The Parliament of the
Commonwealth of Australia

FRASER ISLAND ENVIRONMENTAL INQUIRY

Final Report of the Commission of Inquiry

Parliamentary Paper
No. 333/1976

ISBN 0 642 02089 2

Printed by Advocate Press Pty Ltd, Melbourne, Australia

Established under the
Environment Protection (Impact of Proposals) Act 1974

FRASER ISLAND ENVIRONMENTAL INQUIRY

Dr. JOHN HOOKEY, Presiding Commissioner
ARTHUR HICKS, Commissioner
Secretary: ~~MARK MOLLOY~~ A. S. Luther

Address: **P.O. Box 1937, CANBERRA CITY, A.C.T. 2601**
Telephone **487322** Telex **62506**
Brisbane Address: **Level 19, LEIGHTON BUILDING, 294 ADELAIDE STREET, 4000**
Telephone **250122** **P.O. BOX 418, Brisbane, Q. 4001**

Dear Minister,

We have the honour to submit herewith our Final Report on the environmental aspects of the making of decisions by the Commonwealth Government in relation to the export of minerals extracted from Fraser Island.

Yours faithfully,

(A. B. Hicks)
Commissioner

(John Hookey)
Presiding Commissioner

The Honourable K. E. Newman, M.P.,
Minister of State for Environment, Housing
and Community Development,
Parliament House,
CANBERRA. A.C.T. 2600

ACKNOWLEDGEMENTS

The Commissioners wish to record their gratitude for the invaluable assistance given to them throughout the Inquiry and the preparation of this Report by their Advisers, Secretaries, Stenographers, Typists, Editorial and other Staff. The Advisers in particular worked long hours over a considerable period with dedication and perseverence. They were Dr G. J. R. Linge, Mr C. R. Loorham, Associate Professor G. D. McColl, and Dr P. R. Stevens. Their expertise was invaluable.

The Commissioners trust that it will not be thought invidious if, in addition to their thanks to each and every person who, for a time, was a member of their staff, particular thanks are given to Mrs Peggy Easton, who typed the manuscript of this Report, as well as the Commission's First Report, and assisted the Commissioners throughout the Inquiry.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

PREFACE

This is the Final Report of the Commission appointed on 12 July 1975, in pursuance of Section 11 of the *Environment Protection (Impact of Proposals) Act*, 1974-1975, to conduct an inquiry (known as The Fraser Island Environmental Inquiry)

> in respect of all of the environmental aspects of the making of decisions by or on behalf of the Australian [Commonwealth] Government in relation to the exportation from Australia of minerals (including minerals that have been subjected to processing or treatment) extracted or which may hereafter be extracted from Fraser Island in the State of Queensland.

Four Advisers to the Commission were also appointed, under Sub-section 11.(2) of the Act. They were Dr G. J. R. Linge, Mr C. R. Loorham, Associate Professor G. D. McColl and Dr P. R. Stevens.

The Act states that an Inquiry may be conducted in respect of the environmental aspects of a matter whether or not an Environmental Impact Statement dealing with the subject of the Inquiry has been prepared (Sub-Section 11.(1)). In this case, there was no Environmental Impact Statement in existence which was made available to the Commission. One of the functions of Environmental Impact Statements is to provide information relating to the nature and details of relevant projects and proposals. They can thus facilitate the informed participation of witnesses and reduce the time otherwise spent in gradually acquiring evidence of the details of such projects and proposals. The absence of such an Environmental Impact Statement has also made it necessary for the Commission, in this Report, to provide a deal of factual information which would normally be expected to be found in an Environmental Impact Statement.

On appointment, the Commission advertised the subject matter of the Inquiry, and the time and place at which it was to begin, in the *Australian Government Gazette* and in the press. So great was the interest in the subject matter of the Inquiry, and so extensive and complex was the evidence, that it was necessary to conduct public hearings on thirty-one days between 5 August and 3 October 1975. This was so even though almost every witness who appeared personally before the Commission tendered a written statement which, after verification, was admitted as evidence under the provisions of Sub-section 14.(3) of the *Environment Protection (Impact of Proposals) Act*, without being read into the transcript. In all, the oral evidence occupies 3496 pages of transcript. Furthermore, there were 658 exhibits before the Commission. Many of these exhibits were verified written statements admitted in evidence to

which exhibit numbers were attached in order to avoid the confusion inherent in having more than one system of numbering relating to the documentary and other material before the Commission. In most cases the references to exhibit numbers in the text are to statements verified on oath or affirmation. All the evidence in the Inquiry was given in public.

The Commission and its Advisers also viewed a number of places and activities, including sandmining operations and the rehabilitation of sandmined areas on Fraser Island, North Stradbroke Island, Inskip Point, Rainbow Beach, and the Cooloola area, with the permission and helpful co-operation of the various lessees of the mining sites concerned. Like the exhibits, these views form part of the evidence (*Environment Protection (Impact of Proposals) Act*, Sub-section 14.(6); Tito v. Waddell (Ch. D.) [1975] 1 *Weekly Law Reports* 1303 at pp.1307-1308).

The First Report of the Commission was submitted to the then Minister of State for Environment on 1 December 1975; the Findings and Recommendations of that Report form Appendices III and IV.

Unless otherwise indicated, the facts set out in this Report relate to the position as at 3 October 1975, the day on which the Commission completed its hearings in Brisbane.

CHAPTER 1

INTRODUCTION

1.1 The Report

In order to place the environmental aspects of the making of Commonwealth decisions on the export of minerals extracted from Fraser Island in their appropriate context, the first part of this Report, consisting of Chapters 2 - 4, as well as the balance of this chapter, describes the environment of the Island. Chapter 4 assesses its environmental significance and deals with the evidence relating to Fraser Island as part of the National Estate. The second part of the Report, comprising Chapters 5 - 9, describes sandmining and its effects on the natural and human environment of the Island and on the human environment elsewhere. The discussion of the effect of sandmining on the human environment includes separate chapters on its effects on the national and regional economy. This consideration of the human environment and the environmental aspects of decisions affecting it is necessary because of the wide definition of 'environment' in the *Environment Protection (Impact of Proposals) Act*, 1974-1975 (Section 3), which

> includes all aspects of the surroundings of man, whether affecting him as an individual or in his social groupings, and 'environmental' has a corresponding meaning

The Commission considers that it should interpret the word 'environmental' where it appears in the Direction establishing the Inquiry, in accordance with the definition contained in the Act, particularly since the purpose of the Inquiry is to achieve the object of the Act (Sub-section 11.(1), Ministerial Direction of 12 July 1975).

Chapter 10, the final chapter, explores the interaction between the environmental aspects of the making of Commonwealth decisions on the export of minerals extracted from the Island and the environmental effects of sandmining conducted on it. The phrase 'environmental aspects' appears both in the Direction authorizing the Inquiry and in the sub-section of the Act conferring the power to direct the holding of inquiries (Sub-section 11.(1)). There is no suggestion in the Act or in the Direction establishing the Inquiry that the word 'aspects' is used in any unusual technical sense. The relevant ordinary meanings of this word as defined in the *Shorter Oxford Dictionary* are 'the action of looking at; contemplation;...mental looking'. It would seem then, that the environmental aspects of the making of decisions

relating to the export of minerals extracted from Fraser Island are those environmental matters of significance which should be considered and looked at during the course of making decisions; in essence, the environmental implications of alternative decisions.

The Recommendations of the Commission follow its Findings. The word 'Recommendations' is not defined in the Act and has been interpreted in its ordinary sense of advising a course of action: in this context, a course of action concerning the taking into account of matters affecting the environment to a significant extent in the making of decisions relating to the export of minerals extracted from Fraser Island. The dual objects of fully examining and taking into account matters affecting the environment to a significant extent are quantified in Sub-section 5.(1) of the Act by the words 'to the greatest extent that is practicable'. In other words, the Commission, in reporting its Recommendations, must recommend what is the greatest extent that it is practicable to take into account matters affecting the environment to a significant extent in the making of decisions on the export of minerals extracted from Fraser Island. 'Practicable' remains undefined in the Act, and has been interpreted by the Commission in its ordinary meaning of something capable of being effected or accomplished. It is important to distinguish the words 'practicable' and 'practical', the latter meaning 'being adapted to actual conditions', and the former meaning 'something capable of being effected or accomplished', that is, something possible (cf. Fowler, 2nd. Ed., p.469).

1.2 Brief description of Fraser Island

Fraser Island, off the east coast of Queensland, is approximately 122 km in length, ranges from 5 to 25 km in width, and covers an area above mean high-water mark of about 163,000 ha. The highest elevation is 235 m. It is aligned NNE-SSW and lies between latitudes 24° 40' S and 25° 50' S, and longitudes 152° 55' E and 153° 20' E. At the nearest points it is twenty-six kilometres due east of the urban centre of Maryborough (19,900 population in 1971) and eighty kilometres east of Bundaberg. The west coast is separated from the mainland by the shallow shoals of Great Sandy Strait and the southern tip of the Island is two kilometres from the mainland at Inskip Point (Fig. 1.1).

Most of the Island consists of State Forest Reserve (118,000 ha) and National Park (34,000 ha). The remainder includes vacant Crown land, township reserves, a lighthouse reserve, and some freehold (Table 3.1). A number of Mining Leases have been granted, for the most part within the State Forest Reserve or on vacant Crown land. There is a tourist resort at Orchid Beach, two small settlements at Eurong and Happy Valley, residential facilities for forestry and lighthouse personnel, and a number of huts at

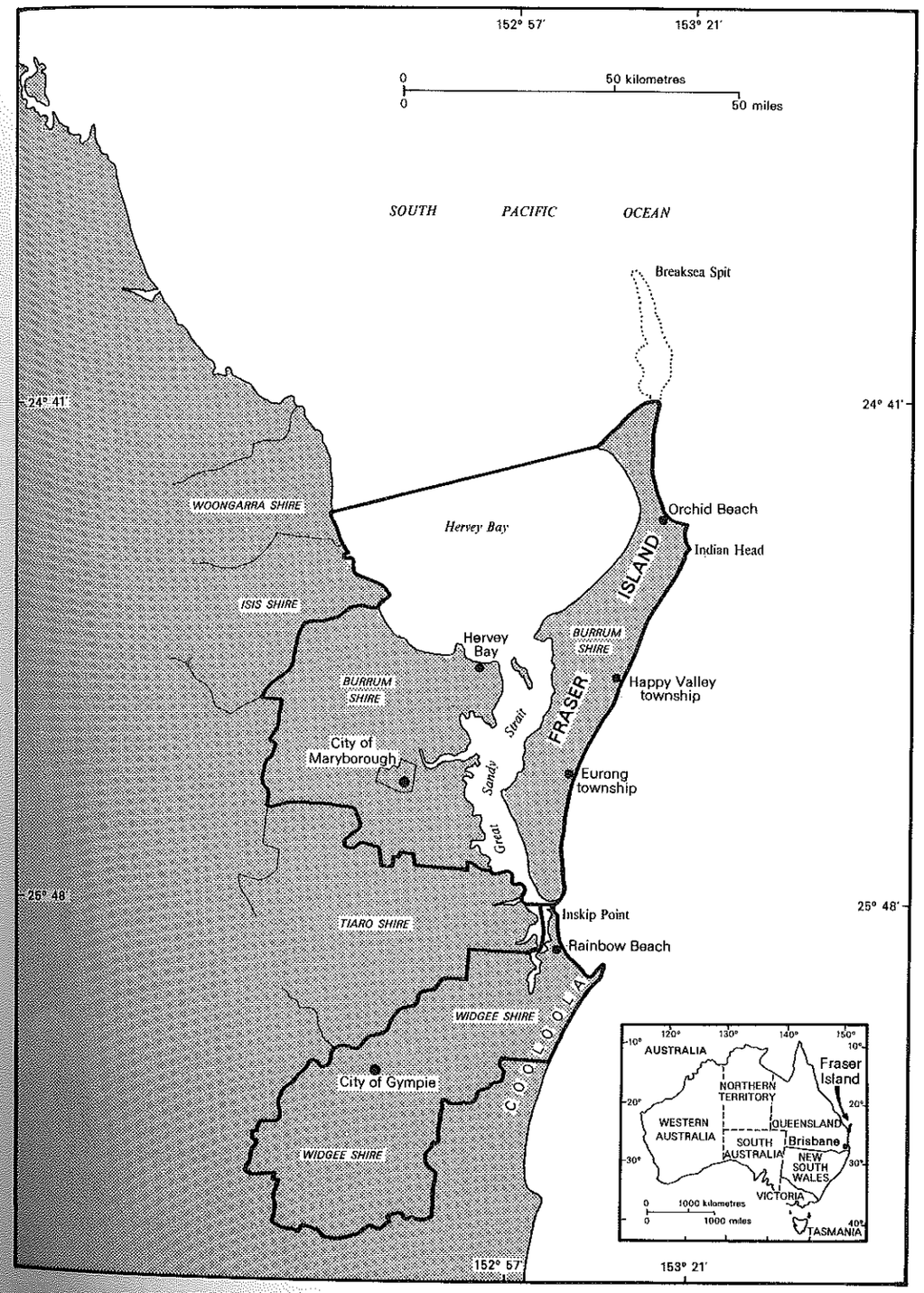


Fig. 1.1 : Location map of Fraser Island

scattered locations. Approximately 100 people permanently reside on the Island. The main activities are tourism, forestry and sandmining; there is no commercial agriculture or grazing.

Fraser Island, the largest sand island in the world in both area and volume, is composed almost entirely of loose siliceous sand apparently deposited in a number of episodes during the last few million years. Hard rock outcrops only in the Indian Head - Waddy Point area on the east coast, and at one locality on the west coast. Many of the numerous sand dunes comprising the Island occur in parabolic form, with steep sides stabilized by vegetation, but there are many naturally-active sandblows some extending over several hundred hectares. High rates of natural erosion of both shorelines and uplands are evident. The Island has over forty lakes, both perched and as 'windows' in the regional water-table, and many of the lakes, swamps and creeks are of great beauty and interest. The vegetation is very diverse, and includes heaths, wetland communities, grasslands, shrublands and forests of several types, including dense rain-forests. The aquatic fauna, in particular, is of considerable scientific interest.

The east coast comprises two very long beaches, mostly trafficable by the four-wheel drive vehicles that are also used on the sandtracks of the Island. The east coast has excellent fishing. Deposits of ilmenite, rutile, zircon and several other heavy minerals occur mostly along or near this coast, concentrated in seams on the beaches and disseminated within parts of the low and high dunes. There was evidence that the qualities of Fraser Island most appreciated by visitors are its isolation and wilderness value, its unusual and unique features, its extraordinary beauty and its present relatively natural and unspoiled environment.

1.3 Sandmining on Fraser Island

Sandmining is the only form of mining conducted on the Island having any significant environmental impact and the only form of mining conducted on the Island resulting in the export of minerals. Its principal purpose and sole economic justification is the extraction of minerals for export. The term 'beach mining', sometimes used as a synonym for sandmining, has not been used in this Report, as little or no sandmining is conducted on the beaches of the Island at the present time.

Queensland Titanium Mines Pty Ltd and D M Minerals are currently engaged in sandmining operations on Fraser Island.

Queensland Titanium Mines Pty Ltd was incorporated under the *Companies Act*, 1961-1964 of Queensland on 12 October 1964. The two equal shareholders are the Titanium Alloy Manufacturing Co. Pty Ltd (which is wholly owned by NL Industries Inc. of the U.S.A. and Titanium Metals Corporation of America). The Company has twelve mining leases on Fraser Island covering an area of about 1,000 ha (Table 3.2). Its mining operations on the Island commenced in December 1971, and by mid-May 1975 the area 'disturbed by mining' was estimated by the manager of the Company's operations on Fraser Island to have been 158 ha. Operations have so far been confined to MLs 84, 104 and 105 in the southeast of the Island (Fig. 3.3). Production to that date was stated to be 44,292 tonnes of rutile and 32,793 tonnes of zircon. The Company has applied for a further five mining leases on Fraser Island (Table 3.3 and Fig. 3.3) covering an areas of about 580 ha.

D M Minerals is a partnership between Dillingham Constructions Pty Ltd (which is a subsidiary of Dillingham Corporation of Australia Ltd, a wholly-owned American company) and Murphyores Incorporated Pty Ltd (a wholly-owned subsidiary of Murphyores Holdings Ltd). The terms of the partnership agreement were not disclosed to the Commission, but a company review compiled by the Research and Statistical Bureau of the Sydney Stock Exchange Ltd shows that Dillingham Constructions Pty Ltd is the Managing Partner, and that Murphyores Incorporated Pty Ltd will receive thirty per cent of the profits until a total of 551,000 tons [about 560,000 tonnes] of rutile and zircon is produced, and thereafter half the profits. According to evidence before the Commission, this quantity of minerals would take eight to nine years to produce. Murphyores Incorporated Pty Ltd has twelve mining leases on Fraser Island covering an area of about 12,000 ha (Table 3.4). In 1975, D M Minerals commenced sandmining operations on ML 102 (Fig. 3.3). No production data were made available to the Commission but, as at 25 September 1975, approvals had been given for export permits to be issued to D M Minerals for 626 tonnes of rutile and 670 tonnes of zircon. Murphyores Incorporated Pty Ltd has applied for a further five mining leases on Fraser Island (Table 3.5 and Fig. 3.3), covering an area of about 2,260 ha.

Evidence was presented to the Inquiry by witnesses on behalf of Queensland Titanium Mines Pty Ltd. However, no witness on behalf of the Companies forming the partnership D M Minerals gave evidence, and the Commission was restrained from compelling the attendance of any such witness by an Order of the High Court of Australia. Nevertheless, the Commission not only indicated willingness to hear any evidence volunteered on behalf of the partnership but also gave it frequent opportunities to ask questions of witnesses. No questions were asked by or on behalf of the partnership of any witness at the Inquiry. Despite the absence of any such witnesses, there was a considerable body of evidence before the Commission relating to the operations of D M Minerals on Fraser Island.

The Commission and its Advisers viewed the operations and areas already mined on the Island by both D M Minerals and Queensland Titanium Mines Pty Ltd.

CHAPTER 2

FRASER ISLAND: THE NATURAL ENVIRONMENT

2.1 Introduction

This chapter briefly describes various facets of the natural environment of Fraser Island of particular relevance to the Inquiry, and highlights the significant environmental constraints within which decision makers must operate if the various ecosystems of Fraser Island are not to be permanently degraded. It also discusses unique or highly unusual features of the Island, including its perched lakes, cliffs of Teewah [Coloured] Sands, sandblows and rain-forests. But necessary as it is to dwell in some detail on these features of the Island, the point must nevertheless be made that its environmental significance lies in something more than the possession of a series of important natural features. It is the overall impression of wilderness which gives unity to these individual natural features and to the Island as a whole. Nevertheless, it is extremely difficult to convey in words either the strength of this impression of wilderness or the quality of the Island's beauty. The reader may, perhaps, obtain some assistance in this regard from the photographs to be found in Appendix 1.

The ways in which the natural features of the Island were formed and are being changed, and the interrelationships between the physical and biological environments, are outlined to serve as a basis for Chapter 6, in which the effects of sandmining operations upon the natural environment are assessed.

The Commission has not attempted to write a definitive text on the natural environment of the Island. Indeed, there is insufficient space in this Report for such an exposition; readers who wish to pursue the matter are invited to read the detailed evidence submitted to the Commission.

While the Commission was impressed by this comprehensive body of factual material, it nevertheless agrees wholeheartedly with numerous witnesses who observed that a great deal remains to be learned about the natural environment of Fraser Island. It is very clear from much of the evidence before the Commission that Fraser Island will play a continuing, and increasingly important, role as a 'natural laboratory' for investigators in many fields of study. In this respect, the Commission concurs with the several witnesses who suggested that there appears to be an excellent case for the establishment of a permanent scientific station on Fraser Island which could be used as

a base to conduct research and to monitor environmental change. Furthermore, the diversity and complexity of the natural environment of the Island provides rich opportunities for secondary and tertiary level teaching and research.

2.2 The physical environment

The location of Fraser Island in relation to the Queensland coast and nearby urban centres was indicated briefly in Chapter 1. This section discusses, in turn, its climate, geology and geomorphology, soils, land systems and hydrology.

Climate

Fraser Island has a maritime subtropical climate, with generally moderate temperatures, though local climatic variations occur due to the influences of topography and vegetation. Occasional inland frosts have been recorded. At Sandy Cape the mean maxima are 28.6°C and 20.7°C in January and July respectively, with a mean minimum in July of 14.0°C. On the average, four days in January exceed 30.6°C (Exhibit 9, p.23).

The wettest parts of Fraser Island occur where the prevailing southeasterly winds impinge on the high dunes. This pattern resembles that found on North Stradbroke Island, where the highest annual rainfall exceeds that of Cleveland (on the adjacent mainland to the west) by more than 800 mm. On Fraser Island, a long-term average (1871-1973) of 1,263 mm is recorded for Sandy Cape, 1,740 mm for Ungowa and about 1,500-1,600 mm for Central Station. The highest dunes in the centre of the Island probably receive about 1,800 mm rainfall annually. About two-thirds of the rain falls during the period January to June, and its variability is likely to have important effects on plant growth on such freely drained and non-retentive soils.

The prevailing winds are from the southeast, and have a predominant influence on the topography of the Island. There are also daily sea breezes while, during the summer months, winds associated with cyclonic disturbances often reach gale force, causing widespread damage to vegetation, as well as initiating and exacerbating erosion of beaches and dunes.

Geology and Geomorphology

Fraser Island is composed entirely of siliceous sands of various types, resting upon bedrock at least thirty metres below sea level (Exhibit 9, p.11). The bedrock is believed to be sedimentary rocks of Cretaceous age, possibly the Burrum Coal Measures. The only rock outcrops on the east coast are at Indian Head, Middle Rocks and Waddy Point, and

are mainly of rhyolitic rocks of Mesozoic or Tertiary age. On the west coast there is a small outcrop of hard rock at Bun Bun Rocks (Exhibit 26, p.4).

Like the sandmasses of Cooloola, North Stradbroke Island and Moreton Island to the south, Fraser Island has been formed from quartz sands which were weathered from rocks on the Great Dividing Range and then moved to the sea by the rivers of northern New South Wales and southern Queensland. The siliceous sands and heavy minerals resisted breakdown, and over long periods the prevailing wave patterns and ocean currents moved them northwards along the coast. An unknown proportion of these materials was 'stranded', and has formed these huge sandmasses. Sand which was not trapped on the beaches, or blown inland to form dunes, passed beyond the northern tip of Fraser Island to form the sandbanks of Breaksea Spit, and finally off the Continental Shelf into deep water at the northern end of the Spit. Some sand also moved westward across Hervey Bay to the mainland. These processes are still continuing, although presumably at different rates from those in the past.

The intricate pattern of the sand dunes on Fraser Island is largely the result of wind action and water erosion. When loose sand on the beach is blown above the reach of the tides it forms dunes, which are initially roughly parallel to the coastline. These are colonized by plants that stabilize the dune and increase its height by trapping further sand blown off the beach. Under certain conditions, such as periods of very high winds or abnormally dry conditions, the stabilizing effect of the plant communities is overcome and a 'sandblow' is formed. These occur in many shapes and orientations, but parabolic or 'hairpin' dunes with their axes from southeast to northwest are common. Some sandblows are presently active, some are quiescent, while some are being colonized and stabilized by vegetation. Once a sandblow has been initiated it usually receives a regular supply of sand from the beach and from its base, and tends to advance inland, overwhelming the vegetation in its path. This can continue until the supply of sand is minimized when the land surface reaches the water-table and/or when plants colonize the periphery of the sandblow. The active sand can still move inland for long distances until it is eventually stabilized, and in the process it will often overlie older dunes and thus raise the land surface. By this process of continual sand movement, the landscape of Fraser Island has become a complex of separate, overlapping, buried, part-buried and excavated dunes of many different ages.

This simplified description of how the Island was formed is complicated by the changes in sea level over recent geological time. For example, the sea was about 100 m below its present level approximately 20,000 years ago, and it has varied up and down at other times during the formation of the Island. When the sea level was low the

coastline would have been many kilometres east of its present position, and dunes and gentle sandplains would have been found adjacent to it. As the sea level rose the coastal dunes and plains were destroyed, and some of the sand moved westwards. It is likely that the orientation of the coast, and the direction of the prevailing winds, would have varied from time to time, thus causing the present day dunes to be differently oriented.

One of the most important features of Fraser Island from a geomorphological viewpoint is that it exhibits the greatest number of distinct and independent dune systems found anywhere in the world. There was uncontested expert evidence that Fraser Island is of importance as a natural geomorphological laboratory, and a considerable amount of scientific work is still required to 'decode' its geological and geomorphological history. The necessity for this decoding is evidenced by the debate as to whether the Island has been formed episodically or continuously -- that is to say whether periods of active dune formation and destruction have alternated with periods of quiescence, or whether these activities have been more or less continuous. This debate has interesting scientific implications which cannot be enlarged upon here, but is also relevant to the ultimate analyses of the environmental effects of sandmining. Thus, if the Island is at present undergoing a period of intense activity, landscape stabilization might be more difficult than during a period of dormancy; but if landscape formation has been continuous there may be a constant and predictable natural hazard. At present we may be experiencing a phase when the natural tendency for wind erosion is relatively slight (Transcript p.174).

The foregoing emphasizes the need for the delineation of geomorphological reserves in any plan of management for Fraser Island. The main function of such reserves would be to preserve a variety of landscapes for geomorphological and archaeological research. Fig. 2.1 shows one such scheme of proposed reservations, delineating five types of reserves; *Benchmark* (for observations of and for monitoring present, active, geomorphological processes); *Unique Case* (for study of unique landforms); *Management* (to study the ways in which the uniformity of the landscape already mined might be broken down by geomorphological processes); *Educational and Representative* (for preservation and study of excellent cross-sections of major landscape types); and *Scenic* (for preservation of very beautiful areas not otherwise preserved).

The eastern beach is formed by high-energy waves cutting into the sand dunes. It is not particularly wide, as the high-tide mark is often at or near the toe of the dunes. Occasional exposures of 'sand-rock' (sand cemented or indurated by organic materials) prevent vehicle movement along the beach at high tide, and sand-rock may lie at shallow depths under much of the ocean beach. The sweep of

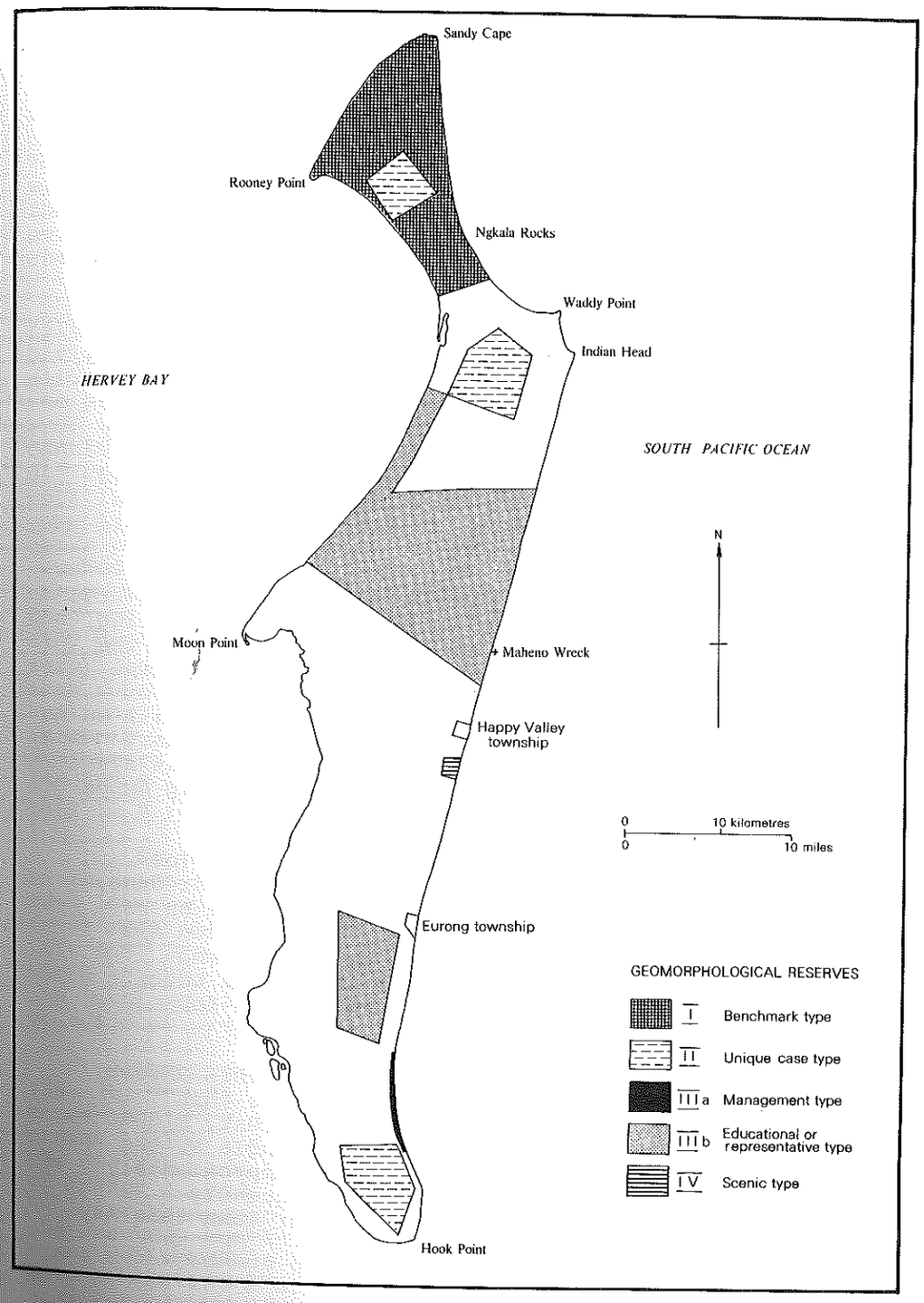


Fig.2.1 : Proposed geomorphological reserves on Fraser Island (after Exhibit 447)

this beach is interrupted by the rock outcrops of Indian Head and Waddy Point, but south of Indian Head it is still approximately ninety kilometres long. The Indian Head and Waddy Point rocks have attractive pools in their vicinity, provide excellent views of the ocean beaches as they sweep away to the south and north, and are popular fishing spots.

Along much of the Fraser Island coastline the sea is cutting into old or moderately old sand dunes, as only the extreme southern part of the Island has modern foredunes running parallel to the coast. Some of the mining leases define a foredune as the dune nearest the sea, whereas, geomorphologically, there is a true foredune only in the southern part of the Island. The effects of sandmining, and the possibility of successful rehabilitation, differ on these two types of coastal dunes.

The modern foredunes on the Island are typical of such dunes elsewhere. While they are often aesthetically attractive, it should be borne in mind that they are naturally unstable, and are being continuously shaped and reshaped. Nevertheless, it is most important that there should be a stabilized foredune if it is desired to avoid new sandblows.

As mentioned already sandblows are natural features of the Island, and may be most attractive and interesting, perhaps because they are observable manifestations of the power of natural forces. They may also reveal landscape history as buried layers are exhumed. Any bare area of sand which is exposed to strong winds from the sea will be much more susceptible to forming a sandblow than a more protected area. Therefore the most susceptible areas are foredunes, the older dunes next to the sea and steep dunes inland which have exposed eastern faces.

Where a foredune has formed, a level area (or basin) is commonly found behind it and then another dune, known as the 'hind-dune'. There may be a succession of such parallel dunes, although usually the first two are more prominent. The foredune, with its grasses and succulent plants, protects the hind-dune to some extent, and low trees often grow there, providing shade for camping.

The term 'steep dune', where used in this Report, means a dune with a maximum side slope of more than twenty-five degrees. Unstabilized, non-coherent, blown sand generally forms slopes with a maximum angle at the 'angle of repose' of the material which is approximately thirty degrees. Where vegetation has subsequently stabilized the dune, slopes slightly greater than this may be found.

The dunes on Fraser Island exhibit great variability in direction, slope and micro-topography, leading to a diversity of plant communities which materially add to the scientific and aesthetic interest of the Island. A dune which lies across the direction of the prevailing winds will commonly have different plant communities on each flank, on the crest and in the valleys. The extent to which they are exposed to salt-laden winds will also strongly affect the structure and appearance of the vegetation communities. This effect is particularly evident within a strip perhaps two kilometres wide along the eastern coast.

It seems that the heavy minerals found on Fraser Island were originally within the rocks of the Great Dividing Range, resisted weathering along with the siliceous sands, and were thus brought to the beaches by the processes described previously. They were (and still are) concentrated near the inner edge of the beaches. Continual reworking by waves and winds brought about the differential concentrations of heavy minerals into relatively rich bands within the dunes near the sea, or in generally lower concentrations disseminated through the upper parts of the steeper dunes. If the heavy minerals reached the Island in the manner already described (and there was no evidence that disputed this) it is possible that pockets of heavy minerals are dispersed throughout many parts of the Island. In short, it would not be surprising if there were many more ore bodies on the Island than those already within the areas leased (or under lease applications) for mining purposes. Whether these would be economic to mine at the present or some future time is conjectural. Extensive exploratory drilling has been conducted over most of the Island (Exhibits 59 and 60) but only to a limited depth (Exhibit 265, p.734).

It could be anticipated that the dunes which formed to the east of the present coastline when the sea level was much lower would have contained heavy minerals. As the sea level rose and the dunes were destroyed, they might have left some deposits behind. Exploration has shown that there are heavy mineral deposits offshore, but apparently the concentrations are not sufficiently high for them to be economic at present.

The Commission had before it a number of Exhibits (38, 39, 40, 41, 61, 67 and 69) delineating in plan and/or cross-section view the known ore bodies in many of the mining leases and lease application areas. Fig. 2.2 shows the distribution of some ore bodies near the eastern coast of Fraser Island. Some of the ore bodies depicted in Exhibits have open ends at the lease boundary, showing that the ore body continues outside the delineated area. While there was evidence of the existence of ore within these boundaries, there was no evidence that all ore bodies were confined within them. Furthermore, there was clear evidence of the existence of an ore body containing

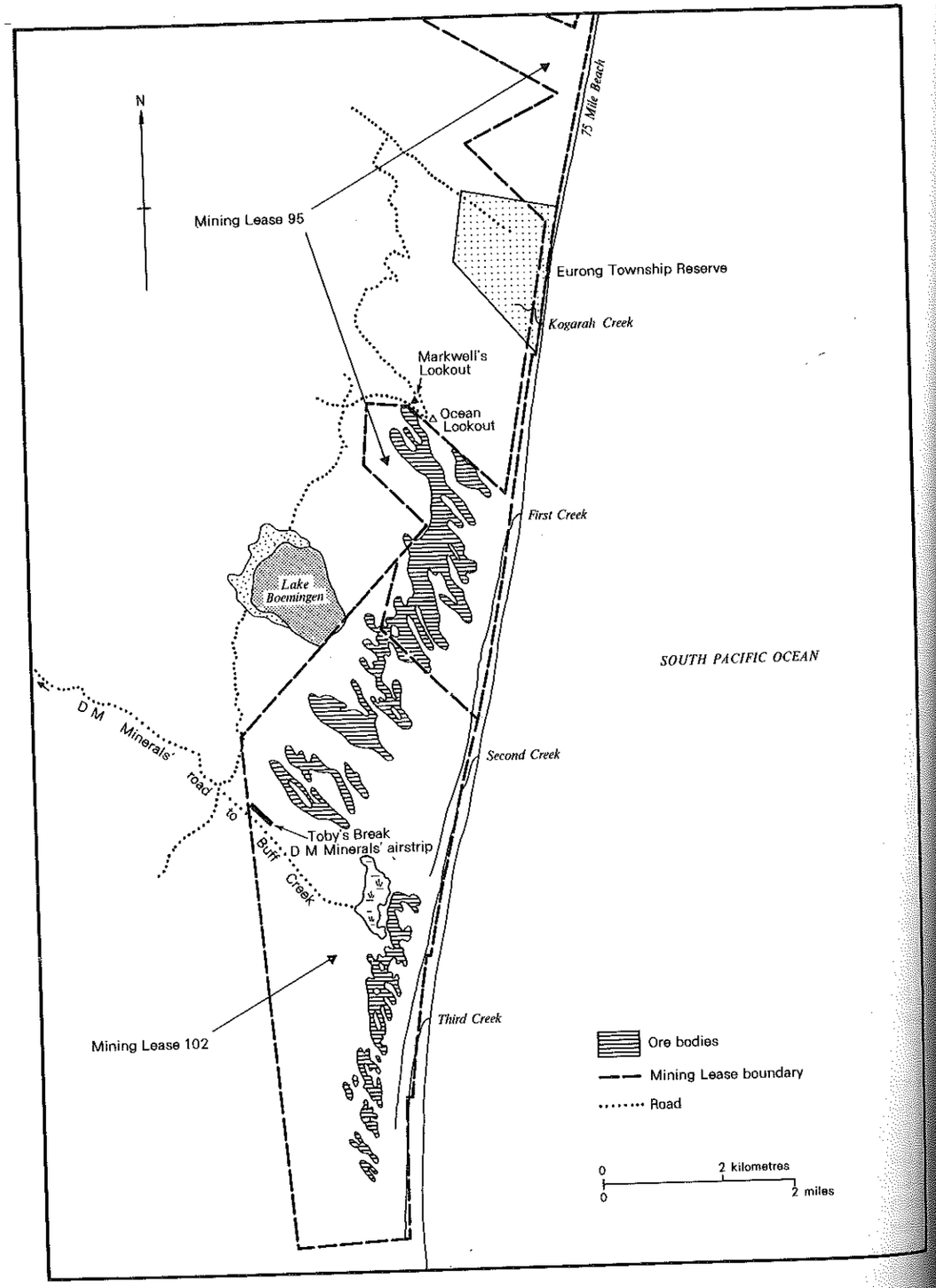


Fig.2.2 : Ore bodies, ML102 and part of ML95 on Fraser Island (based on Exhibit 61)

approximately 50,000 tons of rutile and zircon in and around the White Lake system in the northern end of the Island (Exhibit 265, p.729). Hence, having considered the largely uncontested geomorphological evidence, the Commission must assume that ore bodies of heavy minerals are likely to exist outside existing mining leases and lease application areas, and that they might at some future time become mineable.

Lastly, several of the mining leases (e.g. Exhibit 19) mention other minerals which may be extracted from Fraser Island. As well as rutile, zircon, ilmenite and monazite, they include tin, platinum, garnet, silica, magnetite, leucoxene, tantalite and scheelite. None of these are found only on Fraser Island, and none are particularly rare. There is also some indication that deposits of coal are to be found on Fraser Island, though no precise evidence of their extent and value was presented to the Commission.

Soils

The geomorphology of Fraser Island is a guide to soil distribution, although the soils are variable over short distances and tend to occur in a complex mosaic influenced by topography, vegetation and past and present erosion. In broad terms, deep siliceous sands are dominant in the eastern half of the Island, and podzols (with and without organic hardpans) tend to be most common in the western half. Continuously moist areas often have humus podzols, and acid peats are found in swamps. Low lying areas in the west have a variety of salt-affected soils. Despite the complexity of soil distribution, soils often occur in patterns and sequences according to soil age, attendant vegetation and position on the landscape.

The common soils are generally deep, very freely drained, and inherently of very low fertility due to the siliceous parent materials from which they have been formed. Plant nutrients are held very weakly against the relentless downward movement of rain-water through the soil profile, so that the maintenance of soil fertility depends upon continuous cycling of nutrients through plants, litter layers and soil organic matter and then back again through the plant roots. Nutrients which move below the range of plant roots escape from the cycle and are generally conveyed rapidly to water-tables, and thence to the sea. Small additions of various plant nutrients can occur in seaspray, and in other ways. In effect, the vigour and recuperative ability of most plant communities on Fraser Island depends upon the maintenance of this delicately balanced cycle, seen at its most complex in the rain-forest pockets that occur in sheltered basins where nutrients can accumulate. While it is possible to supply several plant nutrients artifically, using fertilizers on mined land, losses by leaching are usually rapid and severe as the minimal ability of the soil to hold nutrients is further

diminished when the soil profile and plant roots are destroyed by mining. Nor does the replacement of topsoil after mining ameliorate this process to any significant extent (Exhibit 317, Table 4) although, of course, topsoil replacement is very important in post-mining rehabilitation for other reasons.

None of the soils on Fraser Island can be considered unique in itself (similar soils being found on other sand masses such as Cooloola), but it is clear from evidence before the Commission (e.g. Exhibit 26) that the patterns of soil distribution over small areas (such as ridges and adjacent valleys) and within and between larger landscape units (Figs 2.3 - 2.5) are of considerable theoretical and practical interest. Landform, vegetation and soil are inextricably related in numerous and complex ways. Any land use practices which tend to minimize or destroy this landscape diversity detract from its attendant aesthetic and scientific interest.

Land Systems

In order to understand better the geomorphology of Fraser Island, and to aid land use planning and management, the various landscapes may be categorized as land systems, defined as 'an area or group of areas, throughout which there is a recurring pattern of topography, soils and vegetation' (Exhibit 26, p.27). Such a classification is shown in Fig. 2.3 which distinguishes four land systems.

Teewah Land System
Distributed chiefly over the high central massif of the Island and occupying about a quarter of the area of the Island. It contains the highest proportion of the best quality Eucalypt forest, virtually all the rain-forest and many of the perched lakes. Only a few of the present MLs and MLAs touch this land system and together cover only three per cent of it. It contains much of great ecological and aesthetic interest.

Cooloola Land System
Occupies about forty-eight per cent of the Island, essentially consists of the lower altitude dunes surrounding the Teewah Land System, and includes all of the sandblows south of Orchid Beach. Includes the extensive exposures of cliffs of Teewah [Coloured] Sands.

Bribie Land System
Includes wetlands and their low flanking dunes, and is found only on the southeastern and western coasts. Includes the extensive mangrove areas.

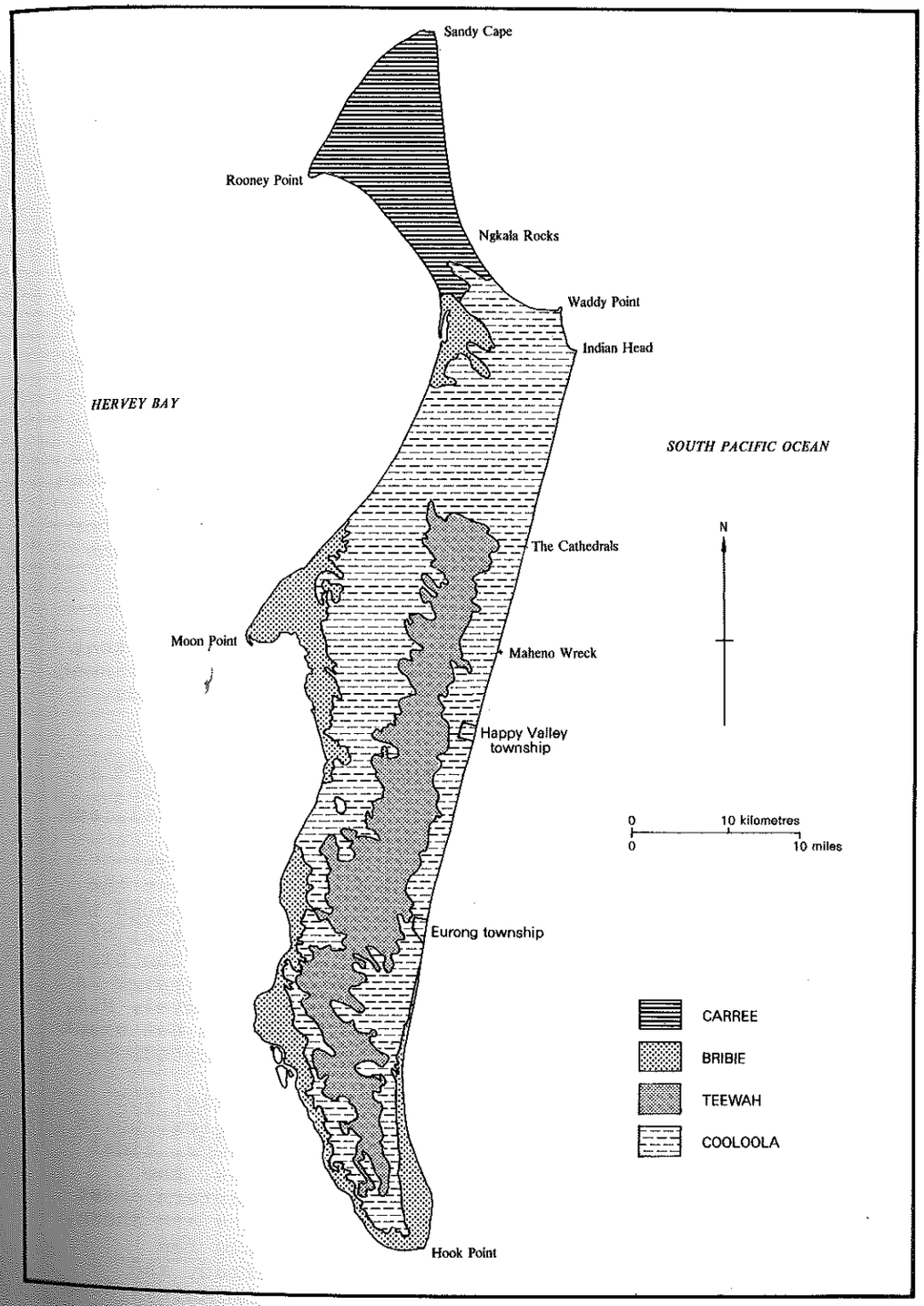


Fig.2.3 : Land systems of Fraser Island (after Exhibit 26)

Carree Land System
Includes the extensive area of generally lower dunes of confused pattern north of Orchid Beach. Includes many lakes and sandblows; the vegetation is dominated by low woodland and heath.

