years has annually processed more than 150 million tonnes of sand to recover approximately 700,000 tonnes of mineral. (MSPA Ltd).

The technology required to achieve this production is usually based on two phases:

- \* The primary phase, that is the actual mining operation involving wet gravity separation of mineral from sand.
- \* The secondary phase, that is the processing/separating.

The first phase is usually a dredging operation, in which advanced gravity separation techniques are applied to recover all the heavy mineral sands as one concentrate. This wet gravity separation is based on five steps:

- \* A suction cutter dredge works the mine face.
- \* This dredge pumps the sand mass to a surge bin and screening system, where "trash" is removed. The mineral bearing sand is then pumped from the screening system to a concentration barge.
- \* Within this barge sophisticated gravity separation equipment separates the heavy mineral sand concentrate from the sand mass.

- \* The concentrate is pumped from the barge to a stockpile and thence trucked to the dry mill.
- \* Simultaneously, the quartz sand (called "tailings") from which the heavy mineral sands have been extracted is ejected and recontoured behind the mining operation as a first stage in the rehabilitation process.

Only the heavy mineral concentrate is removed and as the mineral content is from 0.5% to 3% by weight and 0.25% to 1.5% by volume of the excavated material the change in sand mass volume is insignificant.

The heavy mineral concentrate is transported from the site to a separation plant where the second phase of separation based on dry milling is carried out. This phase relies on the different electrical and magnetic properties of the heavy mineral sands which make it possible to effect separation of each individual mineral by the application of electrostatic and electromagnetic influences.

These minerals - rutile, zircon, ilmenite and monazite - are used in numerous and diverse applications.

Rutile is used as a flux to strengthen welding joints. It is a source for titanium metal, noted for its strength, lightness, high melting point and resistance to corrosion. It is also a source of titanium dioxide pigment, a preferred ingredient in colouring agents for a range of materials in everyday use because of its superior covering properties.

Zircon is used extensively in ceramic products such as tiles and bathroom fittings, both in body material and in the glazes to give long wear. It is also processed into chemicals used in cosmetics, glass, specialised cements, food preservatives, tanning and flame retardants used to make fabric non-flammable.

Zirconium, the metal refined from zircon, is used in atomic reactors.

Ilmenite can be "beneficiated" to convert it into a synthetic rutile. However as most ilmenite found in N.S.W. contains a relatively high chrome content, it is unsaleable for the production of titanium white. Small quantities of ilmenite are used in iron ore blast furnaces.

Heavy mineral sands are used extensively in the automotive industry, in telecommunications, to alloy the steel for natural gas pipelines and in the oil refining industry.

### 2.3 Description of the Proposed Development

Rutile and Zircon Mines (Newcastle) Limited seeks development approval to mine heavy mineral from the M.L.A.'s listed in Figure 1. Integral components of this operation are the refining and processing mill at Tomago, a wastewater treatment plant within M.L. 594 and slime disposal ponds at Williamtown. These are approved and licensed operations and do not form part of the proposed development.

The proposed development is described in section 3 of the environmental impact statement pages 16-40. Readers are referred to that document for detailed information.

#### 2.3.1 Areas to be Mined

Two mining plants are now working on Mining Leases 594 and 785 and are expected to complete these operations by 1986. It is proposed that mineral will then be extracted from the main orebodies southwest of the Richardson/Medowie Road intersection area over a 14 year period.

During this same period the second mining plant will mine the satellite orebodies within M.L.A.'s 1163, 263, 1155, 1168, 1166 and 1173. It is proposed that a third land based plant will extract mineral from leases to the north and east of the Medowie/Richardson Road intersection over a total period of four to five years as and when market conditions permit. The orebodies located in M.L.A.'s 1171, 256, 35, 1151 and 34 near Moffats Swamp at Salt Ash are remote from other orebodies and will also be mined by this plant.

#### 2.3.2 Premining Assessment and Site Preparation

Prior to clearing of vegetation the Company proposes to undertake topographic and vegetation surveys. This will involve the preparation of contour maps and the delineation of a continuous transect 6 metres wide surveyed along the centre of the mining path for seed collection and pre and post-mining vegetation assessment.

The Company proposes to clear vegetation to 120 metres in advance of the dredge over a path which may vary in width from 60-150 metres. Trees will be cleared, stacked and burned and topsoil and understorey species stacked. Islands of vegetation are proposed to be left between runs to provide a seed source, windbreak and visual screen. Concentrated planting of native plants to form artificial islands is also proposed.

Topsoil will be stripped to a depth of 300 mm to be reinstated after mining to a position approximating its original location. Root combing is proposed to a depth of 300 mm in heavily root concentrated zones.

### 2.3.3 Mineral Extraction and Processing

The proposed main orebody operation up to the Richardson Road/Medowie Road intersection will comprise two mining plants, one land-based and one floating in a 3.5 m deep dredge pond. The area to be mined by these two plants will be at a maximum of 30 ha/y in accordance with the present constraints imposed by the Board.

Mining of the sand will be achieved by electrically powered floating suction cutter dredges which will deliver a slurry to a floating or land-based concentrator plant. The heavy mineral concentrates will then be pumped to a stockpile and dewatered before being transported to the existing processing and refining mill at Tomago. Dewatered tailings will be discharged to the rear of the pond.

Periodically, small isolated pockets of heavy mineral which cannot be extracted using conventional dredging methods will be recovered by earth moving equipment and transferred to the mining operation for processing.

All effluents from the two plants will be collected and pumped to a common clarifier/thickener with the clarified water being returned to the dredge pond. Description of this water treatment plant is given in Section 3.5.4 of the environmental impact statement. Settled slime from the thickener will be pumped to ponds covering 30 ha. at Williamstown which, when filled and dry, will be grassed and used for flood-free grazing or turf production purposes. The Company has received consent to develop a further 50 ha. of ponds on its own freehold lands at Williamstown.

The Company has a licence issued by the State Pollution Control Commission under the Clean Waters Act to discharge high clarity water from the surface of the ponds into Dawsons Drain. The requirements under this licence are listed in appendix 8 of the environmental impact statement.

The quality of the effluent discharged from the slime ponds into Dawsons Drain is monitored weekly and these results are shown in Appendix 9 of the environmental impact statement.

The third mining plant to be located east of Medowie Road will be land-based and have a throughput capacity of 250 t/h. The mining procedures to be adopted by this plant will be in accordance with conditions stipulated by the Board.

Site restoration and revegetation proposals will be discussed in Section 4, Environmental Safeguards.

### 2.3.4 Ancillary Operations

#### Transport:

The concentrate produced by the mining plants will be hauled up

to 31 kms by road to the separation mill at Tomago. Public roads will represent 8.8 kms of the journey, mining access roads up to 7 kms and the remainder will be roads constructed by the Board.

A company road located on the southern side of the mined orebody within lease 594 will provide access to the proposed mining areas southwest of the intersection of Richardson and Medowie Roads at Campvale.

Concentrate mined to the west of Medowie Road will be hauled a distance of 18 km to the mill at Tomago via Company and Board roads, Masonite Road and the Pacific Highway.

The Company is examining three options for the most suitable transport route to the mill from Campvale. At this stage no decision has been made.

In consultation with the Board, the Company may seal those roads within the Tomago Sandbeds Water Supply Catchment Area considered likely to carry certain volumes of traffic for a number of years.

Company constructed roads no longer in use will be removed at the Board's request. The Company will restore the condition of any road or track upon completion of the mining operations if required by the Board.

It is estimated that between 75 and 100 loads of heavy mineral will be transported per week from the mine sites to the separation mill. The weight of each truck load will range from 15 to 20 t.

In addition, about 20 other trips would be made each day in Company-owned cars and utilities.

Cartage of heavy mineral concentrate will be undertaken on weekdays during the hours of 7 a.m. to 3 p.m. with the occasional trip to 6 p.m. On average, the mined concentrate will be transported on only three or four days of the week.

The final product will be transported from the separation mill at Tomago to the Port of Newcastle along the Pacific Highway via Hexham, a distance of 17.6 km.

#### Water and Power Supply:

Water required for the mining and irrigation operations will be obtained from the sandbeds by a series of Company-owned pumping stations, the location and capacity of which are matters for determination by the Board.

Under terms and conditions imposed by the Board, the Company pays a rate of charge on the water abstracted from the sandbeds for use in connection with its mining operations.

Power will be provided by the Shortland County Council and the mobile nature of the development will require the erection of at least 35 spans of line per annum.

On-site Operations and Personnel:

The equipment proposed to be used on-site for the extension of the operations and for general maintenance includes three caterpillar bulldozers and two front end loaders. The mining plants will be in continuous operation seven days per week.

Seventy-nine employees will be required for the two-plant mining operation on the main orebody. An additional 23 personnel will be required on the introduction of a third mining plant.

A further 109 personnel are currently employed by the Company in the Region.

### 3. EXISTING ENVIRONMENT

The environment of the site and the surrounding area is described in Section 4 of the environmental impact statement pages 41-76. Readers are referred to that document for detailed information. Environmental factors likely to require specific attention during project design are discussed below. The company's planned response to these factors is presented in a following section, Environmental Safeguards. A later section deals with the expected impact of the project on the environment.

#### 3.1 Zoning, Land Use and Tenure

Four zoning classifications apply for the proposed mine site and surrounding area. These include Special Uses (5A), Non-Urban 1(A), Non-Urban (IB) and Non-Urban (IC). Mineral sands mining is permissible with consent in all four zones.

The subject land is comprised of an area of restricted Crown Land within the gazetted Tomago Sandbeds Water Supply Catchment Area, part Crown Lands and private lands adjacent to the RAAF Base and leased to the Commonwealth of Australia for establishment of an approach lighting system to the RAAF Base and for an air weapons range, freehold lands owned by the Board, and privately owned freehold lands.

The Williamstown RAAF Base is located to the southwest of the proposed mining site within an area of 730 ha and it houses some ninety families. Residential development is also occurring in the Salt Ash and Lemon Tree Passage region and at Medowie and Campvale.

Agricultural pursuits of the surrounding area include poultry farming for Steggle's Pty. Ltd., horse breeding, cattle grazing and hobby farming.

#### 3.2 Natural and Physical Environment

##### 3.2.1 Geomorphology

The Tomago Sandbeds form an unconsolidated coastal sand mass known as the Inner Barrier Dune System occurring some 11 km inland from the coast. The sandbeds have an average width of 5 km, rarely exceed 18 m in thickness and overlie an impermeable bedrock of sandstone, siltstone and mudstone. The sandbeds contain commercially viable leads of heavy minerals within 7 m of the surface and the leads are of medium to low grade.

##### 3.2.2 Soil and Erosion

Sandy humus podsols and iron humus podsols occur on the site. Both soil types tend to be of low fertility and minimal erosion potential.

### 3.2.3 Hydrology

The sandbeds extend to an impervious clay bottom 9 to 18m below the surface and form an extensive water bearing aquifer with the water table usually lying 1.5 to 5m below ground level. Below the water table the permeable alluvial materials are sufficiently saturated so as to yield significant quantities of water.

The aquifer has been developed as one of the three major sources of domestic water for the Newcastle district. Ferrous iron is an important parameter influencing water quality. Safeguards are required to protect this water source.

Groundwater contours determined by the Board are shown in Figure 2. The contours represent the level of the water table when no pumping stations are operating and indicate a sloping of the water table towards the Hunter River, Pacific Ocean and Port Stephens. The Department of Mineral Resources in its submission notes that there is no evidence to support the conclusion that there are perched water tables or indurated sands in the area.

### 3.2.4 Climate

Early spring tends to be the driest time of the year. The lack of rainfall may pose a constraint on the revegetation programme.

The mining area is exposed to northeasterly and easterly winds in summer and west to northwesterly winds in winter. Wind funnels may be experienced along the southwest to northeast orientated mining path. Safeguards will be required to minimise erosion potential.

### 3.2.5 Vegetation and Fauna

A number of field surveys were carried out in the sandbeds area by Crofts and Associates Pty Ltd to determine the type, structure and distribution of vegetation communities and the species of avifauna and non-avian fauna. Appendix 14 of the environmental impact statement details methods employed and results obtained, whilst Figures 10-13 provide a detailed vegetation survey indicating proposed mining paths in relation to vegetation associations. Additionally Tables 7 and 8 in the statement present vegetation lists for two defined areas which represent one months mining advance, prior to mining and at two stages after mining. These have been prepared as part of the revegetation assessment of existing mining operations being undertaken by the Company in association with the Board and its consultant, Ercon Australia.

The vegetation on the sandbeds is relatively undisturbed and is dominated by mixed eucalypt forest, covering some 30-40% of the area, woodland and wetland. Macropods and avifauna are common residents of this habitat.

No rare or endangered species have been recorded in the area. The overall value of the site is rated as medium to high by Croft and Associates because of the comparatively undisturbed nature of much of the area, the high diversity of flora species and units and interesting faunal populations.

The most significant wetland in the area is Moffats Swamp Nature Reserve. The proposed mining path occurs adjacent to the swamp, a section of the orebody under the swamp formerly comprised of MLA 1150, having been excised from the proposed mining.