The Teewah [Coloured] Sands are said to occur as a massive core in the dunes at all elevations, and are widely recognized in other sand masses. They are often overlain by the 'Oceanic Sands', which are evidently younger, and comprise much of the Cooloola Land System. A consultant for D M Minerals was of the opinion (Exhibit 265, p.317) that the Teewah [Coloured] Sands were not mineralized (and presumably would not be mined); heavy minerals occurring only in the 'Oceanic Sands'. On the other hand, there was evidence that the Teewah Sands were being mined on North Stradbroke Island (Transcript p.1828) and that their colouration is simply due to the weathering of the constituent heavy mineral ilmenite and the release of free iron oxides; the distinctive difference between the Teewah and Oceanic Sands being merely one of weathering status (Transcript p. 1829). In any case, during exploration for heavy minerals on Fraser Island drilling ceased where the drill met either indurated [coloured] sand and/or the water-table, and, in any event, at a depth of about twenty-five metres (Exhibit 265, p.734). In these circumstances, and in the absence of evidence proving that the Teewah Sands are not mineralized, the Commission cannot be sure that heavy minerals do not occur in these sands, and that they will not at some time be mined.

Another witness recognized nineteen 'dune lands', defined as areas possessing 'a uniform geomorphological history, which is dominated by the one parent material, and which has a characteristic range and aggregation of vegetation structural types' (Exhibit 9, p.30). This definition resembles that of land systems, but allows the recognition of finer detail in the landscape. Although the individual dune lands cannot be described here because of lack of space, they are shown in Fig. 2.4. Again the high central massif is evident, but the Cooloola Land System is divided into a number of dune lands (Waddy, Cathedral, Eli, Eurong and others) although the correspondence is not exact as different criteria for classification were adopted.

Yet another classification is shown in Fig. 2.5. Here the age relationships of the various geological units become apparent. Apart from the freshwater swamps, tidal marshes and modern foredunes, swamps and marshes, the youngest unit is the Cape dune sands, on the eastern coast north of Orchid Beach. Successively older units are shown, with the Teewah Land System largely falling into the relatively old units of the Garawongera, Bowarrady and Yankee Jack dune sands. The oldest unit is the Awinya dune sands, covering much of the western half of the Island.

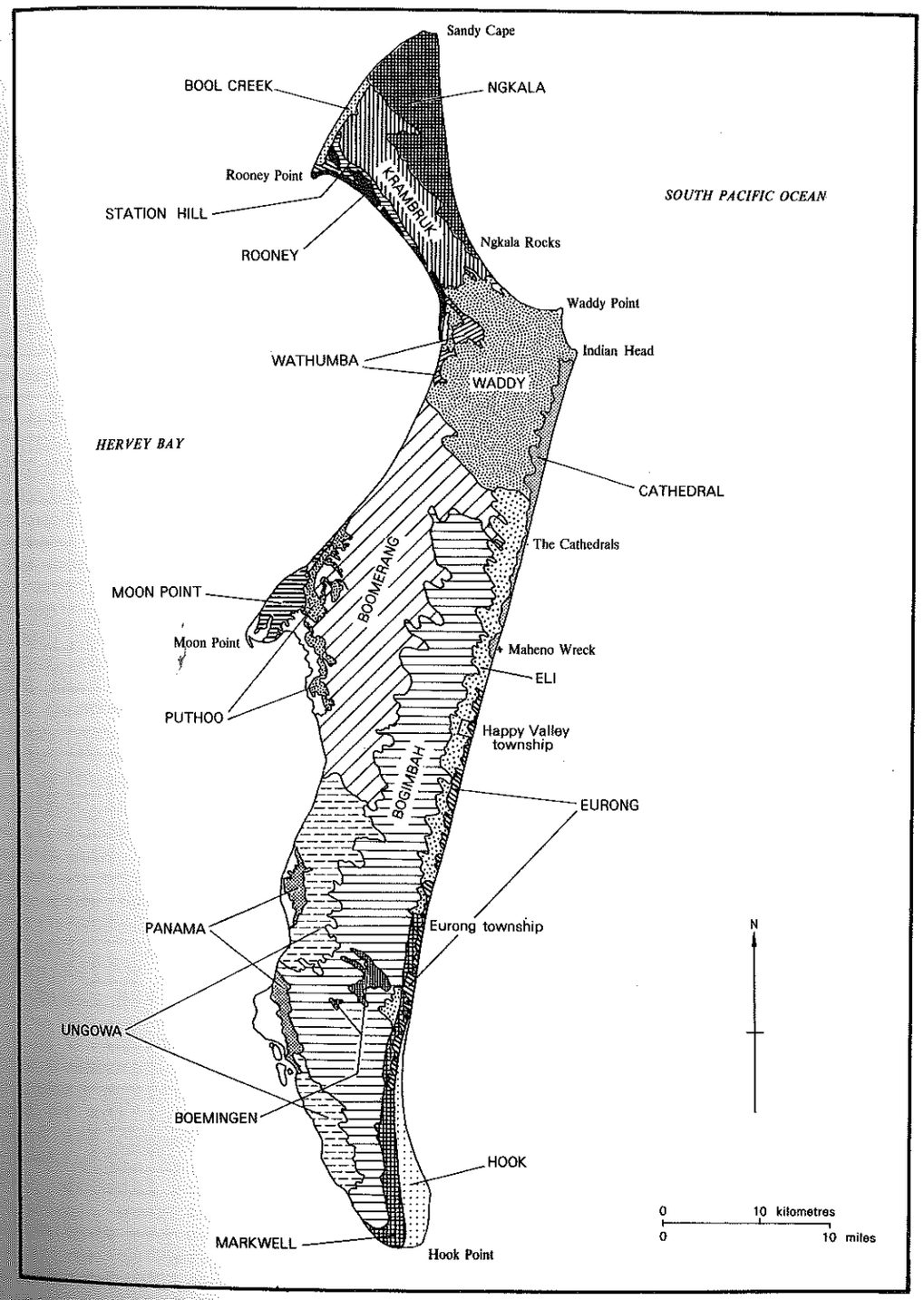


Fig.2.4: Dune lands of Fraser Island (after Exhibit 9, Map a)

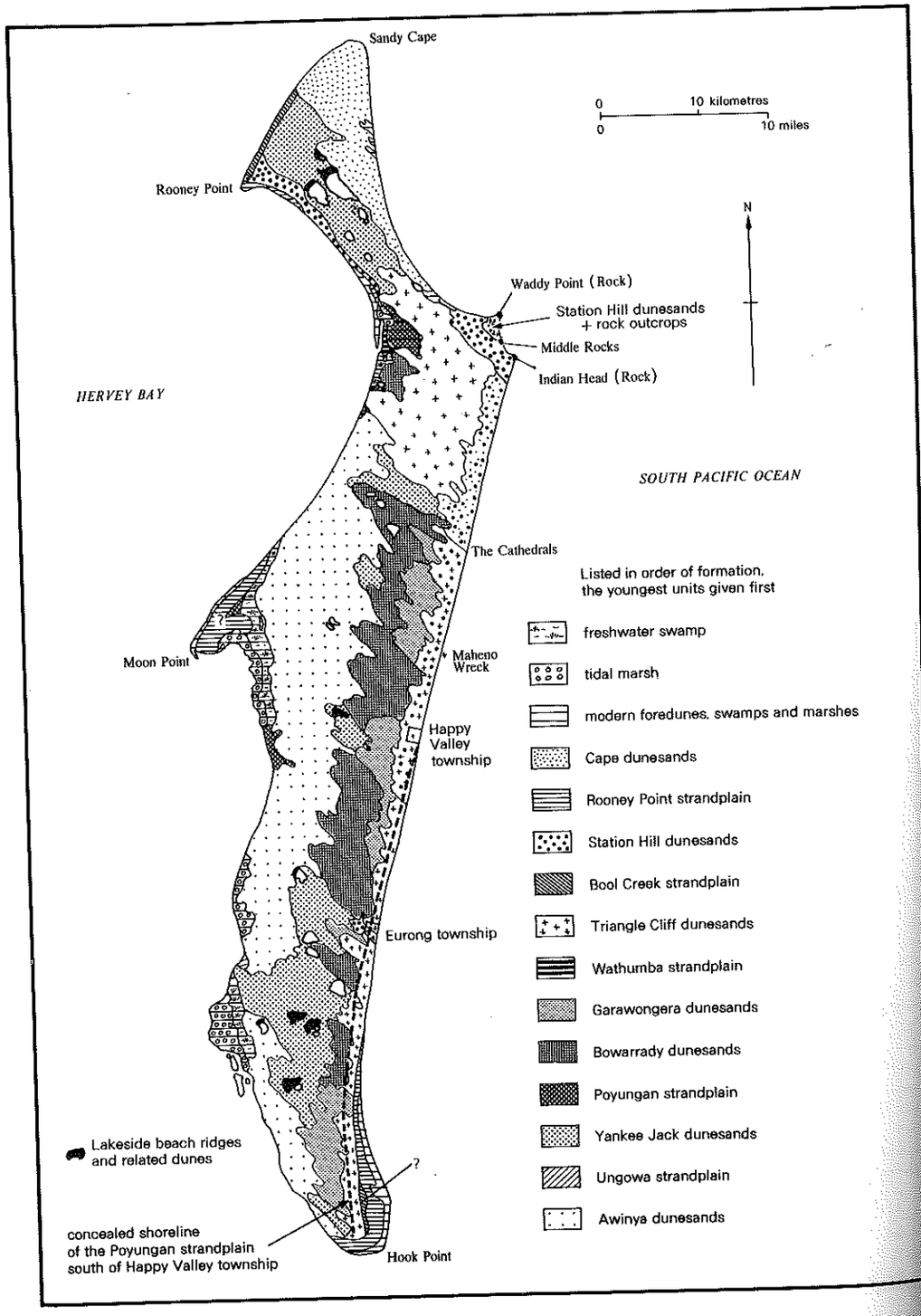


Fig. 2.5: Draft geological map of Fraser Island (after Exhibit 266)

Thus, Figs 2.3 to 2.5 show, at differing levels of complexity, that Fraser Island is comprised of a wide range of 'landscape formations', which differ in many characteristics such as vegetation, topography, soils and age. All these characteristics must be taken into account when planning and managing Fraser Island for various land uses, because each 'formation' will react differently to different intensities and types of activities.

Hydrology

As described earlier in this chapter, Fraser Island is a huge mass of permeable sand with varied surface configuration, resting on hard rock some distance below present sea level. Rain falling on its surface may evaporate, run off over the surface, be used by plants or may infiltrate through the soil profile and down to the water-table (Fig. 2.6). The water-table is the upper surface of the regional aquifer (the permanent body of stored water) and its depth below the surface may fluctuate considerably. A high proportion of the rain falling on the Island will reach the regional aquifer, and will flow slowly in a generally radial fashion from the hinterland to the sea. In some cases the water may not reach the surface at any point before it emerges at the beach, and in others, it may appear as creeks, swamps or as 'water-table window' lakes such as Lake Wabby. Hydrologically, the Island is an unconfined aquifer, with a water-table slope of about 1 in 100 (Exhibit 52, p.7). A gradient of 1 in 65 was quoted for part of North Stradbroke Island (Exhibit 445, p.16). Thus, water is held within the Island as a huge dome shaped body, from whence it moves inexorably to the sea. Seawater is excluded because of its different density, but any diminution in the outward flow from the regional aquifer will allow some ingress of salt water. Huge quantities of water are held in these sandmasses, and various schemes have at one time or another been proposed to tap this resource for domestic water supplies for Brisbane (from North Stradbroke Island) and Hervey Bay (from Fraser Island). There was evidence questioning the technical feasibility and ecological wisdom of such proposals (Exhibit 464).

In addition to evidence on the regional aquifer, the Commission heard much evidence concerning various perched aquifers found on the Island. In various places and at various elevations, bodies of relatively impermeable sand are common, their low permeability being due to cementation by organic materials and/or iron compounds. The vertical and lateral limits of these bodies are largely unknown, even around places like Lake Boemingen, as an extensive and expensive drilling programme would be required to define them adequately. Nevertheless, there is ample evidence that water can be 'perched' within these 'saucer shaped' depressions, and many of the high altitude lakes, such as Lake Boemingen, are in fact regarded as perched lakes (Fig. 2.6). They are probably not completely

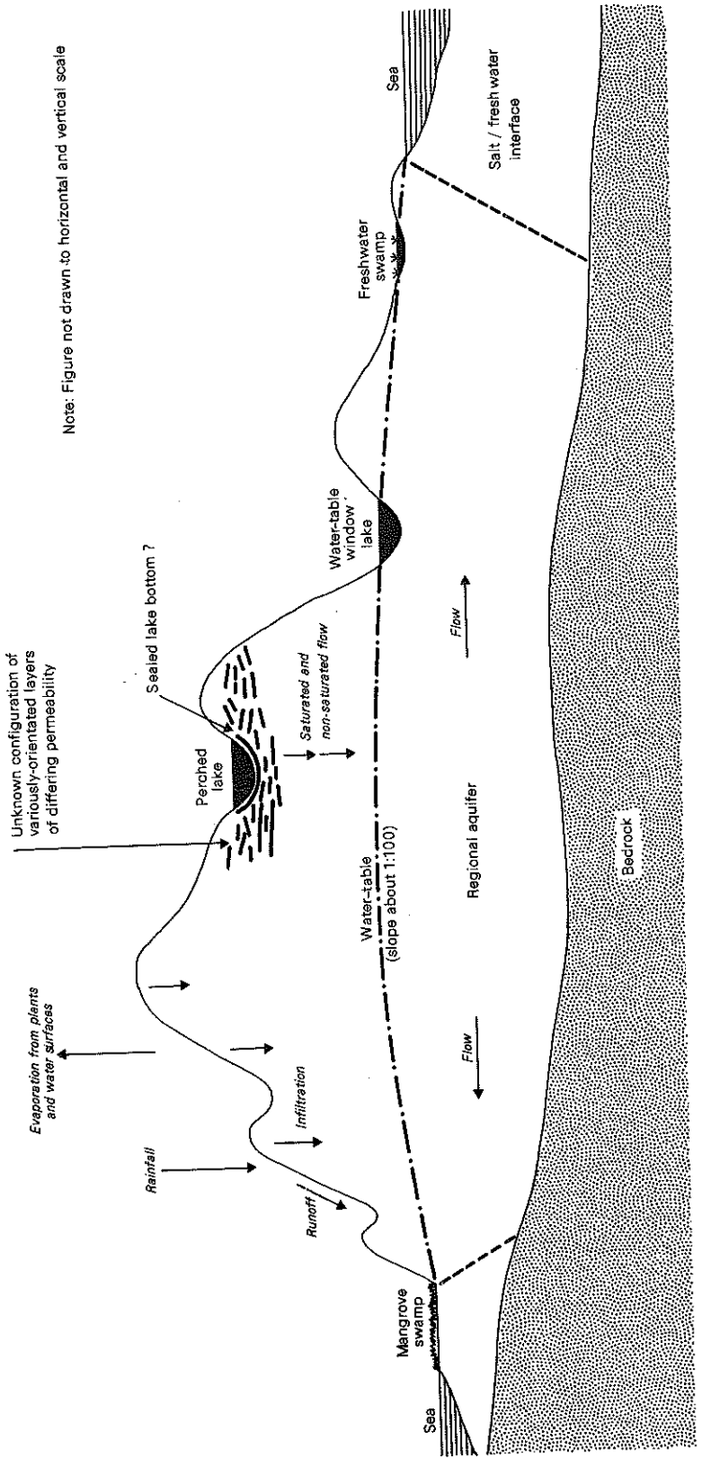


Fig. 2.6 : Diagrammatic cross-section of a typical sand island (adapted from Exhibit 49, Fig. 1)

isolated from the regional aquifer because it is likely that saturated and non-saturated flow through numerous layers of varying permeability occurs beneath the lakes. In the case of Lake Boemingen, water is added by rain falling on its surface, by seepage around its shores and by creek flow at the northwest end of the lake. Evaporation from the surface of this lake approximately balances the input from rainfall, so that seepage through the poorly permeable lake bottom must balance the other inputs if the lake level is to stay approximately constant (Transcript p.1863). There is a danger of inducing changes in the water level of the lakes if any of the layers beneath them are disturbed or breached (e.g. Exhibits 223, 273, 478 and 584).

There was much uncontested evidence -- to which the Commission gives considerable weight -- about the unusual and even unique nature of many of the lakes on Fraser Island (e.g. Exhibits 205, 223, 273, 274, 275, 453 and 584). Some of these exhibits were concerned mainly with the unusual freshwater fauna of the water-bodies, but the Commission accepts the contention, strongly expressed by several witnesses, that the characteristics of the faunal communities cannot be considered separately from the nature of the water-bodies on which the fauna is so dependent. In general, the lakes are highly oligotrophic, containing very small quantities of nutrients (due to the infertile sands around them) and are well oxygenated but of low biological productivity. Such lakes are unusual in Australia -- even in the world -- and can easily become irreversibly eutrophic, or biologically degraded, if human activities add excessive quantities of nutrients to them.

Convincing evidence was presented to the Commission that (Exhibit 273, p.3)

> Most of the Fraser Island lakes are highly unusual and of outstanding aesthetic importance and scientific interest, not only from the viewpoint of the Australian nation, but also in a world context

Referring to the class of lakes called 'lakes resting on impervious organically bonded sand-rock in dune depressions', further uncontested evidence was given that (Exhibit 273, p.4)

> This type of lake is not unique to Fraser Island, but the extent of its development on that Island in numerical terms is, so far as is known, without parallel elsewhere; it is not well represented outside Australia. Additionally it must be pointed out that the largest known lakes of this special type are found on Fraser Island

Queensland is rather poorly endowed with lakes, and in the whole of Australia, Fraser Island is the only area (apart from the central plateau of Tasmania and the western district of Victoria) that might be considered 'a lake district'.

Numerous streams, fed by continual seepage from the regional aquifer, flow to the sea on both the east and west coasts. Many, such as Eli and Woongoolbver Creeks, are of outstanding beauty and interest, while others, such as First and Second Creeks, are valuable recreational resources for visitors camping near the eastern beach.

Swampy areas are associated with many of the creeks of the Island. The plant communities of these swampy areas are delicately balanced and heavily reliant on the maintenance of the quantity and quality of the water under which they have developed.

2.3 Flora

There was a considerable body of largely uncontested evidence relating to the flora of the Island. It is clear that there is a close relationship between the different land systems mentioned previously in this chapter and the distribution of vegetation on the Island. It will therefore be helpful to describe the nature of the vegetation predominating on the different land systems.

Teewah Land System
The dominant vegetation of the Teewah Land System is closed forest of two main types, rain-forest and open (or myrtaceous) forest. The rain-forests are frequently referred to as vine forests because of the presence of a variety of vines, notably the genus *Similax*. Other important genera are *Bielschmiedia*, *Elaeocarpus*, *Flindersia*, *Agathis* and *Araucaria*. The open forests dominate the slopes of the major sand dunes, whilst the rain-forest is to be found in the valleys between the dunes. Normally there are narrow boundaries between the two types.

Satinay (*Syncarpia hillii*) is one of the most characteristic trees of this land system and is usually found in association with brush box (*Tristania conferta*). Blackbutt (*Eucalyptus pilularis*) is predominant in the drier areas of the open forests and is often found on the ridges. It is not normally present in the rain-forests, in contrast to the satinay and the brush box, which are found throughout the Teewah Land System. The undergrowth is frequently dense, and often dominated by carrol (*Backhousia myrtifolia*). Normally the ground stratum is replaced by a continuous litter layer a few centimetres thick.

Cooloola Land System
Open forest is the dominant vegetation of the Cooloola Land System, though on knolls directly exposed to the southeast winds it can become a mallee type open scrub.

Eucalyptus species are dominant, with the scribbly gum (*Eucalyptus signata*) the most common. The bloodwoods (*E. intermedia* and *E. gummifera*) are to be found in association with the scribbly gums on the lower sandhills. In some places the blue gum (*E. tereticornis*) is common, while the grey ironbark (*E. drepanophylla*) is seen occasionally. *Eucalyptus tessellaris* grows on the lee slopes of transverse dunes. *Banksia aemula*, *B. integrifolia* and *Casuarina littoralis* are often associated or in alliance with various eucalypts. *Acacia* and *Persoonia* are common shrub genera.

In the poorly drained areas there are open forests of *Melaleuca quinquenervia*, and a number of species from the families Epacridaceae, Fabaceae, Xanthorrhoeaceae and Myrtaceae form open heath or low shrubland formations on these or exposed areas. Species from the Cyperaceae and Restionaceae families are found in swamps and lakes.

Over much of this land system the dominant understory species are bracken and blady grass, which are able to survive the frequent fires which have resulted in a discontinuous surface leaf litter.

Bribie Land System
Though trees commonly found in the Cooloola Land System also appear on this land system, they are much more dispersed, and are frequently replaced by *Callitris columellaris*. The shrub and ground plants are generally more dense than on the Cooloola Land System and tend towards a greater diversity, though the mangroves, swamp and lagoon floras are distinctly zoned.

Carree Land System
On the dryland areas of this land system low open forest, open scrub and open heath predominate. This vegetation is extremely tolerant of fire.

The distribution of mangrove and tidal marsh flora, especially in relation to the marine fauna, will be mentioned later.

A helpful discussion of the flora on MLs 106, 107 and 120 near Indian Head (none of which have yet been mined) appears in Exhibit 317 (Annexure 'B') which also includes detailed material relating to MLAs 131-134 near Bogimbah Creek (Annexure 'C'). This information will be discussed in Chapter 6 of this Report.

Exhibit 571 gives an interesting account of the relationships between rain-forests on Fraser Island and elsewhere. Fraser Island rain-forests have closest affinities with those at Cooloola, and lesser degrees of resemblance to others at North Entrance, Iluka and Cabarita (all in New South Wales) and near Surfer's Paradise. They bear little resemblance to rain-forests on the adjacent mainland. Forests of satinay (*Syncarpia hillii*) are found only on Fraser Island, which is noteworthy and of considerable scientific interest. The point is made in Exhibit 571 that several rain-forests which would have given important clues to puzzling species distributions have now disappeared due to sandmining (at Cabarita) and tourist development (at Surfer's Paradise). Thus, the remaining rain-forests have an enhanced importance. Lastly, Fraser Island seems to be an 'overlap area' for many species at either their northern limits (e.g. *Eucalyptus gummifera, E. robusta, E. signata*) or their southern limits (e.g. *E. dichromophloia*). Clearly, the vegetation of Fraser Island has much to offer the plant geographer.

Sharp boundaries between various plant communities are common on Fraser Island, due to the influence of at least six factors -- depth to the water-table, differing soil profiles, depth of topsoil, soil nutrient status, fire history and management pressures -- and also to geohistorical factors such as the geomorphology of the Island and its location in relation to the mainland (Exhibit 9, p.15). The first four soil related factors in this list tend to change in a fairly regular fashion according to topography; soils on ridges are generally relatively dry, with shallow topsoils and thin litter layers. They are usually the sites most exposed to dry and/or strong winds, and may suffer more severe fire damage than sites in valleys, where soils are often moist or even swampy. Thus, differing plant communities may be found in 'bands' across slopes, according to altitude and exposure.

Superimposed upon these topographically related vegetation patterns may be further patterns related to distance from the sea (with its salt-laden winds) and to soils of various degrees of development on geomorphic surfaces of differing ages. These and other factors, such as soil phosphorus content and rates of nutrient cycling, act in as yet poorly understood and subtle ways to influence the present vigour and character of the plant communities.

In such a complex pattern, varying susceptibilities to disturbance and management are to be expected. For instance, in some areas long continued fire protection has changed open heath to closed heath and shrublands, and has decreased species diversity (Exhibit 9, p.20). Similarly, grazing by wild horses (brumbies) has severely damaged native grass communities on the vital protective foredune complexes of the exposed eastern coast (Exhibit 9, p.21).

It was asserted that each brumby might require annually the forage from at least one kilometre of dune frontage (Exhibit 26, p.24). Clearly, the problem needs further study but even if this figure is approximately correct, the brumby must be implicated as a destabilizing influence on some foredunes and sandblows, together with other agents of disturbance such as unwise camp placement, and constant foot and vehicular traffic.

Even before Europeans came to Fraser Island, the plant communities would not have been static and unchanging. They would have accommodated themselves at differing rates and in differing ways to many influences, from slow evolutionary development over many millenia and climatic changes over several centuries, on the one hand, to sudden disturbances such as severe fires and cyclones on the other. For instance, sandblows may be started and exacerbated by cyclones, with the effect of setting back the plant succession to its initial stage. The plant communities then recolonize the sandblow in a sporadic and patchy fashion, at varying rates on different sites, resulting overall in a mosaic pattern which is essentially protective, partly because there are few large uniform areas.

Further influences, such as insect plagues, disease outbreaks and changes in grazing pressures by native animals would have altered vegetation patterns, but usually so that species diversity and community vigour were maintained on the broad scale and in the long term within the limits imposed by external environmental factors.

One possible consequence of recent and contemporary human manipulation of plant communities on Fraser Island, however well meant, is that these complex patterns may be simplified in such a way as to destabilize delicately balanced ecosystems. An extreme example of this process is the establishment of plantations of one exotic or native species, which some ecologists allege are susceptible to disruption at unnaturally rapid rates by disease, insects, fire and other agents. Similarly, an extensive sandmining operation bares large contiguous blocks of land in a short time, setting back the plant successions to their initial stages at a greater rate, on a bigger scale and in a more uniform manner than would normally occur. One of the aims of post-mining rehabilitation is to accelerate plant successions artificially with fertilizers and by hand planting of tree seedlings, in an attempt to confer stability and diversity.

2.4 Fauna

The Commission received several submissions about the fauna of Fraser Island. Despite the detailed information in many of these, it was clear that much remains to be learned. In particular, the past biological isolation of Fraser Island

has encouraged the development of distinctive frog and fish fauna which are of great scientific interest, and which should be studied soon before any environmental changes destroy unusual biological features. There was evidence that deliberate or accidental alteration of habitat by any agencies would hamper or invalidate further studies. The following brief notes outline some of the features of the terrestrial freshwater and marine fauna.

Terrestrial fauna

The Island may be divided into seven broad zones, based on a classification of the vegetation (Exhibit 26, p.43; Exhibit 29, p.1), and the distribution of 252 terrestrial vertebrates in one or more of these zones is given in Exhibit 29. 'The vertebrate fauna of Fraser Island is relatively poor, although it does include a number of species which are rare or of limited distribution' (Exhibit 29, p.7), such as the ground parrot (listed by the International Union for the Conservation of Nature as being in danger of extinction), the black-breasted quail, a skink, and the acid frog fauna. A total of fourteen animals deserve special consideration, being either rare or at a geographical limit of distribution (Exhibit 26, p.43). At least 200 different kinds of birds have been identified on Fraser Island and the waters around it. A number of these are migratory, spending part of the year in the Southern Hemisphere and part in the Northern Hemisphere. They include shearwaters, frigate-birds, egrets, sand-dotterels, plovers, sandpipers and terns (Exhibit 220).

Fortunately, the house mouse, exotic rat, fox and the feral cat are apparently absent; this rather unusual situation must be maintained if many of the native animals are to survive. It is perhaps worth noting that the terrestrial vertebrate fauna is probably not very distinctive to the average visitor, except for the numerous birds, the occasional eastern grey kangaroo, and frequent dingoes and brumbies.

Vegetation damage attributable to grazing by brumbies was discussed earlier in this Chapter. Their numbers have 'been variously estimated over a range of 2000 to about 50. It is thought that the number is declining' (Exhibit 26, p.24). From time to time their extermination or removal have been proposed, but vociferous public sympathy (Exhibit 432) seems to have quashed such action. Apparently, dingoes prey on young or sick brumbies, and perhaps artificial removal of this food source might encourage dingoes to prey excessively on the native fauna.

The invertebrate terrestrial fauna has received very little attention. Articles in Exhibit 206 described collections and studies made during a short expedition to the Island in 1967. Exhibit 422 listed species collected from ten localities over two weeks in 1972, and observed

that the insect fauna is probably representative of the mainland types, although two new genera and twenty-nine new species of spiders were collected.

Freshwater fauna

There was uncontradicted evidence of a very distinctive freshwater fauna on Fraser Island, which is due largely to the unusual physical and chemical characteristics of the lakes, streams and swamps which form their habitats (Exhibits 223, 273, 274, 275, 314 and 584).

Development of the 'Gold Coast' and 'Sunshine Coast' on the coastal lowlands ('wallum') of southeastern Queensland and northern New South Wales has rapidly reduced the available undisturbed acidic freshwater habitats. Fraser Island is one of the few remaining places with large areas of habitats of this type. The rainbow fish (*Rhadinocentrus ornatus*) is restricted to them, and is fairly abundant, where found, on Fraser Island. The unusual acid frogs are also found in these wetland habitats, and are specialized relatives of species which are very common in other less acid and very widespread habitats. The two groups do not mix because of their differing requirements, but if the acid freshwaters of the wallum are changed by disturbances of various kinds the genetically distinct acid frogs do not survive interbreeding. Fraser Island offers the largest quantity and variety of undisturbed acid frog habitats, and certainly supports the bulk of the entire populations of *Litoria cooloolensis* and *Pseudophryne* sp. (Exhibit 314, p.4). Moreover the isolation of natural areas on Fraser Island helps to safeguard the genetic purity of the acid frogs.

A new species of sunfish (*Melanotaenia* sp. nov.) has been found only in Lake Boemingen, Lake Wabby and Red Lagoon on Fraser Island, which is noteworthy because species of this genus have not previously been found south of Cairns. This is an interesting example of a disjunct species distribution; another is the presence of the carp-gudgeon (*Hypseleotris klunzingeri*), which is otherwise confined to the Murray-Darling River system. Most other fish species on Fraser Island are also found along much of coastal southern Queensland, so that unusually valuable opportunities exist on Fraser Island for studies of the interrelationships between the rare and the common species (Exhibit 223). In particular, Lake Wabby has the richest fish fauna of all the lakes so far examined, and is the deepest and the least acid (Exhibit 274, p.12). Its preservation, changing only slowly in response to natural factors, seems to the Commission to be of considerable scientific importance.

Of great interest to visitors are the tortoises found in Lake Bowarrady. Considerable numbers come to the shore when vehicles arrive, and are so tame that they can be hand fed (Exhibit 9, p.22; Exhibit 646, p.3).

Marine fauna

The southern part of the west coast of Fraser Island is washed by the shallow shoal-filled waters of southern Hervey Bay and the Tin Can Inlet - Great Sandy Strait complex. The fringes of these waters support approximately 11,500 ha of tidal wetland plant communities, such as mangroves (Exhibit 264, p.9). There are about 4,000 ha of tidal wetlands on Fraser Island alone (Exhibit 454, Table 3). Detailed information on the various mangrove and seagrass communities may be found in these two exhibits. Three species of mangroves evidently reach their southernmost limit in this area (Exhibit 26, p.22) and the presence of a rich mangrove flora on such a coarse substrate as sand is of interest. Such areas also support a rich fauna; collections at the mouth of Bogimbah Creek included forty-eight species of molluscs and twenty-seven species of crabs, and 2,000 to 6,000 gastropod snails per square metre were common (Exhibit 9, p.22).

It is not surprising, then, that these areas, and associated seagrass beds, are important feeding and breeding grounds for a wide range of marine fauna. Biologically, the most significant part of the estuary enclosed by Fraser Island is the part south of the Mary River, which has a greater amount of seagrass per unit area than any other estuary south of Bowen (Exhibit 264, p.9). Such areas are vitally important nursery grounds for marine fauna (such as bream, whiting and flathead), for mud crabs and for prawns.

Another animal which is dependent on the seagrass beds is the dugong, the only existing species of herbivorous mammal that lives exclusively in the sea (Exhibit 379, p.2). The International Union for the Conservation of Nature lists the dugong as vulnerable to extinction. 'The northern shallow coastal waters of Australia possess by far the largest residual stocks of dugongs in the world' (Exhibit 379, p.3), and the Hervey Bay - Great Sandy Strait area is an extremely important habitat for resident and migratory dugongs (Exhibit 379, p.8).

A substantial commercial and amateur fishery for scale fishes, and an important commercial fishery for mud crabs and prawns, is to be found in the waters west of Fraser Island (Exhibit 264, p.4). Most of these fishes and crustaceans are estuarine-dependent for at least part of their life cycles, so the importance of the wetland and marine plant ecosystems is obvious.

Lastly, a high proportion of visitors to Fraser Island camp near the eastern beach and fish the surf enthusiastically for tailor, and many other species, at various favoured times of the year. These resources of fish are an important influence on the temporal and spatial nature of the recreational activities of Fraser Island, and their consequent pressures on its natural environment.

2.5 Conclusion

The natural environment of Fraser Island is of great significance, complexity and fragility. The Island possesses individual features of great attraction and importance, such as its perched lakes, immense beaches, cliffs of Teewah [Coloured] Sands, sandblows and rain-forested sand dunes. But the inevitable highlighting of the presence and importance of these individual features of its natural environment should not be allowed to obscure the links and interdependency of its many fragile elements, while, overall, an impression of wilderness gives unity to the broad spectrum of the particular natural features of the Island.

CHAPTER 3

FRASER ISLAND: THE HUMAN ENVIRONMENT

3.1 Introduction

This chapter describes man's activities on Fraser Island. It helps to show the origins of the present conflict and provides further background for the discussion later in this Report.

Briefly, the considerable Aboriginal population on the Island had all but disappeared by the end of the nineteenth century. Meanwhile, timber firms at Maryborough were tapping the hardwood forest resources, and between 1908 and 1925 virtually the whole Island was declared a State Forest Reserve and brought under the control of the Department of Forestry. This remained the position until 1963 and 1964 when areas along the east coast were excised from the State Forest to facilitate the development of holiday cottage and tourist facilities; in 1971 and 1973 further areas were excised in the north of the Island and gazetted as a National Park. In 1950 four Dredging Leases were granted to a mining syndicate, but little work -- even of an exploratory nature -- appears to have been done on these (and other leases that had been granted in the meantime) until 1956. Extraction of heavy mineral sands commenced during December 1971 on State Forest land in the southeast of the Island.

From a variety of sources the Commission has prepared Table 3.1 which sets out estimates of the areas reserved for various purposes, excised as leasehold or freehold tenements, or retained by the State of Queensland as vacant Crown land. Mining leases are not included because, as a comparison of Figs 3.1 and 3.3 indicates, these are 'superimposed' over areas which, for the most part, are designated as State Forest Reserve or Crown land.

3.2 Pre-European settlement

Evidence was placed before the Commission suggesting that Fraser Island has a cultural history stretching back from the ethnographic present, through its historically recorded past into truly pre-historic time (Exhibit 543, p.4). For example, during a very brief visit an experienced ethno-archaeologist discovered two stone axes and two large core scrapers at middens beside low coastal dunes five miles south of Indian Head; these implements originated on the mainland where tools fashioned in similar ways have, at central sites, been dated at between 18,000 and 22,000 years

before the present (edge ground axes) and up to 30,000 years before the present (core scrapers) (Exhibit 543, pp.3-4). The numerous large middens -- some of which extend over 1,400 m^2 -- along the foredune area of the east coast and elsewhere suggest that there was, at times, a considerable Aboriginal population on Fraser Island. It seems, however, that no detailed expert examination has been made of any of the middens (heaps of aboriginal food remains, tools and weapons, which unless disturbed, are stratified chronologically) so that the Commission cannot form a view as to the seasonal, short-term or long-term fluctuations in the numbers of people involved. Thus, Meston considered (Exhibit 156, p.5) that in 1905 there were only twenty Aboriginals remaining on the Island compared with 2,000 to 3,000 fifty years previously.

TABLE 3.1: AREAS ON FRASER ISLAND HELD AS RESERVES OR OTHER TENURES (EXCLUDING MINING LEASES)

		(hectares)
Above mean high-water mark		
State Forest Reserve	118,200	
National Park	33,640	
Happy Valley Township Reserve	253	
Eurong Township Reserve	282	
Oysterman's Camp Reserve	16	
School Reserve	1	
Other Official Reserves	1	
Lighthouse Reserve	259	
Seven non-urban freehold allotments	383	
Twenty-two non-urban leasehold allotments	161	
Crown land: strip between Happy Valley and Eurong	1,440	
Crown Land: Eurong to Sandy Cape	7,869	
Crown Land: islands off west coast	213	
Sub-total		162,718
Between mean high and low-water marks		
On east coast of Fraser Island	about 1,100	
On west coast of Fraser Island	about 4,850	
Sub-total[1]		5,950
Total area		168,668

Suggestions that there may have been 3,000 Aboriginals on the Island before the advent of white man and that this possibly represented one per cent of the total Aboriginal population were thought by an expert witness (Transcript p.2654) to be within the bounds of possibility. In contrast, a descendant of the Wondunna people indicated (Transcript p.3099) that no more than half-a-dozen extended families lived on the Island but that at certain times of the year, especially during the diamond-scaled mullet (*Liza vaigiensis*) season, there was a considerable influx of visitors from other families in the Badyala (or Batyala) tribe whose territory extended from Burrum River through Bauple Mountain to Hook Point (Transcript p.3100). The same witness emphasized the importance of ceremonial, burial and sacred places on the Island not only for the families residing there but for the remainder of the tribe on the mainland which, nonetheless, 'still belongs to his same land'. An indication was given of the parts of the Island that are still regarded as sacred; the relationship of these to sandmining operations is discussed in Chapter 6.

3.3 Early European contact

The first recorded sighting of Fraser Island by Europeans occurred in May 1770 when Captain James Cook, sailing northwards up the east coast of what was thought to be a headland or peninsula, named Indian Head and Sandy Cape. Europeans first landed on the Island in July 1802 when parties from *Investigator* (Matthew Flinders) and its support vessel spent a day on shore at Sandy Cape collecting botanical specimens. Flinders' chart showed 'Great Sandy Peninsula' as part of the mainland; it was not until the 1840s that voyages were recorded through Great Sandy Strait -- the narrow passage separating this Island from the mainland. By this time, too, the name 'Fraser' was coming into general use following the publicity given to the landing and subsequent murder there of Captain James Fraser and some of the crew from the wrecked *Stirling Castle* in 1836 and the eventual rescue of Mrs Fraser.

For the next hundred years or so, the main European interest in the Island was the exploitation of its hardwood timber resources. As early as May 1842 Andrew Petrie had reported that

> The blacks are very numerous on Frazer [*sic*] Island; there is a nut they find on it which they eat, and the fish are very plentiful. The formation and productions of the island are much the same as those of Moreton Island; the timber is a great deal superior, and also the soil; the cypress pine upon Frazer Island being quite splendid (Petrie, C.C., *Tom Petrie's Reminiscences of Early Queensland*, 1932, p.268).

Twenty years later kauri pine logs were being rafted to a mill on the Mary River and later to others including those of Wilson, Hart and Bartholomew (now known as Wilson, Hart and Co. Ltd) and R. M. Hyne and Son which began operations in 1865 and 1879, respectively. At first the timber operations were concentrated around Woongoolbver Creek on the west coast, but, as millers pursued hoop pine, kauri and white beech, logging operations were extended to Yidney in the east and Woralie and Bowarrady scrubs in the north. Blackbutt and tallowwood then attracted the attention of the sawmillers; by 1905 these species were being logged in the Poyungan and Bogimbah Creek areas, carried on tramlines to the west coast at Urang Creek (Exhibit 11), and rafted to Maryborough. From 1919 to 1925 McKenzies operated a sawmill and jetty at North White Cliffs and a tramline to tap nearby stands of timber; for the most part, however, timber operations on Fraser Island were confined to felling and rough trimming of logs that were milled in Maryborough. The Island was also used by fishermen; in 1889, for instance, sixteen hectares were set aside in the southwest as a Camping Reserve 'for the use of the Licensees of Oyster Banks'.

In 1908 the central portion of Fraser Island was declared a State Forest Reserve (*Queensland Government Gazette*, 10 October 1908, p.683) and came under the control of the Department of Forestry. Two years later this Department set up an administration centre at Bogimbah Creek which was shifted eighteen kilometres south to the mouth of Woongoolbver Creek in 1913, then seven kilometres east to 'Central Station' in Pile Valley on the headwaters of Woongoolbver Creek in 1920, and then again to Ungowa on the west coast in 1959. According to Stanton (Exhibit 9, p.7), the then Director of Forests drew up a working plan for the Island in 1922 to provide for

> The liberation, regeneration and fire protection of Eucalypt areas; the improvement of the Satinay and Brush Box stands by ringbarking (of useless trees) and the planting of poorly stocked areas with conifers, Hoop and Kauri Pine, and in the Cypress areas, regeneration treatment, planting of understocked areas with more valuable softwoods and fire protection of all treated areas.

The northern and southern portions of Fraser Island were added to the existing State Forest Reserve in 1925 (*Queensland Government Gazette*, 23 May 1925, p.2085) making the total approximately 162,163 ha.

During the period 1961-62 to 1973-74 the annual cut of timber averaged 22,097 m^3 (Exhibit 287, p.54), the logs being barged to sawmills at Maryborough from a number of loading sites on the west coast south of Moon Point. The allowable cut of hardwood from Fraser Island has been set by the Forestry Department at approximately 22,500 m^3 (Exhibit 277, p.8).

3.4 Tourist facilities

In the early 1930s the Queensland Government gave permission to one operator to conduct tours on Fraser Island (*Queensland Parl. Debates*, vol. 236, 1963-64, pp.1879-80, 29 November 1963). This firm, The Fraser Island Tourist Resort Company, established huts on the outer beach to accommodate tourists. No leases were entered into under this arrangement but intending tourists were required to obtain a permit from the Department of Forestry. In time a procedure evolved whereby this Department issued permits to people seeking temporary residence on the Island for holiday camps, fishing weekends or other pursuits. Such sites, 'restricted to sixteen perches [405 m^2]', were not intended 'for permanent residential sites or for building for rental'. Given the small numbers involved these were regarded as workable and satisfactory arrangements. During the 1950s and 1960s, however, some permit holders started to sub-let their sites while others who had erected 'substantial structures without authority' endeavoured to secure firm tenure over their sites to protect their assets. Furthermore, the Queensland Government was receiving applications for the lease of areas on the east coast of the Island to cater for tourists on a commercial basis.

Senior officers of several Queensland Government Departments reviewed this increasingly confused situation in 1963 and attempted to resolve it by recommending the excision from the State Forest Reserve of 1,975 ha on the east coast. This area was made up as follows (Fig. 3.1):

	(hectares)
Happy Valley Township Reserve (320 acres)	129.50
Eurong Township Reserve (720 acres)	291.37
Coastal strip, forty chains [805 m] wide between Happy Valley and Eurong (3,840 acres)	1,553.99
	1,974.86

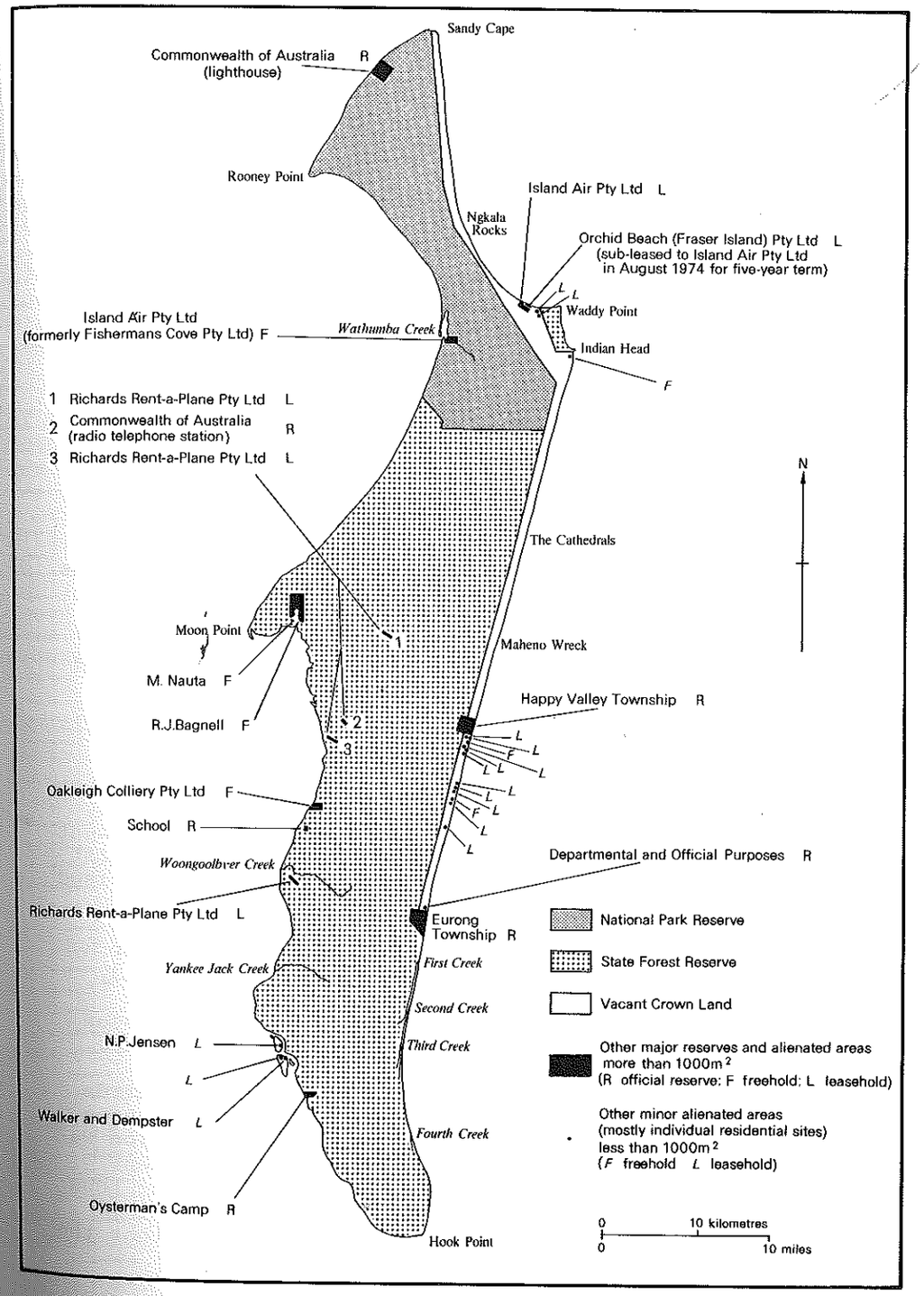


Fig.3.1: Reserves, vacant Crown land and alienated areas on Fraser Island

It was thought that this would cater for the 'squatters' if a further 23.48 ha were set aside on the western side of the Island between Urang and Bogimbah Creeks for them to garage their vehicles; it was envisaged that people would boat from the mainland, pick up their vehicles and drive across the Island to their establishments on the east coast. These proposals were announced in the Queensland Legislative Assembly by the Minister for Local Government and Conservation on 29 November 1963. Four days later the Member for Maryborough indicated his approval (*Queensland Parl. Debates*, vol. 236, 1963-64, pp.1914-5, 3 December 1963) and added

> I take it that the Minister's decision to open up part of the island for settlement in this way is a clear indication that the Government will resist any efforts that may be made by the Commonwealth Government at a later stage to have the island handed over for settlement by Nauruans. This is a matter that concerns Maryborough people very much as the future of the timber industry in that city is dependent on the timber resources of Fraser Island.

It may be that the Happy Valley and Eurong township reserves and the proposed garage reserve have never been gazetted but (from the boundaries shown on the 1:50,000 Department of Forestry map) the township reserves appear to be approximately 253 and 282 ha respectively. The excision of these 1,975 ha reduced the State Forest Reserve to approximately 160,188 ha.

A year later the Queensland Legislative Assembly agreed to the excision of a further 9,429 ha from the Forest Reserve. It was explained (*Queensland Parl. Debates*, vol. 239, 1964-65, p.1943-4, 1 December 1964) that the Government had recently received an application to establish a tourist resort on the Island north of the area that had been excised late in 1963

> The 23,300 acres [9,429 ha] now proposed for excision will, when added to the area already made available, provide an area for private development on the outer beach in a continuous belt from Eurong township north to Sandy Cape.

In effect a strip 800 m wide along the northern two-thirds of the east coast of the Island had reverted to the status of vacant Crown land (Exhibit 111, p.15). The exception was an area of 809 ha embracing Waddy Point and Indian Head which was a designated 'Beauty Spot' (Section 3.5) and thus remained under the control of the Department of Forestry. In fact the area excised measures about 7,910 ha so that the Forest Reserve was reduced to 152,278 ha.

An answer to a question on notice in the Legislative Assembly on 14 September, 1966 (*Queensland Parl. Debates*, vol. 243, 1966-67 p.538) indicates that this decision to review the situation along the Island's eastern seaboard was made not only because of 'numerous inquiries from persons interested in establishing tourist enterprises' but also to 'regularise several instances of "squatting" or unauthorised occupation'. The latter problem was handled by granting special leases to individuals for residential purposes (*Queensland Parl. Debates*, vol. 243, 1966-67, p.539). Six such leases were granted between December 1963 and September 1966: all were for twenty-four perch [607 m^2] allotments located south of the Happy Valley township reserve in two clusters at Yidney Rocks and Poyungan Rocks (Exhibit 647, *passim*).

Evidence of 'sustained interest in the establishment of a tourist resort on the island' encouraged the Queensland Government in 1965 to advertise for applications for the grant of a special lease over a 'suitable area on the ocean frontage'. Only one proposal was received and this led, on 1 January 1969, to Orchid Beach (Fraser Island) Pty Ltd being granted the lease of 5.45 ha north of Waddy Point (Fig. 3.1) on condition that the company effected improvements valued at not less than $80,000 within three years. A 'Samoan-type' tourist village was opened in May 1969 and now has overnight facilities for seventy-nine people.

In addition, accommodation in cabins, cottages, and immobile caravans was being developed elsewhere on the Island, so that by mid-1975 there were a further 220 beds located as follows:

Happy Valley township	90
Eurong township	70
Indian Head cabins	16
Waddy Point cabins	30
Yidney cabins	14

Altogether, then, it seems that there are about 300 beds available on the Island for overnight visitors in permanent structures ranging from relatively expensive, serviced, resort-type accommodation to 'do-it-yourself' fisherman's shacks. Average annual occupancy rates appear to be low -- perhaps no more than twenty per cent overall (precise data are not available since none of the entrepreneurs concerned gave evidence to the Inquiry). However, the Commission estimates that in 1975 possibly 3,600 people spent an average of six nights in such accommodation.

Most visitors to the Orchid Beach resort, which was sub-let to Island Air Pty Ltd in August 1974 (Exhibit 647), are brought to the Island in light aircraft. Some of the visitors to Happy Valley and Eurong settlements arrive in aircraft that land on the beach while others travel from Urangan on the mainland to Moon Point or Urang Creek by boat and then use hired vehicles to take them across to the east coast. The majority, however, travel to these settlements in their own or hired four-wheel drive vehicles from the southern tip of the Island. The proprietor of the barge service which has operated between Inskip Point and Hook Point since 1968 informed the Commission (Exhibit 265, p.1357) that he had conveyed 8,000 people to the Island in 1974 and expected to carry 10,000 - 12,000 there in 1975. Although some of these people -- perhaps fifteen to twenty per cent -- then travelled to the formal accommodation facilities already described, most brought their own camping equipment.

All visitors to Fraser Island are required to carry a permit, issued free on application, by the Department of Forestry (Exhibit 199). This system really exists, according to a former Conservator of Forests (Transcript pp.2298-303) because there are some people -- such as 'firebugs' and 'those who would indulge in some undesirable practices in the area' -- who must be kept out. These permits stipulate

> No camping permitted on State Forest Reserves, Timber Reserves, National Parks or Beauty Spots - only on ocean beach side of island

In practice it appears that little control is exercised over camping on the Island though employees of the Department of Forestry attempt to maintain some sort of surveillance over the activities of visitors as part of their day-to-day duties. The Commission understands that there are no full-time Wardens or Rangers but that three Honorary Rangers have been appointed (although these have very limited powers and perform a mainly advisory and educational role). The Commission saw remains of campsites and some rubbish at various points along the eastern beach.

Evidence before the Commission suggests that the majority of campers try to select shaded sites between high-water mark and the steep frontal dunes fringing the eastern beach. Four main sorts of campers can be identified. First, there are small family groups which visit the Island mainly during school holidays. Second, there are members of bushwalking clubs who tend to stay in the more remote parts of the Island and carry a minimum of equipment. Third, there are several organizations running three or four day 'safaris' for parties of twenty to thirty people. Fourth (and numerically the most significant) there are fishing parties which spend the entire time on the eastern beach. The Commission was told that during the tailor fishing season (August to October) campsites little

more than 100 m apart stretch from Eurong northwards to Indian Head; at the peak of the tailor season it appears on this basis that anything from 3,000 to 4,000 people may be under canvas along the eastern beach. There are no 'official' camping places or facilities outside the Happy Valley and Eurong town reserves; people are free to choose their campsites along almost the whole length of the eastern beach according to their whims. Nor are any controls exercised over the disposal of organic or inorganic rubbish. As may be imagined in this *laissez-faire* situation, a few campsites show little trace of human occupation while others are surrounded by rubbish.

A further group of people come to Fraser Island: these are day visitors, the annual numbers of which it was claimed have reached 10,000 in recent years. Most are conveyed by boat to Urang Creek or Ungowa on the west coast, transferred to ex-army trucks, and taken on a rapid sight-seeing tour across the Island. These visitors do not, of course, come within sight of the sandmining operations in the southeast.

3.5 Beauty Spots

Some of the more outstanding areas of the Island within the State Forest Reserve have been designated as 'Beauty Spots' by the Department of Forestry (Fig. 3.2). Twenty-three such areas, covering 2,778 ha (2.4 per cent of the State Forest) have been selected in this way:

	(hectares)
Indian Head - Waddy Point	809.37
Lake Bowarrady	485.62
'AB' Lake	12.14
Coomboo Lake	30.35
Deep Water Lakes	26.30
Freshwater Lakes	48.56
Hidden Lake	20.23
Eli Creek Scrub	101.17
Black Lagoon	8.09
Yidney Scrub	116.55
Yidney Lake	12.14
Lake Garawongera	107.65
Bogimbah Scrub	66.77
McKenzie old jetty area	64.75
Lake McKenzie	131.52
Lake Wabby	14.16
Basin Lake	8.09
Pile Valley and Eurong Road	129.49
Lake Birrabeen and Jennings Lake	184.13
Lake Benaroon	64.75
Inland from Ungowa	12.14
Lake Boemingen	259.00
Red Lagoon	64.75

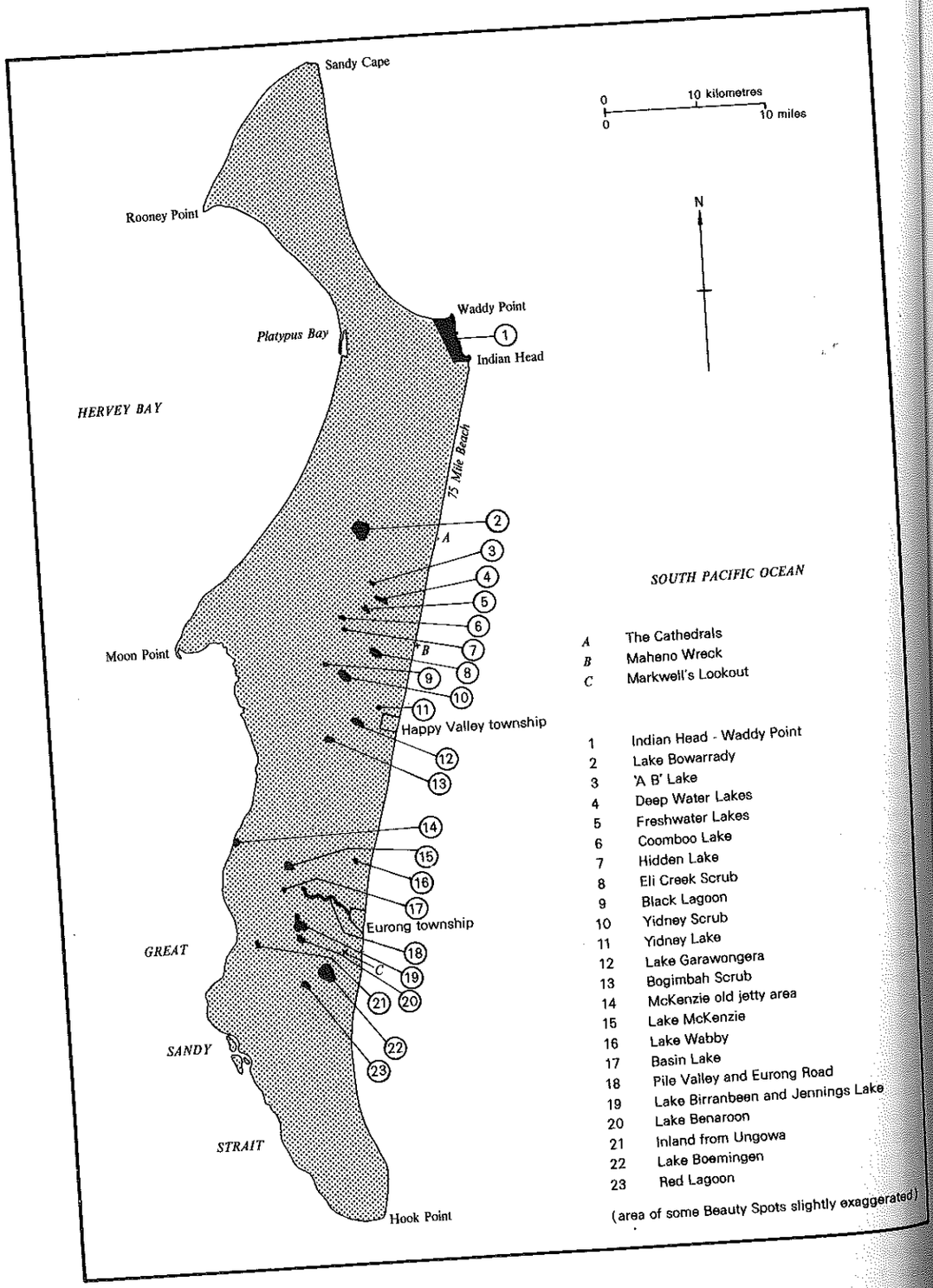


Fig. 3.2: Location of areas on Fraser Island designated as 'Beauty Spots'

The Commission was informed (Exhibit 287, p.39) that there is no provision in the *Forestry Act*, 1959 as amended, dealing specifically with Beauty Spots but that 'written Departmental policy' is that

> Beauty Spots are areas set apart on permanently reserved forest areas so as to preserve their recreational and/or scenic value. Such areas are set apart for the enjoyment of the public and are left in their natural state wherever possible.

It appears that 'Beauty Spots' have been protected for 'many years' (although no firm evidence was offered to the Commission as to when or how such areas were selected) but there is little doubt (Exhibit 472, p.4) that this protection stems simply from the responsible, long-sighted administrative procedures adopted by thoughtful officers within the Department of Forestry.

3.6 National Park

In Section 3.4 it was shown how during 1963 and 1964 a total of 9,885 ha was excised from the Forest Reserve along the eastern seaboard. An even larger area, however, was excised in 1971 and 1973 and gazetted as a National Park.

Evidence was given to the Commission (Exhibit 111, p.9) that suggestions for the dedication of part of the Island as a National Park were made as early as 1935. The National Parks Association of Queensland in 1964 requested that a National Park be created covering the northern part of the Island as far south as the northern limit of commercial timber. Then in 1971 a report by the Queensland Co-ordinator-General's Department (Exhibit 111, p.10) recommended that about 40,500 ha should be devoted to this purpose. Later that same year 24,807 ha in the extreme north were gazetted (*Queensland Government Gazette*, 4 December 1971, pp.1547-8) as a National Park; the Department of Forestry noted in its 1971-72 Annual Report (*Queensland Parl. Papers*, 1972-73, p.1628) that

> This park is of historic and scientific interest and contains sand dunes, swamps, freshwater lakes and wallum vegetation in an almost completely natural state. Vantage points overlooking the lakes together with a profusion of flowering plants make this park a scenic attraction as well as an area of considerable interest. It is intended this area will ultimately form part of a National Park of some 100,000 acres [40,469 ha].

The Park was enlarged by the gazettal of a further 8,834 ha (*Queensland Government Gazette*, 1 December 1973, pp.1632-4) two years later. It is entirely located in the Parishes of Carree and Wathumba but does not extend in the east to the mean high-water mark or even to the foredunes behind it. Much of this area of 33,640 ha still remains in a state of wilderness with no habitations or man-made structures apart from unsealed vehicle tracks linking Wathumba Creek wharf in the west with Orchid Beach resort on the east coast and Sandy Cape lighthouse (built in 1870) in the north.

3.7 Other areas excised from the State Forest Reserve

Previous sections of this chapter have outlined the steps by which the Forest Reserve of 162,163 ha was reduced between 1963 and 1973 by 43,525 ha. The areas involved can be recapitulated as follows:

	(hectares)
National Park	33,640
Happy Valley Township Reserve	253
Eurong Township Reserve	282
Crown land strip Happy Valley to Sandy Cape	9,344
Orchid Beach (Fraser Island) Pty Ltd	5
Six special residential leases	1

In fact a further 435 ha were excised mainly as a result of leasehold or freehold agreements. The areas (identified on Fig. 3.1) were:

(a) *State Government reserves*

(i)	Department of Public Instruction (school reserve)	1.21 ha	
	sub-total		1.21 ha

(b) *Non-urban freehold tenures*

(ii)	Fishermans Cove Pty Ltd	64.75 ha	
(iii)	R.J. Bagnell	126.50 ha	
(iv)	M. Nauta	126.70 ha	
(v)	Oakleigh Colliery Pty Ltd	64.75 ha	
	sub-total		382.70 ha

(c) *Non-urban leasehold tenures*

(vi)	Richards Rent-a-Plane Pty Ltd (airstrip)	20.24 ha	
(vii)	Richards Rent-a-Plane Pty Ltd (airstrip)	8.09 ha	
(viii)	Richards Rent-a-Plane Pty Ltd (airstrip)	20.24 ha	
(ix)	Commonwealth of Australia (radio-telephone station)	2.16 ha	
	sub-total		50.73 ha

The Commission was informed that the parcel of freehold land listed as owned by Fishermans Cove Pty Ltd at Wathumba Creek (64.75 ha excluding 2.01 ha reserved for telegraph purposes) had been the subject of an application to Burrum Shire Council for permission to subdivide it into 425 lots (Exhibit 42). An Environmental Impact Study commissioned by the owners recommended that the allotments should number no more than 351, that certain boundary adjustments should be made which would reduce the area to 54.63 ha, and that the remaining -- mainly swamp country -- should be offered for inclusion in the National Park which completely surrounds this lease. The Commission understands (Exhibit 170) that the Queensland Conservator of Forests has placed this area 'on a list of areas being considered for acquisition for National Park purposes but has given it low priority'. The Commission has noted a report in the *Australian Financial Review* (20 February 1976, p.33) which indicated that during the week a sixty-seven hectares site at Wathumba Creek had been sold for $158,000 to 'a Toowoomba businessman'.

3.8 Other non-urban tenures

In Section 3.4 it was noted that six special residential leases (totalling 0.36 ha) were granted in the mid-1960s in the narrow strip excised from the Forest Reserve along the east coast of the Island from Happy Valley to Sandy Cape, and a further 5.45 ha were leased to the proprietors of the Orchid Beach resort.

In addition, three freehold tenures (0.20 ha) and six leasehold tenures (3.2 ha) have since been granted along this coastal strip for residential purposes (Fig. 3.1) and a further 35.20 ha was leased so that a grassed airstrip could be built immediately adjacent to the Orchid Beach resort.

Between 1966 and 1970 three leasehold tenures were granted in respect of some sixty-seven hectares -- approximately a quarter of their total area -- on Dream and Stewart Islands which lie off the southwest coast of Fraser Island. The Commission was given no evidence about the use being made of these leases.

3.9 Mining Leases

Queensland Titanium Mines Pty Ltd

Interest in the possible extraction of heavy minerals from Fraser Island dates back at least to 1949 when two applications for Dredging Leases were received by the Queensland Government. These and two others (now known as MLs 104 - 107), together covering an area of 254 ha, were granted on 23 May 1950 to Mineral Deposits Syndicate (later known as Mineral Deposits Pty Ltd). All four were narrow strips, from 60 to 120 m wide, above mean high-water mark on

the east coast. A handful of men began exploratory work the following year but no minerals were extracted. Mineral Deposits Pty Ltd was granted six more leases (now known as MLs 108 - 113) in 1956; most of the 219 ha embraced by these were on the eastern beach below mean high-water mark but in some instances (e.g. MLs 108 and 109) part of the foredune was also included. The Maryborough Mining Warden reported that Mineral Deposits Pty Ltd had drilled 296 check bores in its leases during 1956. Apparently little further activity occurred until 1965 when Queensland Titanium Mines Pty Ltd took over the ten leases described, from Mineral Deposits Pty Ltd as well as ML 120 (48 ha) and the part of ML 84 (476 ha) located on Fraser Island from Titanium Alloy Manufacturing Co. Pty Ltd. Queensland Titanium Mines Pty Ltd -- which by 1965 held twelve leases covering 1,002 ha (Fig. 3.3) -- commenced actual mining on Fraser Island in December 1971. So far operations have been confined to MLs 84, 104 and 105 in the southeast of the Island (Chapter 5). Details of the Company's Mining Leases and Mining Lease Applications are set out in Tables 3.2 and 3.3.

D M Minerals

The Commission was unable to trace, from the evidence before it, the prior holders of all the leases currently held by Murphyores Incorporated Pty Ltd. Exhibits 63 and 97 indicate, however, that the applications for MLs 114 - 119 -- all beach leases -- were transferred to Murphyores Incorporated Pty Ltd from N.S.W. Rutile Mining Company Pty Ltd in September 1963. It is also clear from Exhibit 76 that the applications for MLs 93 - 96 inclusive (covering 8,667 ha), which were made on 1 June 1966, were the subject of considerable negotiation and discussion by several Queensland Government Departments before they were eventually granted on 15 March 1973. The applications for MLs 101 and 102 (Exhibits 74 and 75) -- respectively, 686 and 2,556 ha -- were received by the Maryborough Mining Warden on 4 January 1971 and approved, subject to variations in shape, on 23 August 1973. By the latter date, then, Murphyores Incorporated Pty Ltd held twelve leases totalling 12,164 ha (Fig. 3.3); the partnership D M Minerals commenced operations on one of these, ML 102, in mid-1975.

The Commission was informed (Exhibit 265, pp.727-9) that applications made for three other mineral leases in 1970 had been abandoned in 1971. Two, in the extreme north of the Island, covered an area of about 1,942 ha and contained, according to the Company, 'in the order of one hundred million tons of silica sand'. The other lease application covered the White Lakes system south of Wathumba Creek and was estimated by the Company to contain about 50,000 tons of rutile and zircon. The three areas concerned were entirely within the proposed National Park (the subsequent gazettal of which has been discussed in Section 3.6). Details of the Company's Mining Leases and Mining Lease Applications are set out in Tables 3.4 and 3.5.

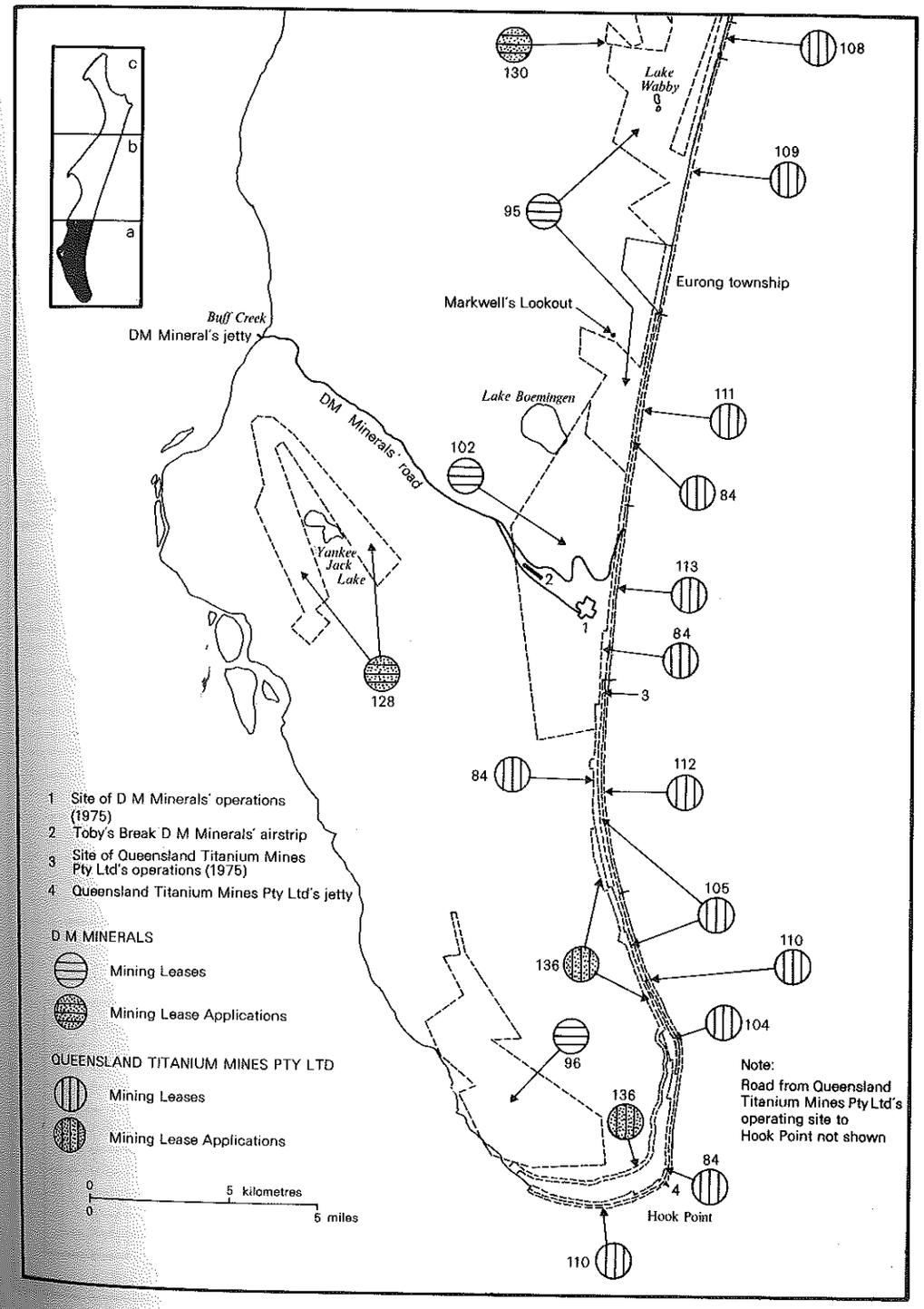


Fig. 3.3 (a): Mining Leases and Mining Lease Applications on southern part of Fraser Island

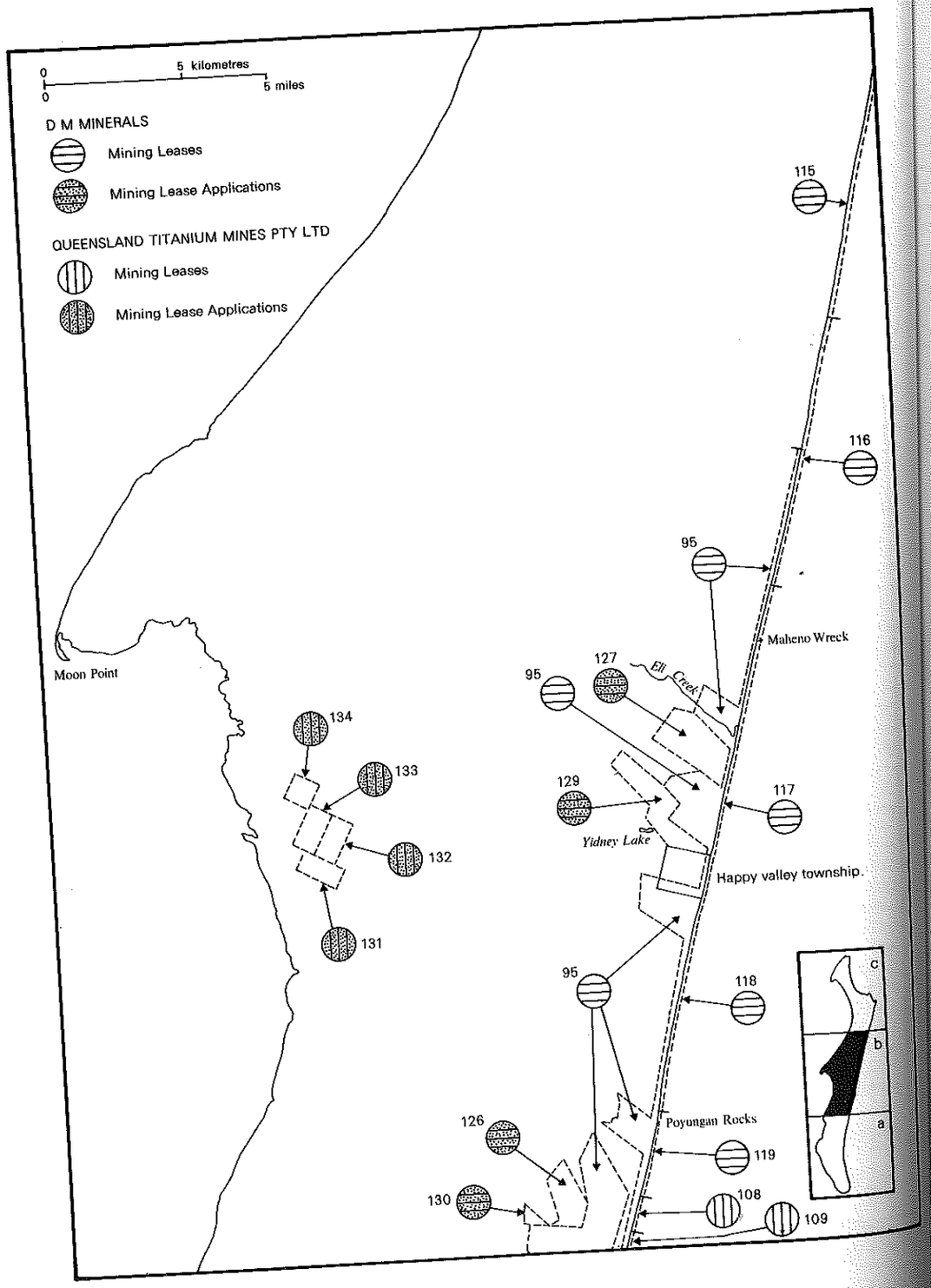


Fig. 3.3 (b) : Mining Leases and Mining Lease Applications on central part of Fraser Island

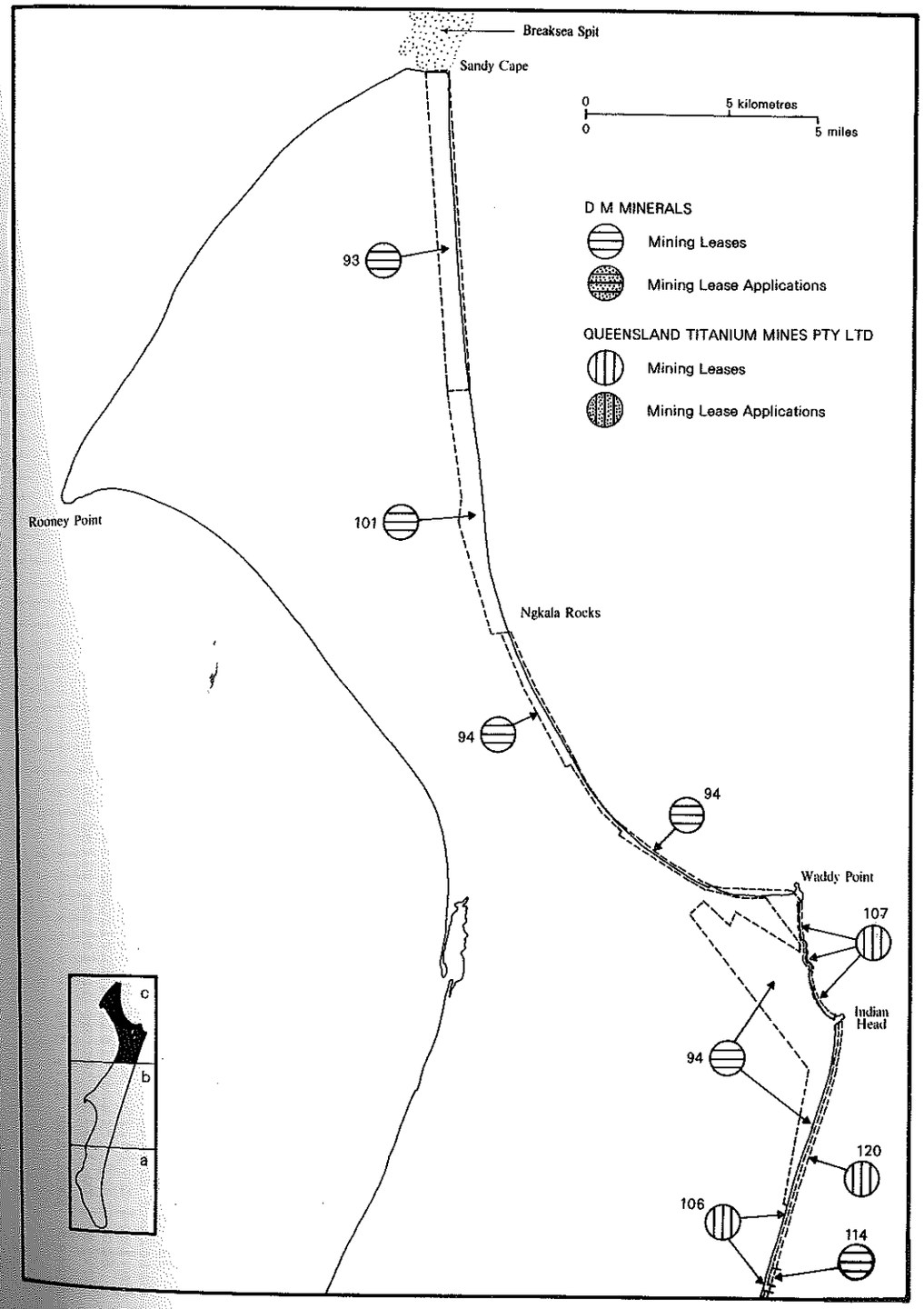


Fig. 3.3 (c) : Mining Leases and Mining Lease Applications on northern part of Fraser Island

TABLE 3.2: FRASER ISLAND LEASES GRANTED OR SUBSEQUENTLY TRANSFERRED TO QUEENSLAND TITANIUM MINES PTY LTD

Mining Lease	Date approved	Term of lease (years)	Area of Lease[a] (hectares)	Reserves	
				Rutile (tonnes)	Zircon (tonnes)
84	8 April 1965	21 from 1 February 1962	476[b]	32,000[c]	23,000[c]
104	23 May 1950	10 from 1 September 1949 18 from 1 September 1959	20		
105	23 May 1950	10 from 1 September 1949 18 from 1 September 1959	89		
108	24 December 1956	5 from 1 November 1955 17 from 1 November 1960	8		
109	8 August 1956	10 from 1 March 1956 11 from 1 March 1966	91		
110	18 December 1956	21 from 1 September 1956	39		
111	18 December 1956	21 from 1 September 1956	12		
112	18 December 1956	21 from 1 September 1956	30		
113	18 December 1956	21 from 1 September 1956	39		
106	23 May 1950	10 from 1 April 1950 17 from 1 April 1960	97	18,000[de]	17,000[df]
107	23 May 1950	10 from 1 April 1950 17 from 1 April 1960	48		
120	1 May 1962	21 from 1 March 1962	53		
Total twelve leases	-	-	1,002	50,000	40,000

a Stated on lease documents in acres and rounded here to nearest hectare.
b Part of Mining Lease 84 at Inskip Point excluded.
c Reserves estimated by firm. These exclude the quantities produced so far (44,292 tonnes of rutile and 32,793 tonnes of zircon: Exhibit 317, p.5) from Mining Leases 84, 104 and 105.
d Reserves estimated by firm (Exhibit 317, p.5).
e Revised to 14,250 tonnes in letter dated 20 January 1976 from Queensland Titanium Mines Pty Ltd to the Secretary, Fraser Island Environmental Inquiry.
f Revised to 11,700 tonnes in letter cited in preceding footnote.

Sources: Exhibits 317, 318.

TABLE 3.3: APPLICATIONS FOR MINING LEASES ON FRASER ISLAND BY QUEENSLAND TITANIUM MINES PTY LTD

Mining Lease Application	Date of application	Term sought (years)	Area of Lease[a] (hectares)	Reserves[b]		Area to be mined[c] (hectares)
				Rutile (tonnes)	Zircon (tonnes)	
131	15 December 1972	21	130	25,000[d]	22,000[e]	69[f]
132	15 December 1972	21	130			
133	15 December 1972	21	130			
134	15 December 1972	21	130			
136[g]	25 May 1973	10	61			
Total five lease applications	-	-	581	25,000[d]	22,000[e]	69[f]

a Stated on lease application documents in acres and rounded here to nearest hectare.
b Information from firm as to reserves available for recovery (Pennycuick, Transcript p.2445).
c Information from firm as to area of ore bodies (69 hectares) and 'area of disturbance' (99 hectares): (Pennycuick, Transcript pp.2445-6).
d Revised to 25,420 tonnes in letter dated 20 January 1976 from Queensland Titanium Mines Pty Ltd to The Secretary, Fraser Island Environmental Inquiry.
e Revised to 22,230 tonnes in letter cited in preceding footnote.
f Revised to 85 hectares in letter cited in footnote d.
g Reservation for road only.

Sources: Exhibits 317, 318, 319.

TABLE 3.4: FRASER ISLAND MINING LEASES GRANTED TO MURPHYORES INCORPORATED PTY LTD

Mining Lease	Date of Lease	Term of Lease (years)	Area of Lease[a] (hectares)	Area to be mined[b] (hectares)	Reserves[c] Rutile (tonnes)	Reserves[c] Zircon (tonnes)
95	15 March 1973	21 from 1 June 1966	3,561	348	168,000[d]	169,000[d]
102	23 August 1973	21 from 1 September 1973	2,557	223	90,000[d]	86,000[d]
Sub-total (two leases)	-	-	*6,118*	*571*	*258,000*	*255,000*
93	15 March 1973	21 from 1 June 1966	881	146	64,000[d]	49,000[d]
94	15 March 1973	21 from 1 June 1966	1,845	243	117,000[d]	133,000[d]
96	15 March 1973	21 from 1 June 1966	2,380	135	59,000[e]	59,000[e]
101	23 August 1973	21 from 1 September 1973	687	24	8,000[d]	9,000[d]
114[h]	4 July 1974	9 from 1 August 1974	5			
115[h]	4 July 1974	9 from 1 August 1974	58			
116[h]	4 July 1974	9 from 1 August 1974	58	88	27,000[f]	51,000[f]
117[h]	4 July 1974	9 from 1 August 1974	58			
118[h]	4 July 1974	9 from 1 August 1974	58			
119[h]	13 June 1974	9 from 1 July 1974	16			
Sub-total (ten leases)	-	-	*6,046*	*636*	*275,000*	*301,000*
Total twelve leases	-	-	12,164	1,207	533,000[g]	556.000[g]

a Stated on lease documents in acres and rounded here to nearest hectare.
b From information provided by firm in acres and rounded here to nearest hectare.
c From information provided by firm in tons and rounded here to nearest thousand tonnes.
d Proven reserves.
e Probable reserves.
f Inferred ore.
g Total of proven and probable reserves and inferred ore.
h Beach leases.
Sources: Exhibits 14 to 25 inclusive, 62, 74 and 75.

TABLE 3.5: APPLICATIONS FOR MINING LEASES ON FRASER ISLAND BY MURPHYORES INCORPORATED PTY LTD

Mining Lease Application	Date of application	Term sought (years)	Area of Lease[a] (hectares)	Reserves[b] Rutile (tonnes)	Reserves[b] Zircon (tonnes)	Area to be mined[c] (hectares)
126	29 September 1972	21	198	35,000	38,000	99
127	29 September 1972	21	364	28,000	33,000	77
128	29 September 1972	21	1,271	88,000	104,000	227
129	29 September 1972	21	393	25,000	29,000	105
130	9 October 1972	21	38	9,000	10,000	14
Total five lease applications	-	-	2,264	185,000	214,000	522

a Stated on lease application documents in acres and rounded here to nearest hectare.
b From information provided by firm in tons and rounded here to nearest thousand tonnes. Reserves described by firm as 'proven reserves'.
c From information provided by firm in acres and rounded here to nearest hectare.

Source: As for Table 3.3.

Other mineral leases

During the 1950s and 1960s various other mining leases were issued on Fraser Island. The relationships, if any, between these and the holdings of the two companies now operating are obscure. It is known, for instance, that in 1954 two Dredging Leases, totalling fifty-seven hectares were granted to 'A. J. H. Wight and party' and that this syndicate acquired a further six such leases during the next two years; in 1956 the Maryborough Mining Warden reported, however, that no work had been done on them and he repeated this comment in his annual summary for the next several years. It is also on record that Crescent Rutile N.L. acquired two leases in 1956 and another in 1958. Five Dredging Leases were granted to Offshore Minerals Pty Ltd covering an area between the southern part of the Island and the mainland; these were issued on 1 December 1968, for a period of ten years but were surrendered on 11 December 1970 (Exhibit 147).

3.10 Population and employment

Population

About 100 people reside permanently on Fraser Island, the majority being at or near the townships of Eurong and Happy Valley, the tourist resort at Orchid Beach, and the forest station at Ungowa. It was noted earlier in this chapter that several residential freehold and leasehold tenures exist along the east coast. But, in addition, there are a number of shacks, converted buses and similar sub-standard 'dwellings' at places where no titles appear to have been granted: these include the State Forest area south of Eurong, at Third Creek, at Markwell's Break, and at Hook Point (Exhibit 177) as well as others at White's Creek, south of Poyungan Rocks, halfway between Poyungan Rocks and Corby's Beach, and north of the Wabby Lakes exit (Exhibit 265, p.1055).

Neither of the mining companies now operating provide permanent accommodation for their workforces on the Island. At the end of each shift Queensland Titanium Mines Pty Ltd conveys most of its employees by road from the mining site to Hook Point and thence by boat to Inskip Point. D M Minerals have constructed an airstrip (equipped for night flying) at Toby's Break and use this to fly most of their employees daily to and from Maryborough and Hervey Bay. Barracks have been built on ML 95 to house the handful of administrative and engineering staff who are required to live on the Island for about a week at a time (Exhibit 265, p.779) and to act as emergency accommodation in the event of any interruption to air services. The Commission was told that a few -- perhaps no more than half-a-dozen -- of the men employed by the mining companies had set themselves up in some of the shack accommodation described in the previous paragraph. A representative of Queensland Titanium Mines

Pty Ltd explained (Transcript pp.2505-6) that all employees were paid a travelling allowance whether or not they lived on the mainland but the Company had no desire to interfere with a man's freedom of choice as to where he prefers to live. The majority of the employees of Queensland Titanium Mines Pty Ltd reside in the Rainbow Beach area of Widgee Shire or in the City of Gympie, while D M Minerals draws most of its labour force from the City of Maryborough and Burrum Shire.

Employment

The Commission estimates that, apart from sandmining, about eighty people are employed fulltime, or almost fulltime, on Fraser Island. This figure *excludes* people who provide air or sea services or who work in establishments on the mainland processing timber derived from the Island.. The Commission's estimate, derived from a number of sources, is made up as follows:

(a)	*Forestry activities*	
(i)	logging contractor and employees	14
(ii)	mills' logging overseer	1
(iii)	Department of Forestry employees	16
(b)	*Tourist activities*	
(i)	Orchid Beach, Happy Valley and Eurong	41
(ii)	other operators (transport, camping contractors, etc)	6
(c)	*Other activities*	
(i)	lighthouse keepers	2
	Total	80

The Commission was informed (Exhibit 317, p.7) that Queensland Titanium Mines Pty Ltd employed sixty-seven men on Fraser Island as at 17 July 1975, plus another sixty-five on the mainland at Rainbow Beach (the site of its dry mill). As at 19 June 1975, D M Minerals had a workforce of 141; it is understood that all but about ten worked on Fraser Island.

The Commission is unaware of any other profit-making activities on Fraser Island apart from those mentioned in the previous paragraph. No one, for example, appears to be employed in market gardening, dairying, livestock raising or commercial fishing.

3.11 Summary

The main point to emerge from this chapter is the contrast between the long established use of Fraser Island's timber resources and the greatly increased use of the Island for other purposes during the last decade. Even ten years ago this was a remote, inaccessible and little-known part of Australia; now it is the scene of two separate sandmining operations, the mecca for thousands of fishermen and a venue for increasing numbers of tourists. At least in part, the recency and rapidity of these developments and their sudden impact on the landscape may help to explain the strength of feeling that has been engendered by the subject of this Inquiry.