The area has been subject to a number of human influences in recent years including:

- \* clearing of areas of natural vegetation for roads, transmission line easements, an airport, meteorological and pumping stations,
- \* sandmining which has resulted in the clearing of natural vegetation and associated removal of resident fauna,
- \* increased incidence of fire causing changes in understorey plant species and adversely affecting fauna populations,
- \* introduction of exotic animals such as feral pigs and hares into the region,
- \* establishment of exotic plant species which typically colonize disturbed locations,
- \* shooting of wildlife which has recently been controlled to a degree by the Board by locking access gates and introducing ranger patrols.
- \* increased noise levels associated with air traffic at Williamtown Air Base.

The incidence of fire, the introduction and establishment of exotic animals and plants and the possible stress on plants owing to the nature of the sandbeds and moderate annual rainfall are identified as potential ecological constraints for future revegetation procedures.

### 3.2.6 Noise Levels

Sound level monitoring was conducted by Croft and Associates Pty. Ltd. at two sites within the proposed mining area in May, 1980.

Results from the monitoring tests indicated that the mean background sound level was 43 dB(A) during the day and 30 dB(A) at night. The main noise source contributing to these readings was traffic movement along Richardson and Medowie Roads. The heavy machinery operating in conjunction with the electrically powered mining plant is the main source of noise generated by the proposal.

The maximum night and day noise levels due to the mining operations are shown in Figure 9 in the environmental impact statement. An analysis of this figure indicates that mining operations will have the greatest impact at Campvale. The maximum noise level experienced during the day time will be 48 dB(A), and this is likely to occur for a duration of 6 months, while 37 dB(A) will be the maximum night-time noise level and will occur for a duration of two months.

Based on these calculations, daytime noise levels at Campvale will exceed the current ambient levels by some 5dB(A) for almost two years, and nighttime levels will exceed current ambient levels by 7dB(A) for a period of eight months.

The Company proposes a number of safeguards to minimise noise when the plant is in proximity to residents at Campvale as outlined in Section 4.5.

### 3.2.7 Archaeological Aspects

During the past decade of mining the Company has not found any archaeological evidence. Croft and Associates note that the Garuagal aboriginal tribe once inhabited the Sandbeds but evidence of their occupation is primarily limited to bark incisions in trees.

### 3.3 Regional Planning Issues

Since 1966, Port Stephens Shire has exhibited a population growth rate greater than any other local government area in the Lower Hunter. The local area encompassing Tomago, Williamtown, Campvale and Medowie districts showed a 50% increase in the population during 1971-76 compared to the overall shire increase of 18%. (Australian Bureau of Statistics). Approximately 2000 people live in the local area.

Port Stephens Shire has diversified and established rural base. The expansion of manufacturing and tertiary industries has broadened the economic base, away from a traditional reliance on rural activities whilst continued population growth and the attractiveness of Port Stephens for tourism and recreation has also significantly influenced this trend in the Shire. The need to widen the economic base of the Region as a whole, is based upon past experiences of economic instability which have been marked by fluctuations in economic activity and high average unemployment rates.

The main employment industries for the district surrounding the mining area include manufacturing, wholesale and retail trade, agriculture, construction and defence. Mining at present employs 1.5% of the workforce.

### 3.4. Mineral Sands Mining in the Hunter Region

#### Current Approvals and Proposed Operations

Current approvals relating to mineral sands mining in the Hunter Region include the existing Tomago operation and two proposed operations by Rutile and Zircon Mines (Newcastle) Limited between Tuncurry and Nabiac. Mineral Deposits Limited have recently undertaken operations within the Newcastle Bight Sandhills, Stockton and at Bridge Hill Ridge, Myall Lakes. The former of these operations which commenced in 1981 has now been abandoned.

The Bridge Hill Ridge operation lies within the Myall Lakes National Park and is one of the operations affected by government policy relating to mining in National Parks determined in 1977. This policy provided that no further approvals would be granted for mineral sands mining in the extended Myall Lakes National Park and further that existing operations with existing development consents would be permitted to continue mining to the extent of their approvals but no further. The Bridge Hill Ridge operation, affected by the latter decision, was completed in March 1983 and the rehabilitation is being monitored by the Department of Mineral Resources, the Department of Environment and Planning and the Bridge Hill Ridge Operation Inter-departmental Authority.

Proposed operations in the Hunter Region involve two development applications by Rutile and Zircon Mines (Newcastle) Limited. The proposed extension of mining within the Tomago sandbeds represents some 85% of the Company's future regional production. The Company also proposes to develop a further two groups of mining leases, the Wallis Lake and Wollomba Groups, within the Tuncurry-Nabiac area.

#### 4. ENVIRONMENTAL SAFEGUARDS

##### 4.1 Past and Present Environmental Investigations and Reports

Rutile and Zircon Mines (Newcastle) Limited, the Board and their respective consultants have periodically studied the procedures adopted in preparing the site for mining, the phases and techniques of post-mining rehabilitation and the treatment of waste water.

A four year trial mining operation conducted on the southern fringe of the beds provided the opportunity for monitoring and assessing the environmental impact under actual mining conditions.

Prior to, during and after mining, the soil structure and stratigraphic character was monitored by the Board. Permeability, pH, presence of dissolved salts, distribution of fine solids as well as the pollution from machinery and the operations in general were assessed. Trials were initiated with respect to vegetation rehabilitation procedures.

As a result of the trial, the Board formulated 'Special Conditions of Authority' under which the Company has been permitted to mine.

The Company undertakes monitoring of all mining operations within the sandbeds and examines premined and post mined areas for botanical and topographic characteristics. The Company maintains a laboratory with a staff of five chemists to facilitate monitoring of operations.

Every four weeks, a drilling rig is positioned immediately behind the dredging plant on the levelled tailings. A grid of 10 holes is drilled and undisturbed samples from the former pond bottom are extracted. These 6 to 10 m deep cores are examined for the presence of fine slimes, which are limited by the Board's specifications to 50mm total slime in 10 holes or an average of 5mm per hole. In any single hole the thickness of slime may not exceed 30 mm. A programme of regular inspection of the pond bottom by scuba divers and removal of any slime layers by suction pump has now been dispensed with.

Every six months the rehabilitation areas are inspected and a technical session on plant growth is held. The total mining operation is reviewed annually by the Company, the Board, both parties' consultants and the Department of Mineral Resources. These procedures are additional to the normal inspection and control procedures carried out by the latter Department.

##### 4.2 Site Restoration and Revegetation

Mining restoration and rehabilitation procedures undertaken by the Company are according to the requirements of the Board and its consultants. The overall revegetation programme including the types and density of flora selected for revegetation and

procedures to be adopted for revegetation will be determined periodically at reviews of progress attended by the Board, its consultant, Ercon Australia, the Company and the Department of Mineral Resources, having regard to the trial and routine planting previously undertaken. The overall programme and any changes thereto shall be approved by the Minister and the Board.

Restoration proposed involves the recountouring of tailings to premined profiles in topographical conditions similar to that existing originally and replacement of soil on access corridors. Every two weeks the Company proposes to prepare a sketch plan and list detailing areas stripped, mining plant location, recountoured tailings, irrigation plant and plant species and quantities planted out.

The Company has developed a nursery for the establishment of seedlings from seeds collected in the areas to be mined. Additionally, trial plots have been set up to determine the relative performance of selected species of seedlings under varying topographic conditions.

It is proposed to use cover crops and brush matting only when surface erosion is likely to occur. Seedlings will be planted out immediately after restoration subject to dry spells in proportions indicated by a species count prior to clearing. The present practice is to use no fertilizer. Irrigation will be used prior to and after planting with Board approval.

Troublesome flora will be controlled by the use of 'Roundup' subject to Board control or by removal by hand. Feral pigs are proposed to be trapped in corrals and removed from the catchment.

Post mining assessment will involve the preparation of contour maps comparable in detail to premining surveys, periodic surveys to assess and record species composition and frequency of occurrence of species, the placement of Permanent Marks (PM's) representing one month's mining advance established for future post mining revegetation assessment and specific reviews of revegetation progress at 6 metre intervals.

#### 4.3 Water Quality Controls

The Company has identified four aspects of importance in regard to water quality control. These include:

- \* The effect cutter-suction dredging has on the groundwater in the immediate vicinity of the operation.
- \* The quality of clarifier overflow returned to the dredge pond.
- \* The life expectancy of slime ponds.

- \* The quality and volume of overflow from slime ponds discharging into Dawsons Drain and Fullerton Cove.

### Dredging

During the initial trial programme of heavy mineral extraction undertaken outside the catchment area, it was found that a layer of slime, containing a relatively high concentration of organic detritus, tended to settle to the bottom of the dredge pond. The subsequent return of cleaned sand (tailings) from the floating or land-based concentrator resulted in the compaction and compression of this unconsolidated slime.

The possible consequences of this were a decrease in rates of infiltration in the areas affected and bacteriological and chemical reactions on the settled slime layer which could have produced ferrous iron causing periodic difficulties in the processing of the natural waters.

As discussed in Section 3.1 after the deposition of at least two weeks of tailings, 10 boreholes are drilled on a variable grid to ensure that the amount of residual process slimes on the former pond bottom do not exceed specifications. Should these specifications be exceeded at any time, the Company, if required, will re-mine the area concerned.

The monitoring of controls and safeguards relating to the mining operations will be undertaken by consultants engaged by the Board and the quality of the ground water will be monitored regularly to verify, on a continuous basis, the efficacy of the control measures adopted.

### Clarifier Overflow

The concentration of suspended matter in the overflow from the clarifier/thickener is controlled by the use of polyelectrolyte and low overflow rate. Slime removal has been and is presently sufficient so as to meet the requirements of the Board in accordance with the Conditions of Authority. Monitoring procedures are subject to constant review by the Board.

### Life Expectancy of Slime Ponds

There are four existing slime ponds occupying an area of 30 ha. The ponds have a capacity adequate to handle another five years of supply from the slime thickener.

Port Stephens Shire Council have approved the development of a further 12 ponds, each 3.3m deep and covering an area of 50 ha. The Company believes these ponds have a capacity for storage for the life of the extended operation. The construction of these ponds has been approved by the State Pollution Control Commission under section 19 of the Clean Waters Act and by the Department of Public Works as the area is a gazetted floodplain.

### Overflow from Slime Ponds

The Company holds a licence under the Clean Waters Act to discharge supernatant from slime settling ponds into Dawsons Drain.

As a condition of the licence the Company monitors the quality of effluent weekly and submits an annual report to the State Pollution Control Commission with its annual application for renewal. The licence permits the overflow of clear water containing less than 30mg/L of suspended solids. Results displayed in Appendix 9 of the environmental impact statement show that for the year ending July 1982 the concentration of suspended matter ranged from 2mg/L to 990mg/L with a geometric mean of 20.2mg/L.

It is estimated that a total volume of about 120ML/y would be discharged as clear overflow to Dawsons Drain. There have been few instances during the past 24 months when any discharges have occurred because of prevailing drought conditions in 1980 and reduction of water consumption by the Company.

#### 4.4 Air Quality Controls

The mining operations involve wet processing at all stages and generation of dust around the mining areas themselves should be minimal. Dust may be generated by haul trucks using unsealed roads during dry weather.

The Company will employ water carts for dust suppression purposes as required.

Under Section 24 of the Clean Air Act open burning is prohibited in Port Stephens Shire. The Company notes that no open burning will be undertaken without appropriate approval under the Act. Additionally the Company proposes to instal spark arrestors on heavy earthmoving equipment.

#### 4.5 Noise Controls

There will be some occasions when the mining operations will approach the residences at Campvale as shown in Figure 9 of the environmental impact statement.

The safeguards the Company proposes to be employed are as follows:

- \* Mining will not be carried out within 200 m of any principal residence without the owner's or occupier's written permission as specified in the Mining Act (1973).
- \* In these locations, the bulldozers and front-end loaders will be modified to achieve an overall reduction in exhaust and engine noise of 15 dB(A). This will be accomplished by the fitting of high performance mufflers, placing acoustic

panels around the engines and temporarily fitting cooling fans having specially shaped blades. (All of these actions severely reduce the performance of mobile equipment and increase running costs. The Company notes that it is for this reason that these modifications will be carried out only when operating within approximately 1 km of residences).

- \* Bulldozers and loaders will operate only during the hours of 7 a.m. to 3 p.m. except in emergencies.
- \* All equipment will be carefully and regularly maintained to ensure that noise levels are kept at a practicable minimum.

The Company recognises the need to obtain approval from the State Pollution Control Commission under Section 27 of the Noise Control Act. The operation would be deemed to be carried out on Scheduled Premises (as specified by Clause 4 of the Schedule).

The Company will, at that time, supply full engineering details of the equipment to be used and the noise abatement plant and procedures to be incorporated into the operation.

#### 4.6 Protection of Moffats Swamp

The Company proposes three main safeguards for the protection of Moffats Swamp. These include the restriction of all phases of the mining operation to an area outside the physical boundaries of the swamp, water quality controls to prevent effluent from the development entering the wetland and ensuring that no water from the swamp is used in the operation.