CHAPTER 4

THE ENVIRONMENTAL SIGNIFICANCE OF FRASER ISLAND AND THE NATIONAL ESTATE

4.1 Introduction

In considering the evidence on the environmental aspects of the making of decisions about the export of the minerals of Fraser Island, it is necessary for the Commission to make an appraisal of the environmental significance of the Island as a whole. This is not just because of the existence of a substantial body of evidence on this subject. Such a course is necessary in order to place sandmining, and decisions on the export of its products, in an appropriate context for the purposes of this Inquiry. The Commission is not evaluating the environmental aspects of sandmining generally, so much as the environmental aspects of Commonwealth decisions relating to sandmining on this particular Island. An analysis of the nature of the environment of the Island, and its significance, is a necessary preliminary step in evaluating the importance of the effects of sandmining on that environment, which is, in turn, a fundamental aspect of Commonwealth decisions relating to the export of minerals extracted from the Island.

Since it is also clear that the environmental effects of sandmining on the Island are not confined within the boundaries of the Mining Leases now being worked, an appraisal of the environmental significance of the Island is also required in reporting

> in respect of all of the environmental aspects of the making of decisions by or on behalf of the Australian Government in relation to the exportation from Australia of minerals...extracted...from Fraser Island

The main purpose of this chapter is to consider the evidence on the interrelated matters of the environmental significance of the Island and Fraser Island as part of the National Estate.

4.2 The importance of Fraser Island to Australians: its environmental significance

The social significance of Fraser Island

In Chapter 3, Fraser Island was described in relation to the human environment, and it was concluded, *inter alia*, that though as recently as ten years ago the Island was remote, inaccessible, and relatively little known, it now attracts increasing numbers of visitors, approximating, on an overview

of the figures on tourism found in Section 3.4, to an annual figure of more than 100,000 visitor days. The growing importance of the Island to people indicates its increasing significance in the human environment, and is a fundamental fact in this consideration of the overall environmental importance of the Island.

Some explanation is required of this increasing social significance of Fraser Island. Having regard to the evidence, it is apparent that the Island possesses a series of characteristics not only traditionally pleasing to man, but which are now, in the last quarter of the twentieth century, of increasing importance. Within the relatively small compass of its island setting, there is to be found a combination of anticipated features, like panoramas of beach, sea and skyline, and characteristics that both surprise and delight, such as sudden prospects of perched lakes surrounded by forested sandhills and tall rain-forests on steep dunes. Overall there is a unifying impression of wilderness.

The evidence indicates that most of Fraser Island, other than the sandmined areas and settlements, remains a wilderness in the sense of a wild or uncultivated tract of land. This wilderness is not confined to the existing National Park at the northern end of the Island. The selective logging which has been taking place on the Island since the mid-nineteenth century has not destroyed the character of the forested areas as wilderness in the sense used here.

The importance of Fraser Island to Australians generally lies not only in its possession of a combination of characteristics of increasing importance at this time, but also in its juxtaposition with the densely populated east coast of Australia and, in particular, of Queensland. This heightened its value to those medical and other witnesses who are aware of the need felt by large numbers of urban dwellers in many parts of the world to withdraw occasionally from the crowded routine of their everyday lives into such wild, undeveloped, and largely unpopulated areas to camp, walk, fish and relax. As it would appear that the need to withdraw to such areas is increasing it can be anticipated that the use of the Island for this purpose will increase substantially. In addition to its special value in this sense, the Island, and particularly its eastern coastline, is increasingly attractive to people sharing the widespread desire of many Australians and others to move towards the coast and the off-shore islands for some part of their leisure time during the course of each year. Within 115 km of Brisbane the only long unbroken beaches flanked by the essentially undeveloped hinterland so sought after for camping by family groups and fishermen are those of Fraser Island, Moreton Island and Cooloola. Like Fraser Island, Moreton Island is the subject of sandmining proposals, while Cooloola is a National Park.

A number of witnesses emphasized the importance to Australians of Fraser Island as wilderness. While the impression of wilderness provides unity to the Island, its significance lies in something more complex. Essentially, a wilderness consists of any wild or uncultivated tract of land, however, uniform its vegetation and landscape. Fraser Island, however, is a wilderness possessing a great variety of natural features, vegetation and landscape forms. To concentrate exclusively on the importance of Fraser Island as wilderness is to ignore, for example, its perched lakes and their relationship with the surrounding landscape. These perched lakes, for the most part surrounded by wooded sand dunes, provide an unusual variety of open prospects to the dunes beyond which, in turn, lead the eye to the open horizon above the forested canopy. This lakeland landscape, set in sand dunes surrounded by the sea, surprises by its variety as well as by the absence of certain features, such as rocky mountainsides, which are frequently found in juxtaposition with lakes. Here the lakes are fringed neither by mountains nor plains, but by sandhills, variously shaped, within a general pattern of dunes running southeast to northwest across the Island in response to the prevailing winds.

Furthermore, the natural landscape of the Island is not at all uniform. Its complexity within an overall pattern of dunes conforming to the prevailing winds can best be appreciated from the summits of high dunes. Immense panoramas of forests, heaths and sea can be seen from high points like Markwell's Lookout and Ocean Lookout. From these places, as well as from the popular eastern beach, the visitor can also observe horizontal vistas of beach and coastline, sky and sea.

Fraser Island possesses a series of intrinsic qualities, unified by an overall impression of wilderness, which, taken separately or together, have traditionally appealed to a wide variety of people of varying tastes and interests and are becoming increasingly attractive. Important as the Island is to specialists in a variety of disciplines, its attractions are by no means confined to those enjoyed exclusively by any small elite. Its geographical location close to the populous eastern seaboard in a period when comparable places are becoming at the same time scarcer and in increasing demand, is a major factor in its growing importance for Australians generally. Having regard to the evidence, Fraser Island in its natural state is of great significance in the human or social environment as a place for leisure and recreation in the widest sense of that word. Its importance to the present generation is likely to be exceeded only by its significance for future generations of Australians. Notwithstanding its scientific value and importance in other respects, Fraser Island is significant principally for people. Mr David Yencken, who, when he gave evidence to the Inquiry was Chairman of the Interim Committee on the National Estate, and is now Chairman of the Australian Heritage Commission, was of the opinion that Fraser Island was one of the four or five most interesting and unique areas in Australia worthy of conservation (Transcript p.2391).

The scientific significance of Fraser Island

Notwithstanding the importance of Fraser Island in the social or human environment, its environmental significance in scientific terms is of great intrinsic importance and is by no means unrelated to its importance in the social or human environment. The scientific significance of the Island is an aspect of its importance to the present community and future generations. Furthermore, an awareness of the scientific importance of particular aspects of the Island need not be separated from an appreciation of those of its qualities which make it increasingly popular for people generally. Indeed, it is clear from the evidence of a number of witnesses that a knowledge of and interest in the features of the Island which are of scientific significance can frequently be linked with, or lead to, a heightened appreciation of their aesthetic value. Illuminating evidence on this point was given by an eminent limnologist who dwelt on the interaction between his aesthetic appreciation of lakes and his scientific studies of them. His detailed technical knowledge of lakes, and the forms of life in them, had obviously intensified his aesthetic appreciation both of the Fraser Island lakes and the landscape in which they are set (Transcript pp.283-6). The scientific significance of the Island's perched lakes lies essentially in their rarity in such a setting, located as they are, for the most part, in sand dunes high above sea level, while their aesthetic merit flows partly from this and partly from their relationship with the other components of the Fraser Island landscape. Scientific and aesthetic considerations are interwoven. The Island's landscape components are not fortuitous or haphazard arrangements of sand dunes, streams, forests and heathlands, while the aesthetic potential of the lakes themselves is determined, among other things, by the shape and nature of the sand surfaces on which they are located. An appreciation of the scientific reasons behind the development of the natural environment of the Island heightens, for many, an appreciation of its aesthetic qualities.

Just as its importance in the human environment is due to a variety of factors, the scientific significance of the Island to the present community and future generations of Australians, and the world, does not depend exclusively on any one feature. Its scientific importance flows, *inter alia*, from its being the largest sand island in the world and its possession of the greatest known number of perched lakes, as well as of distinct and independent dune systems found anywhere in the world. The significance of its perched lakes lies not only in their rarity, but also in their unusual oligotrophic nature, that is to say, in their combination of low biological productivity and excellent oxygenation. Its dune types are of widely differing ages. They contain vital information on climatic and sea level changes through the ages, as well as throwing light on the details of dune formation and destruction.

Furthermore, the Island's biological isolation has led to the development of rain-forests bearing little resemblance to those on the adjacent mainland, and containing some species at their northern, and others at their southern, limits of distribution. This same biological isolation, together with such specific factors as the acidic waters of the lakes, wetlands and streams, has led to the appearance of a distinctive freshwater fauna.

Fraser Island was, at least seasonally, heavily populated prior to European settlement in the area, and the remains of aboriginal culture are apparent in the middens of the eastern coastline, while there are indications that a number of other sites may have anthropological and archaeological significance. Though it is premature to attempt any definitive assessment of the significance of the Island in these respects, it is possible that if these sites are preserved, they will be a source of important discoveries.

Though not attracting an immense range of birds, the Island is a habitat for at least twenty-two migratory birds at a time when the habitats of these birds are diminishing on the east coast of Australia (Section 2.4). Its importance as a habitat is therefore somewhat enhanced.

Looking at the evidence as a whole, it was not seriously disputed by any witness that Fraser Island is of major environmental significance in respect of the scientific qualities of its natural environment. Its scientific importance is related to its social significance in terms of the human environment.

4.3 The *Australian Heritage Commission Act* 1975

In making its appraisal of the environmental significance of the Island as a whole, the Commission has concluded that Fraser Island is of major environmental significance to the present community and future generations. Having regard to the evidence, the Island is undoubtedly a place eminently worthy of conservation in its natural state for the benefit of the nation as a whole.

This appraisal of the evidence relating to the environmental significance of the Island has also led the Commission to make a Finding that the whole of Fraser Island is worthy of being recorded as part of the National Estate pursuant to the provisions of the *Australian Heritage Commission Act* 1975. For the purposes of that Act, it is provided that (Sub-section 4.(1))

> the national estate consists of those places, being components of the natural environment of Australia or the cultural environment of Australia, that have aesthetic, historic, scientific or social significance or other special value for future generations as well as for the present community.

While this Finding flows naturally from the broad scope of the words of the Direction establishing the Inquiry -- requiring the Commission to consider *all* of the environmental aspects of this matter -- such Findings are also envisaged by the *Australian Heritage Commission Act*, the statute dealing specifically with the National Estate. Sub-section 25.(1) of that Act contemplates that a Commission conducting an Inquiry under Section 11 of the *Environment Protection (Impact of Proposals) Act* (as this Inquiry has been conducted) even though not appointed specifically for the purposes of considering matters relating to the National Estate, may make a finding (and a recommendation) that a place be recorded as part of the National Estate.

The *Australian Heritage Commission Act* deals with the definition, identification, recording and conservation of the National Estate. It provides, *inter alia*, for the making of a Register listing places recorded as part of the National Estate. Some of the effects of the listing of a place in the Register should be mentioned. It facilitates the taking of action, and the incurring of expenditure, by the Commonwealth Government with a view to conserving, improving and presenting that place as part of the National Estate. Subject to certain provisos, it also imposes a duty (under Section 30) on the Commonwealth Government and its statutory authorities not to take

> any action that adversely affects, as part of the national estate, a place that is in the Register.

Although listing a place in this Register enables the Commonwealth Government, within the scope of its constitutional powers, to facilitate the conservation and management of that place, it does not vest any proprietary rights in the Australian Heritage Commission or the Commonwealth Government. Listing does not deprive any landowner of his property in a place entered in the Register. Essentially, listing gives the Commonwealth Government certain rights and duties to be exercised in carrying out its normal constitutional functions.

Listing a place in the Register is consistent with, but not the same as, giving that place the status of a national park. Normally, a terrestrial national park is created by dedicating or reserving the lands in question for such a purpose. However, registration as part of the National Estate does not involve dedication or reservation of lands.

To the extent that is possible within a single sub-section, the statutory definition provides a range of criteria which, taken individually or collectively, identify a place as part of the National Estate (Sub-section 4.(1)). The criteria relate to aspects of significance or other special value for present and future generations; those specifically identified being aesthetic, historic, scientific and social aspects.

4.4 Fraser Island and the National Estate criteria

Fraser Island is worthy of being recorded as part of the National Estate because it is a place which is a component of the natural environment of Australia that has aesthetic, scientific and social significance and special value for future generations as well as for the present community (*Australian Heritage Commission Act*, Sub-sections 4.(1), 22.(1) and Section 25). In Section 4.2 the evidence relating to the social significance of Fraser Island and its importance in the Australian human environment, as well as the evidence on its scientific significance, was assessed. It is unnecessary to repeat here the matters dealt with in those sections except to emphasize that, above all else, Fraser Island is of great social significance by virtue both of its possession of a combination of natural features and other qualities in increasing demand in Australia and elsewhere and its geographical position in relation to the east coast of Australia. This significance is likely to be all the greater to future generations in the event that the Island is conserved in its natural state in the national interest. The emphasis on the social significance of the Island is not intended to diminish its scientific importance which, by itself, would justify -- or, indeed, require -- the listing of the Island on the Register of the National Estate.

The evidence on the aesthetic significance of the Island was of two kinds. One related to the immediate sensory perception of the Island, or particular features of it, by witnesses. The other concentrated on the inspirational value of Fraser Island for certain artists and writers, such as Sidney Nolan and Patrick White, who communicate special perceptions of its aesthetic qualities in works which would not normally be regarded as representational or purely descriptive of its landscape.

The first kind of evidence dealt with the importance people attached to their perception of its qualities and the benefits gained from that perception. The Island's aesthetic significance is thus closely related to its social significance and importance in the human environment. In aesthetic terms, the significance or special value of the Island, on the evidence before the Commission, lies essentially in its possession of landscape characteristics traditionally pleasing to man which are here found combined in a comparatively unusual way. The prospects across the perched lakes from the wilderness refuges on the sand dunes

surrounding them constitute an unusual restatement of a well-known theme of lakeland landscape, on this occasion, not in a conventional mountain setting, but on an island possessing a variety of other landscape characteristics which are also partly familiar and partly unusual. Immense horizontal vistas of beach, sea and sky are to be enjoyed not only from the shoreline and the foredunes, but on a grander scale from the huge steep dunes of the interior of the Island. Overall is the unifying impression of wilderness, not of a wilderness which is uniform, but one possessing great variety, and ranging from rain-forests to heathlands, growing on a landscape containing natural features widely regarded as of considerable beauty, such as the perched lakes, the cliffs of coloured sand, watercourses like Eli Creek, and vast sandblows.

The second kind of evidence relating to the aesthetic significance of the Island dealt with its inspirational qualities. The poet Judith Wright-McKinney, herself a member of the Committee of Inquiry into the National Estate, gave evidence concerning its influence on works of artists and writers such as Sidney Nolan and Patrick White (Transcript p.397). Her evidence indicates the significance of the Island as part of the 'cultural environment of Australia' as well as a component of its natural environment (*Australian Heritage Commission Act*, Sub-section 4.(1)). The National Estate, as described in the Act, consists of places that are components of the Australian cultural environment, as well as those that are part of the natural environment. The 'cultural environment' is not confined by the Act to the built environment. In a letter written in Septmember 1975 and exhibited at the Inquiry (Exhibit 477) Nobel Laureate Patrick White indicated that he had just completed a novel based on the story of Eliza Fraser who, with her husband James, landed on the Island which now bears their name after being shipwrecked in 1836. After the killing of her husband, it is generally thought that Mrs Fraser lived with the Aboriginals until she was finally rescued by an ex-convict who had lived amongst them for some years (Exhibit 291). Patrick White has, of course, already used Fraser Island as a source of inspiration in his novel *The Eye of the Storm*.

4.5 Emerging international environmental obligations and Fraser Island

The development of the concept of the National Estate in Australia is linked in practice with the emergence of international environmental obligations. In recent years there has been increasing concern felt by people in many parts of the world that the pressures of population growth and economic development on the natural environment require fresh initiatives to identify and conserve places of special value and significance. The General Conference of the United Nations Educational, Scientific, and Cultural Organisation, at its meeting in Paris in October and November 1972, considered this problem in detail, and adopted the *Convention*

for the Protection of the World Cultural and Natural Heritage. Australia signed this *Convention* on 23 November 1972. Its preamble notes

> that the cultural heritage and the natural heritage are increasingly threatened with destruction not only by traditional causes of decay, but also by changing social and economic conditions which aggravate the situation with even more formidable phenomena of damage or destruction.

The *Convention* declares in Article 4 that each State party to it

> recognises that the duty of ensuring the identification, protection, conservation, presentation and transmission to future generations of the cultural and natural heritage...situated on its territory, belongs primarily to that State.

For the purposes of the *Convention*, 'natural heritage' is defined in Article 2 as

> natural features consisting of physical and biological formations or groups of such formations, which are of outstanding universal value from the aesthetic or scientific point of view; geological and physiographical formations and precisely delineated areas which constitute the habitat of threatened species of animals and plants of outstanding universal value from the point of view of science or conservation; natural sites or precisely delineated natural areas of outstanding universal value from the point of view of science, conservation or natural beauty.

In 1973 the Australian Government acted in accordance with the spirit of the *Convention*, which it had then not yet ratified, by appointing the Committee of Inquiry into the National Estate, whose *Report* was exhibited at the Inquiry (Exhibit 301). Several members of that Committee also gave evidence at this Inquiry emphasizing the environmental significance of Fraser Island. In an Appendix to its *Report*, the Committee set out the *Convention* in full, emphasizing its importance in relation to the conservation of the National Estate. The committee recorded (Exhibit 301, pp.251-2) that

> The convention places important obligations on any country which becomes a party to it. Australia, once it ratifies the convention, will have a strong obligation to conserve those parts of the National Estate which may be regarded as World Heritage. We regard the convention as of the highest significance for Australian National Estate policy.

Australia lodged its instrument of ratification of the *Convention* on 22 August 1974 and, in the following year, the Commonwealth Parliament passed the *Australian Heritage Commission Act*, dealing with the identification and protection of the National Estate. The provisions of that Act are in harmony with the *Convention*, which requires national action in the protection of the cultural and natural heritage (Article 4). Following the lodgment of sufficient instruments of ratification in accordance with Article 33, the *Convention* finally came into force on 17 December 1975.

Another treaty of relevance to the subject matter of this Inquiry containing international environmental obligations by which Australia has indicated a willingness to be bound in the future is the *Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment*, which was signed in 1974. At least twenty-two of the 200 bird species known to occur on the Island are listed in the Annex to the Agreement, which lists the birds known to migrate between the two countries. The birds listed in the Annex which are found on Fraser Island can be ascertained by comparing the Annex (Exhibit 462) with the Systematic List prepared by Vernon and Barry in 1972 (Exhibit 220). They include shearwaters, frigate-birds, egrets, sand-dotterels, plovers, sandpipers and terns. The Agreement notes

> that many species of birds migrate between Japan and Australia and live seasonally in the respective countries and that there are certain species of birds which are in danger of extinction and also that co-operation between the two Governments is essential for the conservation of these birds.

Each Government is required (Article iv.3) to

> encourage the conservation of migratory birds and birds in danger of extinction

and (Article vi)

> endeavour to take appropriate measures to preserve and enhance the environment of birds protected under the provisions of this Agreement.

The recording of Fraser Island as part of the National Estate would be an act in the spirit of this treaty, as it would encourage the conservation of the habitats of birds migrating between Australia and Japan.

4.6 Conclusion

To place its consideration of the environmental aspects of decisions relating to the export of the minerals of Fraser Island in their appropriate context, the Commission has found it necessary to consider the environmental significance of the Island as a whole. Having regard to the evidence, it is the conclusion of the Commission that Fraser Island is of great environmental importance. It is of aesthetic, historic, scientific and social significance for the present community, and for future generations of Australians, as well as being of international environmental significance. It forms part of the National Estate as defined in the *Australian Heritage Commission Act* (Sub-section 4.(1)), and is worthy of being so recorded. The recording of Fraser Island as part of the National Estate is consistent with the spirit of international environmental obligations binding, or soon likely to bind, Australia, but is not an end in itself. The entry of Fraser Island on the Register of the National Estate would be a pointless and sterile exercise unless it serves as a means to the wider end of encouraging the conservation of the Island in the national interest.

CHAPTER 5

SANDMINING ON FRASER ISLAND

5.1 Introduction

This chapter lists the heavy minerals found on Fraser Island, briefly outlines their worldwide distribution and production, indicates the Mining Leases and Mining Lease Applications on Fraser Island, and summarizes the sandmining methods used on the Island.

5.2 Heavy minerals and their uses

'Heavy minerals' and 'heavy mineral sands' are aptly named as their densities are almost twice that of the silica sand in which they occur. The main heavy minerals mined on Fraser Island are rutile, zircon and ilmenite; minor minerals obtained include leucoxene and monazite. At present, only rutile and zircon are commercially significant. Other sources of ilmenite (including Western Australia) are preferred as the east coast product contains impurities which make processing difficult.

Rutile, ilmenite and leucoxene are titanium oxides, while zircon is an oxide of zirconium, and monazite is a phosphate of rare earth elements. Typical chemical compositions are shown in Table 5.1.

TABLE 5.1: COMPOSITION AND TITANIUM DIOXIDE CONTENT OF HEAVY MINERALS

Mineral	Chemical composition	Titanium dioxide content (per cent)
Rutile	TiO_2	96
Ilmenite	$FeTiO_3$	54
Leucoxene	altered ilmenite	up to 90
Zircon	$ZrSiO_4$	not applicable
Monazite	phosphate of rare earth elements	not applicable

Leucoxene and monazite make up considerably less than one per cent of heavy mineral mixtures and are of little practical significance at the present time as far as the subject matter of this Inquiry is concerned. It should be noted, however, that monazite is slightly radioactive.

Rutile and ilmenite

Nearly eighty-five per cent of the rutile and ilmenite produced is used as the raw material for the manufacture of titanium dioxide pigments. About half of these are used in the paint, varnish and lacquer industries and a further quarter in the paper-making industry. The remainder is used in the manufacture of plastics and ceramics and in many other minor applications. Paints using these pigments can cover three times more area than those made with a zinc sulphide pigment and ten times as much as those using a lead-based pigment. The prohibition -- for health reasons -- of the latter traditional pigments in paints in most countries accelerated the move towards the use of titanium dioxide pigments.

The other fifteen per cent of rutile and ilmenite is used to make welding rod coatings and fluxes (such as for the oil and natural gas industries) and titanium metal which, because it is relatively light and extremely corrosion resistant at high temperatures, is particularly suitable for modern aircraft and rocket construction.

Titanium dioxide pigments can be made either by the sulphate or the newer chloride process. The quantity of pigment currently being produced by these two methods is similar, although all the pigment plants built in the United States since 1959 are based on the chloride process which has less severe environmental waste problems and lower labour costs. Natural rutile is preferred for the chloride process while ilmenite can be used in the sulphate process. This trend, which has resulted in the consumption of a higher proportion of rutile in recent years, may be expected to continue in the foreseeable future.

As a continuation of this trend would put pressure on known supplies of rutile, and has apparently already contributed to increases in its price, the beneficiation of ilmenite into 'synthetic' rutile as a material for use in the chloride process has been encouraged. Western Titanium Pty Ltd opened a pilot beneficiation plant in Western Australia in 1968 and subsequently brought a larger plant into operation. Although output of beneficiated ilmenite currently appears to provide a small part of the total input into the manufacture of titanium dioxide pigments, the apparent limitations on the supply of natural rutile suggests that much greater emphasis will be placed on the upgrading of ilmenite in future. Thus the price and availability of beneficiated ilmenite seems likely to have a significant effect on the market for natural rutile in the long run, although this does not seem to have been an important determinant of the price of rutile to date.

Zircon

Zircon is mainly used in foundry sand (fifty-five per cent), in the manufacture of refractory bricks (fifteen per cent), and in ceramic glazes (eighteen per cent). A small amount is used in the production of the element zirconium for the nuclear power industry.

Zircon is a stable material at high and low temperatures. When used as a foundry sand, it enables the production of high quality castings; when used in refractory bricks for glass and steel furnaces, it confers long life. There are, however, lower quality substitutes available for both these applications.

5.3 Distribution and production of heavy minerals

Titanium is the ninth commonest element in the earth's crust but its ores have not been extensively exploited, because of the difficulty of extraction and until recently, insufficient demand to encourage the development of the necessary technology. Titanium and zirconium ores are found extensively in low concentrations in many hard rocks but, as greater concentrations can be found in the easily won heavy mineral sands, it is unlikely that hard rock deposits will significantly influence the price of rutile and zircon for some time.

World production of heavy minerals relies very heavily on Australia which in 1973 produced approximately ninety per cent of the non-communist world's rutile, eighty per cent of its zircon and twenty-five per cent of its ilmenite. Australia has sixty per cent of the entire world's reserves of rutile, thirty per cent of its reserves of zircon and five per cent of its reserves of ilmenite.

The largest known deposits of rutile outside Australia occur in Sierra Leone and Mexico but, although these have been known for some time and efforts made to develop them, no substantial progress has occurred. On the basis of existing information, it seems a reasonable assumption that Australia will supply the bulk of the world's rutile supplies for many years. The main markets to which Australian rutile is exported are the United States, Japan and Europe. Very little rutile is used in Australia itself.

The United States has the largest known deposits of zircon outside Australia but these depend on the production of ilmenite. Large deposits are also believed to exist in the Transvaal in South Africa and probably also in Sierra Leone. Again, on present indications, it seems likely that Australia will continue to supply the bulk of the world's zircon for some time to come. Between them, the United States, Europe and Japan consume ninety per cent of the non-communist world's zircon.

There are many large deposits of ilmenite outside Australia, such as the United States, Canada, Norway, South Africa and Malaysia. Most of the ilmenite produced in Australia for export is mined in Western Australia from whence it is shipped to Europe, Japan and the United States.

The west coast of Australia is not as well endowed in rutile as the east coast, but recent exploration and development have significantly increased the known reserves of rutile there (Table 8.7). Western Australia has very large deposits of high quality ilmenite, and despite teething troubles, Western Titanium Ltd is reported to have achieved an annual production rate of 35,000 tonnes of beneficiated ilmenite by early 1975 and other companies were reported to be planning the production of upgraded ilmenite.

Planet Metals Pty Ltd explored off the east coast of Australia in the hope that some of the ancient submerged coastlines would contain heavy minerals, but there was no evidence to support the view that offshore operations would be economic in the vicinity of Fraser Island.

5.4 Prospecting and exploration

In practice, prospecting or exploration for economic ores has preceded applications for, and the grant and issue of, Mining Leases. Mr D. B. Morrison, legal officer and alternate director of Queensland Titanium Mines Pty Ltd, said in evidence (Transcript p.846) that

> the history of exploration of course is one of a continuing task of any mining company to seek at all times...further resources. All ore bodies no matter how good, finally come to an end, and it is only by continuing to find more resources or more minerals, that one can have a continuity, and a considerable part of the companies' incomes...must be expended in the continual search for mineral. Also their leases must be taken up to secure a title to mine these areas, and these are done in advance of when actual mining can take place, in order to secure reserves.

Indeed, some existing, but unmined, leases on Fraser Island were originally granted as Dredging Leases as early as 1950 under the provisions of legislation now repealed, and there was no suggestion that they would be mined in the near future.

In the past, prospecting on Fraser Island appears normally to have been done under the provisions of Authorities to Prospect issued under the relevant provisions of the Queensland mining legislation (*The Mining Acts* 1898-1967, the *Mining Act* 1968 as amended and cf.

Cudgen Rutile (No. 2) v. Chalk (1975), 49 Australian Law Journal Reports 22). Though there was evidence before the Commission that in 1973 a decision was made not to renew an Authority to Prospect on Fraser Island (Exhibit 320), the evidence fell short of establishing that all prospecting on the Island had ceased for the time being. In any event, whether prospecting has ceased for the present or not, the Commission cannot assume that prospecting will not proceed in the future (*Mining Act* 1968 as amended, Sections 10, 12 and 17), any more than it is entitled to assume that no further Mining Leases will be granted.

Hitherto, after being granted an 'Authority to Prospect' a company undertook scout drilling in areas likely to have heavy minerals. Where there was an indication of mineralization, drilling was then undertaken in a regular pattern to establish the size and grade of the ore body. D M Minerals used hand-carried equipment for both its scout and pattern drilling on Fraser Island. The use of drilling rigs mounted on vehicles would have involved the cutting of an extensive pattern of tracks through the vegetation of the Island. However, hand drilling has meant that only sparse information has been obtained about ore bodies below the ground water-table, below indurated layers, or at depths greater than twenty-five metres. Little is known, therefore, about the relationship between the ground water-table or indurated layers and the perched lakes.

A company discovering an economic ore body within the area covered by its Authority to Prospect then normally applied for a Mining Lease. Currently there are ten such Mining Lease Applications for areas on Fraser Island.

5.5 Mining Leases and Mining Lease Applications

The mining of heavy minerals on Fraser Island is taking place on Mining Leases granted under the provisions of the mining legislation of the State of Queensland. The Commission has no jurisdiction to adjudicate on submissions made to it attacking the validity of Fraser Island Mining Leases. Nor is it particularly relevant to the subject matter of the Inquiry to describe the steps preceding the grant and issue of a Mining Lease. Readers of this Report seeking further detail on these matters should turn to the Queensland *Mining Act* 1968 as amended, the Regulations issued thereunder, as well as to two recent decisions, *Cudgen Rutile (No. 2) v. Chalk* (1975), 49 Australian Law Journal Reports 22, in the Privy Council and *Sinclair v. Mining Warden at Maryborough* (1975), 49 Australian Law Journal Reports 166, in the High Court of Australia.

The locations of the Mining Leases (MLs) and Mining Lease Applications (MLAs) on Fraser Island are shown in Fig. 3.3. The twenty-four MLs and ten MLAs can be divided into eight groups as set out in Table 5.2. The methods of

mining Groups 1 and 2 are described in Section 5.6. An outline of a method of mining Group 3 is also mentioned in that section. Processing and transport related to the various groups are outlined in Section 5.7. Table 5.3 summarizes the areas of MLs and MLAs and the reserves of ore.

TABLE 5.2: GROUPINGS OF MINING LEASES AND MINING LEASE APPLICATIONS ON FRASER ISLAND

Group		Queensland Titanium Mines Pty Ltd	D M Minerals (leases held by Murphyores Inc. Pty Ltd)
1.	Foredune and hind-dune (south)	MLs 84, 104, 105; MLA 136	-
2.	High dune (mixture)	-	MLs 95, 102; MLAs 126, 127, 129, 130
3.	Beach (south of Indian Head)	MLs 108, 109, 110, 111, 112, 113	MLs 114, 115, 116, 117, 118, 119
4.	Indian Head area	MLs 106, 107, 120	ML 94
5.	Northern	-	MLs 93, 101
6.	Northwest of Hook Point	-	ML 96
7.	Bogimbah	MLAs 131, 132, 133, 134	-
8.	Yankee Jack	-	MLA 128

Group 1 consists of the MLs on which Queensland Titanium Mines Pty Ltd is now operating, and an adjacent MLA. They comprise foredunes, hind-dunes and adjacent areas. The lease areas are relatively flat with occasional creeks running through them.

Group 2 includes ML 102 on which D M Minerals is currently operating, the adjacent ML 95 and four MLAs. They include a variety of land-forms, with steep ancient dunes and rolling countryside predominating in the southern section where mining has commenced. They almost surround Eurong and Happy Valley Township Reserves and traverse various creeks, including Eli Creek. They penetrate much further inland than those in Group 1. The leases include the whole of the Beauty Spot at Lake Wabby and part of the Beauty Spot at Lake Boemingen; the MLAs cover the Beauty Spot at Yidney Lake (Fig. 3.2). Groups 1 and 2 combined cover almost all of the eastern coast of Fraser Island, south of Indian Head.

TABLE 5.3: MINING LEASES GRANTED AND APPLIED FOR ON FRASER ISLAND

Leases	Number of leases	Area of leases[a] (hectares)	Reserves[b] Rutile (tonnes)	Reserves[b] Zircon (tonnes)
1. Leases granted				
(i) Queensland Titanium Mines Pty Ltd[c]	12	1,002	50,000	40,000
(ii) Murphyores Incorporated Pty Ltd	12	12,164	533,000	556,000
Sub-total	*24*	*13,166*	*583,000*	*596,000*
2. Leases applied for				
(i) Queensland Titanium Mines Pty Ltd[d]	5	581	25,000	22,000
(ii) Murphyores Incorporated Pty Ltd	5	2,264	185,000	214,000
Sub-total	*10*	*2,845*	*210,000*	*236,000*
Total all leases	34	16,011	793,000	832,000

a Summarized from lease documents and rounded here to nearest hectare.
b Includes quantities described by firms as proven, probable, inferred, and available for recovery.
c See footnotes e and f to Table 3.2 for revised figures supplied by Company.
d See footnotes d, e, f, g to Table 3.3 for revised figures supplied by Company.

Source: Summarized from Tables 3.2 - 3.5.

Group 3 comprises beach mining leases which for the most part, are between high and low-water marks. Some, such as ML 108, also include part of the dune. The six leases south of Poyungan Rocks are owned by Queensland Titanium Mines Pty Ltd, the six further north are owned by Murphyores Incorporated Pty Ltd.

Group 4 consists of four MLs in the vicinity of Indian Head and Waddy Point. The Queensland Titanium Mines Pty Ltd leases are on the beach or just above it, while the Murphyores Incorporated Pty Ltd lease is further inland and covers a mixture of major sand blows and vegetated areas. The MLs cover most of the Indian Head - Waddy Point Beauty Spot (Fig. 3.2).

Group 5 comprises two MLs owned by Murphyores Incorporated Pty Ltd near the extreme northern end of the Island. It is understood that they cover beach, dunes and rear areas.

Group 6 comprises a single ML belonging to Murphyores Incorporated Pty Ltd northwest of Hook Point. It is believed that the ore body is located in a low-lying area.

Group 7 is a group of four Queensland Titanium Mines Pty Ltd MLAs near Bogimbah Creek in relatively steep to undulating ancient dunes on the western side of the Island.

Group 8 is a MLA by Murphyores Incorporated Pty Ltd which virtually surrounds Yankee Jack Lake. One arm is adjacent to a low-lying swamp and the other arm is in high country.

The shape of some of the ore bodies detailed in evidence showed an open end at the boundary of the ML or MLA, thus suggesting that they project beyond it. It is likely that there are also separate ore bodies outside the existing MLs and MLAs but it is uncertain whether any such ore bodies will become viable at a later date.

Many of the leases are within Marine Park Area No. 4 (*Queensland Government Gazette*, 30 November 1974, pp.1258-9) and Beach Erosion Control District No. 16 (*Queensland Government Gazette*, 30 November 1974, p.1243). Both this Marine Park Area and this Beach Erosion Control District were established on the same day, 28 November 1974. The whole of Fraser Island is a sanctuary for the purposes of the Queensland *Fauna Conservation Act*, 1952 as amended (Exhibit 647).

5.6 Methods of mining

A programme of closer pattern drilling of the known ore bodies follows the granting of a lease and facilitates detailed planning. This is a continuing operation which precedes actual mining operations. The final investigatory phase consists of botanical surveys which are undertaken either as prescribed by the lease conditions or as decided by the company concerned.

There are many sandmining methods but both the operations on Fraser Island are dredging methods (although in one case the dredge is not floating). If the beach leases are mined in the future it is likely that a dry mining method will be used similar to that currently employed at Cooloola. These mining techniques will be described, but particulars of others, including off-shore mining, will be omitted.

The two dredging methods presently used on Fraser Island are very similar in principle but vary considerably in detail. That used by Queensland Titanium Mines Pty Ltd will be described first followed by that adopted by D M Minerals.

Queensland Titanium Mines Pty Ltd

This Company's operations on the Leases of Group 1, are illustrated in Fig. 5.1 (based on Exhibit 574). All vegetation up to '80 chains [1,609 m]' ahead of the dredge may be cleared; some is selected for use as 'brushing' in the rehabilitation process and the remainder is stacked and burnt. The topsoil is then bulldozed into stockpiles just beyond the edge of the dredge path. The prescribed depth of topsoil to be stockpiled in this way is '6 inches [15 cm]' unless the topsoil has an economic mineral content. It is understood that the Company is stockpiling fifteen centimetres of topsoil except in foredune areas where no topsoil has developed.

The dredge, floating in a freshwater pond, draws a mixture of sand and water through a floating pipeline into a surge bin and thence to a concentrator. The dredge works at the toe of the underwater slope of sand; this causes the sand above to collapse from time to time into the pond and feed the dredgehead. The head can be moved in an arc and the whole dredge moved bodily forward -- in effect digging out its own flotation pond as it proceeds. The Company stated that it mined an average of about two hectares each week. This method is rather inflexible; although the dredging path can be curved, the full height of the material must be removed. It is best suited, therefore, for working long, wide, straight and uniform ore bodies on relatively flat land.

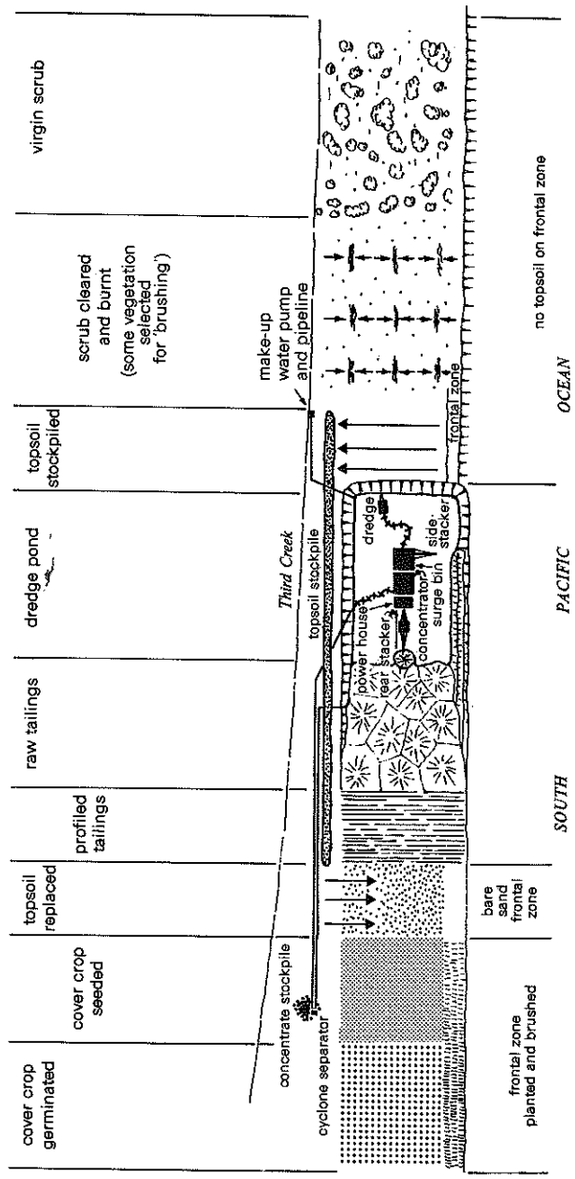


Fig. 5.1: Diagram indicating mining and rehabilitation operations of Queensland Titanium Mines Pty Ltd on Fraser Island

At the concentrator the heavy minerals are separated from the sand and water, and piped to a cyclone separator, the tailings being stacked at the rear of the dredge pond. Much of the remaining water is removed from the heavy minerals by the cyclone separator and piped back to the dredge pond, while the concentrate itself is conveyed to a stockpile. The transport and processing of the concentrate are discussed in Section 5.7.

The tailings, which tend to be placed in conical heaps by the rear stacker, are flattened by bulldozers and then profiled to whatever extent is required by the Special Conditions of the lease or, where these are not explicit, to the extent decided by the Company.

The dredge, surge bin, concentrator, power house and rear stacker are all floating on the dredge pond (unlike the D M Minerals' operation which, therefore, has a much smaller dredge pond). Queensland Titanium Mines Pty Ltd operates very close to the beach and thus requires a strengthened embankment on the seaward side to prevent a break-through either by the sea during a cyclone or by the freshwater pond (which is about three metres above low-water mark). The natural foredune is strengthened by overburden sand being bypassed at the surge bin and placed next to it by a side stacker.

The stockpiled topsoil is then bulldozed over the profiled tailings to a depth of fifteen centimetres except for the foredune areas which are not topsoiled. The rehabilitation methods employed are best described by quoting from the evidence given by the Company (Exhibit 317, p.14)

> the re-soiled surface is then replanted according to type, (a) frontal dune, (b) hind dune. Frontal dunes are planted with local salt-tolerant species. Firstly grasses and creepers, viz., spinifex, pigface, convolvulus and dune couch. After planting, a brush matting is laid over the area to prevent wind erosion during the early establishment period. Secondly, tree species such as horsetail oaks are planted. Later Banksias and other local species are planted as protective cover increases. Hind dunes are firstly planted with a quick cover crop, viz., hybrid sorghums in summer and cereal rye in winter. Light plantings have been made of pangola grass and rhodes grass in the southern areas to provide rapid stabilisation. With these are planted seeds of native species collected from ahead of the dredge path.

The Commission inspected these procedures on Fraser Island; their efficacy will be considered in Chapter 6.

Apart from the infrastructure floating in the dredge pond, the only other facility required at the site is a make-up freshwater pipeline from Third Creek and a sealed road to Hook Point.

D M Minerals

The operations on ML 102 (Group 2) are more difficult to describe. Not only are they more variable -- they move sideways into pockets as well as lengthways -- but they have only been producing since mid-1975. Moreover, the terrain is more variable than that mined by Queensland Titanium Mines Pty Ltd.

After completing drilling and botanical investigations, all vegetation on the area to be mined ahead of the mining operation is removed and buried, burnt or used as mulch. The topsoil is then bulldozed into stockpiles. On steep dunes the topsoil is pushed to the bottom of the dune and partway up the next one; on relatively flat dunes, the topsoil could be moved laterally. It is anticipated, however, that this will not be possible to any great extent in the areas at present being mined. Lease conditions prescribe that any organically enriched soil to a depth of 'twelve inches [thirty centimetres]' shall be stripped and stockpiled.

The operations of this Company are illustrated in Fig. 5.2. Although the diagram shows, for completeness, operations off the Island as well as those on it, this Report does not consider the former. Bulldozers push sand into a small pond which is the sump for a cutter-suction land-based dredge which handles several times the amount of sand handled by the Queensland Titanium Mines Pty Ltd dredge. Whilst the sump pond is relatively small there are other larger water-bodies associated with it. This land-based dredge draws a sand and water slurry from the sump and pipes it to a rougher mill where trommel screens remove the trash. It then passes to a head-feed bin and to pinch sluices; these increase the concentration of heavy minerals from about two to about six per cent. Material from which heavy minerals had been removed is pumped back to the excavation; the sand remains there as tailings while the water is eventually returned to the dredge pond.

The sand containing some six per cent heavy minerals is then transferred to the cleaner mill where non-mineralized sands are rejected and pumped back to the tailings. The magnetic fraction -- mainly ilmenite -- is separated and stockpiled at the site; the ninety-five per cent heavy mineral concentrate (mainly rutile and zircon) which results is also stockpiled ready to be transported to the mainland.

Where steep dunes have been mined, dunes may be reformed -- to some extent -- by placing the tailings pipeline at the new crest level and discharging the

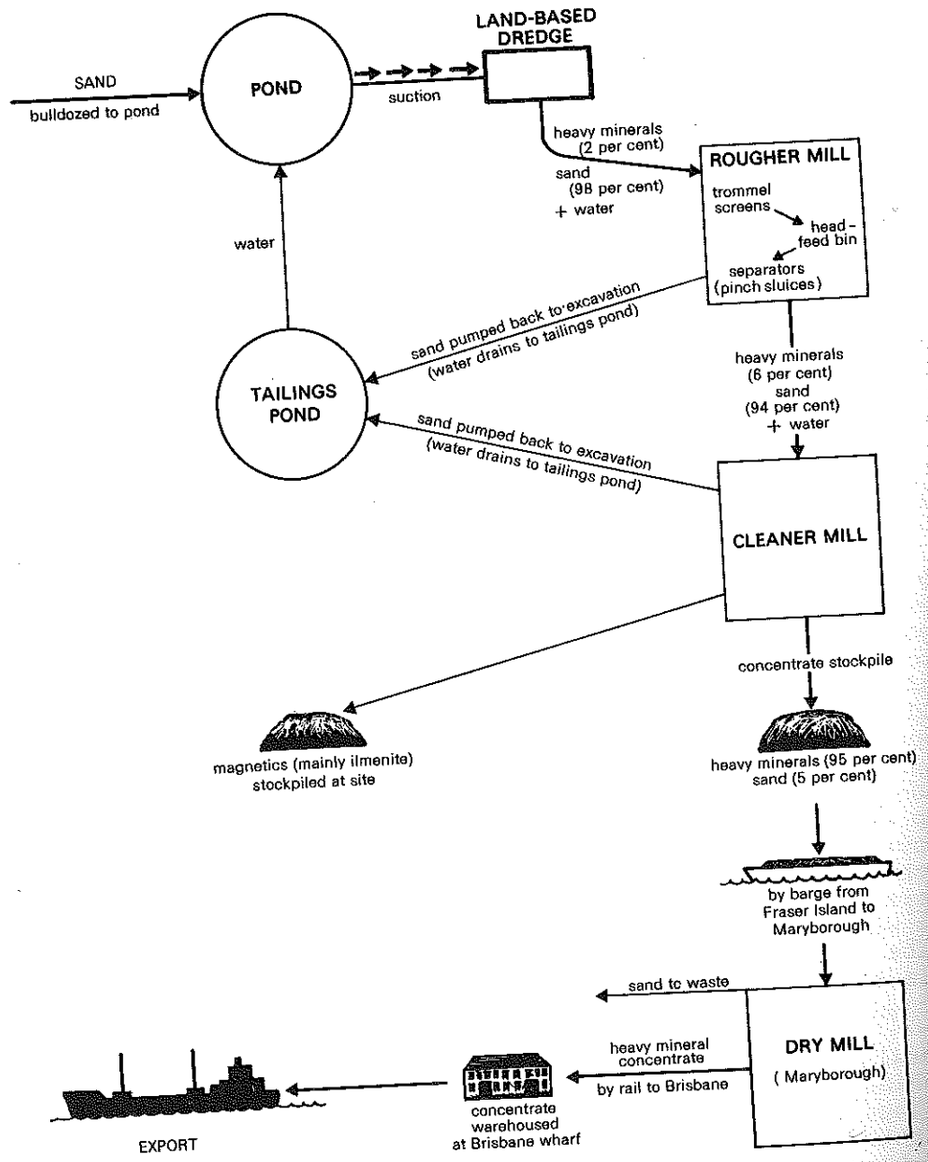


Fig. 5.2 : Flow diagram of D M Minerals' operations in relation to Fraser Island

tailings in the direction in which the dune is to be reformed. The Commission has not been able to ascertain whether this method will, in fact, be used for reforming all dunes, but there is no evidence of any other method being used at present. The evidence indicates strongly that the dunes are not being reshaped to their former contours.

The Commission has little direct oral evidence about the rehabilitation methods used by D M Minerals. They are mentioned in passing within Exhibit 26, but the agronomist employed by the Partnership did not give evidence before the Commission. However, with the consent of the Partnership, the Commission viewed rehabilitation on sites mined by D M Minerals on Fraser Island, and saw that rehabilitation appeared to include the following steps:

(i) the pushing back of previously stockpiled topsoil over the reshaped tailings (in two operations, with bulldozers);

(ii) the planting and fertilization of a crop of sorghum (ryecorn having been planted on the oldest mined area); and

(iii) the hand-planting of tree seedlings when this cover crop is well established.

The efficacy of these methods of rehabilitation will be examined in Chapter 6.

The Commission also viewed D M Minerals' nursery on Fraser Island in February 1976, and saw that it contained seedlings of *Banksia integrifolia*, *Banksia aemula*, brush box, *Leptospermum laevigatum*, *Casuarina littoralis*, Moreton Bay ash, satinay, scribbly gum, blackbutt, ironbark and bloodwood.

The infrastructure at the site comprises a partly gravelled road to Buff Creek for the transport of materials and concentrate, other gravelled and sand roads, an airstrip at Toby's Break used by light aircraft carrying workers, and a pump and pipeline to bring water from Second Creek to the ponds. Although this has been sometimes -- inaccurately -- described as a dry-mining method, nonetheless it appears to use large quantities of fresh water -- considerably more in fact than the quantities required by the Queensland Titanium Mines Pty Ltd operation. In the opinion of a consultant to D M Minerals 1,700 gallons per minute [7,735 litres per minute] would be used (Exhibit 265, p.654). Theoretically the water is circulating around a closed system; the losses probably result from percolation through the sand surrounding the tailings and the ponds in which they are situated, and to a minor extent from evaporation and leakages.

Beach Mining

Beach leases (such as Groups 3 and 4) are normally mined by dry-mining methods and it is likely that these would also be used to work such leases on Fraser Island. Heavy minerals on a beach tend to occur in rich, small, discrete leases which, because of the action of the sea, vary over time and space. However, they tend to be concentrated towards the upper part of the beach near the high-water mark close to the toe of the foredune. It seems that the richest deposits are found after very rough weather; calmer conditions disperse heavy minerals more widely across the beach.

Sand from a relatively short length of beach is bulldozed out from a shallow trench, placed into large trucks by front-end loaders and transported along the beach -- sometimes for considerable distances -- to a fixed separation and concentration plant. The trucks are backloaded with the tailings which are taken along the beach and tipped into the trench. If there is an economic amount of heavy minerals, another trench is opened up beside the first and thus the mining works across the beach. The area disturbed at any one time is relatively small, although the movement of equipment near the excavation and at the separation plant (if this is located close to the beach) interferes to a minor extent with tourist and other vehicles travelling along the beach. If the beach leases cover part of the foredune there may be a temptation to undermine the toe of the foredune, as the richest deposits often occur there.

5.7 Processing and transport

The operations described in the previous section result in the production of a concentrate at or near the mining site. This is then transported across or along the Island to mainland plants which undertake the main separation of the various heavy minerals. The infrastructure required is outlined in this section.

Queensland Titanium Mines Pty Ltd

As the mining of MLs 84, 104 and 105 has proceeded northwards along the eastern coast of the Island, Queensland Titanium Mines Pty Ltd has built a bitumen road on flat or gently rolling terrain roughly parallel to the coast along which the concentrate, as well as materials and equipment, is trucked south to a stockpile at Hook Point, barged across to Bullock Point on the mainland, and trucked twelve kilometres to the Company's dry mill at Rainbow Beach. There the constituent heavy minerals are separated by gravitational and magnetic processes (these, it is understood, have less severe pollution problems than chemical processes). The ilmenite is stockpiled near the mill and the main saleable minerals -- rutile and zircon -- are moved by truck and rail to warehouses in Brisbane prior to export.

D M Minerals

The transport system of D M Minerals is a little more complicated. Concentrate is trucked from the stockpile at the cleaner mill on ML 102 across the Island to Buff Creek (Fig. 3.3). Here it is stockpiled and then loaded by conveyor onto barges which transport it to the Partnership's dry mill at Maryborough. This dry mill was not inspected by the Commission but presumably operates in a similar way to the plant at Rainbow Beach. The gravelled road across the Island, which was built by D M Minerals, passes mainly through undulating country but in the east this -- and the sand and gravelled roads between the airstrip and mine and between the mine and workshops -- runs through steeper country. The airstrip at Toby's Break was built by D M Minerals to facilitate the movement of its workforce between the Island and the mainland (Section 3.10). Heavy materials and equipment are barged from the mainland and trucked across the Island on the gravelled road.

Other possible sandmining operations

If Queensland Titanium Mines Pty Ltd were to mine its beach leases at the southern end of the Island (part of Group 3) it would probably make use of both the beach and its existing surfaced road to transport concentrate to Hook Point. Mining of the beach leases owned by Murphyores Incorporated Pty Ltd further north (also part of Group 3) would presumably necessitate the transport of sand along the beach to a processing plant and then of the concentrate to a barging point on the west coast of the Island.

Mining of the leases at Indian Head or those north of Indian Head (those in Groups 4 and 5 of Table 5.2) would pose considerable transport problems. It is likely that a gravelled road would have to be built across the Island, probably through the National Park, as there are no suitable all-weather barging points on the east coast.

Mining of the Yankee Jack area and that northwest of Hook Point (the leases in Groups 6 and 8 of Table 5.2) would probably require a short road linking them to the barge-loading facilities at Buff Creek.

Mining of the Bogimbah area (Group 7 of Table 5.2) would possibly necessitate a road linking them to a barging facility at Urang Creek. Presumably, Queensland Titanium Mines Pty Ltd would organize the transport of concentrate in a similar manner to its present operations, although the boat journey would be appreciably longer.

5.8 Silica and foundry sands

The Direction to the Commission is to conduct an Inquiry into the environmental aspects of the making of decisions relating to the exportation of minerals from Fraser Island now or in the future. The Inquiry was not specifically limited to heavy minerals alone. Independent witnesses as well as those directly interested in the Island suggested to the Commission that the only other mineral likely to be produced for export would be silica sand. Small quantities of sand are apparently being extracted from the Island for use at a Maryborough foundry.

As indicated in Section 3.9, D M Minerals in 1971 abandoned two lease applications covering very large deposits of high-grade silica sand in the north of the Island, in an area that was about to be declared a National Park.

Virtually the whole of Fraser Island consists of silica sand but only certain areas contain sand of sufficient quality for export and even then, it is worth only four or five dollars per tonne. Australia at present exports large quantities of silica sand to Japan from Cape Flattery on the Queensland coast north of Fraser Island.

Whereas mining for heavy minerals usually involves the extraction of only about two per cent of the sand, leaving the remainder to be replaced in the quarried hole, mining for silica sand involves removing almost all the material from the quarry leaving nothing for replacement.

5.9 Conclusion

This chapter has described sandmining on Fraser Island. The effects of sandmining on the natural and human environment will be considered in the next four chapters.

CHAPTER 6

THE ENVIRONMENTAL ASPECTS OF SANDMINING ON FRASER ISLAND: THE NATURAL ENVIRONMENT

6.1 Introduction

In this chapter the Commission assesses the evidence about the effects of present, proposed and possible sandmining operations on the natural environment of Fraser Island. Although, for simplicity and clarity, the effects of sandmining on the physical environment, flora and fauna are each considered separately, it should be borne in mind that ecosystems -- organic communities of plants and animals viewed within their physical environments or habitats -- are complex and highly integrated systems no part of which can be disturbed without affecting each other part in some way and to some degree.

While there was a conflict of evidence on many aspects of sandmining above the mean high-water mark on Fraser Island, three points were not in dispute. The first was that the immediate effect of sandmining is to destroy all the existing topography and vegetation in the mined areas. The second was that the original vegetation can never be restored in the sense of re-establishing the original number and distribution of species in their former relationships with one another. The third was that it is not practicable, and often prohibited by the Special Conditions of the Mining Leases, to restore the topography to its former state after mining. There is thus common ground both that the existing vegetation and topography of such areas will be destroyed by mining, and that they will not be restored to their former state.

The subject of the rehabilitation of mined areas, as opposed to their restoration, did, however, attract controversy. Rehabilitation, as applied to sandmining on the east coast of Australia, is a term in current technical use describing the reinstating of mined areas by reforming and revegetating dunes. In the context of Fraser Island rehabilitation of vegetation can be regarded as being successful when a plant community has reached a state of being self-sustaining, that is, not requiring any further human assistance, and with a reasonable representation of the pre-existing structure, species and functions. The structure of a plant community may be thought of as the relative proportions of trees, shrubs and ground flora, and its functions can be exemplified by the complex interrelationships in the shading of one species by another, or by the role of ground litter in recycling nutrients. A mono-culture (that is, a vegetative cover of virtually only one species, such as sorghum) cannot be regarded as successful rehabilitation since it is not self-sustaining in the face of traumatic events such as fire, disease or drought.

Another term sometimes used is 'revegetation'. It is used herein to describe a lesser standard of rehabilitation which falls short of being a self-sustaining plant community with a reasonable representation of structure, species and functions. Revegetation can be described as 'agronomic success'. A mono-culture, such as a cover of sorghum or a grass species, could be regarded as successful revegetation and may, for a mined area which is to be later used for residential purposes or playing fields, be all that is necessary.

From time to time in this chapter it is necessary to refer to the provisions of existing Mining Leases and, in particular, to Special Conditions contained in them relating to environmental matters. These references are necessary in evaluating the material before the Commission relating to the environmental effects of sandmining, of which they form a part. In making these necessary references to the Mining Leases the Commission is not dealing with such questions of law as whether particular firms are in breach of their legal obligations as lessees. These matters were raised during the course of the Inquiry, but are considered by the Commission to be outside its jurisdiction.

6.2 The physical environment

Generalized effects

The physical environment is normally changed by sandmining in many different ways, and consequent changes in the biological environment inevitably follow. The primary effects of sandmining on the physical environment may be listed as:

(a) changes in macro and micro-topography, ranging from gross to subtle;

(b) consequent changes in local micro-climates due to alterations in wind patterns, salt influx and deposition, evaporation from open water-bodies, evapo-transpiration from plants, insolation levels, depths to water-tables and the balance between runoff and infiltration;

(c) total elimination of soil profiles, with their established cycles of water, nutrients and energy;

(d) possible changes in stability and permeability of the substrate when tailings are replaced; and

(e) gross disturbances of hydrological regimes.

These generalized effects should be borne in mind while reading the following sub-sections, which describe the effects of sandmining on particular physical environments on Fraser Island.

Beaches and other areas below mean high-water mark

The beach on the eastern side of the Island south of Indian Head would not be severely affected by closely supervised beach sandmining of the type described in Chapter 5, assuming that only limited areas are disturbed at any one time, and that the replacement of sand keeps pace with the mining. It is likely that the benthic (bottom-dwelling) animals would recolonize the area fairly quickly. If the layer of loose sand overlying the harder organic-rich sandrock is less than about one metre deep, and if the latter is disturbed, the situation will be quite different because of the release of large quantities of organic slimes and fine solid particles back onto the beach and into the sea. The effects of this are not known but, at the very least, it is likely that the sea would become so polluted locally whilst mining was proceeding that the benthic animals would be severely affected, and the fish would avoid the area. Some witnesses alleged that removal of heavy minerals from the beach would change the physical behaviour of the remaining sand particles as they adjust to the interrelating forces of waves, winds and tides. The evidence before the Commission on this point was inconclusive, and, on the whole, did not tend to confirm the allegation.

The greatest danger is that beach mining will go too close to the toe of the foredune, and thus undermine it. This possibility is a real one, as some of the so-called 'beach' leases include parts of the foredune.

Foredunes and hind-dunes

Before mining, the foredune has an extremely irregular micro-topography, as it is an area of natural instability where sometimes, and in some places, the dune-building processes are in the ascendency, whilst at other times and places the forces tending to break down the dune prevail. After mining and the commencement of rehabilitation, the foredune is usually made more uniform in topography, and often supports a dense cover of spinifex. In this case, the physical stability of the coastline will have been improved, although its topographic variability (and, probably its aesthetic value) will have been diminished. In any case, the severe climatic conditions usually restore some topographic variability within a short time, and the dense cover, where it is present, helps to prevent severe sandblows.

Given the successful rehabilitation of vegetation, any diminution in ecological variability on mined foredunes is not very apparent, or important, as the natural plant communities are not particularly diverse. Similarly, changes in the substrate are not very important, as soil development under natural conditions is only minimal.

The subduing of the topography in the zone behind the foredune is of greater significance. The Special Conditions of the Mining Leases do not stipulate that this area be reshaped to its original contours, and the hind-dunes viewed by the Commission on Fraser Island tended to be much flatter after mining than before. The many small hillocks and steep-sided pockets found before mining disappear, to be replaced by gently-rolling, rather monotonous, topography. Micro-climatic variability has been largely suppressed, as has the consequent diversity of the plant communities.

Seaward and inland steep dunes, and western dunes

The seaward dunes are defined as those ancient dunes which are now being eroded by the ocean; unlike the foredunes they are usually not parallel to the present coastline, their different alignment having been caused by factors prevailing when they were formed.

Like the foredunes the seaward dunes, and the inland dunes facing east, bear the full brunt of the strong, salt-laden, prevailing winds from the southeast. Any weakness in the vegetation cover is exploited, and wind erosion initiated.

The Special Conditions of the Mining Leases exhibited in the Inquiry do not permit mined steep dunes to be reformed at an angle steeper than twenty degrees. Thus, a dune with side slopes of thirty degrees and a vertical height from the adjacent valley to its crest of (say) thirty metres will be reduced to, at best, a dune with side slopes of twenty degrees and a vertical height of a little less than twenty-four metres as the same volume of sand (less about two per cent of heavy minerals extracted during mining) has to be returned to the site. The adjacent valley bottoms are raised some three to five metres, and the dune crest is lowered, relative to their original levels. Dune reconstruction at a lesser slope than twenty degrees is permitted by the Special Conditions and will have correspondingly greater effects.

The resulting subdued topography tends to be featureless and uninteresting. In addition, the Commission has observed that the sides of the reconstructed dunes can only be replaced in a smooth, even shape, as otherwise it is too difficult to control the thickness of the replaced topsoil.

The final result, despite the most conscientious efforts at dune reconstruction, is an even, rolling landscape where previously there were relatively steep dunes of many shapes and sizes with innumerable pockets and hillocks -- a complex micro-topography. This inevitable reduction in topographic variability will cause the range and diversity of vegetation types, which contribute much to the interest of Fraser Island to laymen and scientists, to be appreciably simplified forever, even if the rehabilitation of vegetation ultimately achieves success. Similar effects occur when dunes which originally had slopes of less than twenty degrees

are replaced at flatter angles. Moreover, there is no requirement in the Special Conditions of the Mining Leases for the replacement of the dunes at all, provided that the shape of the tailings conforms with the surrounding areas. Hence, if an isolated dune were mined, it could be left completely flat like the surrounding areas.

When the Commission viewed ML 102, some slopes of dunes being rehabilitated approached twenty degrees, but the majority were much flatter. Both the macro and micro-topography had been substantially subdued.

The soil profile is completely destroyed in the mining process. This is much more significant for the seaward and the inland dunes than the foredunes, as they have more complex soil profiles developed over long periods of time. The significance of this to the plant communities will be discussed later in this chapter.

No mining has yet taken place on the steep dunes of the western side of the Island. These dunes are more sheltered from strong easterly winds and high saltloads than the eastern dunes, but the comments regarding the physical effects of sandmining apply equally to the steep dunes on both sides of the Island.

The effects discussed earlier are those directly resulting from mining. Another major disturbance associated with mining is the construction of roads -- particularly sealed or gravelled roads. By concentrating the water runoff such roads can cause serious gullying, and the burial of downslope vegetation as has happened in some places on North Stradbroke Island. During the Commission's inspection of sandmining operations on Fraser Island, incipient erosion along the edges of the Buff Creek road from the Toby's Break airstrip to D M Minerals' present mining site was observed. The effect is unimportant in flat or gently undulating country, such as the area being mined by Queensland Titanium Mines Pty Ltd, but becomes important when side slopes are considerable as is the case with the road mentioned above.

Sandblows

Sandblows are a natural feature of Fraser Island, and indeed, were responsible for its formation (Chapter 2). The Commission viewed two of the larger sandblows, and was informed of the interest these areas have to laymen as well as to scientists. Sandblows are rarely just a mass of undifferentiated sand, and they often demonstrate various buried erosion surfaces, especially in their eroding zone. An appreciation of the sandblows is heightened by an understanding of their geomorphological and ecological features, but they also possess an undeniable fascination to many visitors. In this respect they are akin to other natural phenomena demonstrating awesome and irresistible power, such as glaciers.

The two large sandblows inspected by the Commission were on Mining Leases at Lake Wabby and in the Indian Head area. Reputedly only the latter sandblow is mineralized (Exhibit 61). Mining would destroy any geomorphological evidence inherent in the buried layers, and would impose a particularly alien human impression upon some of the most untrammelled landscape on Fraser Island.

If a sandblow is mined, a decision must be taken whether to vegetate it or not. If the tailings are vegetated, a course probably required by existing Mining Leases, all naturalness is lost along the mining path, and the rest of the sandblow will no longer behave naturally due to interference with its dynamic system. If the tailings are not vegetated, they will almost certainly be unnaturally unstable (however carefully replaced) because they will no longer bear their original relationship to buried soil layers which would have served to confer some stability. The sandblow is likely to be rejuvenated, and will probably overwhelm surrounding vegetation.

Lakes, streams and swamps

The possible environmental effects of sandmining on lakes, streams and swamps may be examined by reference to four questions:

(a) Could sandmining on Fraser Island disturb water-tables?

(b) Could sandmining on Fraser Island change the hydrological balance of perched and water-table window lakes, creeks and swamps?

(c) Could sandmining on Fraser Island add substances to creeks, lakes and regional and/or perched water-tables?

(d) If so, could these substances significantly affect the ecosystems of these water-bodies?

(a) Could sandmining on Fraser Island disturb water-tables? Reference should be made to the earlier discussion of the hydrology of Fraser Island in Chapter 2. There is no dispute about the presence of regional and perched water-tables and aquifers (Fig.2.6) and no dispute that water can percolate from the floor and sides of mining ponds through the more-or-less permeable sands of the Island. This water inevitably joins the regional or perched aquifers. In addition, it is quite possible for mining operations to intersect water-tables; indeed, this is the method by which Queensland Titanium Mines Pty Ltd creates the mining ponds for their large floating dredges. There is no doubt that sandmining operations can disturb regional and perched water-tables, and that they can add water to them.

(b) Could sandmining on Fraser Island change the hydrological balance of perched and water-table window lakes, creeks and swamps? As described earlier, the regional water-table probably has an average slope inland from sea level of about 1:100, although the effect of topographic undulations above the water-table is at present unknown (Exhibits 49, 52). However, due to the presence of less permeable layers at unknown depths and dispositions within the steep dunes there could well be variations from this simple model. Little evidence is available on this point (Transcript p.1865). It seems probable (Transcript p.1867) that the situation is very complicated, as Fig. 2.6 indicates.

As there was almost no evidence about the hydrology of any lake other than Lake Boemingen it will be used as the main example, but assessments made in relation to that lake are relevant to the other lakes provided that due consideration is given to their type, i.e. whether perched or water-table window lakes.

What evidence there is suggests that water moves beneath Lake Boemingen in both saturated and non-saturated flow through and between various layers of various permeabilities (Transcript pp.299 and 1866, Exhibits 316 and 453). The position of the regional water-table beneath Lake Boemingen could affect the hydraulic gradient, and any interference with the regional water-table could affect the rate of seepage from the Lake (Transcript p.1867). The stratigraphic data necessary to resolve questions about the sub-lake hydrology is, at this stage, rather sparse.

Mining at any altitude above about ten metres below lake level, that is, above about sixty to sixty-four metres above sea level, could cause water-table disturbance (Transcript p.196), as could mining within the limit suggested in Exhibit 52, Fig. 1. It is possible that mining at an altitude higher than the intersection of the ground and the horizontal projection of the top of the regional water-table under the lake could cause such disturbance (Transcript p.1868). Unfortunately, this height is unknown, but may be about twenty to thirty metres above sea level.

There was also evidence (Exhibit 273, p.12) of the possibility of mining accidentally damaging indurated sand layers in unforseen ways. Evidence to the contrary (Exhibit 49, p.9; Exhibit 50, p.17) was unconvincing, failing to take full account of the incidental, accidental and unplanned effects of mining operations. Such damage might be serious and irreversible if it resulted in the puncturing of an indurated sand layer supporting the waters of a perched lake, such as Lake Boemingen, when it could very likely result in the partial draining of the lake. It is most unlikely that these indurated layers terminate at the shorelines of perched lakes, and unproven that they do not extend beyond the buffer zones around certain lakes, within which mining may not take place. There is indeed, much uncertainty at this stage about the extent of the indurated layers beneath perched lakes.

Special Condition 24.(a) (i) of ML 102 prohibits interference with the land within one-third of a mile [536 m] of the shoreline of Lake Boemingen. It was conceded (Exhibits 49 and 265, p.656) that water could be added to Lake Boemingen by seepage from mining ponds during mining outside the buffer zone, and that it might have to be removed by pumping. It was proposed (Exhibit 265, p.748) to monitor such interference with water level recorders. It will be recalled from Chapter 5 that in D M Minerals' mining operation large volumes of water are used. Large quantities of water entering Lake Boemingen at rates which it seems would probably exceed natural rates, only to be removed (the Commission knows not where) by pumping, could drastically affect the lake level, as well as the surrounding flora and fauna, and would totally destroy all semblance of naturalness. On this basis alone it would seem that the buffer zone around Lake Boemingen is inadequate to maintain its hydrological balance (Exhibits 52 and 273).

A consultant to D M Minerals was of the opinion (Exhibit 265, p.694) that Second Creek flowed at relatively steady rates affected only slightly by seasonal fluctuations, and that any possible decrease in creek flow would be easily compensated by increased flow from the head of water in the unconfined regional aquifer. His limited fieldwork, however, did not establish this point. There was also evidence (Exhibit 265, p.750) that if Second Creek ceased to flow, D M Minerals would have to cease operations, or find some other means of getting water.

It is of interest that Special Condition 24.(b) of ML 102 originally stated specifically that water should not be taken from Second Creek. Subsequently it was replaced by a new Special Condition which permitted the removal of unspecified quantities of water from Second Creek. The Commission was informed that approximately one-third of its flow is being removed from the Creek.

It is apparent that similar variations in the environmental special conditions of the mining leases may be made in the future, should the exigencies of maintaining production appear to warrant such a course. For example, if mining operations move to the southern part of ML 95 water will presumably be required from First Creek. The taking of water from First Creek is at present prohibited by Special Condition 24.(b) of ML 102.

As mentioned previously, mining will inevitably smooth the topography, especially where the original slopes were greater than twenty degrees, which is the maximum post-mining replacement slope. Thus, the altitude of ridge crests will be lowered and that of the valleys raised. Regional water-tables will probably re-establish in their previous configuration and slope after mining, leaving the water-table at a greater relative depth under the valleys.

This will effectively prevent redevelopment of any previous swamps and wetlands, as these are critically dependent upon the relative level of the ground surface and the top of the water-table. Sandmining on Fraser Island is therefore likely to change the hydrological balance of perched and water-table window lakes, creeks and swamps.

(c) Could sandmining on Fraser Island add substances to creeks, lakes and regional and/or perched water-tables? There was considerable uncontested evidence before the Commission that the portion of fertilizers not used in plant growth will easily and rapidly pass through the permeable sands of the Island (Exhibits 26 and 453). For example, Exhibit 516 p.176 reports the complete loss of 730 kg/ha of nitrogen, as ammonium nitrate, from the top twenty centimetres of the soil profile at Eurong within a year of application. The loss of phosphorus was negligible in the study reported in this Exhibit, but other evidence (Exhibit 317 Annexure 'A', Table 4) clearly illustrated the normally rapid movement of phosphorus down the soil profile. A proportion of the phosphorus may be sorbed onto sesquioxides within dunes and thus be effectively removed from circulation (Exhibit 26). The magnitude of this effect cannot be precisely estimated, but it will probably be very slight in permeable tailings sands of the kind resulting from the mining operations on ML 102.

As a result of the downward movement of substances through the permeable sands, calcium, magnesium, potassium, cadmium, sulphur and, most significantly, phosphorus and nitrogen, will inevitably reach the regional aquifer. Water in regional aquifers must eventually move towards the surface to appear as water-table window lakes, creeks, swamps, or as seepage onto the beach.

Dissolved substances must move with this water, and not necessarily at high rates of dilution. Very large amounts of elements may move, and at rates several hundred times greater than would naturally occur (Transcript p.1987). Such flushes of elements could occur after concentrated fertilizer applications during the process of rehabilitation, and also as a result of the burning of piles of vegetation cleared from the mining path.

D M Minerals is currently mining several hundred metres to the west of Second Creek. Any mining west of Second Creek is likely to introduce pollutants into Second Creek. Similarly, the proposed mining of the ore bodies situated above the perched aquifer (of which Lake Boemingen is a surface expression) will eventually add substances to Lake Boemingen, notwithstanding the apparent purpose of Special Condition 24.(c)(i) to prohibit its pollution. The extent of this perched aquifer is unknown. Likewise, any mining west of Lake Wabby in ML 95 will ultimately add nutrient-rich water to that Lake as the water moves eastwards (Exhibit 52, p.7), notwithstanding the apparent purpose of Special Condition 25.(c)(i) of ML 95 to prohibit its pollution.

The provisions of the relevant mining leases restrain mining in buffer zones arbitrarily delineated around the lakes and creeks referred to above. In the case of each lake, the buffer zone is 'one-third of a mile [536 m]', while in the case of Second Creek and the other creeks described in the mining leases, the buffer zone is 'three chains [60 m]'. The evidence indicates that the processes of pollution described above are unlikely to be substantially alleviated by these arbitrary buffer zones. It is inevitable that sandmining on Fraser Island will lead to the addition of substances to creeks, lakes, regional and perched water-tables.

(d) If so, could these substances significantly affect the ecosystems of these water-bodies? The Commission heard detailed evidence (Exhibits 273 and 453) concerning the dangers of adding any substances to Lake Boemingen and other lakes on Fraser Island. There was no contradictory evidence. These lakes are extremely unusual, particularly in Australia, because of their highly oligotrophic nature: that is to say, they contain only relatively small amounts of nutrients. Any abnormal addition of nutrients, especially nitrogen and phosphorus, from fertilizers, sewage or other agencies will produce a potentially irreversible pollution problem, called eutrophication (Transcript p.1971). It was contented that once eutrophication had occurred these lakes could not return to their present oligotrophic state. Such a drastic change in the quality of these water-bodies would have similarly drastic effects on the fauna in them.

In view of this, any mining and associated engineering works (and any incidental, unplanned and accidental side effects of mining) which could possibly lead to the eventual contamination of water in Lake Boemingen (or other lakes) are incompatible with the preservation of their biological and chemical qualities. Special Condition 24.(a)(i) of ML 102 prohibits interference with the land within 'one-third of a mile [536 m]' of Lake Boemingen. In view of the paucity of evidence about the sub-surface nature of the environs of this lake, and the hydrological regimes therein, the prescribed buffer zone seems totally inadequate as a means of preventing serious harm to the lake.

There was uncontested evidence that many, and perhaps all, of the lakes on Fraser Island have high value for scientific studies in disciplines such as geomorphology, palynology and ecology. Any disturbance of the lakes by any agencies changing the natural hydrological balances and the aquatic (and adjacent terrestrial) ecosystems would tend to negate this value, though there might be some merit in studying the processes and results of such disturbances.

It was contended (Exhibit 26, p.14) that any nutrients which reach Second Creek would be rendered harmless by infinite dilution, ammonification of nitrogen, or by sorption onto or into plant materials. However, contaminating nutrients may not be highly diluted before or after they reach the water-bodies; nitrogen may not be

changed in the manner proposed; and while phosphorus may be retained in organic forms, these are of only short-term unavailability and will eventually be mineralized to release their phosphorus. In any case, the evidence suggests that the addition of even small amounts of nitrogen and phosphorus to wetland ecosystems which have evolved in a nutrient-poor environment is unacceptably risky if their natural state is to be preserved.

Several witnesses stressed that physical or chemical alteration of swamps would have serious effects on the fauna, specifically the acid frogs (Exhibits 288 and 314). The topic has been referred to in Section 2.4 of this Report. It is clear that these unusual components of the wetland ecosystems of Fraser Island are very vulnerable to any alteration in their habitats. It would appear to the Commission, from the evidence before it, that sandmining is likely to effect such alterations in any wetlands near its operations. The evidence shows that the addition of substances to the water-bodies of the Island resulting from sandmining would significantly affect the ecosystems of these water-bodies.

6.3 Flora

The flora of unmined areas

While it is obvious that all flora in the mining path is destroyed, it is less widely understood that sandmining can have serious effects on the flora of unmined areas, including some areas remote from mining sites. Examples of such effects are discussed below.

It was evident to the Commission after inspections of the eastern coasts of Fraser Island and North Stradbroke Island, and the Cooloola area, that the seaward vegetation is naturally organized so as to give increasing degrees of protection to the plant communities further inland. Environmental conditions are so severe on the seaward face of the foredune that only a limited range of hardy plants can establish themselves there and survive. As discussed earlier, these plants trap windblown sand, help the foredune to build itself higher, and thus confer some protection to the hind-dunes.

In these more favoured localities a slightly wider range of plant species may grow, although savage windshear and saltblast above the protected zone maintain canopy height at a relatively low level. These effects are even more evident on the seaward face of the most easterly steep dunes, where species which in more sheltered places attain heights of twenty to thirty metres may be reduced to stunted shrubs of two or three metres in height. This effect was observed when traversing the easternmost few hundred metres of the road across North Stradbroke Island. The height and form of brush box for instance, varied dramatically according to its

occurrence on the sheltered or exposed faces of the most easterly dunes. It is evident that this progressive sheltering effect depends upon the maintenance of unaltered dune topography, combined with the preservation of the natural range of plant communities, with their ranges of species, forms and heights characteristic of their places in the landscape.

The natural system then, is in a delicate and fragile state, wherein the disturbance of the seaward topography and/or plant communities can affect wind patterns, salt influx and other environmental variables in such a way that plant communities a kilometre inland may suffer deleterious effects. Such effects may be observed even further inland if the community is in a particularly exposed location. After considering the evidence and viewing D M Minerals' present mining site, it seems to the Commission that plant communities west of that site are more exposed now than before mining commenced. Mr Lewis, an ecologist advising Queensland Titanium Mines Pty Ltd, stated (Exhibit 317, Annexure 'A', p.3) that some trees appeared to have been killed by this effect at the south end of the Island. It is also important to realize that unnaturally severe exposure is likely to continue for many years, at least until the seaward vegetation has attained sufficient height and density to confer the same degree of protection as existed before mining. In the meantime, increasingly larger areas of vegetation exposed on the periphery of mined areas could be affected.

This problem is even more acute with respect to rain-forests, whose ecosystems are even more fragile than the relatively hardy sclerophyllous trees and shrubs of seaward areas. Rain-forest communities on Fraser Island can continue to exist only with the natural protection from the prevailing southeasterly winds and salt influx conferred by topographic barriers and plant communities on the windward side.

There was evidence that it was not intended to mine rain-forest areas found in mining leases, and that a 100 m buffer strip might be left unmined around the edges of them (Exhibit 26, p.41). The efficacy of such a buffer strip -- insignificant by comparison to that naturally present -- in protecting the fragile rain-forests from harm by exposure was not established, and was disputed by a witness who is a rain-forest ecologist (Transcript p.2872).

The third type of plant community which could be affected by future mining in the Bogimbah and Yankee Jack areas is the wetland ecosystem. It is possible that sand and/or mining water might spill onto these wetlands, which would not tolerate sudden changes in their environments (Transcript p.1956). Such events were alleged to be infrequent (Exhibit 26, p.39), and of minimal long-term importance. While individual spillages may be rare, the localized consequences of an occasional inadvertent spillage (or, more importantly, a slow continuous leakage) could be

temporarily severe, and could induce long-term secular changes in wetland ecosystems by inundation with sand or change in water quality.

Lastly, the importance of the seagrass beds to the marine fauna was discussed in Section 2.4. There was little detailed evidence of the effects of sandmining on these ecosystems, although much generalized discussion was presented. It seems clear that any major change in substrate height or composition, and any serious short or long-term changes in water turbidity or chemical quality, could rapidly affect the seagrass beds, and consequently their dependent fauna. Such changes could occur around loading facilities and wharves, but would be localized. If impure water from sandmining affected the quality of streams running directly to the sea (particularly from the Bogimbah area and ML 96) more widespread damage may occur. This is a situation where deleterious effects are more likely than not to occur.

The rehabilitation of flora after mining

Sandmining can occur on a number of different landscapes which, for the purposes of the following discussion, can be grouped into (a) beaches, (b) foredunes, hind-dunes and sandblows, and (c) steep dunes. Ecosystems on these landscapes are distinguishable by the relative harshness of the environment for biological productivity; the stability of the substrate; the complexity and longevity of the plant communities and inter-related faunal assemblages; their susceptibility to perturbation by numerous environmental and other agencies -- their fragility -- and their ability to recover from such perturbations and regain their former state. The requirements for, methods of, approaches to, and problems of rehabilitation on each of the three landscape types are sufficiently different as to compel their separate treatment in this Report.

With the co-operation of the firms concerned, the Commission viewed sandmining and rehabilitation operations on Fraser Island in February 1976. It also viewed operations by Queensland Titanium Mines Pty Ltd on the mainland at Inskip Point, as well as those of other companies on North Stradbroke Island and on the beach to the south of Double Island Point.

Sandmining operations have been conducted along the east coast of Australia for over thirty years, although the scales and methods of operation have varied considerably during this period. In recent years mining leases have been increasingly stringent in their rehabilitation requirements, apparently with the aim of ensuring that mined areas achieve an appearance which bears some resemblance to adjacent unmined areas (or their premining condition) as soon as possible after mining. Several sandmining firms now employ professional staff, conduct a great deal of applied research work into problems of rehabilitation, and have developed considerable skill in rehabilitation methods.

Some witnesses commented upon the lack of long-term land use planning in relation to sandmining and subsequent rehabilitation. Mr Lewis, the consultant ecologist for Queensland Titanium Mines Pty Ltd, agreed (Transcript p.1025) that rehabilitation should be a function of the long-term land use planning for mined areas, with the aim of preparing the land for its end use. This, of course, cannot be achieved if mining is incompatible with the end use.

From the evidence before it, and its view of sandmining sites, the Commission considered the following vital questions in relation to beaches; foredunes, hind-dunes and sandblows; and steep dunes:

(a) is it ecologically possible to achieve the successful rehabilitation of mined sites?

(b) if it is ecologically possible, is successful rehabilitation likely to be achieved in practice?

Beaches Clearly no plant rehabilitation is possible or required after beach mining, although the question arises as to whether beach mining as such is likely to predispose to, or to stimulate, instability in adjacent foredunes which may or may not have been mined.

Foredunes, hind-dunes and sandblows All three of these types of landscapes present similar types of problems in rehabilitation. All are likely to be exposed to strong, salt-laden winds, and the underlying soils have minimal development and very small reserves of organic matter or of most plant nutrients.

There was a considerable body of evidence relating to the rehabilitation of foredunes and hind-dunes mined by Queensland Titanium Mines Pty Ltd, which since December 1971 has been mining wholly on foredune and hind-dune environments at the southern end of Fraser Island. The Commission also viewed all of the area mined by that Company, which at May 1975 covered nearly 160 ha (Exhibit 317, p.2) and also inspected older mined areas on the mainland at Inskip Point. None of these sites are more than about one kilometre from the sea. They are all gently undulating and at low altitude. Some of the inland sites are reasonably well sheltered by distance from the sea and by unmined strips of vegetation, contrasting with the extremely exposed seaward dunes and the foredunes.

The following observations may be made on the rehabilitation carried out by Queensland Titanium Mines Pty Ltd on Fraser Island and the adjacent mainland:

(a) Most foredunes appeared to be revegetating with *Spinifex hirsutus, Carbobrotus glaucescens, Ipomoea pes-caprae* and other species in a reasonably satisfactory manner, although growth was not as luxuriant as on similar sites on the east coast of North Stradbroke Island, which have been heavily fertilized. Some damage, such as the development of small sandblows, and gullying, has occurred, apparently as a result of storms in January 1976.

(b) The brushing and fencing of the foredune crest and hind-dune (which was acknowledged to be essential) generally appeared to be controlling sand movement reasonably well, although in one place some sand had been blown over the bitumen access road 200 m inland. The shelter provided by the brush had encouraged the establishment of some seedlings of the species comprising the brush matting.

(c) Inland areas, parts of which had been sown with different cover crops, displayed variable degrees of success in rehabilitation. A common problem was over-fertilization of the cover crop, so that it smothered any planted or naturally regenerating native species. The worst area in this respect was about 1.5-2 km south of Fourth Creek, revegetated in December 1972 (Exhibit 317, Annexure 'A', Area 1) where vigorous pangola grass has excluded most regeneration, and even much of the normally ubiquitous *Acacia cunninghamii*. Even hand-planted *Casuarina equisetifolia* had not established at all well in this area, while small sand scours had developed in many of the small cleared patches around the planted trees. Clearly, the tendency of cover crops to dominate native species must be carefully controlled by limited fertilizing. The Commission observed similar situations on seaward dunes at Inskip Point, and on the Yarraman area of North Stradbroke Island. Conversely, a younger and more sheltered site, about three kilometres north of Fourth Creek, revegetated only in March 1974, had a less vigorous cover crop which was allowing about twenty native species to regenerate, including a range of tree and shrub species (Exhibit 317, Annexure 'A', Area 3).

(d) Areas where native species are not re-establishing naturally have to be hand-planted with nursery-raised seedlings. This process is expensive and time-consuming and there must be a temptation to avoid such expenditure in the hope that natural regeneration will suffice.

(e) The oldest area of rehabilitation inspected by the Commission was a fairly protected landscape west of the Rainbow Beach airstrip on the mainland. The area had been mined in late 1968 and rehabilitation began early the following year. Topsoil had been respread, the area fertilized once only and then left entirely alone. Despite this apparent neglect, this area, and other slightly younger but similar places nearby, generally possessed vigorous stands of *Acacia cunninghamii* to about eight metres in height and numerous other understory and (eventual) upper-canopy species were present and growing vigorously. Apart from a tendency in places to excessive dominance by the acacia, this community appeared on casual inspection to be regenerating the same species as an adjacent unmined strip although, of course, had not yet developed the same structure and height.

(f) The danger of developing an excessively mono-specific community, whether of grasses or of a species such as *Acacia cunninghamii*, is that the growth of other species may be inhibited for so long that, upon the eventual death of the dominant species, there are no species present to replace it. Furthermore, few viable seeds, from which a replacement community could develop, may remain in the soil. If this happens, there is a serious likelihood of the surface being exposed to windblow and several years' revegetation wasted. If such a situation occurs on all areas of rehabilitation a few years after mining, it may well strain the financial and other resources of the lessee to replant yet again the whole area. Such mono-dominant communities are also undesirable on the grounds of monotony and danger of widespread disease or fire which could again leave a bared surface and few replacement species to fill the gap. The same comment applies to the use of *Casuarina equisetifolia*, too often planted in unnaturally straight rows with even spacing.

In summary, and with reference to the aforementioned criteria distinguishing these ecosystems from others, the evidence indicates that successful rehabilitation is ecologically possible on foredunes, hind-dunes and (by extrapolation only) sandblows, although whether it will be actually achieved on particular sites is a different matter. Ecologists have been given few definitive guidelines about rehabilitation standards (Transcript p.1019). In practice, results are not always consistently satisfactory, especially on seaward and less sheltered areas, often due to excessively competitive cover crops. A delicate balance needs to be struck between the desire to prevent erosion by the use of a dense cover crop, and the need to encourage regenerating and planted native species. Careful fertilizer management, and a certain amount of luck, appear to be required. On the material before the Commission, it would be unjustified to conclude that the successful rehabilitation of mined foredunes, hind-dunes and sandblows on Fraser Island will be achieved in practice.

Steep dunes There is no doubt, on the evidence before the Commission, that the problems of rehabilitation on steep dunes -- particularly forested steep dunes -- are of a substantially different and greater magnitude than those already discussed in relation to foredunes and hind-dunes. The experience of Queensland Titanium Mines Pty Ltd does not yet extend to such areas, which are, however, to be found on ML 102, the lease now being mined by D M Minerals. The Commission viewed juvenile rehabilitation on low altitude rolling sites on ML 102, there being no example of rehabilitation of high altitude steep dunes at the time the Commission viewed D M Minerals' mining operations in February 1976. The oldest area on ML 102, consisting of only a few hundred square metres, had been planted to a cover crop of ryecorn in August or September 1975. Much of the cover crop had died by mid-February 1976, and the Commission saw some natural regeneration of *Lantana camara* and occasional acacia, Moreton Bay ash and bloodwood seedlings. *Casuarina littoralis* and *Banksia integrifolia* had been planted into the dead cover crop. Whilst the natural regeneration was encouraging, a high proportion of the seedling tips had been damaged at heights of ten to twenty centimetres, presumably by salt and strong winds in this exposed site, as they attempted to emerge from the shelter of the cover crop. Younger rehabilitation inspected by the Commission had been fertilized and planted to sorghum and was being hand-planted at the time the Commission visited the site. Topsoil was being replaced on other sites to a depth of at least twenty centimetres in several places the Commission inspected. Clearly, the likelihood of successful rehabilitation on steep dunes has not been established by current operations on these low-altitude rolling sites.

Some trials have been conducted by the Queensland Department of Forestry on a 'simulated mining site' on a steep dune 2.3 km inland from Eurong (Exhibit 516). The original forest vegetation had been removed and burnt, and the topsoil (twenty to thirty centimetres deep) had been removed, stored for about one month and then replaced. The subsoil had not been disturbed. Ammonium nitrate and superphosphate had been applied in split applications at several rates, ranging up to 300 and 600 kg/ha respectively. Three to four months after the topsoil had been replaced, advanced (fifteen months old) seedlings of blackbutt *Eucalyptus pilularis* were planted in April 1972 and after nearly two year's growth at least eighty per cent had survived and had grown to heights of about one metre on unfertilized plots and up to three metres on heavily fertilized plots. About twenty, of the pre-existing fifty, species of native plants had returned to the site. These results might be thought relevant in assessing the chances of achieving successful rehabilitation on mined sites, but such extrapolation is difficult for several reasons:

(a) subsoils were not disturbed at all (which is quite different from what happens during sandmining), while in many places the soil profiles remained essentially intact;

(b) topsoils were stored for only one month, which is a much shorter period than is usual during mining;

(c) the area cleared was only small (3.5 ha) and remained rather sheltered by adjacent forest on steep dunes;

(d) ample sources of seed of native species remained in very close proximity;

(e) large amounts of fertilizer had been applied; and

(f) while the demonstrated growth rates (over two wet years) are impressive, especially on the fertilized areas, there is no certainty that they will be sustained through future climatic vagaries.