#### 4.7 Archaeological Aspects

Any aboriginal relics discovered during surveying or mining by the Company will be reported to the District Office of NPWS to allow for inspection before destruction occurs.

## 5. SUBMISSIONS

### 5.1 Public Authorities

#### 5.1.1 Crown lands Office

The Department raises no objection to the proposal subject to the fulfillment of assurances made in the environmental impact statement, a number of which are highlighted in the submission.

#### 5.1.2 Department of Defence/Department of Administrative Services

These two Departments are negotiating with the Company in respect to lands within proposed mining paths required by the Department of Defence.

This includes firstly an area within the safety template of Salt Ash Air Weapons Range to be mined over a two year period. The area is used for Air to Ground and Rocket and Bombing Practice. Included also is a RAAF proposed new explosives storage area to be located outside current boundaries and within ML 1155.

#### 5.1.3 Department of Main Roads

The Department raises no objection to the proposal.

It considers that consideration should be given to alternative modes of transport and the impact of mining operations on the road system. It also notes that access points to service orebodies east of Richardson Road intersection should be shown.

Proposed widening schemes for Richardson and Medowie Roads will require minor acquisition from the lease areas however the Department notes that neither schemes are likely to be completed prior to mining.

#### 5.1.4 Department of Mineral Resources

The Department considers the Company should provide additional information in three main areas including:

- \* an estimation of the likely loss to Local, State and Commonwealth revenues in the event of not mining the deposit;
- \* provision of a topographic plan which would show sufficient detail to indicate the "isolated high dunes rising to 27m a.s.l." with respect to mining paths and indicate directly the position of the orebodies in relation to major swamps;
- \* provision of data on rates and location of recharge and discharge in particular the role of Moffats Swamp in recharge of the aquifer.

The Department also considers that there is no evidence to support the conclusion that there are indurated sands and/or perched water tables. It considers that Figure 3 suggests the opposite, that the water table is at 8m A.H.D. and is probably intersecting the ground surface.

#### 5.1.5 Department of Public Works

The Department notes that the company has met the Department's requirements regarding the construction of slime ponds on flood prone land, the ponds being sited so that they will have no significant effect on flood flows or drainage.

The Department objects to the disposal of vegetation by burning noting the value of cleared vegetation in revegetation success, provision of habitat and the control of erosion, feral pigs, and unauthorized vehicles.

#### 5.1.6 Hunter District Water Board

The Board considers the major omission from the environmental impact statement is the effect that clearing of forest will have on evapotranspiration and water yield.

The Board has listed 10 conditions it considers should be included with any consent and these are listed in Appendix B.

#### 5.1.7 National Parks and Wildlife Service

The Service objects to any mining taking place in M.L.A. 1171 and M.L.A. 256 on the grounds that mining would detract from conservation values associated with Moffats Swamp Nature Reserve.

The Service further objects to the balance of the operation pending the undertaking of an archaeological survey.

It also objects to the siting and likely effluent quality of sludge settlement ponds, located adjacent to and discharging into the proposed Fullerton Cove Nature Reserve, pending a review of the short and long term implications of the disposal proposal.

In this latter regard the Service considers that the State Pollution Control Commission licence should prohibit any overflow which exceeds the pH, suspended solid concentration and temperature range which naturally occurs in the Cove.

Two plant species in the area have been identified as having botanical value. The Service notes the Baumea juncea is assessed by Specht (1974) to be "in need of constant monitoring" and the Drooping Red Gum, Eucalyptus parramattensis is not adequately reserved.

The Service recommends both deeper and double stripping of topsoil to ensure that the original surface soil and seeds are replaced above the bulk of the A horizon. It considers the practices now adopted in national parks be applied to this proposed operation. The Service supports the avoiding of burning of cleared wood debris so that such material can be respread over the rehabilitation surface to facilitate regeneration.

#### 5.1.8 Royal Botanic Gardens, Sydney

The major criticism of the statement is the intent to restore all of the affected areas to forest. The Gardens can see no reason why areas of heath and swamp cannot be regenerated as such.

The Gardens also recommend that neither fertilizer be used, nor the Western Australian wattle, Acacia cyanophylla. It notes that species, Callistemon macrophyllus and Banksia serrata are not compatible in swamp areas suggesting that B. robur or B. aspleniifolia would be more appropriate.

#### 5.1.9 Soil Conservation Service

The Service raises no objection to the proposal, noting that adequate measures have been made in the statement for effective rehabilitation of disturbed areas.

#### 5.1.10 State Pollution Control Commission

The Commission is satisfied that the emission of air pollutants or noise or the discharge of pollutants to waters will not be such as to warrant development consent being withheld on these grounds.

The proponent must make an application to the Commission for the necessary approvals under section 19 of the Clean Waters Act and section 27 of the Noise Control Act, and the Commission will make a final determination of control measures necessary when it is considering those applications.

**Air Quality:** The Commission does not support the proposed disposal of cleared vegetation by burning. The proposal will not however require an approval or license under the Clean Air Act.

**Water Quality:** Discharge from tailing ponds are already licenced under the Clean Waters Act. The Commission does not expect any problems in regard to the infiltration of contaminated surface or groundwater into the water supply aquifer.

**Noise:** The Commission considers that additional noise control measures are feasible and will be examining this matter in greater detail when considering the proponent's application for approval under section 27 of the Noise Control Act.

**Radioactivity:** The Commission considers that the proponent should have examined the possible increase in radioactivity in the vicinity of areas used for the disposal of tailings. The Commission does not expect that there will be any risk to public health provided disposal areas are not used for residential development.

#### 5.1.11 Water Resources Commission

The Commission has no objection to the proposal as long as the mining company maintains constant testing and monitoring to ensure the Hunter District Water Board's requirements are met.

#### 5.2 Private Submissions

##### 5.2.1 Mr & Mrs Bates and family, Newcastle, lot owner Medowie

Mr Bates on behalf of his family, objects to the proposal on the basis of the likely destruction of flora and fauna, the downgrading of the characteristics of the aquifer, the anticipated rise in noise levels in adjacent residential areas and the associated increase in heavy haulage vehicles on the roads. Mr Bates considers there is a need for additional noise monitoring sites in Campvale and Medowie if the development is approved.

#### 5.3 Port Stephens Shire Council

Port Stephens Shire Council seek the Department's concurrence so that consent to the development application can be granted subject to the following conditions:

- \* The application is to satisfy all conditions relative to extraction of mineral sands which may be imposed by the Mining lease and the Company's agreement with the Hunter District Water Board.
- \* The Company is to negotiate with Council relative to the use of Masonite Road and the necessary maintenance to that road which will occur as a result of the Company's operations. In this regard Council is prepared to accept a contribution of \$6,000 per annum.
- \* Where mining operations are carried out in areas affected by future road proposals, mine tailings shall be compacted to provide an even bearing to at least that existing prior to mining.
- \* Any proposal to create additional accesses to an existing road system will be subject to the concurrence of the authority having jurisdiction over that road system.

#### 5.4 Mineral Sands Mining Committee

The Committee resolved that the Mining Lease Applications should be allowed to proceed to grant and that a condition be included

in the leases requiring consultation with National Parks and Wildlife Service and the Department of Mineral Resources on mining proposals adjacent to Moffats Swamp when detailed plans of the operation are available.

## 6. ASSESSMENT OF ENVIRONMENTAL IMPACT

The expected impact of the proposal on the environment has been assessed by examining the environmental impact statement, by examining further information requested from the company, by inspecting the site and by reviewing both submissions received from various Government authorities and the public and the company's response to these submissions. Account is taken of the environmental safeguards proposed by the Company.

### 6.1 Topography

Whilst mining is in progress, the terrain along the mining path will be significantly disturbed but topography restoration safeguards proposed for the project and outlined in Section 4.2 will ensure satisfactory replacement of the surface features within three to four months after mining.

### 6.2 Hydrology and Water Quality

The sandbed is susceptible to sources of surface pollution due to the high infiltration rates of such a deposit. Stringent operational procedures adopted by the Company will ensure that no lubricants or effluents are permitted to come in contact with the highly porous sandbeds. The State Pollution Control Commission does not expect any problems in regard to infiltration of contaminated surface or groundwater in the aquifer.

The operations presently being undertaken and those proposed and described in the environmental impact statement cause disturbance of the soil layers and generate liquid effluents containing finely divided silt and clay particles.

The operations are not generators of water pollutants in the traditional sense. No chemical changes occur and no contaminants are produced that cannot be readily removed by conventional water treatment practices.

The clarified overflow from the water treatment plant which is pumped back to the dredge pond, contains, on average, 100mg/L of suspended solid, representing an overall treatment efficiency of approximately 97.5 percent.

By implementing the Board's requirements for the removal of any slime residues from the bottom of the dredge pond it is considered that any longterm deterioration in water quality will be prevented.

Croft and Associates note that large-scale water pumping tests undertaken by Herzog and Gerard 1973 and Hindley et al 1974, have indicated that the permeability of the mine tailings is significantly greater than that of the undisturbed ground. This impact is considered likely to improve groundwater recharge due to the greater permeability of the sands in the mined areas.

Earlier studies by the Board have indicated that evaporation and transpiration may account for 75% of the water loss from the sandbeds. Transpiration losses are considered to be the major contributing factor. Such studies indicate that the clearing of forest is also likely to improve groundwater recharge due to reduced rates of transpiration associated with rapid infiltration.

Mineral sands mining does disturb the consolidated nature of sandbeds and has a tendency to destroy stratification in underlying indurated sands which are advantageous in providing perched or elevated water tables. Thus, if the proposed mining operations were to be over the whole of the sandbeds, the disturbance and reduced consolidation of the sands may lead to a flattening of the water table throughout and a resultant decrease in the storage capacity. The Department of Mineral Resources however notes in its submission that there is no evidence to support the conclusion that there are indurated sands and/or perched water tables in the area. The Department considers that the nature of the water table contours when no pumping stations are in operation (Figure 2) suggests the opposite, that the water table at 8 m A.H.D. is probably intersecting the ground surface.

Whilst the zone of operations is small relative to the total area of the sandbeds and is located centrally within the catchment area, evidence to date indicates that mineral sands mining will have negligible detrimental effect on the water retaining characteristics of the sandbeds.

Mining of low-lying swampy areas is considered likely to cause disturbance to any impermeable layers at the base of such wetlands. The restoration of topography after mining may not replace the conditions required for the re-establishment of a swamp where such layers occur extensively. Opinion differs however amongst authorities regarding the extent of occurrence of impermeable layers of indurated sands and their influence over water retention in swampy areas. Evidence indicates that the water is not perched but lies generally some 1.5 to 5 metres below ground level, below which the permeable alluvial materials are saturated with significant quantities of water.

National Parks and Wildlife Service object to the siting and likely effluent quality of proposed sludge ponds located adjacent to and discharging into the proposed Fullerton Cove Nature Reserve. It considers that more stringent requirements as outlined in its submission in Section 5.1.7 should be defined under the licence presently held by the Company for the discharge of supernatant from the ponds into Dawsons Drain. This is a subject for discussion between NPWS and SPCC.

The construction of the ponds has received development consent from Council, approval by SPCC under section 18 of the Clean Waters Act and approval for development in a gazetted floodplain from the Department of Public Works. PWD notes that all its requirements have been met so that the ponds will have no significant effect on flood flows or drainage.

### 6.3 Air Quality

Dust deposition rates resulting from mining operations are considered unlikely to cause any significant impact on the sandbeds or surrounding environs. Dust emissions generated by vehicular movement on unsealed Board and Company roads will be controlled if and when necessary by road watering.

The State Pollution Control Commission, the Department of Public Works and the National Parks and Wildlife Service object to the disposal of vegetation by burning. The latter two authorities highlight its use for later revegetation and access control.

### 6.4 Noise levels and Impact on Local Residents

The results of studies carried out in order to assist in the prediction of impacts from noise are detailed in Appendix 13 and Figure 9 in the environmental impact statement.

Predicted noise levels due to the mining operations will exceed existing daytime ambient levels at Campvale for almost two years. Night time noise levels will exceed background levels for approximately eight months and will be more than 5 dB(A) in excess of ambient levels for a period of two months.

The introduction of special noise control safeguards as proposed by the Company will significantly reduce the potential impact on the 17 residences (housing approximately 70 people) likely to be affected in the Campvale area.

The State Pollution Control Commission will consider additional control measures when considering the application by the proponent for approval under Section 27 of the Noise Control Act.

#### PREDICTED NOISE LEVELS AT CAMPVALE DUE TO MINING OPERATIONS

Noise level dB(A)	Duration in Months	
	Daytime	Night Time
45 - 50	6	-
40 - 45	15	-
35 - 40	36	2
30 - 35	60	6
< 30	Remainder of time	Remainder of time

Haulage of mined material along Richardson Road will occur on one or two days per week, one truck leaving the site every 20 to 40 minutes. The balance of raw product will be transported via Board and mine access roads.