In a report compiled by a group of ecologists acting as consultants to D M Minerals, and exhibited at the Inquiry, the opinion was expressed that ML 102 was in the Cooloola Land System, and that (Exhibit 26, p.36)

> The prospects for successful rehabilitation on the Cooloolah [*sic*] Land System can only be judged by reference to the work now proceeding on similar lands on North Stradbroke Island.

The Commission viewed rehabilitation on steep dunes on North Stradbroke Island in the Yarraman and Kounpee areas. It was apparent that regeneration of native species had been seriously retarded or inhibited at Yarraman, presumably by excessive competition from cover crops. One area where rehabilitation commenced in September 1971 had not been fertilized since 1972, but a dense cover of siratro and molasses grass had effectively (and apparently permanently) smothered many planted and regenerating native species.

The Commission inspected areas at Kounpee on which rehabilitation had started in December 1973, January 1974 and March 1975 and also a very steep dune (at about twenty-six degrees slope) which had been brushed. On all sites several native species, such as *Acacia ulicifolia* and *Dillwynia peduncularis*, had regenerated and a number of others (including *Eucalyptus planchoniana, E. gummifera, Angophora costata* and *Banksia serrata*) had been hand-planted. High survival rates were attributed to winter planting into moist soils, and the use of fertilizer pills with long residual effect. This was only a very early stage in rehabilitation, but many plants were up to two metres in height; and on the area which started regenerating in January 1974, about twenty-five species, of some fifty to sixty species which existed before mining, were present and showing some growth.

Kounpee is on the relatively sheltered western side of the Island, and would not suffer the same severe environmental conditions as the exposed eastern steep dunes.

The subject of rehabilitation on North Stradbroke Island was also discussed in a paper by four authors, who recorded their initial misgivings and criticisms following an inspection of rehabilitation in 1970. They then went on to reassess rehabilitation in 1975 and stated (Exhibit 288, Appendix 2, p.5)

> that the present evidence on N. [*sic*] Stradbroke Island substantiates the claims that a vegetation cover, sufficient to bind the surface sand and so prevent obvious dune or surface sand movement, can be established on most of the surface of sand dunes within months of mining.

While admitting the possibility of this agronomic success, which represents the first stage of rehabilitation, they shared the concern expressed by some witnesses about the long-term stability and nature of the ecosystems so established, especially given the environmental stresses and possible neglect likely to be suffered by large areas of land undergoing rehabilitation over several decades. The joint authors wrote that

> artificial introduction of species in the early stages of succession, and the application of fertilizers, completely alter the course of the natural successions which are adapted to achieve long-term stability of the vegetation patterns on moving sand surfaces. The stability of such species combinations in time is therefore highly questionable, and there is no evidence for this stability over periods of decades and hundreds of years which are involved in the continuing movement and growth of old and new sand dune surfaces.

In one of the very few available discussions of the rehabilitation of vegetation on steep dunes based on lengthy field experimentation, two ecologists reported, *inter alia*, in 1975 (Exhibit 44, p.17) that

> The potentially dominant tree species of later seral stages have shown halting progress in becoming established in the first five years. An estimate based on analogy with other dune succession studies and limited experience on age of mature trees in the present ecosystems suggests that 100-250 years might be a minimum time for secondary succession to a regional pyric climax.

This report was based on detailed experiments and establishment trials on mined sites on North Stradbroke Island over a five year period (cf. Exhibit 224).

The evidence before the Commission from those connected with the sandmining industry on the subject of the rehabilitation of steep dunes did not go very far towards establishing the ecological possibility or practical likelihood of success. Mention has already been made of the reference in the report prepared by D M Minerals' consultants (Exhibit 26) to the example of rehabilitation on North Stradbroke Island, but this demonstrates neither the ecological nor the practical possibility of successful rehabilitation of steep dunes on Fraser Island after mining. The other references in that report to this problem are couched in generalized terms which provide very little detailed information about proposed rehabilitation methods or the likelihood of their success. Mr Lewis, the consultant ecologist for Queensland Titanium Mines Pty Ltd, who is experienced in rehabilitation after sandmining on the coast of New South Wales, was unable to identify any area of rehabilitated dunes above twenty metres in height conclusively showing that rehabilitation can be successful (Transcript p.1040).

The evidence before the Commission indicates that the ecosystems on steeper dunes tend to be more complex, and occur on more developed soils, than those on the foredunes and hind-dunes. The interrelationships and interdependencies between soil profile morphology and fertility, soil water regimes, and tiers of vegetation (which can include grasses, shrubs, seedlings, saplings, juveniles of the upper canopy species, and the upper canopy trees themselves), the macro and micro-fauna, and all the external and internal environmental factors, are not capable of being easily and rapidly re-established.

Some witnesses who considered that successful rehabilitation might be ecologically possible on steep dunes were adamant, nevertheless, that long periods of time would elapse before success could be achieved. Periods of years in excess of 50 (Transcript p.682), 100 (Transcript p.1345) and 250 (Exhibit 44) were mentioned.

The evidence also established that, while the return of a certain proportion of the number of pre-existing species after mining gives some indication of the state of the rehabilitation process, it is not a reliable guide because the species which re-establish rapidly are rarely those which will dominate the ultimate plant community. Perhaps a better guide to the success of rehabilitation at a given moment is the presence, vigour and state of growth of these eventual dominants. Early revegetation is no certain indicator of the future character of the community (Transcript p.1264).

The concept of diversity was mentioned by several witnesses (Transcript pp.1684 and 3329). Ecosystem stability depends to a considerable extent upon the development of diverse community types at macro and micro-scales. This in turn is largely dependent upon diversity in environmental factors, such as topography, drainage and soil characteristics. Sandmining is an homogenizing influence, in that this environmental heterogeneity is largely destroyed when the pre-existing vegetation and soil profiles, each developed over very long periods of time, are destroyed.

There was also some evidence (Exhibit 640) that the use of fertilizers in rehabilitation increased biomass (a measure of biological productivity) but tended to retard the development of diversity. Large amounts of plant nutrients will be lost when the area is cleared (by burning trash) and later replanted, because the mechanisms for nutrient retention in soils and mature plant communities are destroyed. Fertilizers are used to replace the lost nutrients, but there is a danger of ecosystem simplification, leading to divergent successions (Transcript pp.645 and 3325; Exhibit 298) which means that the ultimate plant community may not resemble the premined plant community. The use of fertilizers really amounts to an injection of energy into the system, which then suffers simplification and loss of many homeostatic (self-stabilizing) mechanisms (Exhibit 298, p.48).

Several witnesses referred to the necessity, not only of initial, but also of continual, care and attention to rehabilitating communities. Such rehabilitation may involve considerable expenditure and several witnesses doubted whether this attention would be given to rehabilitating communities if prices received for minerals declined drastically or the lessee stopped mining and left the locality. In such circumstances there may be little commercial incentive to spend much money on rehabilitation, although it would seem that mining leases cannot be surrendered until the lessor considers rehabilitation has been successfully completed.

During these lengthy periods while rehabilitation is proceeding toward completion there is the ever-present possibility of some catastrophe -- natural or otherwise -- which could seriously divert the plant succession (Transcript p.680) and result in irreversible deterioration in the sense that it may not be (Exhibit 288, Appendix 2, p.5)

> economically, socially, politically, or aesthetically feasible to return to the former situation within a relatively short time even though it is technically possible to do so.

To sum up this analysis of the evidence, successful rehabilitation is impossible in the case of those steep dunes covered by rain-forests. The ecological possibility of the successful rehabilitation of the balance of the steep dunes which form such a significant feature of Fraser Island has not been established, and the tendency of the evidence is against the likelihood of their successful rehabilitation being an ecological possibility. Assuming for the moment that their successful rehabilitation is an ecological possibility (which is not the Commission's view), on the evidence before the Commission it is unlikely that this would be achieved in practice.

6.4 Fauna

The survival and vigour of all types of fauna are dependent upon the maintenance of their close interrelationships with the physical and biological characteristics of their habitats. In a study of the wildlife on a number of MLs and MLAs on Fraser Island -- including ML 102 -- prepared by consultants to D M Minerals (Exhibit 29, p.5), it was noted that

> Wildlife depends primarily on vegetation for food, shelter and reproduction. Some species have extremely specific habitat requirements, whilst others may be able to tolerate a wide range of conditions. Many require different habitats for different functions; e.g. feeding in one and resting in another.

Ecosystems change naturally at different rates but, as McEvoy has pointed out,

> Animals generally are adaptable to change and if sufficient habitat is retained to ensure the survival of the diversity of the species present then a gradual change in the nature of the island may do no more than bring about relative changes in abundance rather than the disappearance of a species.
> (McEvoy, J.S., *A Plan for the Preservation of Habitat for the Mammalian and Avian Fauna of North Stradbroke Island*, Proc. Roy. Soc. Qd 1975, Vol. 86, p.79)

This introduces the parameter of time. Even though an adequate area of habitat may be preserved, abrupt changes may be inimical because fauna need time to establish food webs and other inter and intra-specific cultural relationships which are not wholly dependent upon the character of the habitat.

The fauna of Fraser Island can be affected by human interference in at least four ways:

(a) by direct interference, such as hunting (by humans or feral animals);

(b) by indirect influences, such as the presence of people and their pets, roads, interruption of feeding patterns and routines, presence of litter and human wastes, introduction of feral animals, and alteration of the physical, chemical and biological environments of water-bodies;

(c) by reduction, elimination or drastic alteration of habitats; and

(d) by stimulation of certain faunal components, such as dingoes (by rubbish), or by producing areas of unusually suitable habitat, such as palatable grazing on rehabilitation areas on foredunes.

There may be 'flushes' of faunal species and/or groups dependent upon particular stages of rehabilitation. In the study of wildlife on Fraser Island mentioned earlier (Exhibit 29, p.5) it is stated that

> If an ecosystem is made unsuitable for organisms the only option is for them to move out, or die. The non-flying animals are unlikely to leave the Island and many of the smaller species will not move more than a hundred metres or so...if that. They usually cannot live in a habitat which has been disturbed, nor are they able to move to a new one unless it is comparatively close by, and is suitable for their requirements and contains room for them. This latter condition is unlikely to obtain. Habitat interference can therefore cause extinction of individuals or species in non-flying wildlife and also the death or loss of birds with specialised requirements (e.g. rainforest birds, water birds and ground parrot).

The possible effects of sandmining on water-based animals have been discussed in Section 6.2, but very little information exists on the populations of terrestrial fauna after mining. Clark commented that

> Some limited trapping of mammals...indicates that some species will return when their habitat requirements are fulfilled in the course of succession. This usually happens fairly rapidly for *Mus musculus*, and later for *Pseudomys novahollandiae* and *Rattus lutreolus*. Suitable undisturbed habitat nearby is important in this re-colonization process.
> (Clark, S.S., Bull. Ecol. Soc. Aust. 1975, Vol. 5(2), p.6)

It seems that habitat 'graininess' is important in the provision of refuges: 'fine-grained' habitats with low diversity may not provide sufficiently large areas of different types of habitat to ensure that fauna can avoid, or adapt to, the effects of rapid environmental perturbations such as fire (Exhibit 10). Rehabilitation areas are likely to be 'fine-grained' habitats.

In the study of wildlife (Exhibit 29) seven different habitat types, based on vegetation types, are distinguished and summarized with respect to their occurrence in six Mining Lease and five Mining Lease Application areas. After some discussion of the fauna within these habitat types, including animals requiring special consideration, the comment is made (p.8) that

> Changes in habitat are certain to cause losses, local extinction or worse to the fauna. Wildlife has evolved with the vegetation and with the effects of burning (which may even enhance the area for animals at a later date), but few of the smaller flightless vertebrates will be able to survive sand-mining, and many of the birds may also be adversely affected.

However, even if, overall, only a small proportion of the total area of a habitat type is affected by sandmining it is incontestable that large contiguous areas of habitat would be destroyed, and that similarly large areas of rehabilitation would result from mining operations. These would be recolonized with terrestrial fauna only slowly, and mostly from the periphery, and so would be somewhat impoverished for lengthy periods. Despite the outward appearance of the plant communities, they would not be fully rehabilitated with respect to the faunal component of the ecosystems until long after the vegetation was regarded as rehabilitated, because the range of micro-habitats takes a very long time to be recreated, if ever. The mining leases now being worked on Fraser Island are concentrated along part of the eastern coast in a long, relatively thin, strip. These mining operations will thus disproportionately affect the fauna of the part of the Island which is of greatest importance for visitors.

6.5 The mining leases and the effects of sandmining on the natural environment of Fraser Island

The provisions of the Fraser Island mining leases in existence at the time the Commission conducted its public hearings were admitted in evidence, and form part of the material before the Commission relating to the effects of sandmining on the natural environment. These mining leases and, in particular, their special conditions, deal *inter alia* with the environmental obligations of lessees on the Island. A number of these have been specifically referred to in the preceding sections of this chapter. The main environmental

obligations consist of restrictions on the clearing of land in advance of the mining operation, burning off, and the pollution of water-bodies; requirements for the rehabilitation and revegetation of mined areas, and the prohibition of mining operations on, or interference with, certain sites, such as lakes and watercourses, and buffer zones around them.

Though specific provisions of existing mining leases may be varied in the future, and a different formulation of the environmental obligations of lessees inserted in any subsequent leases granted, mining leases can be expected to continue to deal with the sorts of environmental obligations set out above. There is little scope for the insertion of any wider environmental obligations, given the essential nature of Fraser Island mining leases as instruments necessarily permitting the permanent destruction of the premining topography and vegetation as a preliminary step in the extraction of those minerals sought by the miner and which constitute the primary motive for the acquisition of mining leases on the Island.

There is no doubt that the existing mining leases influence the effects of sandmining on the natural environment of Fraser Island. Without the environmental obligations contained in them, miners would not be restrained from clearing all the vegetation on the mining path whenever they chose. They would not be specifically prohibited from mining the shores of lakes and the banks of creeks. Without the mining leases, they would have no obligations in respect of rehabilitation, while their duties not to pollute water-bodies would be derived from the general law and be less than specific.

The existing mining leases contain a number of provisions directed at minimizing the deleterious effects of sandmining on the natural environment of Fraser Island. But they cannot, and generally do not, purport to compel the attainment of environmental goals that are ecologically impossible or impracticable. They cannot, and do not, purport to compel the restoration of the natural environment of the Island to its premining condition, although the environmental significance and importance of Fraser Island essentially lies in, and is derived from, the qualities of that natural environment. They cannot achieve successful rehabilitation where this is ecologically impossible or impracticable.

The presence of Special Conditions purporting to restrain the pollution of lakes and watercourses cannot prevent the percolation of substances through the permeable sands of the Island into these water-bodies, and their resulting pollution. This is quite a different issue from whether in a particular case the lessee may or may not be liable for a breach of a special condition in a mining lease.

Depending on the facts and the wording of particular special conditions relating to pollution, significant environmental harm may be caused to water-bodies by pollution as a direct or indirect result of mining, while the lessee may not be technically liable for a breach of the special condition in question.

The special conditions of several of the mining leases prohibit direct interference with certain places of special environmental significance: these include Lake Boemingen, First, Second and Third Creeks in the case of ML 102: and Lake Wabby, Eli Creek and Markwell's Lookout in the case of ML 95. Special Condition 26. (c) of ML 94 provides similar, though less stringent, restrictions in relation to Beauty Spot No. 80 between Waddy Point and Indian Head. Where mining is planned in areas of lesser environmental significance than Fraser Island, the preservation of particular places of beauty is of undoubted value. However, the prohibition of direct damage to these particular places on Fraser Island will not safeguard the special environmental significance of the Island as a whole. The present aesthetic value of these places stems largely from their natural setting. They cannot retain this aesthetic value if the wilderness character of their broader surrounds is destroyed by mining.

Fraser Island possesses a large number of natural features which make it a significant place, both to the layman and the specialist. They range from its vast expanse of wild seascapes and its densely forested hinterland, to its ancient dunes and sandblows. However, the one element which spans and gives unity to the broad spectrum of its particular natural features is an overall impression of wilderness. The beaches, sandblows, forests and lakes are but particular components which go to make up the Island's totality. The individual natural features of the Island cannot be conserved in isolation from one another and abstracted from the overall character of the Island.

The imposition of environmental obligations upon the mining operation, either in the present form of the Special Conditions of the Mining Leases, or in a more stringent form, will not prevent the significant environmental damage which inevitably will result from the mining operations and, in particular, will not prevent the destruction of the unity and integrity of the Island's environment, and of those qualities which make it desirable to record it as part of the National Estate.

Although such obligations may well provide sufficient protection for areas of lesser environmental significance than Fraser Island, they are insufficient to conserve the Island's special environmental qualities and significance. On the evidence before the Commission, mining above the mean high-water mark is incompatible with their conservation. No environmental obligations inserted in a mining lease can achieve the twin goals of allowing mining above mean high-water mark and protecting the environment of Fraser Island.

6.6 Conclusion

There are a number of ways in which man can utilize the Island which, if properly controlled, will not be inconsistent with the conservation of its natural environment. These uses include recreation, scientific research, and probably, selective logging. But with the exception of beach mining in certain areas, continued sandmining is inconsistent with the conservation of the Island's natural environment. This is so, even if, contrary to the overwhelming weight of the evidence before the Commission, successful rehabilitation of the flora after mining is found to be ecologically possible on all mined sites on the Island as well as being actually achieved in practice, and even if individual features of special significance remain unmined.

The overall impression of a wild, uncultivated island refuge will be destroyed forever by mining, together with most of those qualities of the Island's natural environment that make Fraser Island of special value for the present community and for future generations and thus worthy of being recorded as part of the National Estate. These qualities can never be restored after destruction by mining.

CHAPTER 7

THE ENVIRONMENTAL ASPECTS OF SANDMINING ON FRASER ISLAND : THE HUMAN ENVIRONMENT : SPATIAL ASPECTS

7.1 Introduction

This chapter examines the relationship between sandmining and other land uses on Fraser Island, including sustained-yield forestry, Beauty Spots and tourism. It also considers the conflict between sandmining and the preservation of Aboriginal relics and sacred places, and between sandmining and proposals given in evidence to the Commission about extensions to the boundaries of the present National Park.

7.2 Sandmining and forestry

A great deal of evidence was given to the Inquiry about forestry and sustained-yield logging activities on Fraser Island. The Commission was impressed both by the responsible attitude to Fraser Island which has been adopted over the years by the Queensland Department of Forestry and the harmonious working relationship that seems to exist between it and the Maryborough sawmilling companies which process most of the timber shipped from the Island. For example, there appears to be no lack of understanding or support for the strict controls imposed by the Department on the activities of logging contractors. No tree in the Forest Reserve can be touched by a logging contractor without the express permission of the Department, whose officers indicate the precise direction in which each tree is to be felled so as to cause the least damage to the forest nearby. A condition imposed on some mining leases on the Island (e.g. ML 102) is that the lessee must inform the District Forest Officer in writing one year prior to commencing mining operations within any State Forest area upon the land demised whereupon arrangements may be made to salvage any merchantable timber there. Other than that, and the general condition that the lessee shall conduct his operations in a manner that will not cause 'unnecessary damage to shrubs, trees or other flora', mining companies are free to clear trees and shrubs without the express permission of the Department of Forestry.

After inspecting the Island, the Commission has come to the view that, in general, the visual integrity of Fraser Island has not been adversely affected by the carefully controlled logging operations. It seems likely that most visitors to the Island -- apart from experienced botanists, ecologists or foresters -- would be unaware that its timber resources have in fact been exploited for over a hundred years.

The annual output of timber is limited by the Department of Forestry to about 22,500 m^3 (Exhibit 277, p.8). Selective felling has virtually no visual impact except briefly at the actual site of operations (which is, of course, constantly shifting). The logs are trucked along unformed roads, made and maintained by the Department of Forestry, to barging points on the west coast; these sites are simple and relatively unobtrusive since the vessels carry their own loading gear.

It is necessary to note that some current forestry practices, such as clear-felling, chemical treatments in the thinning of stands of timber, and burning off, may, if pursued, be inconsistent with the preservation of the visual integrity of the Island.

It is apparent from Fig. 7.1 that there is little overlap between the areas logged on Fraser Island during the past decade and those that have already been leased, or are currently under application, for sandmining. (The witness who tendered Exhibit 195 explained (Exhibit 265, p.996) that this map, showing the scope of logging operations during the last ten years, had been prepared from memory and excluded some areas where salvage work had been undertaken in cyclone-damaged forest.) Representatives of the Maryborough and Bundaberg District Timber Merchants' Association indicated (Exhibit 265, pp.1025-9) that there were some commercial stands of timber on parts of ML 95 (west of Lake Wabby) and MLAs 131-134 (near Bogimbah Creek). They further explained that the Department of Forestry had asked them not to commence operations on part of ML 95 west of Lake Wabby because it did not know whether the area should be logged on a selective basis as usual or clear-felled and replanted after mining.

Even so, the Commission has reached the view that there is no serious conflict between logging and sandmining operations on Fraser Island. On the contrary there is, if anything, some community of interest. Thus the road built by D M Minerals from ML 102 to Buff Creek could be used by logging trucks and fire-fighting vehicles, and the D M Minerals' airstrip -- one of only a handful on the Island still licensed by the Department of Transport -- could facilitate the rapid removal of an injured forestry worker (or tourist) to the mainland or the transport of emergency medical, fire-fighting or other personnel and equipment from the mainland to the Island. There is no doubt, too, that logging contractors on the Island have been of assistance in the event of mishaps and emergencies and that their heavy earth-moving machinery has been employed from time to time (under contract) in preparing airstrips, improving telecommunications facilities and making rubbish dumps (Exhibit 265, pp.279-288). Although no direct evidence was given to the Commission on this point, it seems highly likely that the sandmining companies have made, and are still making, considerable use of the tracks, prepared for forestry purposes, during the course of their

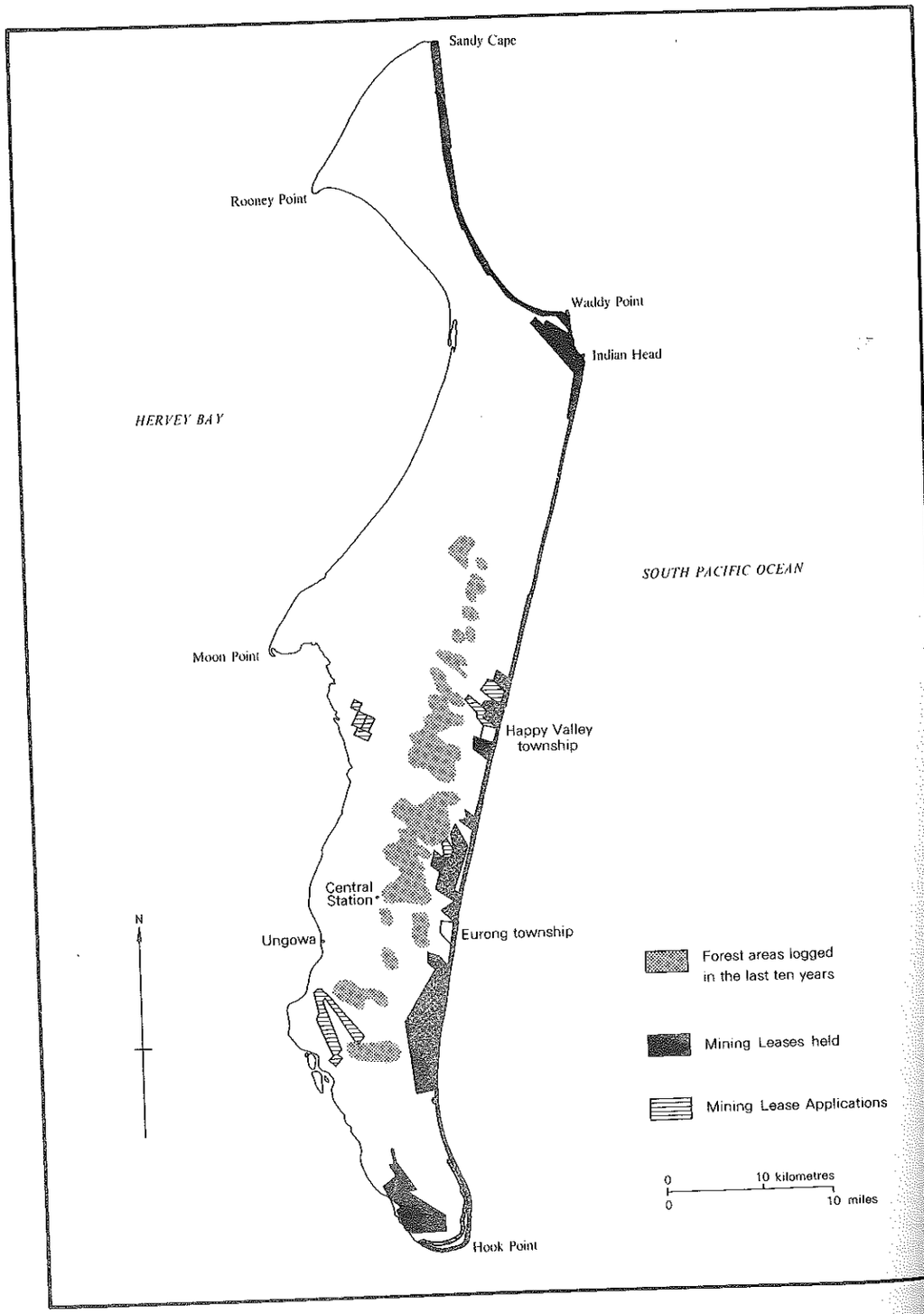


Fig. 7.1: Forest areas logged in the last ten years, in relation to Mining Leases and Mining Lease Applications on Fraser Island (after Exhibit 195)

field investigations. In short, on the mining leases so far granted or already applied for, the conflict between sandmining and forestry operations is negligible whereas the potential for mutually beneficial co-existence on this relatively inaccessible Island is considerable.

The conclusion of the Commission, therefore, is that sandmining operations on *existing* MLs and MLAs do not have, and are unlikely to have, any significantly detrimental impact on sustained-yield logging operations. However, if mining operations were to take place on ore bodies outside the existing MLs and MLAs, there is likely to be a growing conflict between sandmining and forestry activities.

7.3 Sandmining, forestry and national park proposals

If anything, the continuation of logging operations on Fraser Island is much more obviously inconsistent with the acceptance of the submission (Exhibit 265, pp.16-17) that the obligations of the Commonwealth Government would best be met if it encouraged both the designation of the whole of Fraser Island above mean high-water mark as a National Park and the phasing out of the timber industry by 1990. This is largely because once a National Park is established under Queensland law, commercial logging, as well as granting of mining leases and authorities to prospect, are prohibited within it (*The Forestry Act*, 1959 as amended, Section 46 (1), the *Mining Act* 1968 as amended, Section 44 (1)). Advocates of this scheme saw the additional merit that it would enable the whole of Fraser Island to be associated with the proposed Cooloola National Park (Exhibit 569) and even managed jointly with it under a name such as 'The Great Sandy National Park' (Exhibit 265, p.67).

Other witnesses (Exhibit 9, p.44; Exhibit 265, p.408) suggested that the present National Park should be extended southwards to embrace a greater and more varied sample of the ecosystems and features of outstanding scenic and scientific importance. It was argued, for instance, that the National Park should contain 'as compactly as possible, the maximum variety of the island's natural assets, and most of its features of outstanding scenic and scientific importance'. To do this, it was suggested, it will be necessary to preserve, among other things, most of the better development of perched dune lakes, most of the remaining virgin tall forest, the major exposures of coloured sands, part of both coastlines, a sample of major sandblow topography, and intertidal areas to low-water mark.

The Commission was impressed by the considerable body of opinion which favoured some extension of the National Park boundary. It is worthy of note, too, that there was substantial agreement -- at least in principle -- on this issue between conservation bodies on the one hand and sandmining companies on the other (e.g. Exhibit 265, pp.16-17 and 579-80). But, despite the weight of evidence about this subject and the related need to protect the integrity of Fraser Island, the Commission is unable to make recommendations stemming from it. Findings and Recommendations relating to the extension of Queensland National Parks are outside the Commission's terms of reference. It can only strongly commend consideration of extension to the appropriate authorities.

At the same time, it is clear that decisions made by the Commonwealth Government permitting the export of minerals derived from Fraser Island do affect the options available to the Queensland Government in relation to national park proposals. For example, if decisions were made permitting the export of minerals extracted along the east coast in the extreme north of the Island on parts of MLs 93 and 101 (both of which extend to the mean low-water mark) the option of an eastward extension of the present National Park boundary 'to preserve...part of both coastlines' in their natural state (Exhibit 9, p.44 and map 'B') would be foreclosed. As another instance, if decisions were made having the effect of enabling mining to proceed on parts of any of the leases which extend to mean low-water mark (MLs 93, 94, 101, 107 and 120) near the north of Indian Head, there would probably be a related requirement for a road across the Island to a barging point on the west coast; this would be in conflict with the proposal (summarized in the second paragraph of this section) for a southerly extension of the present National Park boundary in order to preserve a greater variety of the Island's natural features.

Given the possibility of these and other land use conflicts (some of which are mentioned elsewhere in this Report), it is essential that a long-term planning and management study be carried out *covering the whole of Fraser Island*. There is merit in the suggestion of some witnesses that the Commonwealth Government should offer any assistance that would enable such a detailed investigation to be put in hand immediately. In Chapter 3 a brief account was given of the way in which the present pattern of land use on Fraser Island evolved. No evidence was given that this evolution took place in accordance with any overall plan or concept. Although, for the reasons given, it would be inappropriate for the Commission to comment on the merits or otherwise of the outline management plan submitted by one witness (Exhibit 9) and supported by several others, this Exhibit does clearly illustrate the importance of viewing the Island as a whole rather than as a series of disparate and unrelated parts. Hence the Commonwealth Government's decision to grant export licences

for heavy minerals derived from ML 102 affected, in a very material way, the land use planning and management options available to the appropriate authorities. Participation in the studies suggested earlier in the paragraph would assist the Commonwealth in making more informed decisions in relation to the export of minerals extracted from Fraser Island.

7.4 Sandmining and Beauty Spots

In Chapter 3 it was noted that twenty-three Beauty Spots have been designated on Fraser Island by the Department of Forestry. Several of these are within or close to mining leases. Three of them are considered in the following paragraphs.

Indian Head - Waddy Point

A substantial part of this Beauty Spot is within MLs 94 and 107. Any sandmining operations in, or transport of minerals or supplies through, this Beauty Spot would totally destroy its integrity. This elevated area (108 m), which is a popular attraction for visitors, contains the only massive rock outcrops on the Island and is scenically important because it forms a prominent landmark along the eastern seaboard. The importance of the Indian Head - Waddy Point area appears to have been recognized in 1964 when it was the only tract along the east coast north of Eurong not to be excised from the State Forest Reserve (Fig. 3.1). The Commission noted that a large signboard erected near Waddy Point indicated that

> BEAUTY SPOT 80 [1 on Fig. 3.2] -- WADDY POINT -- THIS IS PART OF FRASER ISLAND STATE FOREST AND FAUNA SANCTUARY. TO ENSURE THAT THIS AREA IS KEPT IN ITS NATURAL STATE PLEASE NOTE THAT THE DAMAGE OR REMOVAL OF PLANTS AND ANIMALS, THE LIGHTING OF FIRES IN THE OPEN, DISTURBANCE OR REMOVAL OF EARTH OR SAND, THE POSSESSION OF FIREARMS AND THE DEPOSITING OF RUBBISH OR OTHER MATERIAL ARE ALL STRICTLY FORBIDDEN. YOUR CO-OPERATION IS REQUESTED. THANK YOU.
>
> DEPARTMENT OF FORESTRY

Lake Wabby

The whole of this Beauty Spot is within ML 95. Special Condition 25(a)(i) to this lease states that

> The lessee...shall not interfere with or cause to be interfered with for mining purposes...the area of Lake Wabby and the land abutting that lake to a distance of one-third...of a mile [536 m] from the shoreline of that lake.

The inadequacy of this Special Condition has already been discussed in Section 6.2.

Lake Boemingen

The eastern side of this Beauty Spot is within ML 102. Special Condition 24(a)(i) attached to this lease is identical to Special Condition 25(a)(i) of ML 95 except for the difference in the name of the lake. The inadequacy of this Special Condition has already been discussed in Section 6.2.

There is no doubt that sandmining in or near Lake Wabby or Lake Boemingen would destroy the very values which far-sighted foresters were attempting to preserve by declaring them Beauty Spots. An essential part of the attractiveness of these and other lakes on Fraser Island lies in their setting and perspective (a point developed further in Chapter 4). The fact that an arbitrary distance of 536 m all round the shoreline of each lake has been chosen as the limit of mining interference itself suggests that no close study was made of the landscape details or the particular lines of sight from various vantage points.

7.5 Sandmining and Aboriginal sites

In Chapter 3 it was noted that, at various times, Fraser Island sustained a considerable Aboriginal population. The Commission saw for itself, and heard evidence from several witnesses about, the large numbers of middens and other Aboriginal sites on the Island, the majority of which are located along the east coast within a few hundred metres of high-water mark. No surveys have been made about the locations of these middens and few have been investigated in any detail. The Commission was greatly assisted, therefore, by a report (Exhibit 455) relating to a survey of six middens in a foreshore area measuring only 1.5 ha just north of Eurong township. An experienced ethno-archaeologist (who had made only a brief visit to the Island) opined that it was very likely that some object of Aboriginal origin would be found 'on every acre' along the eastern coastline (Transcript p.2718).

The general significance of Aboriginal artifacts appears to have been well summarized by the authors of a notice which -- the Commission observed -- had been erected beside several of the more conspicuous frontal dune middens along the eastern beach. The notice states

> THIS AREA IS AN ABORIGINAL MIDDEN, FORMED BY THE CONTINUOUS ACCUMULATION OF SHELLS DROPPED BY THE ABORIGINES AFTER MEALS. IT WAS HERE THAT THEY COOKED AND ATE THE SHELLFISH COLLECTED FROM THE RIVERS AND SEA.

> THE EARLY EUROPEANS, IN THEIR OBSERVATIONS, SAID THAT THE ABORIGINES WOULD MAKE A SMALL FIRE AND DROP THE MUSSELS AND OTHER SHELLFISH INTO THE COALS. WITH THE HEAT OF THE FIRE, THE SHELLS WOULD OPEN AND THE FLESH WOULD BE EATEN IMMEDIATELY. ANOTHER METHOD USED WAS TO PRISE OPEN THE SHELL WITH A THIN, SHARP FLAKE OF STONE, AND YET ANOTHER, TO SMASH THE SHELL WITH A HAMMER STONE (THE 'RIAMBI', A PEAR SHAPED IMPLEMENT WAS COMMONLY USED FOR THIS).
>
> TO THE ARCHAEOLOGIST MIDDENS CAN SUPPLY CONSIDERABLE INFORMATION. APART FROM THE ACTUAL AGE OF THE MIDDEN FROM CARBON DATING, THE SEASONAL MIGRATIONS OF THE TRIBES CAN BE DETERMINED, PLUS THEIR DIET AND THE SIZE OF THE POPULATION PRESENT. IF THE SITE HAS BEEN USED FOR A LONG TIME, CULTURAL OR ENVIRONMENTAL CHANGES CAN BE SEEN BY CHANGES IN THE TYPES OF STONE TOOLS FOUND. FROM A STUDY OF THE POLLEN IN THE DIFFERENT LAYERS OF THE MIDDEN, CHANGES IN CLIMATE AND VEGETATION CAN BE WORKED OUT.
>
> MIDDENS ARE NOT NORMALLY VERY IMPRESSIVE IN APPEARANCE BUT THEY REPRESENT AN IMPORTANT ASPECT OF ABORIGINAL EVERY DAY LIFE.
>
> IT IS OFTEN SAID, THAT THE HISTORY OF A PEOPLE CAN BE DETERMINED BY A STUDY OF THE REFUSE THEY HAVE THROWN AWAY.
>
> MIDDENS ARE, IN A SENSE, FRAGILE, AND YOUR CO-OPERATION IS SOUGHT IN ORDER TO PRESERVE THEM. WALKING OVER THEM OR DISTURBING THE VEGETATION WILL EVENTUALLY LEAD TO THE EROSION AND IRREPARABLE LOSS OF SUCH RELICS.

The preservation of artifacts, or any other traces of Aboriginal culture, is encompassed by the Queensland *Aboriginal Relics Preservation Act*, 1967. There is some evidence that the management of D M Minerals is 'fully aware of the legislation concerning the preservation of Aboriginal relics' and that 'it is our intention to commission the Queensland Museum to investigate the midden heaps and other areas where they could exist well in advance before our mining operations take place in those particular areas' (Exhibit 265, p.710). However, no evidence was presented to the Commission that any such request had been made or investigations undertaken. Most of the mining leases on Fraser Island are along the eastern fringe which, as indicated already, is regarded as particularly important from an archaeological point of view.

The mining methods currently being used on Fraser Island do not permit an adequate scrutiny of the sand being fed into the processing plants to ensure the identification and preservation of any archaeological material contained in it. Even if archaeological investigations were undertaken ahead of operations, the rate of mining (two hectares a week by D M Minerals alone) would not allow time for any more than sample or superficial surveys. One expert witness pointed out that nowadays archaeologists never excavate more than ten to fifteen per cent of a site: the remainder is thereby left for future investigation and interpretation in the light of changes in archaeological theory, methodology and techniques. Thus, surveys of Aboriginal sites -- even if undertaken by trained personnel -- are not in themselves an adequate procedure. Given that skeletal remains of world-wide significance have been found in sand at Lake Munro, in western New South Wales, the possibility that similar remains may have been preserved on Fraser Island cannot be discounted.

Sandmining operations above high-water mark appear to be inconsistent with the spirit and intention of the Queensland *Aboriginal Relics Preservation Act*, 1967, in its application to the Island.

The Commission was informed (Transcript p.3094) that middens tend to be concentrated along the east coast of the Island because it was 'entirely free of restrictions' as most of the ceremonial and sacred areas and corroboree grounds were on the west coast. Evidence about the location of these places having special significance for Aboriginals was too imprecise for the Commission to determine whether any lie within the boundaries of MLAs 128 (Yankee Jack) and 131-134 (Bogimbah Creek). However, the Commission wishes to record the fact that both these areas were named by witnesses as having some particular ceremonial or sacred significance.

7.6 Sandmining and tourist activities

Evidence before the Commission suggests that, apart from day trippers, a considerable proportion of the visitors to Fraser Island spend most of their time on or near the east coast. The preference for the eastern seaboard is understandable. It appears that most vehicles are brought from the mainland to Hook Point in the south from whence, depending on tides, the full length of the beach can be traversed by four-wheel drive vehicles or those equipped with low pressure tyres. Moreover, this side of the Island has most of the commercial accommodation facilities, provides access to nearly all the Beauty Spots (Fig. 3.2) and other tourist attractions like the *Maheno* wreck and The Cathedrals (Fig. 2.3), and is a popular venue for campers and amateur beach-fishing enthusiasts. In contrast, the west coast is fringed by low-lying mangrove swamp vegetation which, being generally unsuitable for camping,

beach fishing or swimming, is less attractive to the majority of tourists. It was suggested to the Commission, however, that increasing numbers of people are spending at least part of their time on the Island exploring those inland attractions which are reasonably accessible on foot or in four-wheel drive vehicles. Among the reasons suggested for this change in emphasis were the increased publicity about the existence of features like rain-forest and perched lakes, and the larger numbers of family parties who are visiting the Island. The one-day trips (during which people are driven across to the east coast and then back again) and the longer 'safari' tours are also enabling those people who do not own a four-wheel drive vehicle (or who are unwilling to test their navigational skills on the confusing system of topographically-aligned and unsignposted tracks) to see the interior of the Island.

Even so, it is fair to say that the Island's present tourist activity is largely focused along the east coast, much of which is, as already noted, within existing mining leases. Some conflict between these two land uses already exists and, if mining operations were to continue, it seems that this conflict would become more intense.

Existing conflicts

Since 1971, Queensland Titanium Mines Pty Ltd has extracted heavy minerals from a strip -- now about 12.5 km in length -- beside the east coast in the south of Fraser Island on MLs 84, 104 and 105. Over much of this distance the mining path has been only a few metres from high-water mark and its effects are visible to people passing along the beach. A number of witnesses suggested that these operations affected visitors to the Island in two ways. First, anyone travelling up the beach from Hook Point has to pass by mined areas and, as one witness explained (Exhibit 407, p.7), 'the sight of them certainly detracts from any first impressions one might have of the beauty and "naturalness" of Fraser Island'. Second, the removal of the vegetation, the flattening of the dune contours, and the lack of shade trees means that these areas 'have little if any appeal for uses such as picnicking or camping since their recreational potential is eliminated' (Exhibit 407, p.7). Another witness described the same strip as 'a most unattractive, uninviting place for anyone to think of camping' (Transcript p.2805). The Commission, after viewing this area, came to the same conclusion. Even supposing that, over a period of years, some trees and other flora are grown, the hand of man will still be apparent because of the smoothing out of the topography underlying the vegetation and the absence of detailed and interesting idiosyncracies of nature.

The seaward edge of the area disturbed by the mining operations of D M Minerals on ML 102 was approximately one kilometre from high-water mark when viewed by the Commission in February 1976. At that time

the D M Minerals' site was not visible from the beach; it could be claimed that a visitor who did not know that this operation existed could drive up and down this section of the beach and remain unaware of the mining operation. However, parts of the area mined by D M Minerals could be clearly seen from the top of the foredune.

If sandmining activities were to continue, two circumstances make it probable that the results of D M Minerals' mining activities would become visible from the beach. First, its operations appear to be moving on to higher and more conspicuous dunes. Second, assuming that Queensland Titanium Mines Pty Ltd's plant continues to progress northwards up ML 84 at approximately the same rate as at present it will within two years be mining the foredunes directly east of the present D M Minerals' site. The extent of the man-made vista that would then be revealed to the beach traveller is uncertain since much would depend on the precise mining paths selected, the details of the intervening topography, and the speed at which the one firm removes the natural sand barrier screening the operations of the other. This is another instance of an environmentally deleterious consequence that may flow from the decision to grant export licences for heavy minerals derived from ML 102 without a full appreciation of its relationship to circumstances *beyond the boundaries of the particular mining lease involved*. In February 1976, it was already possible to see, from the vicinity of Markwell's Lookout, the higher areas cleared by D M Minerals on ML 102. This Lookout, a well-known tourist attraction approximately nine kilometres north of D M Minerals present mining site, affords an extensive vista of the undulating country, about two kilometres wide, sweeping down from the high dunes to the eastern beach. Special Condition 25 (a)(iii) to ML 95, which states that

> The lessee...shall not interfere with or cause to be interfered with for mining purposes...the area of Markwell's Lookout and the land abutting the Forestry Department's road to and from that Lookout to a distance of fifteen...chains [301 m],

protects the access road and the Lookout itself, but there is no condition in this or any other mining lease which prevents interference with the landscape that can be seen from it.

Long-term conflicts

A considerable body of evidence (which will be summarized later) was presented to the Commission about the significance of Fraser Island in relation to the likely long-term growth in demand for relatively undisturbed natural areas. But even if the numbers of people who visit Fraser Island each year were to remain static, the conflict of interest between tourism and sandmining (were it to

continue) would become sharper. A representative of one of the mining firms pointed out that, taken together, the twenty-four Mining Leases and ten Mining Lease Applications on Fraser Island covered less than nine per cent of its area (Transcript p.3401). He further argued that, as companies take up leases in excess of the ore body, the area to be disturbed by mining in all thirty-four leases would amount to no more than 1.03 per cent of the whole Island. This argument was not supported by sufficient evidence to persuade the Commission of its accuracy. In any event, even if only 1.03 per cent of the Island were to be disturbed by mining, this disturbance would be spread virtually over the whole length of the eastern seaboard and would affect conspicuous high dunes which are visible over considerable distances, as well as the environs of some of the perched lakes and other attractive places inland from the coast. Following such disturbance, it would be impossible to travel anywhere along the eastern beach or to visit many of the Beauty Spots or Lookouts without being conscious that the Island was no longer in a relatively natural state. For the reasons already given, visitors tend to spend most of their time on the eastern side of the Island and this preference is unlikely to diminish. Indeed, any spread of tourist accommodation (except under very strict supervision of full-time resident rangers) away from the eastern beach would itself help to destroy the naturalness of the Island by planting man-made structures, with their related interference, where none exists at present.

The force of this argument becomes even stronger when seen in the context of the evidence about the likely growth in the number of people who will in future desire to visit relatively untouched areas like Fraser Island. There are two aspects of this. There was evidence of the growing need felt by urban dwellers in many countries to spend at least part of their increasing leisure time in wilderness areas. The general point that emerges from data maintained by government instrumentalities and authorities in the United States, Canada and the United Kingdom, for instance, is that wilderness use (expressed, say, in man-days) is increasing approximately twice as quickly as all other forms of outdoor recreation. The limited data available suggest that, similarly, the demand for wilderness recreation is growing in Australia. Thus, McMichael (*Society's Demand for Open-Air Recreation*, unpublished Paper, 1971) has observed that the rate of usage of National Parks within about 150 km of Australian capital cities has been increasing at about ten to twelve per cent a year -- a rate far in excess of that for population increase. Or again, the Queensland Department of Forestry which, until recently, was responsible for the National Parks in the State, noted in its 1972-73 *Annual Report* (p.21) that

Queensland's National Parks are being called upon to meet an increasing public demand for the healthy recreation and educational opportunities they provide. Observations by Park Officers show that park visitation in Southern Queensland is now the equivalent of each person in that area making one visit per year to one of these parks. This usage is expected to continue to increase as it has in other affluent countries.

A typical example of this increased demand for outdoor recreation was provided by numbers of people who visited Carnarvon National Park over the 6-day Easter-Anzac Day break. This park is 480 miles [772 km] west of Brisbane and preserves outstanding examples of sandstone cliffs and gorges, aboriginal relics, a wide range of birds and other animals together with examples of dry inland vegetation in close proximity to ferns, mosses and rain forest species. Over the 6-day holiday period some 2,000 people visited the park and about two-thirds of these visitors came from South-East Queensland. These people were prepared to travel long distances to reach the park and then to hike far into the gorges and camp away from the camp grounds. Camping facilities were provided in 1965; before that only a few hundred people visited the area each year, in that year there were 1,200 visitors. Factors contributing to this large increase are improved access, the appeal of the scenic attraction of the natural landscape and provision of well kept basic camping facilities.

The Commission was informed (Exhibit 407, p.3) that the number of visitors to National Parks in southeast Queensland increased by an average of about five per cent per annum (to 2,500,000) during the five years to 1971-72. This was almost three times the rate of population growth during the same period in 'Southern Queensland' as defined in the *Queensland Year Book*.

The second aspect is that the increased use of wilderness areas is placing considerable pressure on those near the centres of population. Inevitably, perhaps, the provision of facilities to cope with large numbers of visitors (and the crowds themselves) reduces to some extent the impression of naturalness in such areas. As the Queensland Department of Forestry pointed out in its 1972-73 *Annual Report* (p. 21),

> It is good to see such appreciation of the parks by the public but in the case of the more popular areas it poses problems of management. There must be a proper balance between the use and preservation of the environment and management must endeavour to prevent erosion of the natural values of these parks.

Along the south coast of Queensland, the pressure on wilderness areas has developed to such an extent in recent years that people must now travel ever-increasing distances to find relatively undisturbed peaceful scenic areas. On a large scale this also appears to be the situation along the south coast of Queensland. A number of witnesses pointed out that the character of North Stradbroke Island has been affected by sandmining; that there is uncertainty about the future of Moreton Island (which, in any case, lacks the diversity of vegetation and the spectacular scenery of Fraser Island); that Bribie Island is small and has largely been developed for residential and holiday resort purposes; and that the Cooloola area which, though similar in many respects to Fraser Island, is becoming heavily used because of its greater accessibility. To these witnesses, then, Fraser Island represents the last opportunity to preserve, in a fairly natural condition, a wilderness of increasing importance to people which possesses individual features of great merit and contains a substantial range of the ecosystems and natural features which are characteristic of these coastal regions.

The Commission, which has viewed several of these areas including North Stradbroke Island and the Cooloola area, shares the concern of these witnesses and sees the preservation of Fraser Island in its present relatively untouched state as essential for the well-being of future generations. As areas having scenic and ecological diversity are limited in number and cannot be artificially created, the few that remain more or less untouched by man will become increasingly valuable.

An implication of the argument in the previous paragraphs is that larger numbers of people will probably be seeking to visit Fraser Island in future years. In Chapter 3 it was noted that little control is exercised over visitors and that this inevitably leads to some minor abuses such as unburied rubbish near campsites. But this is, for the most part, superficial damage that could easily be remedied. Of greater concern must be the deterioration of particularly fragile spots on the Island (such as Eli Creek or the approaches to Lake Boemingen and Lake Wabby) which are subject to considerable visitor pressure and must be carefully managed in order to conserve their outstanding qualities.

7.7 Summary

The Commission has reached the view that there is little existing or potential conflict between sandmining (on existing MLs and MLAs) and sustained-yield forestry on Fraser Island. However, it is clear that the granting of further export licences for minerals extracted from the Island will affect the options available to the Queensland Government in relation to any extension of the boundaries of the present National Park and the preservation of Aboriginal relics and sacred places. There is already conflict between sandmining and tourism and this is likely to become more intense, if sandmining were to continue, because of the concentration of both these activities along the eastern side of the Island. The Commission has noted that there is a considerable amount of evidence from other countries, and supporting data from Australia itself, to the effect that the demand for, and use of, wilderness areas is increasing markedly at a greater rate than other forms of outdoor recreation. Areas such as Fraser Island which remain in a more or less natural state are becoming scarcer and increasingly valuable. There is an urgent need for a management plan embracing the whole of the Island so that the values which make it worth preserving for the present and future generations are sustained.

CHAPTER 8

THE ENVIRONMENTAL ASPECTS OF SANDMINING ON FRASER ISLAND : THE HUMAN ENVIRONMENT : NATIONAL ECONOMIC ASPECTS

8.1 Introduction

This chapter considers the environmental aspects of decisions relating to the export of mineral sands from Fraser Island insofar as they relate to the impact of sandmining on the national economy. Chapter 9 discusses the economic impact of the sandmining operations on the region directly affected by this activity.

The chapter begins with a short review of the mineral sands industry in Australia as a whole. A benefit-cost analysis of sandmining proposals on the Island is followed by a discussion of the matters which need to be considered in evaluating the losses incurred by those who value parts of the natural environment in its undeveloped state. The effects of curtailing sandmining are considered in the context of a number of economic aspects of a decision to restrict exports of mineral sands.

8.2 The Australian mineral sands industry

In recent years, Australian production of rutile and zircon has exceeded 300,000 tonnes of each mineral per annum, and similar quantities have been exported. In 1973-74, the last year for which detailed statistics are available, earnings from exports of the two minerals constituted more than eighty per cent of the sales revenue of the industry, and overseas sales of ilmenite provided a further ten per cent of its total revenue.

As shown by item 2(c) in Table 8.1, the average price received for export sales of rutile and zircon increased considerably in 1973-74 and rose much more significantly in 1974-75. This was especially true in the case of zircon, the increased demand for which caused its quoted price to rise temporarily to the same level as the price obtained for rutile. By the end of 1975, however, quoted prices for zircon on European markets were in the range of $140 to $160 per tonne for standard grade, and in the range $160 to $190 per tonne for premium grade, considerably less than the maximum levels reached in the previous two years. Changes in quoted prices are reflected in export data after a lengthy time lag, mainly because considerable quantities of exports are sold at prices set in contracts written in previous periods.

TABLE 8.1: PRODUCTION AND EXPORT OF MINERAL SANDS FROM AUSTRALIA, 1972-73 TO 1974-75

Item	1972-73			1973-74			1974-75		
	Rutile	Zircon	Ilmenite	Rutile	Zircon	Ilmenite	Rutile	Zircon	Ilmenite
1. Production - tonnes	318,698	373,024	720,996	308,050	347,014	676,566	315,897	370,010	931,044
2. Exports									
(a) tonnes	338,760	419,962	521,823	359,043	401,545	710,570	338,087	388,926	628,459
(b) value ($m)	39.750	15.131	5.731	45.324	18.615	8.136	56.780	56.972	7.658
(c) average price ($ per tonne)	117.3	36.0	11.0	126.2	46.4	11.4	167.9	146.5	12.2
3. Price range - European markets ($ per tonne)	n.a.	n.a.	n.a.	127-240	45-200	n.a.	200-330	170-330	13-18
4. Value of mineral sands exports ($m)	60.6			72.1			121.4		
5. Value of all exports of goods	6,010.0			6,694.0			8,479.0		
6. Mineral sands as per cent of all exports of goods	1.0			1.1			1.4		
	1973			1974			1975		
7. Value of mineral sands exports ($m)	65.0			90.5			125.4		
8. Value of all mineral exports ($m)	1,701.7			2,431.3			3,118.1		
9. Mineral sands as per cent of mineral exports	3.8			3.7			4.0		

Sources: Australian Bureau of Statistics, *Minerals and Mineral Products*, June 1975; and *Balance of Payments*, June Quarter 1975; Bureau of Mineral Resources, *Summary of Principal Mineral Statistics*, 1975.

Items 4 to 9 in Table 8.1 show that mineral sands exports represented about four per cent of the value of all minerals exports from Australia in recent years, and rose from 1.0 per cent to about 1.4 per cent of foreign exchange earnings from all exports of goods from Australia between 1972-73 and 1974-75.

Official information about employment, turnover and value-added in the industry is summarized in items 1 to 5 in Table 8.2. Items 7, 9 and 11 in Table 8.2 indicate the size of the mineral sands industry in relation to the Australian economy as a whole. The figures in items 9 and 11 show that the industry employed about 0.05 per cent of the total Australian workforce in recent years, and was responsible for about 0.07 per cent of total wages and salaries paid. Although the figures for value-added by industry are not strictly comparable with those for gross domestic product at factor cost, the data suggest that the industry has contributed between 0.12 and 0.15 per cent of the value of all goods and services produced in Australia. This is about twice the percentage contribution in respect of wages and salaries, reflecting the greater capital-intensity of the mineral sands industry when compared with the economy generally.

No separate data are available in relation to the amount of income generated from capital invested in the industry, or for the amount of income owned abroad, both of which form part of gross domestic product and value-added by industry. Income owned abroad would need to be deducted from the industry's contribution to the economy before estimating its net contribution to national income, since by definition the latter excludes income payable abroad.

As shown in Table 8.3, the industry's operations account for about five per cent of all employment in mining and a slightly smaller proportion of wages and salaries paid in all mining activities. Figures for turnover and value-added by industry suggest that mineral sands activities represented about three to four per cent of the value of all mining operations in recent years.

Further information concerning the revenue and costs of the industry is shown in Table 8.4. Although the relationship between revenue and costs is likely to vary considerably in circumstances in which average revenue is subject to significant variations, it appears that the expenditure included in item 4 in Table 8.4 represented from thirty-five to forty per cent of revenue in the years shown and that wages and salaries accounted for approximately a further twenty per cent of revenue. Lease and royalty payments were equal to about three per cent of revenue in later years.

TABLE 8.2: MINERAL SANDS INDUSTRY AND AUSTRALIAN ECONOMY, 1969-70 TO 1973-74

Item	1969-70	1971-72	1973-74
	Mineral sands industry		
1. Number of establishments	n.a.	21	23
2. Employees:			
(a) administrative, office, technical and mining services	844	748	836
(b) production and all other	2,090	1,981	2,066
(c) total	2,934	2,729	2,902
3. Turnover[a] ($m)	58.0	68.1	79.1
4. Value-added[b] ($m)	39.9	44.5	52.8
5. Wages and salaries ($m)	11.7	15.6	18.2
	Australian economy and the mineral sands industry		
6. Gross domestic product at factor cost ($m)	26,880	32,945	45,211
7. Value-added by mineral sands industry as per cent of gross domestic product	0.15	0.14	0.12
8. Total wages, salaries etc. ($m)	15,633	20,061	27,502
9. Wages and salaries paid by mineral sands industry as per cent of total	0.07	0.08	0.07
10. Total labour force[c] (m)	5.363	5.542	5.845
11. Labour force in mineral sands industry as per cent of total	0.05	0.05	0.05

a Revenue from all sales, including capital work for own use.

b Turnover, plus or minus change in stocks, less purchases and selected expenses.

c In May of year shown.

Sources: Australian Bureau of Statistics, *Mining Establishments: Details of Operations; Australian National Accounts: National Income and Expenditure; The Labour Force*, May 1975.

TABLE 8.3: AUSTRALIAN MINERAL SANDS INDUSTRY AS PERCENTAGE OF MINING INDUSTRY, 1969-70 TO 1973-74

Item	1969-70	1971-72	1973-74
1. Number of establishments	n.a.	1.5	1.7
2. Employees	5.0	4.3	4.5
3. Turnover	3.8	3.4	2.8
4. Value-added	3.7	3.1	2.7
5. Wages and salaries	4.3	4.2	3.8

Source: Australian Bureau of Statistics, *Mining Establishments: Details of Operations.*

Items 10, 11 and 12 in Table 8.4 show the results of calculations which provide estimates of the approximate average cost of producing rutile and zircon in the years shown. As the data are based on actual costs incurred in those years, the estimates need to be expressed in terms of more recent price levels to facilitate their use later in the chapter. No specific price indexes are available for the purpose of making the appropriate calculations, but when price changes implicit in official estimates of expenditure on gross domestic product are used to express the values in item 13 of Table 8.4 in June quarter 1975 price levels, the adjusted cost per tonne is approximately $89 for 1971-72 and $86 per tonne for 1973-74.

8.3 General principles of benefit-cost analysis

In traditional benefit-cost analysis, the expected net change in national income arising from any project can be estimated by finding the excess of the value of output from the project over all the costs incurred, due allowance being made for differences which may occur between the benefits and costs experienced by the owners of the project and benefits and costs accruing to the nation as a whole.

TABLE 8.4: AUSTRALIAN MINERAL SANDS INDUSTRY, REVENUE AND EXPENDITURE, 1969-70 TO 1973-74

Item	1969-70		1971-72		1973-74	
	$m	Per cent of total	$m	Per cent of total	$m	Per cent of total
1. Turnover	58.0	94.2	68.1	93.9	79.1	97.8
2. Net additions to stocks	3.5	5.8	4.4	6.1	1.8	2.2
3. Total (1 plus 2)	61.5	100.0	72.5	100.0	80.9	100.0
4. Expenses:						
(a) Stores and materials	6.2	10.0	8.3	11.4	10.3	12.7
(b) Electricity	2.4	3.9	3.3	4.5	3.4	4.2
(c) Other fuels	0.9	1.5	1.2	1.6	1.6	2.0
(d) Other purchases for processing or sale	1.9	3.1	1.1	1.5	0.1	0.1
(e) Contracting, processing	1.8	3.0	4.1	5.7	3.2	4.0
(f) Repairs and maintenance	3.0	4.9	4.3	5.9	4.6	5.7
(g) Freight, other transport	5.3	8.7	5.8	7.9	4.9	6.1
Total above expenses	21.6	35.1	28.1	38.7	28.1	34.7
5. Value-added (3 minus 4)	39.9	64.9	44.5	61.3	52.8	65.3
6. Wages, salaries:						
(a) Office, technical, etc.	3.7	6.0	4.7	6.5	5.6	6.9
(b) Production, other	8.0	13.0	10.9	15.0	12.6	15.6
Total	11.7	19.1	15.6	21.5	18.2	22.5
7. Rent and lease expenses	0.4	0.6	0.9	1.2	1.2	1.5
8. Royalties:						
(a) To governments	0.7	1.1	1.0	1.3	0.8	1.0
(b) To other	0.1	0.2	0.3	0.4	0.3	0.4
	0.8	1.3	1.3	1.7	1.1	1.4
9. Remainder[a] (5 - (6 + 7 + 8))	27.0	44.0	26.8	36.9	32.3	39.9
10. Total rutile and zircon produced (tonnes)	748,741		746,190		655,054	
11. Expenses (item 4) per tonne ($)	28.82		37.60		42.90	
12. Wages and salaries (item 6) per tonne ($)	15.65		20.89		27.78	
13. Total (4 plus 6) per tonne ($)	44.46		58.49		70.68	

a This figure does not equal net profit, since no deduction has been made for expenses not included in item 4, nor for depreciation of capital.

Values shown in items 1 - 9 are rounded to the closest $100,000; percentages are based on original data.

Source: Australian Bureau of Statistics, *Mining Establishments: Details of Operations*, 1968-69 to 1970-71, 1971-72 and 1973-74.

In summary form, it is necessary to estimate

$$NNB = GV - C + E \qquad (1)$$

where NNB = net national benefit (defined as equal to the change in net national income);

GV = gross value of the change in output directly resulting from the project;

C = opportunity cost of all resources directly used in the project;

E = indirect ('external') effects (both benefits and costs) arising from the project.

It is customary to attempt to quantify each element of this equation in monetary terms. For this purpose, data are required for each year in which benefits and costs are expected to be incurred. The present worth of the stream of benefits and costs is then obtained by discounting future flows. Since the existence of a positive rate of interest means that members of society may save and invest sums now which will grow to higher values through time, it is appropriate to use a rate of discount which reflects the rate of return on investment. While there is considerable controversy about the appropriate rate of discount to be used, it may be that some degree of agreement exists that the rate is within the range from five to ten per cent per annum, these being the rates used in this chapter.

In the present context, it is useful to expand the general equation in the following way:

$$NNB = P_r Q_r + P_z Q_z - M - K + E_b - E_c \qquad (2)$$

where NNB = net national benefit;

P_r = price of rutile per tonne;

Q_r = quantity of rutile in tonnes;

P_z = price of zircon per tonne;

Q_z = quantity of zircon in tonnes;

M = current operating costs;

K = capital costs;

E_b = indirect benefits;

E_c = indirect costs.

When estimating the value of minerals produced, it is necessary to distinguish between the revenue which is expected to be received by the mining firms and the net addition to foreign exchange earnings as the result of all sales of the minerals by Australian producers. These two amounts may differ because the sale of output from a project may affect the price received for other Australian production of the minerals. It was suggested to the Commission that no net export income may be earned from the export of mineral sands from Fraser Island because marketing the expected output of rutile and zircon may cause average export prices for the minerals to fall to such an extent that Australia's total foreign exchange earnings will not be increased. In these circumstances, the net benefits directly attributable to the project will be negative, since the input of resources yields no increment in the value of national output (Exhibit 288, Appendix 1, p.2, and Sub-Appendix 5).

Such a result could possibly occur if there were unco-ordinated marketing and production of the minerals by firms operating in Australia, and if firms attempted to maintain their rate of production in periods when demand for the minerals diminishes. As shown by events in 1975, when some sandmining companies reduced output and dismissed employees in the face of a downturn in sales, it seems more likely that production will be curtailed in such circumstances in an effort to prevent further downward pressure on prices. As a consequence, the time taken to extract a given level of minerals is increased when demand contracts.

There are minimum prices below which producers will not operate because they need to cover the current costs of mining and processing. Once a mining operation has commenced and the initial capital expenditure has been incurred, firms will generally operate whenever prices exceed operating costs. This suggests that, based on recent average cost levels, firms may be prepared to accept prices down to a level which returns them about $200 per 'double' tonne of rutile and zircon (i.e. a tonne of rutile plus a tonne of zircon). Before embarking on new projects, it seems that firms would need to see the prospect of obtaining an average of at least $300 per 'double' tonne to cover expected capital and operating costs.

Falls in the price of zircon in the latter part of 1975 illustrate the effects of both expanded supply and reduced demand on market prices. The availability of additional output from Fraser Island increased the total supply available to purchasers and made it more difficult for producers from other areas to sell their output. Although the extent to which supply and demand considerations separately affected prices cannot be readily ascertained, it seems evident that the availability of additional supplies, at times when demand is contracting, makes it necessary to reduce prices or curtail output, or to effect some combination of both, thus reducing the value of export sales. Some price falls may be prevented by co-ordinated action by the industry, with or without government support. In late 1975, the Commonwealth Government agreed to lower minimum prices for exports of zircon below those that previously prevailed. Without government intervention to fix a minimum price level, prices may have fallen to lower levels. In such circumstances it is necessary for producers to retard the rate of production to prevent stockpiling of the minerals in Australia, so that the principal effect of the downturn in demand and the setting of minimum export prices is to prolong the life of available mineral supplies.

Lack of information about the effects of output from Fraser Island on the price and rate of production of rutile and zircon in Australia makes it difficult to incorporate such effects in the benefit-cost analysis in the next part of this chapter. It is therefore important to appreciate that the estimates of gross value of output represent estimates of total receipts by the mining firms operating on Fraser Island and that any effects arising from repercussions on prices or on output of other firms should be deducted from gross and net returns before arriving at estimates of net national benefits.

This discussion of one possible difference between the financial returns to the mining firms operating on Fraser Island and the benefits to the nation as a whole demonstrates the necessity to consider whether there are any other items in the assessment of benefits and costs which may result in similar divergences. Another important

example may be the possibility that a project provides employment for resources which would otherwise be unemployed or under-employed. In many benefit-cost studies, this possibility is ignored on the grounds that the national economy has operated at high levels of employment in recent decades and that, to the extent that unemployment exists, the project under consideration provides no particular opportunities to utilize otherwise unemployed resources. Recent circumstances, with higher and apparently more persistent levels of unemployment, suggest that it may be more realistic to modify the traditional approach by allowing for a divergence between wage-rates and the opportunity cost of labour according to the general level of unemployment. In the estimates contained in Sections 8.5 and 8.6, the approximate effects of such an amendment to costs are illustrated.

In equations (1) and (2), no attempt was made to allow for the existence of overseas ownership of firms associated with the projects. However, overseas ownership implies that part of the income generated by a project accrues to non-residents, the amount depending on profits and other income payable abroad and the extent to which these returns are reduced by taxes and similar payments made to government authorities in Australia. Consequently it is necessary to estimate the amounts of tax and related payments to governments by the firms concerned. These are not separately considered in the case of domestically-owned projects, because they are already included in net income generated by the project, and the whole of the net income remains in Australia.

In the case of a project wholly owned by non-residents, net national benefits may be written as

$$NNB_f = t(PQ - M - D - rPQ - L) + rPQ + L + E_b - E_c \quad (3)$$

where

NNB_f = net national benefit from overseas-owned projects;

t = average rate of income tax payable on net profits (as assessed for income tax purposes);

PQ = value of output = $(P_r Q_r + P_z Q_z)$;

M = current operating costs (excluding royalties and other payments to State and local governments);

D = annual depreciation of capital expenditure;

r = rate of royalty payments;

L = other payments to State and local governments, for leases, rates, etc.;

E_b = indirect benefits;

E_c = indirect costs.

In cases involving overseas ownership, it is necessary to consider whether the capital invested would have been used in Australia in the absence of the project under consideration, or whether it would have been employed elsewhere in the world. If the capital would otherwise have been employed in Australia, it is necessary to add to equation (3) a negative term representing the estimated amounts of income tax and other government revenue that would have accrued to Australia from the alternative use of the capital concerned. It is difficult to be certain whether the overseas funds involved would have been used in Australia in the absence of sandmining opportunities on Fraser Island but, in view of the international and diversified scope of the operations of the parent companies concerned, it will be assumed that they would not otherwise have been invested in Australia. Consequently, taxes and other government receipts resulting from the projects are treated as additions to Australian income. To the extent that similar gains would have accrued to Australia from the use of the capital in other Australian projects, the gains attributable to overseas investment are overstated.

As D M Minerals is a partnership partly owned by an overseas company and partly by a domestically-owned company, it is necessary to give appropriate weights to calculations based on equations (2) and (3) when estimating the net benefits of its operations to Australia.

8.4 Application of benefit-cost analysis to Fraser Island sandmining

When applying the principles summarized in the previous section, it is general practice to make use of available information about benefits and costs, modifying the data available from the firms concerned to reflect national benefits and costs where necessary. The evidence before the Commission appears to provide sufficient data to facilitate a reasonably accurate assessment of the economic costs and benefits usually included in benefit-cost studies. Estimates of net national benefits are heavily dependent on the assumptions made about future benefits and costs. The assumptions used in the following analysis are those which appear to be most appropriate in the light of the information available to the Commission.

One general difficulty associated with expressing benefits and costs in money terms relates to changes in overall price levels during the expected period of benefits and costs. The usual practice, therefore, is to express results in terms of the average levels of prices ruling in a particular time period -- preferably a recent one for which the available data enable allowances to be made for changes in price levels between earlier periods and the period chosen. In the estimates that follow, all money values are expressed in terms of June quarter 1975 price levels.

Price level changes also affect future benefits and costs. No particular problems occur when both price and cost levels are expected to change at the same rate in the future, since the relationship between prices and costs will be unaffected by percentage changes of the same magnitude. Past experience has shown, however, that prices for all commodities do not rise at the same rate, so that it is necessary to consider current expectations about future zircon and rutile prices. Costs per unit of output will be assumed to remain constant in terms of the June quarter 1975 price level.

8.5 Operations of D M Minerals

Table 8.5 shows the data used in estimating the benefits and costs associated with the sandmining operations of D M Minerals. The assumptions made are outlined in the following paragraphs.

The time period was calculated by reference to the expected dry mill capacity of 32,500 tonnes of rutile and a similar quantity of zircon per annum (Exhibit 265, p.770) and dividing the quantities of estimated heavy minerals contained in the various leases (Exhibit 62) by the annual production figures. These calculations suggest a total life of twenty-three years if all areas covered by existing leases are mined, and if all applications for leases are granted and the areas concerned mined. For convenience, it was assumed that equal quantities of the two minerals will be mined in each of the first twenty-two years of operation and that the residual quantities are mined in the final year of operations. As already noted, the duration of mining may be affected by fluctuations in demand for the minerals, and the production figures used should be regarded as approximations to the course of events under the assumptions made.

The estimates of capital expenditure in column (2) of Table 8.5 are intended to cover initial expenditure, annual replacement expenditure on equipment (such as vehicles, tractors, etc.), and additional capital expenditure which would presumably be associated with transferring activities to new areas of operation. It was assumed that capital equipment depreciates at a constant annual figure, as shown in column (3), and that there is no scrap value at the end of the operations. The figures in column (4) show the estimated value of capital equipment at the end of each year.

In considering the price of the minerals, shown in columns (7) and (8), it will be noted that approximations to prices reported in 1974 and 1975 have been used to estimate the returns from the first year's output. As it seems unlikely that the high level of these prices will persist, the price for rutile was assumed to average $250 per tonne over the remaining period of mining operations

TABLE 8.5: ESTIMATES OF BENEFITS AND COSTS OF OPERATIONS OF D M MINERALS

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Year	Capital expenditure (K)	Depreciation of capital (D)	Accumulated capital	Quantity rutile (Q_r)	Quantity zircon (Q_z)	Price of rutile (P_r)	Price of zircon (P_z)	Revenue from rutile ($Q_r P_r$) (5)x(7)
	$m	$m	$m	tonnes	tonnes	$ per tonne	$ per tonne	$m
0	8.000	-	8.000	-	-	-	-	-
1	0.250	1.000	7.250	32,500	32,500	300	300	9.750
2	0.250	1.000	6.500	32,500	32,500	250	200	8.125
3	0.250	1.000	5.750	32,500	32,500	250	150	8.125
4	1.250	1.000	6.000	32,500	32,500	250	150	8.125
5	0.250	1.000	5.250	32,500	32,500	250	150	8.125
6	0.250	1.000	4.500	32,500	32,500	250	150	8.125
7	0.250	1.000	3.750	32,500	32,500	250	150	8.125
8	0.250	1.000	3.000	32,500	32,500	250	150	8.125
9	5.250	1.000	7.250	32,500	32,500	250	150	8.125
10	0.250	1.000	6.500	32,500	32,500	250	150	8.125
11	0.250	1.000	5.750	32,500	32,500	250	150	8.125
12	0.250	1.000	5.000	32,500	32,500	250	150	8.125
13	0.250	1.000	4.250	32,500	32,500	250	150	8.125
14	0.250	1.000	3.500	32,500	32,500	250	150	8.125
15	2.250	1.000	4.750	32,500	32,500	250	150	8.125
16	0.250	1.000	4.000	32,500	32,500	250	150	8.125
17	0.250	1.000	3.250	32,500	32,500	250	150	8.125
18	1.750	1.000	4.000	32,500	32,500	250	150	8.125
19	0.250	1.000	3.250	32,500	32,500	250	150	8.125
20	0.250	1.000	2.500	32,500	32,500	250	150	8.125
21	0.250	1.000	1.750	32,500	32,500	250	150	8.125
22	0.250	1.000	1.000	32,500	32,500	250	150	8.125
23	-	1.000	-	3,000	3,000	250	150	0.750
Totals	23.000	23.000	-	718,000	770,000	-	-	181.125

TABLE 8.5 (continued): ESTIMATES OF BENEFITS AND COSTS OF OPERATIONS OF D M MINERALS

(1)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Year	Revenue from zircon ($Q_z P_z$) (6) x (8)	Total revenue (PQ) (9) + (10)	Operating costs (M)	Royalties r(PQ)	Lease payments (L)	Profit before tax (11)-(12)-(13)-(14)-(3)	Income tax on profits 45% (15)	Profits after tax (15) - (16)
	$m	$m	$m	$m	$m	$m	$m	$m
0	-	-	-	-	-	-	-	-
1	9.750	19.500	6.500	0.390	0.060	11.550	5.197	6.353
2	6.500	14.625	6.500	0.293	0.060	6.773	3.048	3.725
3	4.875	13.000	6.500	0.260	0.060	5.180	2.331	2.849
4	4.875	13.000	6.500	0.260	0.060	5.180	2.331	2.849
5	4.875	13.000	6.500	0.260	0.060	5.180	2.331	2.849
6	4.875	13.000	6.500	0.260	0.050	5.190	2.336	2.854
7	4.875	13.000	6.500	0.260	0.050	5.190	2.336	2.854
8	4.875	13.000	6.500	0.260	0.050	5.190	2.336	2.854
9	4.875	13.000	6.500	0.260	0.050	5.190	2.336	2.854
10	4.875	13.000	6.500	0.260	0.050	5.190	2.336	2.854
11	4.875	13.000	6.500	0.260	0.030	5.210	2.344	2.866
12	4.875	13.000	6.500	0.260	0.030	5.210	2.344	2.866
13	4.875	13.000	6.500	0.260	0.030	5.210	2.344	2.866
14	4.875	13.000	6.500	0.260	0.030	5.210	2.344	2.866
15	4.875	13.000	6.500	0.260	0.030	5.210	2.344	2.866
16	4.875	13.000	6.500	0.260	0.020	5.220	2.349	2.871
17	4.875	13.000	6.500	0.260	0.020	5.220	2.349	2.871
18	4.875	13.000	6.500	0.260	0.020	5.220	2.349	2.871
19	4.875	13.000	6.500	0.260	0.020	5.220	2.349	2.871
20	4.875	13.000	6.500	0.260	0.010	5.230	2.354	2.876
21	4.875	13.000	6.500	0.260	0.010	5.230	2.354	2.876
22	4.875	13.000	6.500	0.260	0.010	5.230	2.354	2.876
23	8.250	9.000	5.800	0.180	0.010	2.010	0.904	1.106
Totals	122.000	303.125	148.800	6.063	0.820	124.443	56.000	68.443

TABLE 8.5 (continued): ESTIMATES OF BENEFITS AND COSTS OF D M MINERALS

(1)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)
Year	Cash flow to firm (17)+(3)-(2)	NNB if wholly locally owned and financed (11)-(12) -(2)	NNB if wholly overseas owned (16)+(13)+(14) + 15% of (17)	NNB locally and overseas owned (weighted average)	Present worth factor (10% p.a.)	Present value (year 0) (21)x(22)	Present worth factor (5% p.a.)	Present worth (year 0) (21)x(24)
	$m	$m	$m	$m		$m		$m
0	-8.000	-8.000	-	-	1.000	-	1.000	-
1	7.103	12.750	6.600	8.445	0.909	7.677	0.952	8.040
2	4.475	7.875	3.960	5.134	0.826	4.241	0.907	4.657
3	3.599	6.250	3.078	4.030	0.751	3.027	0.864	3.482
4	2.599	5.250	3.078	4.030	0.683	2.752	0.823	3.317
5	3.599	6.250	3.078	4.030	0.621	2.503	0.784	3.160
6	3.604	6.250	3.074	4.027	0.564	2.271	0.746	3.004
7	3.604	6.250	3.074	4.027	0.513	2.066	0.711	2.863
8	3.604	6.250	3.074	4.027	0.466	1.877	0.677	2.726
9	-1.396	1.250	3.074	4.662	0.424	1.977	0.645	3.007
10	3.604	6.250	3.074	4.662	0.385	1.795	0.614	2.862
11	3.616	6.250	3.064	4.657	0.350	1.630	0.585	2.724
12	3.616	6.250	3.064	4.657	0.319	1.486	0.557	2.594
13	3.616	6.250	3.064	4.657	0.290	1.351	0.530	2.468
14	3.616	6.250	3.064	4.657	0.263	1.225	0.505	2.352
15	1.616	4.250	3.064	4.657	0.239	1.113	0.481	2.240
16	3.621	6.250	3.060	4.655	0.218	1.015	0.458	2.132
17	3.621	6.250	3.060	4.655	0.198	0.922	0.436	2.030
18	2.121	4.750	3.060	4.655	0.180	0.838	0.416	1.936
19	3.621	6.250	3.060	4.655	0.163	0.759	0.396	1.843
20	3.626	6.250	3.055	4.652	0.149	0.693	0.377	1.754
21	3.626	6.250	3.055	4.652	0.135	0.628	0.359	1.670
22	3.626	6.250	3.055	4.652	0.123	0.572	0.342	1.591
23	2.106	3.200	1.260	2.230	0.112	0.250	0.326	0.727
Totals	68.443	131.325	73.149	105.165	-	42.668	-	63.179

since there appears to be a general expectation that it will remain on a much higher plateau than was the case prior to increases in 1974 and 1975 (if only because of the general inflationary conditions which have prevailed in the world economy during this period). It also seems likely that zircon prices will fall back considerably from their recent levels and revert to lower levels than prices for rutile, but probably not to the much lower levels which formerly applied. Hence a long-term average price of $150 per tonne was used, after an assumed fall to an average of $200 per tonne in the second year of operations.

Operating costs, as shown in column (12), are assumed to be $100 per tonne of mineral output. This is greater than the average of expenditure, including wages and salaries, per tonne of the two minerals produced in Australia in 1973-74 (see items 10-13 in Table 8.4 and the discussion at the end of Section 8.2), and is intended to provide adequate allowance for the items not included in the official statistics. Although it appears that the sandmining industry has been able to take advantage of technological changes to reduce unit costs of production in the past, no evidence was presented which suggested substantial increases or decreases in costs over the estimated mining period (apart from general inflationary influences). Consequently, it was assumed that the production cost remains at $100 per tonne (in June quarter 1975 price levels) throughout the period.

Royalties were estimated on the basis of two per cent of total revenue, and lease payments by estimated annual payments provided in leases. The assumption was made that rentals are initially paid on all leases held but that these are phased out a few years after completion of operations on each lease. Actual lease payments may differ considerably from the figures shown in the table, but such differences would have little effect on the overall calculations because of their relative insignificance in relation to the main items of revenue and cost.

The income tax estimates in column (16) assume that all profits are subject to a forty-five per cent rate of company income tax, this rate being chosen to represent the average rate which may apply over the expected period of operations. Column (17) shows the amount of profits after this tax is paid. Column (18) shows the estimated cash flow (after income tax is paid) to the owners of the project in each year. The figures in this column suggest that the firm would recover more than eighty-eight per cent of its initial capital expenditure in the first year of operations and would recover all its initial capital outlay early in the second year of operations.

Column (19) indicates the estimated net benefits which would accrue if the firm were wholly Australian owned and all capital expenditure were financed from Australian sources. Column (20) shows the estimated net national

benefits if the firm were wholly overseas owned, remitted all its after-tax profits abroad and paid a fifteen per cent withholding tax on such profits. The difference between the net benefits shown in columns (19) and (20) is attributable to the fact that net profits (after tax) owned abroad do not form part of net national income accruing to Australians.

Column (21) shows the weighted average of net benefits on the assumption that seventy per cent of profits from the project will be overseas owned and thirty per cent locally owned in the first eight years of operation (as implied in Exhibit 101), and thereafter that fifty per cent of profits will be owned by each partner. In accordance with the reported provisions of the partnership agreement, it was assumed that all capital expenditure will be financed by Dillingham Constructions Pty Ltd from external sources.

The total of column (21) shows estimated net national benefits in excess of $105m over the expected period of operation of all mining leases and applications. When a rate of discount of ten per cent per annum is applied to the estimates of future benefits, as shown in column (23), the present worth of the net national benefits is approximately $43m; when a five per cent per annum rate of discount is used, column (25) shows the present worth to be approximately $63m.

It is relatively simple to calculate the sensitivity of the estimates to changes in the principal variables. For example, a fall in the export revenue of Australian producers of mineral sands equal to about thirty-five per cent of the estimated revenue from the operations of D M Minerals would reduce the net national benefits to approximately zero. As pointed out already, a contraction of demand may make it difficult for existing producers to sell current output and result in a slowing down in the rate of output through time. It will be apparent that any such slowing in the rate of output reduces the present worth of net national benefits because some benefits are then postponed to a later date. Moreover, further costs may be incurred in delaying the extraction and processing of minerals, with consequential falls in profits and in the net national benefit.

Although it would be necessary to carry out a detailed study of the extent to which the sandmining activities provided jobs for otherwise unemployed persons before an accurate assessment of differences between financial and economic costs could be attempted, a simple calculation may be used to illustrate the magnitude of the effects of possible adjustments for this purpose. If a deduction of five per cent were made from estimates of all current operating costs to allow for the utilization of otherwise unemployed resources, in the light of recent levels of general unemployment in Australia, the operating

costs in column (12) of Table 8.5 would be reduced by an undiscounted total of $7.44m. This would have the effect of adding approximately seven per cent to the estimates of the net national benefit: that is, the total of column (21) would then be approximately $113m, of column (23) approximately $46m, and of column (25) approximately $68m. A fall in the export revenue of Australian producers of minerals sands equal to about thirty-seven per cent of the estimated revenue from the operations of D M Minerals would reduce net national benefits to zero in this case.

8.6 Operations of Queensland Titanium Mines Pty Ltd

The estimates contained in Table 8.6 reflect an approach to the economic aspects of the operations of Queensland Titanium Mines Pty Ltd similar to that contained in Section 8.5. The expected time periods and output levels are based on information supplied by the Company (principally in Exhibit 317). The estimates provide for approximately three years to complete operations on ML 84, followed by the same period to mine the MLs in the Indian Head - Waddy Point area, and a further two years to cover the mining of areas covered by its five MLAs.

Table 8.6 contains no estimates for locally-owned operations, since they would be irrelevant to this case. It is also unnecessary to calculate income and withholding taxes separately, since all profits (after payment of income tax) earned by Queensland Titanium Mines Pty Ltd are assumed to be subject to the withholding tax. Hence column (16) of Table 8.6 shows the calculations based on the combined tax rate (45 per cent plus 15 per cent of 55 per cent, i.e. 53.25 per cent).

The total of column (19) of Table 8.6 shows an undiscounted net national benefit of about $6.5m, which is equivalent to about $4.6m when discounted at the rate of ten per cent per annum, and approximately $5.4m when discounted at the rate of five per cent per annum. In this case a reduction in the export revenue of Australian producers of mineral sands equal to about 21.5 per cent of the estimated revenue from the operations of Queensland Titanium Mines Pty Ltd would cause net benefits to fall to approximately zero. A deduction of five per cent from operating costs, to allow for the utilization of unemployed resources, would increase net national benefits by approximately ten per cent: that is the total of column (19) would increase to approximately $7.1m, the total of column (21) to approximately $5.1m, and the total of column (23) to approximately $6m. In these circumstances, a fall in the export revenue of Australian producers of mineral sands equal to about twenty-four per cent of the estimated revenue from the operations of Queensland Titanium Mines Pty Ltd would cause net national benefits to fall to approximately zero.

TABLE 8.6: ESTIMATE OF BENEFIT AND COSTS OF OPERATIONS OF QUEENSLAND TITANIUM MINES PTY LTD

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Year	Capital expenditure (K)	Depreciation of capital (D)	Accumulated capital	Quantity rutile (Q_r)	Quantity zircon (Q_z)	Price of rutile (P_r)	Price of zircon (P_z)	Revenue from rutile (P_rQ_r)	Revenue from zircon (P_zQ_z)	Total revenue (PQ) (9)+(10)	Operating costs (M)
	$m	$m	$m	tonnes	tonnes	$ per tonne	$ per tonne	$m	$m	$m	$m
0	2.500	-	2.500	-	-	-	-	-	-	-	-
1	0.100	0.600	2.000	10,700	7,700	300	300	3.210	2.310	5.520	1.840
2	0.100	0.600	1.500	10,700	7,700	250	200	2.675	1.540	4.215	1.840
3	0.100	0.600	1.000	10,700	7,700	250	150	2.675	1.155	3.830	1.840
4	1.600	0.600	2.000	8,500	7,800	250	150	2.125	1.170	3.295	1.630
5	0.100	0.600	1.500	8,500	7,800	250	150	2.125	1.170	3.295	1.630
6	0.100	0.600	1.000	8,500	7,800	250	150	2.125	1.170	3.295	1.630
7	0.100	0.600	0.500	8,500	7,800	250	150	2.125	1.170	3.295	1.630
8	0.100	0.600	0	8,500	7,800	250	150	2.125	1.170	3.295	1.630
Totals	4.800	4.800	-	74,600	62,100	-	-	19.185	10.855	30.040	13.670

TABLE 8.6 (continued): ESTIMATE OF BENEFIT AND COSTS OF OPERATIONS OF QUEENSLAND TITANIUM MINES PTY LTD

(1)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
Year	Royalties r(PQ)	Lease payments (L)	Profit before tax (11)-(12)-(13)-(14)-(3)	Income and withholding tax on profits 53.25% (15)	Profits after tax (15)-(16)	Cash flow to firm (11)-(12)-(13)-(14)-(16)-(2)	NNB (foreign owned) (13)+(14)+(16)	Present worth factor (10% p.a.)	Present value (year 0) (19)x(20)	Present worth factor (5% p.a.)	Present value (year 0) (19)x(22)
	$m	$m	$m	$m	$m	$m	$m		$m		$m
0	-	-	-	-	-	-2.500	-	1.000	-	1.000	-
1	0.110	0.004	2.966	1.579	1.387	1.887	1.693	0.909	1.539	0.952	1.612
2	0.084	0.004	1.687	0.898	0.789	1.289	0.986	0.826	0.814	0.907	0.894
3	0.077	0.004	1.309	0.697	0.612	1.112	0.778	0.751	0.584	0.864	0.672
4	0.066	0.003	0.996	0.530	0.466	-0.534	0.599	0.683	0.409	0.823	0.493
5	0.066	0.003	0.996	0.530	0.466	0.966	0.599	0.621	0.372	0.784	0.470
6	0.066	0.003	0.996	0.530	0.466	0.966	0.599	0.564	0.338	0.746	0.447
7	0.066	0.003	0.996	0.530	0.466	0.966	0.599	0.513	0.307	0.711	0.426
8	0.066	0.003	0.996	0.530	0.466	0.966	0.599	0.466	0.279	0.677	0.406
Totals	0.601	0.027	10.942	5.824	5.118	5.118	6.452	-	4.642	-	5.420

8.7 Summary of analysis of both operations

In summary, and ignoring adjustments that may be required to allow for effects on prices or to allow for the utilization of unemployed resources, the above calculations suggest that the present worth of all sandmining operations on Fraser Island is approximately $47.3m when future returns are discounted at the rate of ten per cent per annum and $68.7m when discounted at the rate of five per cent per annum. When no discount is applied, total net national benefits amount to approximately $112m when added over the total expected period of operations.

In undiscounted terms, gross revenue from sales of the two minerals is expected to aggregate approximately $333m, and the deduction of total operating and capital costs of approximately $190m, leaves profits -- before deducting taxes, royalties and lease payments -- of approximately $143m. Of this, approximately $31m represents profits owned abroad (after payment of taxes, royalties, etc.), leaving $112m as the estimated increase in Australian national income. The latter is made up of approximately $36m in the after-tax profits of an Australian-owned company, $68m in payments of company income tax and withholding tax to the Commonwealth Government and $8m in royalties and lease payments to the Queensland Government and local authorities.

Averaging these undiscounted figures over the twenty-three year period of mining, the average annual net national benefits would comprise approximately $3m in payments of company income tax and withholding tax to the Commonwealth Government, approximately $1.5m in after-tax profits of the Australian-owned company, and about $0.3m in royalties and lease payments to the Queensland Government and local authorities. An average of approximately $1.3m per annum would accrue to foreign-owned companies.

If a discount rate of ten per cent per annum is applied, the present worth of these average annual benefits would be about forty per cent of the undiscounted amounts, and if a discount rate of five per cent per annum is applied, the present worth of the average annual benefits would be about sixty per cent of the undiscounted amounts. As already stated, these benefits would be reduced to the extent that sandmining operations on Fraser Island affect the revenue received by other Australian producers of the minerals.

8.8 'External' effects

In the preceding estimates, no attempt has been made to incorporate monetary values that would reflecf so-called 'external' benefits and costs associated with sandmining activities. Such 'externalities' may be broadly defined as benefits and costs which accrue to the economy as a whole

but which are not normally disclosed in the financial transactions of firms associated with the projects concerned. The omission of such values may be significant in some circumstances, since it is possible that favourable or unfavourable effects of certain actions may outweigh the directly measurable effects, or serve to change the present worth of net benefits to an important extent.

There was some evidence that certain works such as transport and recreation facilities, already constructed or to be constructed by the mining companies, may be used by various members of the public either directly for recreational purposes or to gain access to Fraser Island for similar purposes. Benefits created in this way should properly be assessed as 'external' effects. On the other hand, the overwhelming weight of evidence submitted by groups opposed to mining was that substantial losses would be incurred by people who attach value to the availability, and in some cases to the use, of the areas to be mined in their undeveloped state.