Local residents are likely to experience low levels of noise from

bulldozers working in conjunction with the mining plant when the operation is nearby.

## 6.5 Flora

### Tomago Sandbeds Environment :

Approximately 500 to 600 ha of forest, heath and wetland will be progressively cleared over a 15 to 20 year period at the rate of some 30 ha/year. This disturbed area represents 5.7 per cent of the 106 km<sup>2</sup> covered by the Tomago Sandbeds Water Supply Catchment Area.

Regeneration practices will mitigate the long term effects of mining although the re-established vegetation, especially in the heath and wetland areas, is unlikely to replace the previously existing climax communities at least in the short term.

The National Parks and Wildlife Service recommend both deeper and double stripping of topsoil, the adoption of practices now applied in national parks to facilitate revegetation and the avoidance of burning so that cleared wood debris can be respread over the rehabilitated surface to facilitate regeneration. Such methods have proved successful in trial plots at Bombah Point and are worthy of consideration by the Board and its consultants at future reviews of revegetation progress.

The incidence of fire, the introduction and establishment of exotic animals and plants and the possible stress on plants owing to the nature of the sandbeds and moderate annual rainfall are identified as potential constraints for future revegetation procedures.

Wetlands may not be rehabilitated to similar systems after mining if an impermeable peat layer plays a role in the retention of water in these communities. Small changes in the topography of an area may similarly modify the swamp type or even result in a dryland ecosystem. The Royal Botanic Gardens however, supporting the belief that there is no evidence to suggest the existence of any extensive areas of indurated sands and/or perched water tables, can see no reason why areas of heath and swamp cannot be regenerated as such. The Department of Mineral Resources also support this view. This is another area requiring future discussion by the Board and its consultants.

In respect to impact of mining on Moffats Swamp it is considered that water quality controls proposed by the company will ensure that no effluent will enter the wetland nor water in the swamp be used in the operation. The company's stated intention is to restrict all phases of the mining operation to an area outside the physical boundaries of the swamp. The existing residential development along the swamp's western boundary, the location of a sewerage treatment works within the swamp and changing landuse patterns overtime are the main factors likely to affect the quality of the swamp.

One of the conditions of mining within the sandbeds is that the company supply a detailed plan of its operations 12 months in advance of mining and this would seem the opportune time for relevant authorities, including N.P.W.S. and the Department of Mineral Resources, to assess plans for the operation adjacent to the swamp.

#### Possible Effects of Fluoride on Revegetation :

Information has been documented by Croft and Associates pertaining to the impact on surrounding flora of atmospheric fluorides that may result from existing emissions in the industrial areas of Newcastle and the construction of an aluminium smelter at Tomago.

It is not considered that the Company's revegetation programme is likely to be affected by such emissions, as the areas relevant to the proposal are at least 10 km away from the smelter site and the species proposed to be used are not considered to be unduly sensitive to fluoride.

#### 6.6 Fauna

The removal of the existing habitats will result in a loss in existing fauna populations as a result of the loss of shelter and nesting sites for a considerable period of time. Sedentary birds and small non-avian fauna will be most affected.

Arboreal species such as possums and gliders will be affected for a long period as such species require mature trees for nesting and shelter sites. Studies quoted by Croft and Associates, indicate that no individuals from the mined areas can be expected to survive by moving into adjacent habitat.

Some small ground species may be able to utilise regenerating areas relatively quickly as indicated by the capture of a New Holland Mouse (Pseudomys novaehollandiae) in PM 37. This species favours seral communities after fire and it is likely that such regenerating areas simulate the required habitat sufficiently for the animal to colonise. Fox and Fox (1978) considered that a minimum period of 20 years was necessary for the vegetation and the New Holland Mouse biomass to correspond with values for undisturbed areas of heath.

The overall impact is anticipated to be a 6 per cent decrease in the forest and wetland habitats within the Tomago Sandbeds ecosystem as areas are mined progressively over a 15 to 20 year period. There will be a corresponding decrease in the populations of some fauna species in the affected areas for a period of up to 40 years as a consequence of the loss of shelter and nesting sites.

#### 6.7 Visual Aspects

The landscape is characteristically flat to undulating and contains dense vegetation. These features will assist in

alleviating the visual impact of mining by providing an effective screen when viewed from main roads in the district. Residents who live along Richardson Road, near the intersection with Medowie Road may experience some visual impact. The Company proposes to minimize this impact by providing screen plantings of vegetation adjacent to the roadways.

The revegetation programme proposed by the company and screening of roadways should facilitate revegetation of the disturbed areas and lessen the visual impact.

#### 6.8 Socio-Economic Aspects

The proposed development encompassing two mining plants will serve to maintain the Company's existing employment levels and ensure that other socio-economic benefits continue to accrue to the region.

If a third mining plant is introduced an extra 23 employment positions will be created resulting in additional expenditure and income contribution to the regional economy.

Croft and Associates Pty. Ltd. have calculated that the proposal may create a further 59 indirect and 126 induced employment positions. Due to the location of the proposal and the manner in which operations expenditure and employee's income are spent, the majority of these additional positions are estimated to be located in the Lower Hunter.

Based upon existing employment characteristics, it is estimated that the 23 positions will comprise 12 skilled, 6 semi-skilled and 5 unskilled employees. It is expected that due to the relatively small number involved, together with the Company's policy of hiring and training unskilled personnel, the need for immigration of labour will be minimal.

The operation of a third mining unit will result in additional expenditure and income contributions to the regional economy. Wages and salaries paid to the 23 employees are estimated to total \$0.42 million.

The growth in operating expenditure is likely to result in an increase in the value of regional production output due to indirect and induced multiplier effects. Similarly the additional income paid to direct employees is predicted to create a further \$0.34 million in income throughout the region due to multiplier effects.

The Company considers the proposal has the potential to generate income worth between \$95 million and \$126 million in the region over 15 to 20 years. Based upon the Company's existing labour supply patterns, it is estimated that immigration of labour and hence, increased population, will be negligible.

#### 6.9 Consequences of Not Implementing the Proposal

Should the total proposal be refused the Company's long term future in the region will be placed in jeopardy. The local and regional economies will also be adversely affected. If the Company is forced to cease regional operations 188 employment positions together with indirect and induced employment levels will be lost when existing mining is completed in 1986.

Effect on Income in the Local and Regional Economy :

The Company has calculated that direct income payments that would be lost if the development did not proceed total \$3.37 million per year and further that indirect and induced income loss associated with the project totals \$2.95 million.

This figure includes the 79 positions at Tomago and an additional 109 elsewhere in the region, largely associated with the Company's Tomago processing plant.

Based on employment multipliers as discussed in Appendix 15 of the environmental impact statement, Croft and Associates has calculated that direct, indirect and induced impact employment in the Hunter Region should the Company's operations be closed could result in the loss of up to 374 jobs.

The regional industries that would be most affected by a displacement of employees embrace mining, wholesale and retail trade, transport, building and construction.

In terms of the occupations of those who could be rendered unemployed (based on the multiplier calculations as set out by Croft & Associates and including direct, indirect and induced effects) up to 98 mining jobs would be lost together with 68 jobs for skilled tradesmen. In addition, 43 clerical workers and 48 unskilled and semi-skilled production workers would also become redundant. These latter positions involve those occupations which comprise a large proportion of the existing pool of unemployed.

Effects on the Value of Industry Output and Export Earnings :

The Company has estimated that the proposed development has the potential to increase industrial output in the region over 15 to 20 years by between \$260 million and \$423 million (1981 prices).

Denial of this proposal would mean the loss of a valuable contribution to economic growth and continued productivity in the Hunter Region.

The Company presently exports \$10 million of heavy minerals per year through the Port of Newcastle. If approval is not given to continue mining in the Tomago Sandbeds these export earnings will be lost.

## 7. CONCLUSIONS AND RECOMMENDATIONS

### 7.1 General

In respect to the proposed development five main areas of concern have been identified. Of these, the necessity for the protection of the aquifer from discharge of pollutants and deterioration in water quality and storage capacity is of primary importance. The anticipated loss of vegetation and corresponding loss in fauna for a period of up to 40 years, the effectiveness of revegetation, the need for noise controls near Campvale and the socioeconomic implications of the project in regard to jobs, export earnings and contributions to regional economic growth are seen as the other main considerations.

A number of authorities have proposed some variations to the rehabilitation and revegetation methods now being employed. Such proposals are worthy of discussion with the Board, its consultant Ercon Australia, the Company and the Department of Mineral Resources' representative at future reviews of revegetation progress. Proposals principally relate to the retention of wood debris for respreading, double soil stripping, dispensing with the use of the W.A. Wattle, Acacia cyanophylla and the restoration of wetland habitats and species where appropriate.

The Department of Environment and Planning is satisfied that with the environmental safeguards proposed by the company, the implementation of conditions, monitoring and testing as proposed by the Board and its consultants and the overseeing or licencing of various aspects of the project by a number of authorities, that mining can be undertaken in an environmentally acceptable manner. It is considered that the impact of the proposal in relation to the main areas of concern highlighted will not be such as to warrant development consent being withheld.

### 7.2 Recommendations for Development Approval

Having regard to the conclusions of this report, pursuant to clause XII(2) of I.D.O. No. 23, Shire of Port Stephens the Director concurs with the development application lodged by Rutile and Zircon Mines (Newcastle) Ltd in respect of mineral sands mining subject to the following conditions:

1. The Company shall meet the requirements of all public authorities having statutory responsibilities in respect of the proposed operations.
2. The Company shall obtain from the State Pollution Control Commission all statutory approvals required under the Clean Waters and Noise Control Acts in regard to necessary pollution control measures.

3. The Company is to satisfy all conditions relative to extraction of mineral sands which may be imposed by the Mining lease and the Company's agreement with the Hunter District Water Board.
4. The Company shall meet the requirements of Port Stephens Shire Council in regard to road maintenance, preparation or addition.
5. The Company shall supply the Department of Environment and Planning, the National Parks and Wildlife Service and the Department of Mineral Resources with a detailed plan of its operation adjacent to Moffats Swamp for consideration 12 months in advance of mining.
6. The Company is to produce detailed vegetation maps and data for the proposed mining path in accordance with the S.P. Schedule model at such period prior to mining as determined by the Department of Environment and Planning and shall forward three copies of such plans to the Department of Environment and Planning.
7. The Company to provide the Department of Environment and Planning with a report by the 31st December each year and at the completion of mining indicating:
  - (1) a plan of areas mined;
  - (2) a plan of the original contours with an overlay showing post mining contours of areas rehabilitated;
  - (3) a description of revegetation work carried out including details of species planted;
  - (4) vegetation transects undertaken in accordance with specifications as provided by the Board in conjunction with the Department of Mineral Resources of areas revegetated.

REFERENCES

1. Morley, I.W. 1981. Black Sands - A History of the Mineral Sands Mining Industry in Eastern Australia. University of Queensland Press, St. Lucia, Queensland.
2. Australia's Mineral Sand Industry Mineral Sands Producers Association Limited (MSPA) Booklet.
3. Environmental Impact Statement for extension of Existing Mineral Sands Mining Operations in the Tomago Sandbeds Water Supply Catchment Area. 1982. Croft and Associates Pty. Ltd. for Rutile and Zircon Mines (Newcastle) Limited.
4. Tomago Mineral Sands Mining Revegetation Assessment. July 1981. The Hunter District Water Board, Ercon Australia, R.Z.Mines (Newcastle) Pty. Ltd.

APPENDIX A

Request by the Department and Response from the Applicant to matters Raised in the Submissions.

Mr. Doug Kelley,  
Property Officer,  
Rutile and Zircon Mines (Newcastle) Limited,  
Private Bag 32,  
Newcastle Mail Exchange 2301

Dear Sir,

Environmental Impact Statement - Proposed Mineral Sands Mining  
Within Tomago Sandbeds Water Supply Catchment Area.

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In respect to the abovementioned proposal all submissions received from public authorities and the public have been forwarded to the Company for your information and response. To assist the Department's review of the project, the Company is invited to comment on the various items of concern raised in the submissions.

Yours faithfully,

Barbara Stockton  
Environmental Studies  
and Coastal Branch.

SUBMISSION TO PORT STEPHENS SHIRE COUNCIL AND DEPARTMENT OF ENVIRONMENT AND PLANNING RE COMMENTS RECEIVED FROM GOVERNMENT DEPARTMENTS AND INSTRUMENTALITIES, LOCAL GOVERNMENT AND INDIVIDUALS, ON ENVIRONMENTAL IMPACT STATEMENT ON PROPOSED MINING IN TOMAGO SANDBEDS CATCHMENT AREA DURING PERIOD OF PUBLIC DISPLAY

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(1) MR. H. & MRS. B. BATES, 10 KING STREET, HILLSBOROUGH - 31ST MAY 1982

Mr. & Mrs. Bates own a vacant block of land at Lot 42, Boyd Parade, Medowie, which is distant some 800 metres from the proposed mining operations. Their concern for the proposal is noted, but it is considered that all matters raised in their submission have been adequately dealt with in the Document. As in any commercial undertaking, particularly mining, it is not unreasonable for the proponent to expect a return on his capital investment.

(2) HUNTER DISTRICT WATER BOARD - LETTER DATED 9TH JUNE 1982

The following comments are offered:-

First and second paragraphs - accepted.

Third paragraph - A surprising comment considering the Company's successful association with the Board over the last fifteen years. The Board has engaged independent Consultants to monitor all aspects of the Company's mining operations (soil characteristics, water yield and quality, and revegetation programme) since the commencement of mining, all of which have been at the Company's expense.

(a) The proposal to mine 5.7% of the gazetted catchment area as portrayed in the E.I.S. Document covers only those orebodies which are viable under the restrictions and conditions imposed by the Board.

(b) This statement does not pay cognisance to the existing programme. A full pre-mining and geological study was undertaken by the Board's Consultants, Soil Mechanics Ltd. of London (Ercon Australia).

The Board is provided with pre-mining cross-sections each year as part of the annual mining submissions.

All exploration drillings are logged as to stratification and ground conditions, including date and water table data.

Sieve analyses of water quality spearpoint boreholes, both pre and post-mining, are provided. The number of whole profile analyses done so far and supplied to the Board total 80 since commenced in 1977. Details provided to the Board for each borehole include:

- (i) size distribution;
- (ii) depth drilled;
- (iii) soil pH;
- (iv) percentage organic matter;
- (v) percentage iron (acid soluble).

Notwithstanding the above information provided at 80 of the water quality spear sites, details of all prospecting drillings within the Catchment Area are supplied to the Board as a precondition of the Prospecting Licence. These are presented as geological cross-sections and/or borehole soil logs.

(c) If the water requirement of 0.6 ML/day is understated then the Board should supply the correct figure, as the Company disputes the Board's statement. No allowance has been made for the evapotranspiration loss as a result of removal of vegetation. The water requirements are variable - according to varying ground conditions the Company has applied consistent pumping up to 1.5 ML/day. At the time of the study the then current rate was 0.6 ML/day.

(d) No studies of hydrology have been undertaken by the Company as it is considered not its role to do so. However, data has been supplied to the Board and its Consultants, Ercon Australia, from which conclusions can be drawn.

(e) The nexus between rainfall, and recharge potential with respect to rainfall, is not within the scope of this study.

(f) The Company does consider relocation of fauna, particularly koalas (*Phascolarctos cinereus*) as trees containing these species are not immediately felled. It has been found that after clearing around the tree the animals have usually vacated for other areas within 24 hours. The technique of dozing a tree down slowly when containing a stubborn animal reduces ground impact allowing it to leave and relocate unharmed.

(g) The area cleared for mining is necessarily wider than each mining run. Soil is stacked outside the mining path to allow for the provision of service areas for pipes, topsoil, access, etc., and in most cases subsequent mining runs return along the previously cleared margins. Mining lease conditions stipulate that topsoil must be so stacked during the mining process and returned to the surface after tailings have been levelled.

In the Section referred to, Section 5.1.1 Site Preparation, deals with details and effectiveness of safeguards and is a summation only - refer to page 22 et. seq. Section 3.5.2 Site Preparation, which adequately explains the process.

As part of the revegetation programme the Company compiles records of all trees planted, both as to number and species, and these are presented fortnightly to the Board with location indicated on sketch maps. Revegetation Memorandum produced by the Board's Consultants is complied with, and has been constantly reviewed and updated as required.

The Company's revegetation programme is outlined in detail in 'Tomago Mineral Sands Mining Revegetation Assessment' - Ercon Australia and R.Z. Mines (Newcastle) Pty. Ltd. of July 1981, referred to in the References on page 175 of the E.I.S. Document.

(h) There will be no mining undertaken in Moffats Swamp and it is not part of this proposal. Therefore it cannot have any effect on the role of Moffats Swamp in the recharge of the Tomago aquifer.

(i) After fifteen years continuous mining in the Tomago Sandbeds monitored by the Board's Consultants, one could assume that had there been any adverse effect by mining on the aquifer, it would have been apparent prior to this Study being undertaken.

(j) The programme outlined in the proposal is not inconsistent with previous and current mining operations. Refer 1.3 MINING OPERATION Page 1, and 3.3 AREAS TO BE MINED, Page 18 et. sec. It is necessary that all inter-dependent sections of the Document be read in conjunction.

The effect of evapotranspiration on water yield is not a major omission in the proposal study as it was considered in Section 4.5.2 Groundwater at page 48 et. seq. 'Groundwater Losses' - reference McGrath (1967) estimating that 86% rainfall was lost to transpiration. Removal of the forest canopy in the mining area must mean a saving in water lost by evapotranspiration, the nett effect being an improvement in the water yield.

Pages 3 & 4 - Nos. 1 to 10 -

The Company is in agreement generally with the Board's recommendations on conditions to be attached to mining with the exception of the following:

2. Provision for investigation work on the effects of mining on the aquifer are adequately covered by conditions Nos. 163 (a) and (b) and 164 of the Special Conditions of Authority approved by the Board, outlined in APPENDIX 5 on Pages 113 and 114 of the E.I.S. Document.

One would expect that after 15 years of mining in the Tomago Sandbeds Catchment Area the results of such investigations would be self evident to the Board and any effect of the Company's mining operations would now be apparent as the result of continuous monitoring.

The amount of ground cleared over a long period by the Board for pumping bores, roads and services in the Tomago Sandbeds would be far greater than the total area to be disturbed by the Company's mining operations. The impact of the Company's mining proposals would be minimal in relation to the impact of the Board's operations in water harvesting in the Sandbeds.

4. The impact of the Company's operations in this regard is not really the function of the Board. It is more properly controlled by Port Stephens Shire Council, Department of Mineral Resources and Department of Environment and Planning.

(3) SOIL CONSERVATION SERVICE - LETTER DATED 4TH JUNE 1982

Accepted without comment.

(4) CROWN LANDS OFFICE - LETTER DATED 7TH JUNE 1982

(1) Refer to Section 3.5.6 - Site Restoration - Page 30.

(2) Refer to Section 3.5.7 - Revegetation - Page 31 et. sec.

(3) Environmental controls (vegetation, screening, noise control, restoration etc.) applicable to the third mining plant when introduced will be the same as for the two existing mining plants. However, water quality controls will be in accordance with the requirements of Hunter District Water Board.

(4) Access across unmined areas is dealt with under Site Preparation in Sections 3.5.2 and 5.1.1.

(5) Refer to Section 6.11 - VISUAL ASPECTS - on page 95.

Also refer to reply to comments of Public Works Department under '(3) Visual'.

(5) DEPARTMENT OF MAIN ROADS - LETTER DATED 8TH JUNE 1982

The Department's comments have been noted and it is considered that numbers 1 to 3 are already covered in the Document. Two items only require comment as follows:-

- 4 - No new accesses will be made to main roads in the mining proposals. Only existing accesses will be used.
- 5 - All mine tailings will be hydraulically stowed.

(6) ROYAL BOTANIC GARDENS SYDNEY - LETTER AND ANNEXURE OF 8TH JUNE 1982

The Company collects seeds from native species within the area of proposed mining prior to clearing and during seasons when seeds are most readily available. Only local native species are used for propagation at its Nursery at Tomago and subsequent planting of the seedlings after mining is part of the revegetation programme.

Page 91 Section 6.6.1 Tomago Sandbeds Environment - The present revegetation procedures approved by the Board and its Consultants require that the Company's revegetation programme is aimed at returning the majority of the mined area to forest.

The remainder of the comments are accepted.

(7) DEPARTMENT OF MINERAL RESOURCES - LETTER AND ANNEXURES DATED 25TH JUNE 1982

Items 1.0 to 5.0 - no comment.

5.1 - Visual Aspects

The Company considers that Figures 11, 12 and 13 comply in this regard as interpretation of mining path, vegetation, etc. can readily be made in relation to public roads.

5.2 Loss of Revenue

Tables contained in Section 6.12.2 - Consequences of Not Implementing the Proposal - page 97 et. sec. broadly cover losses of income to the region. More detailed flow is not considered necessary to highlight the impact.

5.3 Topographic Data

The Company is not able to define a detailed mining path within the orebodies shown in Figure 1, owing to lack of development work up to the present time. However, the Company has provided the Water Board with an on-going five-yearly development programme and contour surveys as outlined in Section 3.5.1 showing close details of proposed mining in the orebodies delineated in Figure 1 which will only be provided on an on-going annual basis. The Company does not supply topographic data in respect of the areas within its proposed mining paths, but as from the commencement of its mining operations in the Tomago Sandbeds availed itself of such information as is provided by plans supplied by Hunter District Water Board compiled from aerial photography by Adastra Airways in April 1970 at scale 1:4000, referred to elsewhere in submission of Department of Public Works - (1) Contour Surveys.

The position of the orebodies in relation to the major swamps shown in Figure 3 can be readily identified in Figures 10 to 13 of the Document shown at a larger scale.

#### 5.4 Hydro-geological Aspects

After such comments it is pointed out that the Department is unable to spell the word 'aquifer' correctly on at least four occasions in this Section.

##### 5.4.2 Swamps

As Hunter District Water Board has undertaken studies over many years and collated data therefrom, these have been accepted as the basis upon which the specifications for the control of mining were set.

##### 5.4.3 Groundwater Quality

Same comments as 5.4.2.

6.0 - Accepted.

7.0 - Impact Assessment for this proposal is only for the extraction of heavy minerals. Any potential deposits of glass sands which exist within the mining path will not be suitable for use in the making of high quality colourless glass after processing in the mining operation for extraction of the heavy minerals.

8.0 - Definition as supplied by Croft & Associates of "maintain rehabilitation of vegetation until the flora has reached a self sustaining state" -

"By 'self sustaining state' is meant a vegetation community which is compatible in species type with the adjacent climax vegetation undisturbed by mining, is reasonably advanced and can successfully reproduce. With the passage of time beyond this point it is expected that a series of vegetational changes will naturally occur until such time as the rehabilitated areas are in dynamic equilibrium with the environment (that is a climax vegetation community has evolved)."

9.0 - The use of nested quadrats for pre-mining vegetation assessment has recently been abandoned in favour of a continuous transect 6 metres wide surveyed along the centre of the mining path for both pre and post-mining vegetation assessment.

#### (8) NATIONAL PARKS & WILDLIFE SERVICE - LETTERS DATED 7TH AND 23RD JUNE 1982 AND ATTACHMENTS

Comments are offered on relevant parts of the detailed submission as follows:

1. The proposed operations will not encroach on Moffats Swamp or interfere with the environment of the Swamp as stated in the Document. Mining will not destroy the geological reference and will not interfere with the groundwater level. Refer to Pages 3 and 4 of Department of Mineral Resources' comments on 5.4.2 Swamps. The Company is not harvesting water from the ground and therefore its proposed mining operations cannot have a long term effect on the water table.

The area of Moffats Swamp proclaimed as a Nature Reserve covers the western part only and does not extend beyond the boundary of Tomago Sandbeds Catchment Area, leaving more than 60 hectares of the Swamp outside of the Nature Reserve. This area was formerly comprised in Special (Private Lands) Lease Application No. 1150 East Maitland by this Company, lodged on 13th December 1972, and at the time of proclamation of the Nature Reserve on

24th June 1977, the area within the Company's Mining Lease Application was excluded as the Company's mining priority was recognised. However, in the interests of conservation, and to preserve Moffats Swamp in its entirety, the Company reassessed its situation and relinquished its interest in the area by withdrawing the application, gazettal of which took place on 13th March 1981.

## 2. Fullerton Cove - Kooragang Island - Proposed Nature Reserve.

The areas of freehold lands owned by the Company bordering on Fullerton Cove are located outside of the Nature Reserve. No indication has yet been given to the Company that the proposals affect any part of privately owned lands bordering on Fullerton Cove. The Company's original proposals to construct settlement ponds were approved in 1972 by the following relevant Authorities:- Port Stephens Shire Council; Department of Public Works; Department of Lands; State Fisheries Branch of Chief Secretary's Department; National Parks & Wildlife Service. Photocopy of the relevant consent from the Service dated 13th September, 1972; is enclosed.

Fullerton Cove, as part of the Hunter River Estuary, has also been included by the Australian Heritage Commission for inclusion in the Register of the National Estate, and confirmation of such is evidenced in a letter from the Director of the Commission to the Company dated 11th March, 1980, with photocopy of plan attached.

The extension of the area for construction of more settlement ponds was completed in 1980 when consents of all relevant Authorities, including Port Stephens Shire Council, Department of Public Works, State Pollution Control Commission, Longbight & Williamstown Drainage Union, etc. were obtained. National Parks & Wildlife Service, whilst not involved directly as evidenced above, was advised, and copy of a letter to the Company from the Service dated 26th May 1981 is attached, with attention drawn to paragraph 2 and subsequent paragraphs. To date the Service has not made any attempt to follow up its interests in the Company's proposals or proclamation of the Reserve. It would appear that in this area there is an overlapping interest by both Commonwealth and State Authorities.

The Company's discharge of effluent water from the settlement ponds into the Drainage Union drains has always been covered by conditions set on the standard of the discharge in Licences issued by State Pollution Control Commission. The discharge from the settlement ponds is directly into a drainage system which ultimately flows into Fullerton Cove.

The pH reading of the discharge is the same as the natural groundwater abstracted from Tomago Sandbeds during the mining operation, whereas the pH of the groundwater in the Drainage Union system is lower than that being discharged from the ponds. Before the discharged water reaches Fullerton Cove its temperature would equate that of the water in the drainage system.

## 3. Archaeological Survey

In 14 years of mining within the Tomago Sandbeds area the Company has not encountered any evidence of Aboriginal sites or relics. If the Service knows of any such sites or can produce evidence that Aboriginal relics exist within the area of the Company's proposals, then the Company would be most willing to undertake a study of such sites in any part of the area proposed to be disturbed by its mining operations.

The above comments are based solely upon the recommendations contained on Page 6 of the submission by the Service.

(9) WATER RESOURCES COMMISSION - LETTER DATED 2ND JULY 1982

The Commission's comments are noted and accepted by the Company.

(10) DEPARTMENT OF ADMINISTRATIVE SERVICES - LETTER DATED 9TH JULY 1982

All aspects of the Company's mining proposals were discussed at a conference in Sydney on 5th August, 1982, with representatives of Department of Administrative Services, Department of Defence and RAAF. Continuing discussions with RAAF Command at Williamtown will be undertaken as the Company's mining proposals become finite in areas adjacent to the RAAF Base and Runway at Williamtown. Action will be taken to withdraw the Company's mining lease applications within the boundaries of the danger zone proclaimed for the Air Gunnery and Rocket Firing Range at Salt Ash.

(11) STATE POLLUTION CONTROL COMMISSION - LETTER DATED 9TH JULY 1982

Air Quality

On 4th August, 1978, in NSW Government Gazette No. 91 at Folio 3251, the Minister for Environment & Planning, pursuant to Section 24 of the Clean Air Act 1961, prohibited burning by open fire on the recommendation of the State Pollution Control Commission, except for certain purposes and within designated Shires. Burning off operations on mining leases are in compliance with lease conditions under the Mining Act 1973, and copies of correspondence of September 1978 between the Mineral Sands Producers Association and Department of Mineral Resources are attached.

Burning off is the only acceptable method of disposal of timber within the Tomago Sandbeds Catchment Area.

Water Quality - Noted.

Radioactivity

After removal of the heavy minerals containing monazite from mined areas, the overall background radioactivity levels should be less than pre-mining. Radioactive tailings which require monitoring are associated with secondary processing of the minerals outside of the area comprised in this proposal, at the Company's processing mill situated on its freehold lands at Pacific Highway Tomago.

Noise

Comments noted. The Company will make application for approval under Section 27 of the Noise Control Act at the appropriate time.

Impacts on Flora and Fauna

In respect of swamps, refer to submission of Department of Mineral Resources herein of 25th June 1982, at Page 3 under 5.4.2. Swamps.

Mining restoration and rehabilitation procedures are according to the requirements of the Board and its Consultants. Therefore the proponent is not in a position to vary any of those procedures of its own volition.

12. DEPARTMENT OF PUBLIC WORKS - LETTER DATED 27TH JULY 1982

1. Contour Surveys

The original plans presented by Hunter District Water Board to the Company for its mining proposals to be plotted thereon were prepared from aerial photographs of the Tomago Sandbeds undertaken by Adastra Airways in 1970 for the Board. These plans were on a scale of 1 to 4000 (5.05 chains to an inch) with contour intervals of 1.5 metres (5 feet) with spot levels where no contours could be shown. The Company's pre-mining cross sections supplied to the Board are to 0.1 metre with spot levels in areas where the plans do not show relief. Post-mining plans submitted to the Board show contour information to 0.1 metre.

2. Vegetation

Only heavy timber removed from the mining path is stacked and burnt. Light vegetation is stripped, stacked adjacent to the mining path and respread with the topsoil - refer 3.5.2 - Site Preparation - Topsoil Removal on page 23.

3. Visual

The nature of the orebody is such that a perimeter band of screening vegetation will always be maintained adjacent to the mining path, except where the orebody crosses major roads as shown in Figures 10 to 13.

The visual impact will only be of a temporary nature, as in the long term the revegetation programme will mitigate the short term impact - refer Section 6.11 - VISUAL ASPECTS - page 95.

GENERAL COMMENT

It is evident to the Company from submissions made by Government Departments and Instrumentalities that they all tend to get involved in aspects of environmental protection outside of the scope of their individual function.

APPENDIX B

Proposed Hunter District Water Board Conditions:

1. The Applicant shall not carry out its mining operations within 30 metres of any plant, equipment or installation of the Board or in such a manner as to cause disturbance or damage to such plant, equipment or installation unless prior agreement has been reached between the Applicant and the Board. Any temporary or permanent relocation and re-establishment of that plant, equipment or installation shall be at the Applicant's expense.
2. The Applicant shall, at its own expense, undertake investigations into both short term and long term effects of clearing and revegetation of the mining areas on the water balance of the Tomago aquifer system. The investigations shall examine evaporation and evapotranspiration effects under varying degrees of ground cover. The Applicant shall reach agreement with the Board concerning the extent and scope of these investigations.
3. The Applicant shall maintain islands of natural vegetation throughout the mining operation so as to preserve specific sections of the environment and encourage natural regrowth in the area. The islands shall be selected in conjunction with the requirements of the Board.
4. The Applicant shall not conduct mining operations within 100 metres of a public road. In addition, the Applicant shall undertake preplanting of trees and shrubs in the remaining buffer zone to reduce the visual and noise impact, of future operations, on the public.
5. The Applicant shall at all times abide by the conditions of mining as laid down in the mining lease. Particular attention shall be paid to those clauses as written or as later negotiated with the Board regarding the prevention of pollution or depletion of the aquifer, revegetation, etc.
6. The Applicant shall, prior to commencement of mining operations, enter into an agreement with the Board concerning extraction of water from the Tomago Sandbeds.
7. The Applicant shall establish and operate at its own expense, monitoring systems, as may be required by the Board, at and adjacent to mining operations, to evaluate the effects of such operations on water yield, water quality, vegetation, flora and fauna in the area.

8. The Applicant shall reach agreement with the Board regarding engagement of independent consultants to supervise, on the Board's behalf, the mining operations and their effects on the Tomago Sandbeds. The Applicant shall bear all costs associated with the continued engagement of such consultants.
9. The Applicant shall immediately inform the Board of any action or occurrence on the site which may affect the Board's water supply. Further, the Applicant shall, in order to remedy any defect arising out of the action or occurrence, comply forthwith with the requirements of the Board.
10. The Applicant shall in the event of any deleterious affect to the Board's water supply, which affect can be attributed to the mining oprations, re-examine its operations and shall make such adjustments as may be required by the Board. Further the Applicant shall bear any costs incurred by the Board to remedy the defect in the water supply.

APPENDIX C

Schedule of Special Conditions of Authority Pertaining to Mining Lease 594 (1973 Act) (Numbers 135 to 188 only).

DEFINITIONS:

In these Conditions (as hereinafter defined) the following words shall have the meanings hereby assigned to them except where the context otherwise requires.

- (a) The Board shall mean the Hunter District Water Board.
  - (b) The Registered Holder shall mean the Mining Company granted this authority within the Board's gazetted Catchment Area, and "subject area" has a corresponding meaning.
  - (c) Conditions means the Conditions of Authority to be applied in Protection of the Board's interests regarding mineral extraction from the Tomago Sandbeds.
  - (d) A dredging plant shall consist of one (1) cutter suction dredge with associated concentrating units.
135. The registered holder shall abide by the provisions of the Catchment Area By-Laws applying to the Catchment Area of the Tomago Sandbeds Water supply works and shall conduct operations in such a manner as not to cause any detrimental effect to the aquifer or the Board's assets. As there may be a time interval before some of these effects are recognised and assessed, the mining of the subject area shall be considered as a trial and for this reason the rate of mining shall be limited to the maximum rate of progress hereinafter stipulated.
136. The registered holder shall give one month's notice in writing to the Board of its intention to enter upon the Board's gazetted Tomago Sandbeds Catchment area for mining operations to permit supervision by the Board's officers to be arranged.
137. The registered holder shall formally notify the Board of its exit from the subject area upon the completion of mining operations in the subject area.
138. All the registered holder's operations within the Tomago Sandbeds area shall be subject to approval of the Board and will be carried out under the supervision of the Minister and of officers of the Board.
139. Compliance with the terms of these conditions shall be entirely at the expense of the registered holder.

140. The registered holder shall comply expeditiously with instructions issued by the Board within the terms of these Conditions and in the event of failure so to comply, the registered holder shall cease all mining operations in the Catchment Area within twenty-four hours of receipt of written instructions to that effect from the Board and mining shall not recommence until these instructions are rescinded by the Board.
141. The registered holder shall comply with any instructions which may be given by the Board for the purposes of preventing the pollution of the Tomago Sandbeds and/or the water supply derived therefrom, and, failing such compliance the Board may order the additional measures to be carried out by others at the expense of the registered holder and may order suspension of all mining operations until such work is completed.
142. The Board reserves the right to withdraw approval to mine in areas for which this authority has been granted should the Board consider it necessary in order to safeguard its interests.
143. (a) Operations on the subject area shall be conducted in such a manner as not to cause any damage to or interference with the Board's installations and/or operations.  
(b) During the course of mining operations the registered holder may apply to the Board for permission to re-site any road, powerline, pipeline or other asset of the Board located on the subject area and shall comply with such Conditions as may be imposed by the Board if any such permission is granted.
144. The registered holder shall compensate the Board for any damage which may be caused to the installations or property of the Board.
145. Whenever possible the registered holder shall restrict his access through the Board's land to formed roads. Alternative or additional access by the registered holder shall be subject to the prior approval of the Board.
146. The registered holder shall indemnify the Board against any claims whatsoever arising out of mining operations on the Board's land.
147. (a) The registered holder shall lodge with the Board security in a form acceptable to the Board in the sum of twenty-five thousand dollars (\$25,000) per mining plant conditioned upon compliance by the Registered Holder with the terms and conditions of this Authority generally and in particular with the requirements of all those conditions thereof

which may in the opinion of the Board require for the evaluation of their satisfactory performance the lapse of a period of time extending beyond the time for which this Authority may remain in force. In the event of such terms and conditions not being fulfilled in their entirety or if upon cancellation or other determination of this Authority the Board is of the opinion that the requirements of any of the conditions requiring the lapse of time as aforesaid have not been fully complied with then notwithstanding any release or acquittance given by the Minister in respect of any of the terms and conditions aforesaid the Board may demand and receive payment of the sum secured by the security.

- (b) i. Subject to subparagraph (ii) of this paragraph the Board may at any time or times after the expiration of two years from the commencement of this Authority review the amount of security required in accordance with paragraph (a) of this condition and increase or decrease the amount to be secured.
- ii. Not more than one variation in the amount of security required shall be made under sub-paragraph (i) of this paragraph during any period of two years.

- 148. Unless otherwise approved by the Minister and the Board, mining operations on the subject area shall be confined to dredging and associated processes.
- 149. Unless otherwise approved in writing by the Minister and the Board, not more than two dredging plants shall be used within the subject area. No dredging plant or major part thereof shall be brought on to the subject area without the approval of the Minister and the Board first had and obtained.
- 150. Stockpiles of mine concentrate shall be sited at localities previously agreed to by the Board.
- 151. (a) Mining shall be restricted in depth from the surface down to such depth below the surface as may be approved from time to time by the Minister and the Board.
- (b) The registered holder shall submit to the Minister and the Board at yearly intervals proposals defining the extent of mining desired both in respect to area and to depth during the following year. The proposals shall include plans and sections showing surface levels and depths of mining; depths of mining should be related to the datum nominated by the Minister and the Board.
- (c) Furthermore the above proposals shall include plans of the proposed future mining advances within the subject area, with the anticipated mining advance locations shown at 12 monthly intervals.

The advances should be such that mining of the subject area

will be undertaken at a maximum rate of 30 hectares per annum.

152. (a) The registered holder shall ensure that any water added or returned to the pond with the exception of any suspended solids shall be of no lesser quality than that of the local ground water as determined to the satisfaction of the Minister and the Board. Suspended solids in any water added or returned to the pond shall not exceed the limit to be set from time to time by the Minister and the Board.
- (b) The Minister and the Board may direct that the dredging operations shall be so conducted as to maintain such a positive hydrostatic head of the additional water above mean sea level as is from time to time required to prevent pollution of the water supply.
153. Mining operations shall be carried out in such a manner that no soil fines (defined as material passing B.S. No. 100 Sieve) and no potential pollutant solids, including iron and organic matter, hereafter denoted together as process slime or slime, are permitted to accumulate in the bottom of the dredge pond. This requirement will be considered to have been complied with:
- (a) If not more than 50 mm total in situ thickness of process slimes is encountered in 10 investigation boreholes and not more than 30 mm in any one of the 10 boreholes through the former pond bottom within one month of the deposition of tailings; the 10 boreholes are to be put down on a defined pattern subject to the position of two of the boreholes being movable to other defined positions when instructed by the Minister and the Board. The areas investigated are to be contiguous and will represent, on average, two weeks deposition of tailings or such longer period as may be determined by the Minister and the Board. In the event of this requirement not being complied with the Board will require initially further investigation holes to be put down to delineate the slime area.
- (b) While mining is proceeding, as a guide to the effectiveness of the measures taken, samples of the pond bottom shall be taken with samplers, approved by the Minister and the Board, prior to backfilling with tailings and the Minister and the Board shall have the right to suspend mining operations if the results, in the opinion of the Minister and the Board, indicate that 19 (a) above will not be complied with.
154. The registered holder shall conduct tests of the dredge pond water as required by the Minister and the Board shall so conduct operations that there is no increase above that existing naturally in the local ground water prior to mining operations in the saline, iron or other deleterious content of the water caused by the mining

process or by the addition of any oils or greases or other substances which may be used either directly or indirectly in the mining process. Suspended solids in the pond water shall not exceed the limit set from time to time by the Minister and the Board. Furthermore no deleterious material including organic matter will be permitted to float on the surface of the pond.

155. All sanitary arrangements for the persons employed in mining operations on the subject area (demised) shall be such as may be approved and directed by the Board. At no time shall the mining pond be used for disposal of sewerage wastes.
156. All solid or liquid discharge onto open ground within the Tomago Catchment Area or any area which may effect the Board's existing or potential water supply and any discharge back into the pond from any water treatment plant forming a part of the mining process shall conform to the standards of Clauses 152, 153 and 154 of these Conditions.
157. The supply of water for the mining operations shall be by arrangement with and to the approval of the Board.
158. The dredge pond shall not be connected to the sea or to the areas of highly saline groundwater. Special measures may be required by the Minister and the Board should the dredge be located at any stage near the sea or a highly saline area. The registered holder shall comply with all measures deemed necessary by the Minister and the Board to prevent the intrusion of salt water into the Tomago aquifer.
159. The process slime removed in the mining processes shall be disposed of outside the Tomago Catchment Area in a location which will not affect the Board's existing or potential water supply. If such material is temporarily stored within the Catchment Area after extraction, then the storage area shall be completely isolated from the aquifer and regularly cleared to the satisfaction of the Minister and the Board.
160. (a) Unless required otherwise for such purposes as roads, pipelines, firebreaks, the registered holder shall ensure that the area affected by the mining operations shall be revegetated with the flora indigenous to the area, or such other types as may be decided by the Minister and the Board.  
  
The overall revegetation programme including the types and density of flora selected for revegetation and the procedures to be adopted for revegetation will be determined periodically at reviews of progress, having regard to the trial and routine planting undertaken. The overall programme and any changes thereto shall be approved by the Minister and the Board.

- (b) The registered holder shall be responsible for introducing and implementing in the mined and other affected areas a management programme approved by the Minister and the Board designed to control soil erosion and to ensure progressive rehabilitation to a stable vegetation cover. The registered holder's responsibility shall remain until such time as the Minister and the Board are satisfied that the revegetation is adequately and fully established.
  - (c) Mining paths shall be planned by the registered holder to preserve the existing vegetation wherever economically feasible, especially in areas where the existing vegetation includes trees and shrubs over 4 metres high. Preservation areas of undisturbed vegetation known as "islands of vegetation" shall be left such that no mined area is greater than 150 metres from islands of vegetation which are not less than 0.15 hectares in area and not less than 15 metres in average width: the dimensions noted may be varied from time to time by the Minister and the Board. Alternatively, islands of vegetation may be obtained artificially by planting advanced seedlings of trees and shrubs and obtaining accelerated growth of all species in the multilayered forest system in protected and, where necessary, irrigated areas, all subject to the agreement of the Minister and the Board first had and obtained. All the above applies particularly to non swamp areas.
161. Any fertilisers to be used in assisting regrowth of pasture or vegetation on the area demised shall be of a kind approved by the Minister and the Board and shall not contain any substance in quantity likely to be deleterious to the water supply.
162. (a) Unless otherwise directed by the Minister and the Board the registered holder shall remove the surface material to a depth of 300 millimetres on such part of the subject area as may be disturbed by mining operations and shall stack such surface material separately on the subject area.
- (b) After extraction of mineral sands by the dredge mining process, the dredge pond shall be backfilled with the sand previously excavated from the pond, any surface material previously removed shall be replaced and the ground surface levelled to a form similar to that existing before mining or to such other form as may be decided by the Board.
- (c) The registered holder shall restore all worked areas concurrently with mining operations and shall observe any instructions which may be given by the Minister and the Board in connection with the restoration of the subject area.
- (d) The registered holder shall as far as may be practicable so conduct operations as not to cause any damage to shrubs and trees or other native flora growing upon the subject area and shall stack and burn all shrubs and trees or other native

flora which may be disturbed or destroyed as a result of the operations hereby consented to provided that before doing so the registered holder shall obtain from the responsible authority permission to light fires. The registered holder shall take all precautions necessary to prevent the spread of fire from such burning operation. In the event of a fire occurring other than from such burning operations within the areas designated for burning in the cleared areas in advance of the mining path, the registered holder shall take the measures necessary to control the fire and shall keep the Minister and the Board informed of the situation and shall be subject to the instructions of the Minister and the Board. The registered holder shall co-operate with the Minister and the Board both in preventing, and where fires occur, controlling the fires.

163. (a) Before mining is commenced in any part of the subject area the registered holder shall, if required by the Minister and the Board, provide for the carrying out of an initial site investigation to the satisfaction of the Minister and the Board and obtain clearance in writing from the Minister and the Board for mining all land selected to be mined. Such investigation may include the putting down of boreholes and the taking of samples to provide soil and water data for the Minister and Board as further described under subclause (b) below.
- (b) Within the overall site investigation programme, either before, during or after mining, the Board may require boreholes to be put down within and outside the subject area to provide soil and water data for the control and assessment of the effects of the mining operation. The boreholes are to be put down in such positions and at such times as the Minister and the Board may determine. The boreholes may be used, inter alia, for in-situ testing such as for permeability tests, for taking soil samples and for the installation of water sampling points. Physical and/or chemical testing of soil samples will be required. Chemical testing of water samples will be required. Periodic accurate readings of groundwater levels will be required. The investigation programme will not necessarily be limited to the sampling of boreholes and associated work and testing but may include such investigatory work as undertaking continuous soundings of the soil profile.
- (c) The registered holder shall make provision for the taking and testing of samples as instructed by the Minister and the Board for a period starting at the date of this authority and continuing up to three years after completion of mining operations or such further period as may be determined by the Minister and the Board should the results indicate a situation of concern to the Minister and the Board.
- (d) All the above investigation, sampling and testing work shall be at the expense of the registered holder.

- (e) The Board shall be entitled to arrange for independent monitoring checks to be undertaken, either by the Board or others, as and when it considers fit and the registered holder shall co-operate to the extent required by the Board in such checks. The registered holder shall not necessarily be liable for the costs incurred for the work undertaken under this subclause.
164. The registered holder shall conduct tests of the groundwater existing after mining, in such positions as may be determined by the Board, and will so conduct operations that the groundwater in and around the ground mined is not caused to become of a lesser quality after mining than the groundwater in the area before mining.
165. Notwithstanding the above the registered holder shall be responsible for any deterioration in the quality of water drawn by the Board caused by any effect of the mining operations, irrespective of whether such effect is recognised or unrecognised at present.
166. At any time in the event that the Minister or the Board decides that as a result of the mining there is a deterioration in the quality of water drawn from the aquifer, or there is a danger that this will occur, the registered holder shall cease all mining operations within twentyfour hours in the Catchment Area upon receipt of a written instruction to this effect from the Minister and the Board. The instruction to cease operations shall be followed as soon as possible by a statement of the problem from the Minister and the Board in order that the registered holder may take such steps as are necessary to investigate the problem and to determine means acceptable to the Minister and the Board to counteract it before mining shall be allowed to continue.
167. The registered holder shall send to the Minister and the Board regularly and promptly written records and reports regarding all matters affecting the aquifer and the Board's assets, including in particular:
- (a) Results of all routine tests and investigations called for by the Conditions. The requirements contained in the conditions may be varied or amended by the Board during the currency of the term of this authority if deemed necessary by the Board.
  - (b) Any event that represents a detrimental effect.
  - (c) Any information of which the registered holder becomes aware that suggests there may be a possible detrimental effect.

Furthermore, the registered holder shall keep the Minister and the Board fully informed of all investigations and research work undertaken under the direction of the registered holder with regard to all matters affecting the aquifer and shall supply the Minister and the Board with results and reports, as applicable, on

completion of the various stages of the work. To avoid duplication of work the Board intends to inform the registered holder of work being undertaken or planned to be undertaken by the Board of a similar nature relevant to the mining operations.

168. If, in the opinion of the Minister and the Board, the quantity of silica being removed from the subject area as a consequence of mining operations is likely to impair the restoration of the subject area or cause damage to or interference with adjoining mining leases or other lands the Minister and the Board may direct by writing under his or its hand from time to time as the circumstances so require the registered holder to reduce the quantity of silica being so removed. The registered holder shall comply forthwith with any direction so given and in the event of non-compliance this authority may be cancelled.
169. The registered holder shall treat by means of spiral concentrators or other approved method of concentration on or adjacent to the subject area all material mined so as to produce a concentrate containing not less than sixty-five per centum of heavy minerals and all tailings from such operations shall be returned continuously as far as may be practicable to the excavations made on the subject area.
170. In the event of operations by the registered holder on the subject area causing damage to any lands which have been rehabilitated after the mining the registered holder shall repair such damage at the registered holder's own expense to the satisfaction of the Minister and the Board.
171. The registered holder shall confine the deposition of overburden removed during dredging and/or other mining operations within the boundaries of the subject area.
172. Upon the expiry or sooner determination of this authority or any renewal thereof, the registered holder shall remove all machinery and buildings and the subject area shall be left in a clean and tidy condition to the satisfaction of the Minister and the Board.
173. If so directed by the Minister and the Board, the registered holder shall fill in any dredge pond or other excavation on the subject area and shall observe any instruction which may be given from time to time in this regard by the Minister and the Board.
174. If so directed by the Minister and the Board, the registered holder shall provide and maintain a secure fence to the satisfaction of the Minister and the Board around each dredge pond or other excavation opened up or used by the registered holder and shall observe any instructions which may be given from time to time in this regard by the Minister and the Board.

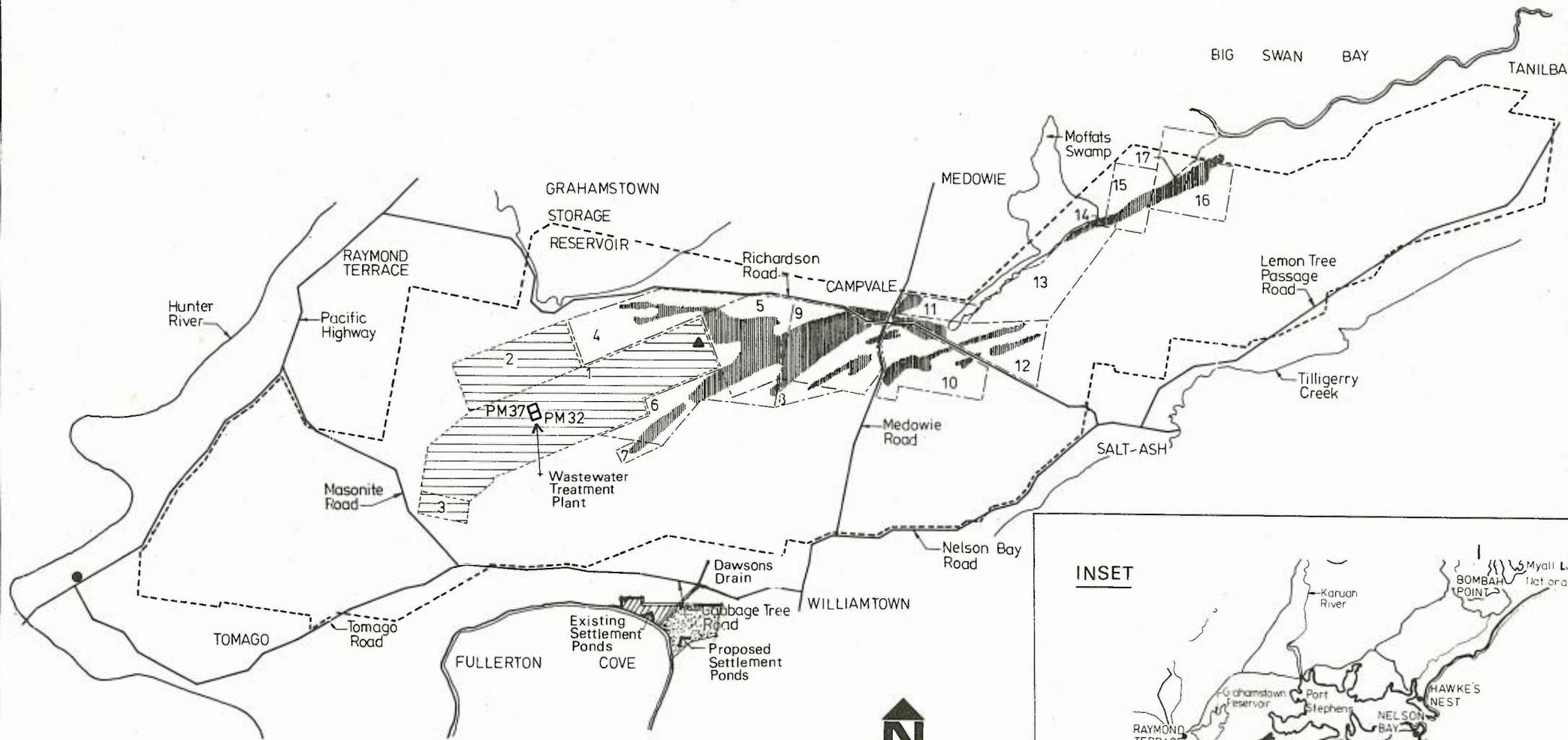
175. If so directed by the Minister and the Board, the registered holder shall spread fertiliser of such type and in such quantity as may be directed over the restored area to assist the growth of such grasses, plants, shrubs and/or trees as may have been planted in accordance with any of the foregoing special conditions.
176. If so directed by the Minister and the Board, the registered holder shall enclose the subject area with a secure stock-proof fence and such fencing shall be erected and maintained in a manner satisfactory to the Minister and the Board.
177. The registered holder shall observe any instructions which may be given by the Minister and the Board with a view to minimising or preventing public inconvenience or damage to public or private property.
178. In the event of any improvements on the subject area being damaged or disturbed by dredging and/or other mining operations by the registered holder such improvements shall be restored to the satisfaction of the owner of such improvements or the Minister and the Board.
179. (a) The registered holder shall conduct operations in such a manner as not to cause any danger to fauna or stock on the subject area, except where measures are required to control fauna deemed to be objectionable by law or by the Minister or the Board (e.g. Feral pigs and hares), where control measures are required they shall be to the approval of the Minister and the Board and the registered holder shall observe and perform any instructions given or which may be given by the Minister and the Board with a view to minimising or preventing damage to such area or the restoration thereof by the said objectionable fauna.  
(b) Unless with the approval of the Minister and the Board, the registered holder shall not keep nor permit to be kept any dog on the subject area.
180. The registered holder shall not cut, destroy, ringbark or remove any timber or other vegetative cover on the said land except such as directly obstructs or prevents the carrying on of the operations hereby authorised.
181. The registered holder shall not interfere in any way with any fences on or adjacent to the subject area unless with the consent of the owner or the Minister and the Board first had and obtained.
182. The registered holder shall conduct operations in such a manner as not to create any danger from floods or storms and shall observe and perform any instructions given or which may be given by the Minister and the Board with a view to minimising or preventing any flood or storm damage.

183. If it is found that the operations hereby authorised are causing any undue damage to or erosion of the subject land or other land in the vicinity thereof the Governor with the advice of the Executive Council may cancel this authority or any renewal thereof without compensation to the registered holder upon giving one month's notice of his intention so to do.
184. (a) The registered holder shall within twelve months of the date of this authority or any renewal thereof, erect a separation plant upon the subject land or other land to the satisfaction of the Minister and the Board or furnish to the Minister and the Board satisfactory evidence that the registered holder has made suitable arrangements for the treatment of concentrates.
- (b) The registered holder shall not permit excessive quantities of silica sand tailings to accumulate around or adjacent to a separation plant and all such tailings shall be returned continuously as far as may be practicable to the excavations made on the subject area or on such other land as may be directed by the Minister and the Board.
185. (a) In the event of operations being conducted other than by means of dredging the registered holder shall mine the area in sections of such dimensions as the Minister and the Board may stipulate from time to time.
- (b) Upon completion of mining operations in each section all residues and tailings shall be returned to the excavation made and all worked ground shall be levelled off and any surface material previously removed shall be replaced and planted with such grasses, plants, shrubs and/or trees as may be required by the Minister and the Board provided that the mining of the next section may be carried out conjointly with the restoration of the last worked section but no further section shall be mined until such restoration is completed.
186. The registered holder shall during restoration of the subject area or any part thereof, remove all domestic animals from such area as may trespass thereon and shall take all such action as is necessary to prevent them from depasturing thereon and shall observe and perform any instructions given or which may be given by the Minister and the Board with a view to minimising or preventing damage to such area or the restoration thereof by the depasturing of any animal thereon.
187. (a) Within a period of three months of the commencement of dredging and/or other mining operations on the subject area the registered holder shall establish a nursery for the propagation of a sufficient number and variety of plants, shrubs and trees which in the opinion of the Minister and the Board is adequate for the purpose of satisfactorily rehabilitating the subject area in the secondary and tertiary stages.

(b) Provided that in the event of -

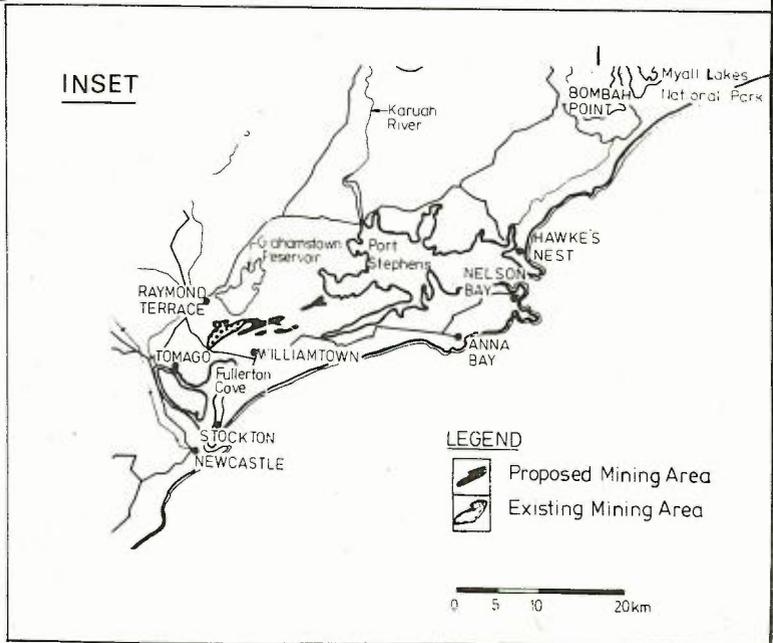
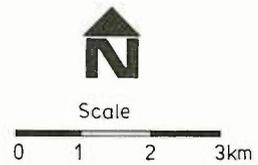
- (i) an adequate nursery having been established by the registered holder in the vicinity of the subject area; or
- (ii) satisfactory evidence being furnished that the registered holder has made suitable arrangements for adequate quantities of plants, shrubs and trees to be provided and maintained, the Minister and the Board may dispense with the requirements of the foregoing clause (a).

188. The registered holder shall as far as may be practicable so conduct operations as not to interfere in any way with the public use and enjoyment of Water Reserve 51277 for water supply.



- LEGEND**
- Catchment Boundary
  - ▲ Duckhole Trig Station
  - MLA Boundaries
  - ▨ Mining Leases Currently being Mined
  - ▩ Mineralised Ore Bodies included in this Proposal
  - Tomago Dry Mill

- 1 ML 594 (Act 1973)
- 2 ML 785 (Act 1973)
- 3 ML 744 (Act 1973)
- 4 MLA 1163 (Act 1906)
- 5 MLA 1168 (Act 1906)
- 6 MLA 1166 (Act 1906)
- 7 MLA 1173 (Act 1906)
- 8 MLA 1155 (Act 1906)
- 9 MLA 263 (Act 1906)
- 10 MLA 1170 (Act 1906)
- 11 MLA 1175 (Act 1906)
- 12 MLA 1169 (Act 1906)
- 13 MLA 1171 (Act 1906)
- 14 MLA 256 (Act 1906)
- 15 MLA 35 (Act 1973)
- 16 MLA 34 (Act 1973)
- 17 MLA 1151 (Act 1906)



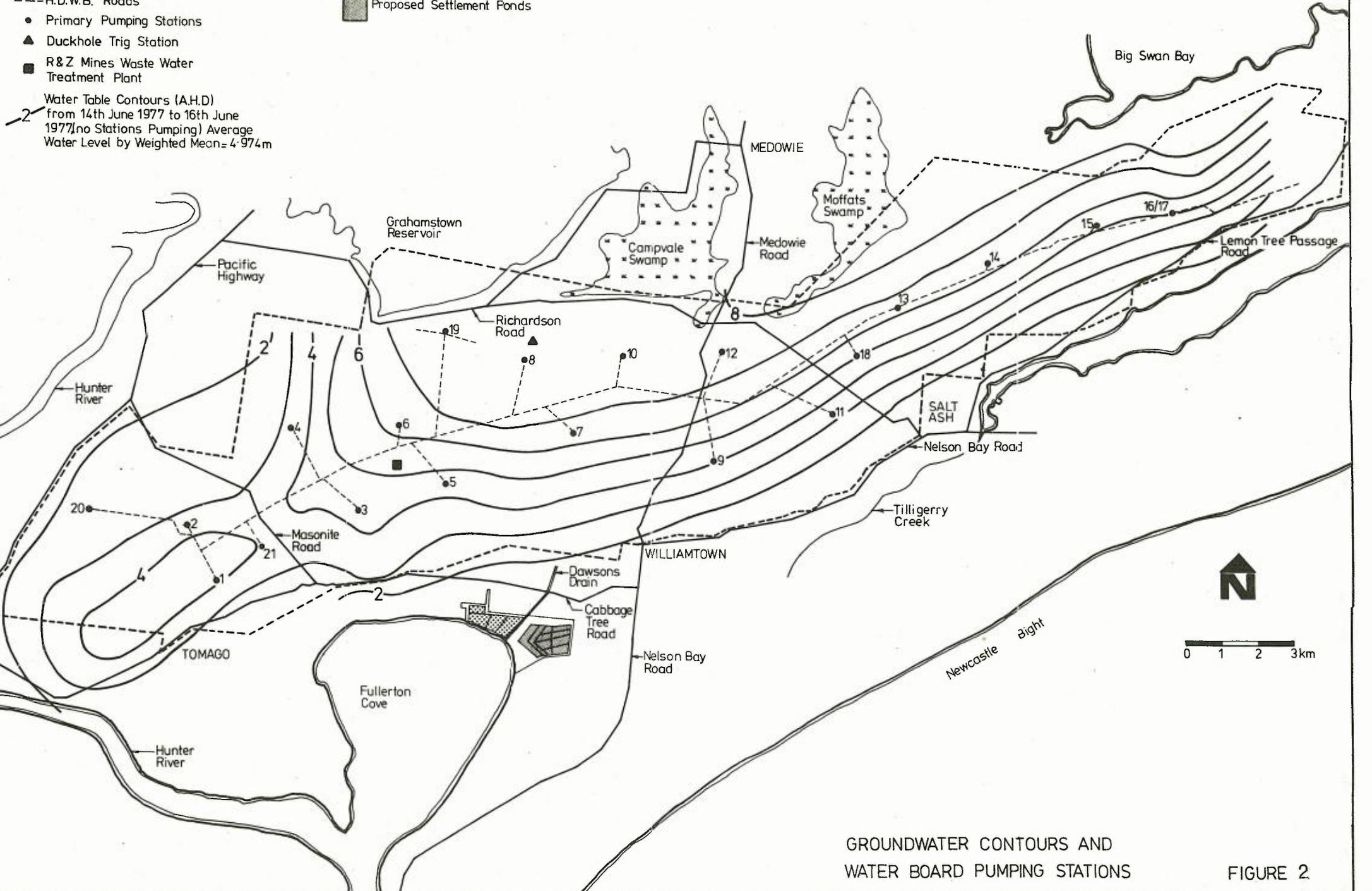
LOCATION OF MINING LEASE APPLICATIONS HELD BY THE COMPANY

FIGURE 1

**LEGEND**

- - - Catchment Boundary
- - - H.D.W.B. Roads
- Primary Pumping Stations
- ▲ Duckhole Trig Station
- R&Z Mines Waste Water Treatment Plant
- Existing Settlement Ponds
- Proposed Settlement Ponds

Water Table Contours (A.H.D.)  
 from 14th June 1977 to 16th June  
 1977 (no Stations Pumping) Average  
 Water Level by Weighted Mean = 4.974m



GROUNDWATER CONTOURS AND  
 WATER BOARD PUMPING STATIONS

FIGURE 2



EIS 737

NEW SOUTH WALES - DEPARTMENT OF EIS  
737

Proposed mineral sands mining Tomago  
sandbeds water supply catchment area