In relation to the use of facilities provided by mining companies, the problem is mainly one of attaching values to represent the present worth of the stream of benefits which will be provided by such facilities through time. There are considerable difficulties associated with the assessment of such benefits, including the necessity to forecast future levels of use of the facilities and the value to be placed on the services provided to different types of users through time. Although techniques exist for the measurement of these benefits, no direct evidence was submitted to the Commission on which quantitative estimates of the effects could be made. Measurement problems may be particularly acute in circumstances in which the facilities provided are not the same as those which would have been established if the provision of services to potential users had been used as the criteria for providing facilities, as opposed to the existing situation in which the work has been carried out as a by-product of mining operations and related activities.

In view of both the conceptual and practical difficulties associated with the assessment of such benefits, no attempt has been made to include them in the formal benefit-cost assessments. However, it is relevant to point out that no evidence was submitted to indicate that total benefits from the use of these facilities would be large when compared with the benefits which might accrue from the mining operations themselves. The Commission considers such total benefits would be relatively small.

With regard to the losses incurred by those who value the areas affected by mining operations in their undeveloped state, there are also substantial conceptual and methodological problems which are considered in the next section.

8.9 Evaluation of environmental losses

The traditional framework used in most benefit-cost studies suffers from a number of deficiencies which cast doubts on its usefulness as an analytical tool in cases where there are significant environmental considerations to be taken into account in the making of decisions about whether or not development of specific areas should take place. Methodological approaches have been developed in an effort to try to take proper account of what appear to be the most important aspects of the dynamic situations that exist when decisions have to be made about whether or not to proceed with the development of areas which contain valuable or potentially valuable environmental attributes.

One significant result of recent research relates to the need to consider the losses associated with areas to be used for development projects where the retention of such areas in an undeveloped state is regarded as a valuable asset by at least some members of the population. This contrasts with the traditional view, embodied in most benefit-cost studies, that land not currently used for the production of commodities does not represent a valuable resource, so that its development does not incur an opportunity cost in the form of losses incurred by those who value it in its undeveloped state. Recognition of this cost appears to be an important consideration in relation to the sandmining proposals on Fraser Island, where such losses will be incurred through the use of areas for mining both in the more immediate future and over a very long span of time. While uncertainty exists about man's ability to rehabilitate and/or restore mined areas, account must be taken of the losses which will be suffered by those who value the Island in its unmined state. Moreover, there is strong evidence that the real value placed on areas of high environmental quality, such as Fraser Island, will increase substantially through time. This is apparent from long-term trends in developed economies with respect to demand and supply factors associated with manufactured goods on the one hand and the availability of high quality environmental areas on the other.

Growth in real incomes per head in developed countries in recent decades has increased the demand for both manufactured goods and for services provided by the natural environment. However, it is clear that in recent times the demand for services provided by the environment has been growing more rapidly than the demand for manufactured goods. The availability of many manufactured goods has reached or seems likely soon to reach saturation levels, while the demand for recreation and related amenities continues to grow rapidly. Accompanying these trends, the proportion of consumer expenditure going to manufactured goods is no longer rising, and an increasing percentage is being spent on services, including travel and related costs incurred in visiting recreational areas. In turn, this increasing travel and related expenditure is

reflected in the rapid growth in demand for the use of national parks and similar areas which afford people the opportunity to make closer contact with the natural environment (see Section 7.6).

On the supply side, technological change, capital investment and increasing skills have combined to reduce the average costs and prices of most manufactured goods relative to changes in general price levels. By contrast, the supply of high quality natural environmental areas cannot be increased, since such areas are generally incapable of being replicated. Consequently the marked differences in supply considerations reinforce the influences operating on the demand side in raising the value of environmental areas and the services they provide in relation to the value of manufactured goods.

Since most of the minerals produced by extractive industries are used as inputs into manufactured goods of various kinds, it is important to investigate likely trends in the use of minerals obtained from development projects, as well as trends in the manufacture and consumption of the goods in which they are incorporated. Technological change and secular trends in consumption have been associated with significant changes in the pattern of manufactured goods consumed and have also made possible the substitution of various materials as inputs to productive processes. Thus the opportunities for substitution by alternative materials may be of particular importance, since the extraction of some materials used as inputs may incur environmental losses and others may not do so. On the other hand, the scope for substitution between environmental areas is restricted by the available supply, and substitution possibilities are much more limited compared with those for manufactured goods.

With respect to the quantitative assessment of demand factors, it is apparent that the main influences on the growth in the value of services provided by high quality environmental areas are likely to be

(a) the rate of growth in the number of people wishing to make use of the areas concerned, as a result of both general increases in population and in the increased proportion of the population becoming aware of the value of such areas;

(b) the rate of increase in the average value of benefits from such areas as real income rises and an increasing percentage of income is spent on recreational and related activites; and

(c) the optimal economic 'carrying capacity' of the areas, which may be defined as the maximum number of people who may use the areas in any given time period so that the benefits derived are not reduced by the activities of excess numbers of people.

It is evident that the existence of a ceiling under (c) may be extremely important in many areas, since increased usage stemming from the influences in (a) cannot continue at an exponential rate without affecting the environmental quality of these areas.

Recent investigations have shown that approximate estimates of these determinants of the value of benefits from environmental resources may be made if sufficient research effort is devoted to the task. Given estimates of parameters (a), (b) and (c), the extent to which the current annual value of preservation of an area would increase through time may be calculated. In simplistic terms, one appropriate procedure would be to calculate the growth of one dollar's worth of current benefits, resulting from changes under (a) and (b), taking account of limits imposed under (c), and then to find the present worth of current and future benefits by using the same discount rates as are applied to the net benefits from development of the area. The present worth of benefits in future years will depend initially on the relationship between the overall growth of the value of benefits under the influences listed in (a) and (b) on the one hand, and the rate of discount on the other. In those years in which the combined effect of growth under (a) and (b) exceeds the discount factor, the present worth of benefits will exceed one dollar; in those years in which the discount factor is greater than the growth elements, the present worth will be less than one dollar. The sum of the present worth of all future benefits will generally be substantial although, when the carrying capacity constraint operates, only value increases under (b) will be possible and it is then more likely that the present worth of future year's benefits will fall. Recognition of the capacity constraint makes it unlikely that the total present worth of benefits will be infinite.

Attaching what may be regarded as realistic values to growth components, carrying capacity and discount rates studies in the United States show that the present worth of the sum of benefits provided by important environmental areas may be more than 100 times their value in the base period when a ten per cent rate of discount is used. Much higher increases may be applicable at lower discount rates. By way of illustration, suppose that benefit-cost analysis shows that the present worth of a proposed development, discounted at the rate of ten per cent per annum, is approximately $50m, and that the present worth of the sum of benefits lost through time due to the development is 100 times the benefits in the base year. Then the important

question is whether the value of benefits lost in the base period is greater or less than $500,000 (i.e. $50m divided by 100). This result raises the question of the value of preservation in the base year. United States studies use available data about the number of people visiting an area and their willingness to pay, as disclosed in what they actually pay for travel and access to the area, as a basis for deciding whether the value of current benefits required is clearly above or below the net benefits from development of the area.

The methodology does not necessarily provide a clear answer in all cases since the final estimates may leave considerable doubt about whether development or preservation benefits are greater. Evidence presented to the Commission in relation to Fraser Island was grossly inadequate for making the calculations required, but the methodological approach at least indicates some of the most important factors which need to be taken into account, if only subjectively.

The procedures described above do not take account of the value of areas preserved to people who benefit from a knowledge that irreplaceable natural areas exist and will continue to exist for the benefit of future generations, even though they may never visit the areas themselves. These so-called 'option values' appear directly relevant to Fraser Island because of the many Australians who have shown interest in retaining the areas concerned in an undeveloped state, even though they have no immediate intention of visiting them. The aggregate value of such option values also appears likely to grow over time and in view of the fixed supply of high quality environmental areas, may well grow at a faster rate than the rate of discount.

8.10 Importance of Fraser Island reserves of mineral sands

Table 8.7 summarizes the most recent estimates of economically recoverable and sub-marginal reserves of rutile, zircon and ilmenite in Australia. Evidence submitted to the Commission shows that reserves in leases granted and applied for on Fraser Island amount to approximately 793,000 tonnes of rutile and 832,000 tonnes of zircon. It appears that the Island contains about nine per cent of recoverable reserves of rutile in Australia and about fifteen per cent of those located on the east coast. The Island's zircon reserves are equal to about five per cent of recoverable reserves in the whole of Australia and approximately seventeen per cent of those available from the east coast. If annual output of each mineral from the operations of D M Minerals is approximately 32,500 tonnes and the output from the operations of Queensland Titanium Mines Pty Ltd continues at recent levels, total output from the Island will be equal to approximately fourteen per cent of total Australian production of rutile in recent years and about nine per cent of zircon production over the same period.

TABLE 8.7: ESTIMATES OF RESERVES OF AUSTRALIAN MINERAL SANDS

(million tonnes)

Location	Rutile		Zircon		Ilmenite	
	June 1972	June 1975	June 1972	June 1975	June 1972	June 1975
Recoverable reserves[a]						
East Coast	6.2	5.3	5.7	4.9	14.0	10.6
Western Australia	1.7	3.7	5.8	10.7	35.0	45.9
Australia[b]	7.9	9.2	11.6	15.7	49.0	56.9
Sub-marginal reserves						
Australia	2.8	2.3	4.8	4.3	21.1	17.5
Total recoverable and sub-marginal	10.7	11.5	16.4	20.0	70.1	74.4

a Including measured, inferred and indicated reserves.

b Including areas not shown separately.

Sources: (i) June 1972: Exhibit 599 (J. Ward, 'Australian Resources of Mineral Sands', *Australian Mineral Industry Quarterly Review*, 25, No. 1, September 1972, p.15); (ii) June 1975: J. Ward, Transcript, pp.3169-74.

The effect of curtailing potential output from the Island has to take into account the fact that several other areas included in the figures for east coast and total Australian reserves relate to areas which have been 'frozen' for environmental or similar reasons, or relate to mining leases still under consideration. It is therefore important to consider the possibility that any reduction in output from Fraser Island may represent a higher proportion of reserves and output than is represented by the figures for the Island itself. It is proposed to trace the probable effects of a curtailment of east coast production, irrespective of its particular origin, by considering the alternative courses of action most likely to be followed by producers and consumers of the two minerals and the end-products manufactured from them.

8.11 Consequences of reduced supply of rutile and zircon

Information about the operation of the markets for rutile and zircon and the end-products in which they are incorporated suggests that a reduction in the potential supply of the two minerals from some eastern Australian sources can be expected to have the following consequences:

(a) an increase in the demand for rutile and zircon from other sources, including other east coast areas and Western Australia, which together seem likely to be able to meet a substantial part of future world demand for some considerable time;

(b) a possible increase in the price of rutile, an outcome which may be alleviated to the extent that production from Western Australia and other sources is increased, but which may eventually occur earlier than would be the case if all the recoverable east coast reserves were available;

(c) an additional incentive to proceed with plans to increase the output of upgraded ilmenite, particularly from Western Australian sources, thus increasing the likelihood that more synthetic rutile will be used in the production of titanium dioxide pigments;

(d) a possible acceleration in efforts to find substitutes for natural rutile in its other end-uses; and

(e) to the extent that any increase in the price of end-products takes place, an acceleration of research into substitutes for those end-products.

While it is impossible to be certain about the final outcomes of these changes on the prices for end-products, partly because the degree of price change is unknown and partly because the percentage of cost accounted for by inputs of titanium varies markedly between products, it might reasonably be expected that there will be some increase in the prices of end-products as a result of a curtailment of sandmining on the east coast of Australia. This is not a certain outcome, however, since it is possible that beneficiated ilmenite will eventually prove to be less expensive than natural rutile in the production of titanium dioxide pigments. To the extent that there would be any effects on the prices of end-products, these would be felt mainly by users of products such as paint, paper and plastics, which together account for a high proportion of total titanium usage. In other uses, the cost of titanium is generally a small part of total costs, and any increase in price seems unlikely to affect the quantity of end-products demanded to any marked extent. Moreover, it appears that the long-run effect of any price increase may be to encourage the development of substitutes for those uses of titanium dioxide pigments, such as paint, which do not provide extensive opportunities for recycling.

In relation to zircon, east coast supplies do not form such a large part of total recoverable reserves as is the case for rutile, mainly because of the availability of a higher proportion of zircon in deposits at Eneabba and other places in Western Australia. Consequently, it appears that a curtailment of east coast production of zircon would result in a proportionately smaller direct effect on zircon supplies than is the case for rutile. Moreover, it seems that the effects on the total quantity of zircon exported from Australia would be negligible. In view of the difficulties encountered in disposing of zircon at various periods in the past, reduced supplies may help to sustain price levels for this mineral. In the event that a reduction in zircon production on the east coast of Australia was instrumental in causing the price of zircon to rise, this could cause some reduction in the quantity demanded for refractory and foundry uses, for which substitutes are available. In other uses, where no substitutes are readily available, it seems doubtful whether any likely effects on the price of zircon would make a substantial difference to the price of end-products or to the quantities demanded for these purposes.

8.12 Summary

In considering the overall effects on Australia of a decision not to permit the export of minerals from Fraser Island, it is necessary to investigate the principal effects of such a decision on important aspects of the Australian economy.

The aforegoing benefit-cost analysis shows that sandmining on Fraser Island would contribute an addition of approximately $10m to Australian income in years in which prices for the minerals remain at the high levels of 1974 and early 1975, falling to about half that amount if prices fall to what appear to be more realistic long term averages. A figure of $5m is equal to less than 0.01 per cent of Australian national income of over $54,000m in 1974-75. Bearing in mind that any reduction in prices received or quantities sold abroad by Australian producers as a consequence of sales of rutile and zircon from Fraser Island would have to be deducted from these figures, it appears that production of mineral sands from Fraser Island would have only a very marginal impact on the overall level of income or activity in the Australian economy. Consequently a curtailment of such mining would have only a very small impact on the Australian economy as a whole. Moreover, the matters discussed in Section 8.9 suggest that those sections of the community which value the land covered by mining leases and mining lease applications in its undeveloped state may incur substantial losses as a result of mining.

The conclusion to be drawn from the discussion in Section 8.11 is that, although there may eventually be some increase in prices of end-products and some substitution of other minerals for Australian output of rutile as a result of a curtailment of sandmining on the east coast of Australia, the net effects of such changes on consumers of final products would not be sufficiently important to justify interference with environmentally fragile areas. The conclusion appears to hold whether the consumers of the final products are Australians or residents of other countries.

Some consideration may also be given to the effects of a restriction on exports of minerals from Fraser Island on the Australian balance of payments with the rest of the world. At price levels ruling in 1974 and early 1975, annual mineral output from the Island would produce export income of about $25m, which would represent an addition of about 0.3 per cent to total Australian export earnings of nearly $8,500m in 1974-75. Falls in prices for the minerals would result in smaller contributions to total export income, as would any effects on the prices or quantities of minerals produced in other parts of Australia. These figures also make no allowance for profits payable abroad, which would reduce net foreign exchange earnings by about $5m per annum at recent price levels. Because of the comparatively favourable prospects for Australian exports in the long term, and because it seems likely that any reduction in the value of exports of mineral sands from the east coast would be offset by increased exports from Western Australia, it does not seem appropriate to give any particular weight to balance of payments considerations in assessing the sandmining proposals on Fraser Island.

The matters considered in this chapter lead to the conclusion that a decision not to permit exports of mineral sands from Fraser Island would have, at most, a very small impact on the Australian economy as a whole. Any losses which might otherwise occur would be reduced to the extent that production from Fraser Island is replaced by production from other Australian sources of rutile and zircon. The extent of the profits foregone by the sandmining firms, if all MLs and MLAs on Fraser Island were mined, can be seen in the totals of column (17) of Tables 8.5 and 8.6, which indicate that the undiscounted after-tax profits of D M Minerals would fall by about $68m and the undiscounted after-tax profits of Queensland Titanium Mines Pty Ltd would fall by about $5m over the estimated lives of their operations. In these figures no allowance is made for the impact on the profits of other producers of mineral sands in Australia as a result of sales from production on Fraser Island. The profits foregone by the two firms would be reduced to the extent that profits are made before mining on the Island is terminated.

There would also be a reduction in taxation receipts of the Commonwealth Government as a result of the curtailment of mining, but such a reduction would be offset to the extent that mining operations are stimulated elsewhere in Australia. Reductions would also occur in royalty and lease payments to the Queensland Government, unless there were increases in such payments from other ventures established within the State. Although the receipts by the Queensland Government from these sources would not be large when related to that Government's total receipts, residents of the local economies directly and indirectly affected by the sandmining operations on Fraser Island would suffer relatively more important losses in terms of employment and income foregone. These regional effects are considered in Chapter 9.

CHAPTER 9

THE ENVIRONMENTAL ASPECTS OF SANDMINING ON FRASER ISLAND : THE HUMAN ENVIRONMENT : REGIONAL ECONOMIC ASPECTS

9.1 Introduction

The main purpose of this chapter is to consider the environmental aspects of decisions relating to the export of mineral sands from Fraser Island insofar as they relate to the impact of the sandmining on the regional economy directly affected by the mining operations. Some quantitative assessment of the regional impact of the operations has been made by using official statistics based on local government areas. In this respect evidence was given to the Commission that the principal areas directly affected by the operations of D M Minerals are the City of Maryborough and the Shire of Burrum, and the principal areas directly affected by the operations of Queensland Titanium Mines Pty Ltd are the City of Gympie and the Shire of Widgee. Accordingly this chapter examines the available data for these four areas (hereafter called the region) to assess the impact of sandmining on the regional economy.

A brief survey of population, workforce and unemployment in the region is contained in Section 9.2. Section 9.3 contains an estimate of the value of regional income; Section 9.4 is devoted to the contribution made by sandmining operations to regional income and employment; Section 9.5 makes brief reference to some aspects of employment provided by tourist activities on Fraser Island; and the final section considers whether the region should be given special economic assistance if a decision is made to prohibit the export of mineral sands from Fraser Island.

9.2 The regional economy

As shown in Table 9.1, the region's population increased from 47,159 to 48,049 during the 1961-71 intercensal period. A further increase of 751 is estimated to have occurred during the three years to mid-1974.

The only area to show a persistent increase in population was the Burrum Shire, which gained 1,724 additional people between 1961 and 1971, mainly because of the growth at Hervey Bay. While both Maryborough and Gympie recorded population gains between 1961 and 1966, they lost through net emigration between 1966 and 1971. Widgee Shire suffered a decline in population throughout the period. Estimates of population changes in more recent years suggest a continuation of these trends.

TABLE 9.1: REGIONAL POPULATION, 1961 TO 1973

Local government area	Population[a] 1961	1966	Change 1961-66	Population[b] 1966	1971	Change 1966-71	Estimated population 30 June 1974	Change 1971-74	Percentage of State population 1961	1966	1971	1974
Burrum Shire	8,991	9,271	+280	9,293	10,737	+1,444	11,800	+1,063	0.59	0.56	0.59	0.60
Maryborough City	19,126	19,659	+533	19,670	19,257	- 413	19,100	- 157	1.26	1.18	1.05	0.97
Sub-total	*28,117*	*28,930*	*813*	*28,963*	*29,994*	*+1,031*	*30,900*	*+ 906*	*1.85*	*1.74*	*1.64*	*1.57*
Gympie City	11,094	11,279	+185	11,286	11,096	- 190	11,000	- 96	0.73	0.68	0.61	0.56
Widgee Shire	7,948	7,490	-458	7,503	6,959	- 544	6,900	- 59	0.52	0.45	0.38	0.35
Sub-total	*19,042*	*18,769*	*-273*	*18,789*	*18,055*	*- 734*	*17,900*	*- 155*	*1.25*	*1.13*	*0.99*	*0.91*
Total	47,159	47,699	+540	47,752	48,049	+ 297	48,800	+ 751	3.10	2.87	2.63	2.48

a 1966 boundaries

b 1971 boundaries

Source: Australian Bureau of Statistics, Brisbane.

As a result, the proportion of Queensland's population residing in the region declined from 3.1 per cent in 1961 to an estimated 2.5 per cent in 1974, with Burrum Shire being the only area to retain its share of the State total over that period. Between 1966 and 1971 births exceeded deaths in the City of Maryborough by 563, so there was an apparent net emigration of 965 people from the city. In this respect Maryborough shared the experience of many non-metropolitan areas in Australia during this period.

The attraction of the Hervey Bay area as a place of residence for retired people is illustrated by the data in Table 9.2 which show that Burrum Shire had a much higher proportion of Queensland's population aged sixty-five years and over than it had of the State's total population. The same was true, though to a lesser extent, in the Cities of Gympie and Maryborough. The emigration of younger people to other areas was partly responsible for this outcome. Detailed data show that almost all the loss of population from Maryborough between 1966 and 1971 was accounted for by a decline in the numbers of children and young people under twenty years of age.

The increased proportion of the population in older age groups was associated with a relatively small reduction in the total labour force resident in the region between the 1966 and 1971 censuses. As shown in Table 9.3, there was a small decline in the total labour force in the combined Maryborough-Burrum area, a loss of over 300 persons in Maryborough being substantially offset by the increase in workers resident in Burrum Shire. The decline of 240 in the labour force in the combined Gympie-Widgee area was almost entirely attributable to the reduced number of workers located in Widgee Shire.

It is also apparent from Table 9.3 that during this period the region had the same difficulty as most other non-metropolitan areas in retaining employment opportunities in primary and secondary industries. Because of changes in classifications between the two censuses, the data in the table overstate the reduction in the number of people employed in manufacturing industry; but there was undoubtedly a substantial loss of employment opportunities in this type of activity between the two census dates. As against this, however, the creation of additional jobs in the tertiary sector made a substantial contribution to the maintenance of labour market opportunities in the area.

Data relating to unemployment levels at the time of the 1971 census are contained in Table 9.4 and indicate that the region's overall unemployment rate at that date was approximately the same as that in Queensland as a whole. Unemployment levels were relatively lower in the Gympie-Widgee area, marginally above the State average in Maryborough and substantially higher in the Burrum Shire.

TABLE 9.2: AGE DISTRIBUTION OF POPULATION IN REGION, 1971 CENSUS

Local government area	Number of persons in each age-group				Percentage of State total				
	0-4	5-19	20-64	65+	Total	0-4	5-19	20-64	65+	Total
Burrum Shire	853	2,451	5,358	2,075	10,737	0.48	0.47	0.56	1.25	0.59
City of Maryborough	1,656	5,317	9,936	2,348	19,257	0.93	1.02	1.04	1.42	1.05
City of Gympie	966	3,266	5,487	1,377	11,096	0.54	0.62	0.57	0.83	0.61
Widgee Shire	714	2,179	3,644	422	6,959	0.40	0.42	0.38	0.25	0.38
Total	4,189	13,213	24,425	6,222	48,049	2.35	2.53	2.54	3.75	2.63

Source: Australian Bureau of Statistics, Brisbane.

TABLE 9.3: EMPLOYED WORKFORCE IN REGION 1966 AND 1971

Industry	1966							
	City of Mary-borough	Burrum Shire	Sub-total	City of Gympie	Widgee Shire	Sub-total	Regional total	
							number	per cent of total
Agriculture	197	872	1,069	332	2,146	2,478	3,547	20.7
Mining	69	171	240	26	88	114	354	2.1
Manufacturing	2,266	317	2,583	624	247	871	3,454	20.2
Electricity, gas, water	231	101	332	94	11	105	437	2.6
Construction	563	265	828	396	83	479	1,307	7.6
Tertiary	3,763	1,095	4,858	2,464	408	2,872	7,730	45.2
Others	127	41	168	74	47	121	289	1.7
Total	7,216	2,862	10,078	4,010	3,030	7,040	17,118	100.0

Source: Australian Bureau of Statistics, Brisbane.

TABLE 9.3 (continued): EMPLOYED WORKFORCE IN REGION 1966 AND 1971

Industry	1971								Change in region 1966 to 1971	
	City of Mary-borough	Burrum Shire	Sub-total	City of Gympie	Widgee Shire	Sub-total	Regional total			
							number	per cent of total	number	per cent
Agriculture	212	714	926	309	1,728	2,037	2,963	17.6	-584	-16.5
Mining	42	111	153	37	96	133	286	1.7	- 68	-19.2
Manufacturing	1,894	329	2,223	459	149	608	2,831	16.9	-623	-18.0
Electricity, gas, water	126	76	202	63	17	80	282	1.7	-155	-35.5
Construction	416	295	711	408	108	516	1,227	7.3	- 80	- 6.1
Tertiary	4,036	1,428	5,464	2,603	602	3,205	8,669	51.6	+939	+12.1
Others	162	151	313	118	103	221	534	3.2	+245	+84.8
Total	6,888	3,104	9,992	3,997	2,803	6,800	16,792	100.0	-326	- 1.9

Source: Australian Bureau of Statistics, Brisbane.

TABLE 9.4: UNEMPLOYMENT IN REGION AT 1971 CENSUS

Local government area	Total labour force	Unemployed as at 30 June 1971	Per cent of total labour force
City of Maryborough	7,023	135	1.92
Burrum Shire	3,179	75	2.36
Sub-total	*10,202*	*210*	*2.06*
City of Gympie	4,053	56	1.38
Widgee Shire	2,841	38	1.34
Sub-total	*6,894*	*94*	*1.36*
Regional total	17,096	304	1.78
State of Queensland	723,922	13,294	1.84

Source: Australian Bureau of Statistics, Brisbane.

More recent data on employment in the region supplied by the Department of Labor and Immigration (Exhibit 650) is summarized in Table 9.5, which also contains comparative data for estimated unemployment rates in Queensland and Australia from November 1974 to August 1975. Although labour force estimates for local government areas are not available for intercensal periods, it appears unlikely that there has been any marked change in the total workforce in any of the local government areas in the region since the 1971 census, except for Burrum Shire (Table 9.1). Consequently the percentage figures shown in Table 9.5 may be taken as reasonable approximations to the degree of unemployment in the region during the period shown, although the percentages for Burrum Shire may be overstated when compared with the other areas.

As in other areas of Australia, the level of unemployment in the region increased considerably in 1975. The data also reflect the addition of school leavers to the labour force in December and the marked seasonal variation in the region associated principally with employment in the sugar industry. Although the total region had average unemployment in excess of the State and national averages in this period, it appears that the City of Maryborough has been less affected by unemployment problems than Queensland or Australia as a whole.

9.3 Estimate of regional income

No official estimates are available of the value of production or incomes received in particular regions of Australia. Although no evidence was submitted to the Commission on this matter, it is desirable to have an estimate of the region's income to assess the relative significance of the contribution of sandmining to its economy.

Table 9.6 contains estimates of the region's gross product at factor cost (defined as the value of goods and services produced after deducting the cost of goods and services used in the process of production but before deducting allowances for the depreciation of capital equipment). Gross product is equal to total incomes paid to factors of production, and it is necessary to deduct estimates of depreciation of capital to arrive at figures for net income.

The calculations in Table 9.6 are based on the latest available statistics which are reasonably consistent in terms of industry classifications for employment and output data. Labour force data from the 1971 population census are used in conjunction with estimates of gross product prepared by the Australian Bureau of Statistics (*Australian National Accounts -- National Income and Expenditure*). The methodology assumes that gross product per person in each industry group in the region was the

TABLE 9.5: UNEMPLOYMENT IN REGION: PERSONS REGISTERED WITH COMMONWEALTH EMPLOYEMENT SERVICE OFFICES

Area	November 1974	December 1974	January 1975	February 1975	March 1975	April 1975	May 1975	June 1975	July 1975	August 1975
	(i) Number of persons registered in region									
City of Maryborough	315	507	504	434	399	287	313	232	292	259
Burrum Shire	260	379	482	424	402	300	241	261	269	294
City of Gympie	145	287	337	330	277	255	200	156	194	211
Widgee Shire	110	263	290	230	199	163	142	126	195	192
Total	830	1,436	1,613	1,418	1,277	1,005	896	775	950	956
	(ii) Number of persons registered as per cent of total labour force as at 1971 census									
City of Maryborough	4.5	7.2	7.2	6.2	5.7	4.1	4.5	3.3	4.1	3.7
Burrum Shire	8.2	11.9	15.2	13.3	12.6	9.4	7.6	8.2	8.5	9.2
City of Gympie	3.6	7.1	8.3	8.1	6.8	6.3	4.9	3.8	4.8	5.2
Widgee Shire	3.9	9.3	10.2	8.1	7.0	5.7	5.0	4.4	6.9	6.8
Total	4.9	8.4	9.4	8.3	7.5	5.9	5.2	4.5	5.6	5.6
	(iii) Number of persons registered as per cent of estimated labour force									
Queensland	3.5	5.2	6.4	6.3	5.7	5.1	4.5	4.4	4.5	4.6
Australia	3.2	4.5	5.2	5.0	4.5	4.4	4.1	4.1	4.2	4.2

Sources: *(i) and (ii):* Exhibit 650;
(iii) Department of Labor and Immigration, *Monthly Review of the Employment Situation*, November 1974 to August 1975.

TABLE 9.6: ESTIMATE OF REGIONAL INCOME

Industry	Gross domestic product per employee in Australia, 1970-71	City of Maryborough and Burrum Shire		City of Gympie and Widgee Shire	
		Employed labour force 30 June 1971	Estimated gross product ((2) x (3))	Employed labour force 30 June 1971	Estimated gross product ((2) x (5))
(1)	(2)	(3)	(4)	(5)	(6)
	$	No.	$m	No.	$m
Agriculture, forestry, fishing	5,170	926	4.787	2,037	10.531
Mining	13,265	153	2.030	133	1.764
Manufacturing	6,684	2,223	14.859	608	4.064
Electricity, gas, water	11,261	202	2.275	80	0.901
Construction	6,081	711	4.324	516	3.138
Transport, storage and communication	6,580	1,201	7.903	1,273	8.376
Wholesale and retail trade	4,344	1,630	7.081	512	2.224
Public administration, business and community services	5,092	1,969	10.026	1,155	5.881
Other	2,587	977	2.527	486	1.257
Estimate of gross product in 1970-71 (1970-71 prices)			55.812		38.136
Adjustment to allow for increase in labour productivity			3.907		2.670
Estimate of gross product in 1974-75 (1970-71 prices)			59.719		40.806
Adjustment to allow for increase in average prices			32.248		22.035
Estimate of gross product in 1974-75 (June quarter 1975 prices)			91.967		62.841
Adjustment to allow for estimated depreciation of capital goods			-7.357		-5.027
Estimate of net product in 1974-75 (June quarter 1975 prices)			84.610		57.814

Sources: Australian Bureau of Statistics, *Australian National Accounts -- National Income and Expenditure 1973-74; 1971 population census bulletins.*

same as that in each industry group in Australia in 1970-71. This approach overstates gross income accruing to residents of the area to the extent that productivity in the region may be lower than the national average, and also to the extent that income produced in the region accrues to non-residents of that region.

The calculations show an estimate of approximately $56m for the gross product of the Maryborough-Burrum area in 1970-71 and an estimate of approximately $38m for the Gympie-Widgee area. To make these figures comparable with data relating to the effects of sandmining, adjustments are needed to allow for the growth of output between 1970-71 and 1974-75 and for the increase in average price levels between 1970-71 and the June quarter 1975. No direct estimates are available with respect to the growth in output in the region, and the best approximation which can be made is to assume an increase in output per person commensurate with that achieved nationally. As already noted, it seems likely that there was little overall change in the size of the labour force in the region between 1970-71 and 1974-75, so that no adjustment is required on that account. Data for the national economy show that an addition of approximately seven per cent would be appropriate to allow for the increase in average labour productivity between 1970-71 and 1974-75. The Consumer Price Index indicates that an increase of fifty-four per cent is required to allow for price movements between 1970-71 and the June quarter 1975. The effects of making these adjustments are shown in Table 9.6: the resulting estimates are approximately $92m for Maryborough-Burrum and $63m for Gympie-Widgee.

Little reliable information is available about the extent of depreciation on capital equipment, but in recent years recorded depreciation provisions have amounted to about eight per cent of gross domestic product for Australia as a whole. Using this percentage to adjust the regional estimates produces a figure of approximately $85m for net product for the Maryborough-Burrum area and approximately $58m for the Gympie-Widgee area for 1974-75 (expressed in June quarter 1975 prices).

9.4 Effects of sandmining operations

An assessment of the impact of the sandmining operations on the regional economy requires an estimate to be made of both their direct and indirect effects on regional income and employment. Direct effects occur through the employment of workers by the sandmining firms and also through the income generated in the local economy as a result of purchases of goods and services from businesses located in the region. Indirect effects occur through subsequent additions to spending on goods and services by recipients of the initial increases in income.

The evidence indicates that 141 persons were employed by D M Minerals as at 19 June 1975 (Exhibit 265, p.779) and 175 persons in September 1975 (Exhibit 575). There was also evidence that the total number to be employed by this firm in its operations (both on and off the Island) may rise to 210 (Exhibit 288, Sub-Appendix 2). The latter figure would represent about three per cent of the estimated labour force of the City of Maryborough and about two per cent of the estimated labour force of the combined Maryborough-Burrum area. Other evidence indicated that Queensland Titanium Mines Pty Ltd provides direct employment for 132 employees (Exhibit 317, p.7), which is slightly less than five per cent of the estimated labour force resident in Widgee Shire and about two per cent of the labour force of the combined Gympie-Widgee area.

The magnitude of incomes created by direct employment associated with the mining operations can be estimated from data relating to average wage and salary payments. Evidence was given to the effect that the average annual earnings in the mineral sands industry in Queensland in the December quarter of 1974 were approximately $8,163, which gives an estimate of approximately $1.71m as the annual wage and salary payments for 210 employees (Exhibit 288). Adjustment to allow for the increase in average male earnings in Queensland from the December quarter 1974 to the June quarter 1975 would increase this estimate to $1.77m. On a similar basis, annual wage and salaries paid by Queensland Titanium Mines Pty Ltd would be about $1.10m.

There are considerable difficulties associated with estimating the direct regional component of operating expenditure (other than wages and salaries) of the sandmining operations, since accurate estimates would need to be based on data detailing the components of such expenditure in the region and the extent to which such expenditure creates regional incomes on the one hand and goes out of the region to pay for imported components on the other. It seems clear that the principal incomes created are in the form of the value-added regionally in contract and other work performed for the mining firms and in the sale of goods and services to them.

Evidence was given to the effect that the operations of D M Minerals would create an annual regional component of operating expenditure (other than wages and salaries) of $840,000 and the operations of Queensland Titanium Mines Pty Ltd of $220,000 (Exhibit 288). Both figures relate to the net regional effect after allowing for imported components. These estimates appear to have been expressed in 1973-74 price levels: when converted to June quarter 1975 prices they would be about $1.12m in the case of D M Minerals and approximately $290,000 for Queensland Titanium Mines Pty Ltd.

As mentioned already, in addition to the initial effects of wage and salary payments and local incomes generated by the purchase of goods and services by the mining firms, it is necessary to make allowance for the secondary effects on incomes caused by increased expenditure by the recipients of the initial increases in incomes. A well-known economic model is available for the purpose of making such estimates. The extent of the induced effects is limited by three important 'leakages' from regional income: (a) the amount taken in the form of income and other taxes which are paid to governmental authorities outside the region and not automatically respent within the region; (b) the extent to which incomes are saved and the savings not automatically used for financing capital expenditure within the region; and (c) the importance of imported components in meeting the demands of consumers in the region.

In the case of the first two 'leakages', national averages may reasonably be applied to ascertain the extent of the dampening effects, but in the case of (c) it would be necessary to do a considerable amount of research into the structure of the regional economy before very precise estimates of local and imported components could be made. However, the economic structure of the region under consideration seems reasonably similar to other Australian non-metropolitan regions, which suggests that the addition of twenty per cent to estimates of direct expenditure effects is probably appropriate in estimating the extent of the additional annual income which would be generated (McColl, G.D. and Throsby, C.D., 'Multiple Objective Benefit-Cost Analysis and Regional Development', *Economic Record*, 48 (1972) pp.201-9).

TABLE 9.7: SUMMARY OF ESTIMATED EFFECTS ON REGIONAL INCOME
$m per annum (June quarter 1975 prices)

Item	D M Minerals	Queensland Titanium Mines Pty Ltd	Total
Direct effects:			
Wages and salaries	1.77	1.10	2.87
Local content of other operating expenditure	1.12	0.29	1.41
Total direct effects	2.89	1.39	4.28
Secondary effects (addition of 20 per cent)	0.58	0.28	0.86
Total effects	3.47	1.67	5.14

The figures shown in Table 9.7 suggest that the sandmining operations add about $5m per annum to the income of the region. The estimate for D M Minerals is equal to about 4.1 per cent of estimated net income of the Maryborough-Burrum area and the estimate for Queensland Titanium Mines Pty Ltd is equal to about 2.9 per cent of the estimated net income of the Gympie-Widgee area.

These estimates relate to the continuing effect of sandmining operations after they have commenced, and do not incorporate any estimates of effects arising from initial capital expenditure associated with the operations. The effect of such expenditure is generally to provide an initial effect on regional economic activity which precedes the start of operations. No evidence was submitted on which to base an assessment of the effects of initial capital expenditure, but it may usefully be thought of as advancing the date on which the regional effects commence.

Nor do the estimates take account of any stimulus to any local economic activity caused by the mining operations in respect of additional expenditure on facilities which might be required to meet the demand for goods and services for the mining operation, or from increased demands associated with the general uplift in economic activity in the local areas. In regions where considerable excess capacity already exists, such effects may not be of great significance. However, it was submitted to the Commission that there had been an important contribution to business confidence in the Maryborough-Burrum area as a result of the commencement of operations by D M Minerals (Transcript p.2436). It was also submitted that other recent events, such as an upsurge in orders for sugar mill and mining machinery, had also contributed to the more optimistic attitude prevailing in the area recently (Transcript p. 2428).

9.5 Effects of tourism

It was submitted to the Commission that an increase in the level of tourism on Fraser Island could create incomes in the Maryborough-Burrum area commensurate with those provided by the sandmining operations of D M Minerals. For this to occur, the total direct effects of additional expenditure by tourists would have to be approximately equal to $2.89m per annum (Table 9.7) since the secondary effects would probably be similar in each case.

The Commission sought assistance from many witnesses in the hope that, with their help, it could gather enough data to prepare its own approximate estimates of the expenditure in the region by visitors to Fraser Island. Two witnesses provided estimates of annual tourist expenditure: one calculated it as being about $500,000 (Exhibit 288) and the other at about $1,470,000 (Exhibit 489). Taking all the evidence into account, the Commission

reached the view that the first of these figures is too low and the second is probably too high. The Commission was unable to undertake the very considerable research that would be necessary to produce a more accurate estimate. But, whatever the precise figure, if an expenditure of $1m per annum were nearer reality it still implies that there would have to be a threefold increase to match the direct regional impact of the operations of D M Minerals.

Although the amount spent per head varies greatly between tourists who stay in fully-serviced accommodation and those who go bushwalking, it seems not unreasonable to suggest that a threefold increase in expenditure implies a similar increase in the number of tourists. Herein lies the dilemma. Several of the earlier chapters in this Report have commented on the *laissez-faire* nature of tourist activities on Fraser Island and the problems that have already arisen because of the growing numbers of people holidaying along the east coast. The point has been made, too, that a plan of management is urgently required for Fraser Island but that this, in turn, implies the appointment of personnel to implement and supervise such a plan. To the extent that such staff are employed by government departments or agencies and are paid by funds drawn from general revenue sources (or derive their income from tolls or fees imposed on tourists), the contribution to local employment and income from tourism would be increased.

In the short-run, at least, the numbers of persons in the local area providing services to tourists and who depend on the visitor industry as their main source of income will, judging from experience elsewhere in Australia, probably grow at a greater rate than the numbers of tourists themselves. It is less easy to predict the medium or longer-term outcomes. On the one hand, there appears to be little doubt that Fraser Island is attractive to some folk because of its free, easy and informal life-style and the lack of controls (including the absence of almost anyone directly charged with the responsibility for policing the few controls that exist). The increased numbers of tourists (and the greater competition for favoured camp sites or treasured fishing spots), along with the likely imposition of some forms of controls, restrictions, permits, fees and similar outward signs of what may appear to be regimentation or officialdom might lead some people to seek uncontrolled areas -- if these are available -- elsewhere. On the other hand, the upgrading or extension of services and facilities (such as mainland firms specializing in hiring four-wheel drive vehicles) may attract the less self-contained or more timid tourists as well as those who feel more at ease in a crowd.

On balance, it seems most probable that there will be further substantial increases in tourism on Fraser Island, including visits by those wishing to take advantage of its general attractions as a holiday area, to enjoy the

opportunities it provides for bountiful fishing at certain times of the year, and to experience its environmental features. There seems no doubt that employment and income created by these activities will grow, but it is difficult to estimate the extent of such growth.

9.6 The regional economic effects of curtailing sandmining operations

It is clear from a consideration of the likely regional effects of sandmining operations on Fraser Island that a decision to prohibit or curtail the export of mineral sands from the Island would have an important economic impact on the areas concerned. Although there may be some stimulus to tourist activity by those who prefer to have the Island kept in a relatively undeveloped state, the levels of employment and income generated in this way would not offset the losses to the region caused by the cessation of mining activities for many years. Nevertheless it needs to be borne in mind that the estimates of the impact on the region of such a decision relate to a complete cessation of sandmining; if the impact was partly offset by other economic activities, such as increased tourism or sandmining on the eastern beach below mean high-water mark south of Indian Head, the adverse effects would, to some extent, be mitigated.

Consideration of the distribution of benefits and costs of a decision to prohibit or curtail the export of minerals from Fraser Island suggests that a strong case exists for regional economic losses to be made good by the nation as a whole. Those who would benefit most from a decision to curtail sandmining would be those who value the Island in its undeveloped state. The evidence before the Commission indicates that the people concerned are not only residents of the region who prefer this outcome, but include many Australians living outside the region. In addition, it is likely that many future residents of Australia would value the Island in its undeveloped state and would therefore also ultimately benefit from a decision to curtail sandmining.

Those who would lose from such a decision would be the owners of the sandmining ventures, the Commonwealth and Queensland Governments (through the loss of taxation and royalty revenues) the employees who lose their jobs and face costs in finding other employment, and the recipients of the additional incomes created in the region -- directly and indirectly -- as a result of the mining operations. As shown in Chapter 8, the mining firms have already earned profits which would need to be taken into account in considering any case for compensating them. The losses by the Commonwealth and Queensland Governments would be small by comparison with their overall revenues and would represent part of the benefits foregone as a result of a decision to curtail mining. If alternative employment opportunities are not available in the region, many

employees who lose their jobs will seek employment elsewhere and to the extent that they are successful in finding equally productive employment, no national economic loss will occur as a result. To the extent that displaced employees find such employment within the region, no regional loss will occur. But unless other economic activity is generated in the region, the losses to regional income may be important; consideration therefore needs to be given as to whether some form of governmental assistance should be provided in the event that there is no offsetting increase in economic activity.

It appears that different approaches to the question of special economic and other assistance may be appropriate when no activity has actually commenced before a decision is made as compared with the situation which arises when economic development has already begun. In the former cases, no expenditure may have been incurred by residents of the region and no expectations about future incomes created, and a decision that development is not to proceed avoids movements of labour and other resources in the expectation of receiving future income. Where operations have commenced, as in sandmining on Fraser Island, assistance to the region in the event of a subsequent cessation of sandmining may be justified by the expectations created and the decisions to commit resources. In this respect, a further distinction may be made between operations which had commenced before it was announced that an Inquiry under the *Environment Protection (Impact of Proposals) Act* would be held, as in the case of the operations of Queensland Titanium Mines Pty Ltd, and those which commenced after that date, as in the case of D M Minerals. In the latter instance, those benefiting from the operations were aware that such an inquiry would be held as well as of the possible consequences of its recommendations when they commenced production, and were presumably prepared to take the risks associated with decisions made following such recommendations.

The differences noted above may need to be taken into account in considering appropriate measures to assist the region concerned. In this respect, there appear to be few, if any, precedents on which to base a consideration of the appropriate course of action by the Commonwealth Government. However, a representative of the former Department of Manufacturing Industry informed the Commission that it would be appropriate for representatives of a region adversely affected by a decision taken on environmental grounds to apply for assistance from the Commonwealth Government (Transcript pp.3299-3318). One possibility may be for government action to be taken to stimulate economic activities in which the region already has important human and material resources. This may be an attractive proposition in the case of Maryborough, where a stimulus to engineering and associated industries may be an efficient way of providing alternative employment and income opportunities in the event that adverse effects on that area were not offset by other activities.

However, it does not seem appropriate for the Commission to make specific recommendations to the Commonwealth Government on this matter, especially as any measures taken would need to be formulated in the context of Commonwealth and Queensland Government policies towards economic development in the region concerned. Moreover it is clear that considerably more research may need to be carried out into the more detailed effects on the regional economy of a decision not to approve the export of minerals from Fraser Island before any detailed proposals for assistance are formulated. Such research should be undertaken in conjunction with the Queensland Government.

Accordingly, the Commission recommends that appropriate steps be taken, in conjunction with the Queensland Government, to provide whatever economic or other assistance is required to the region concerned to make good any losses which may be sustained as a result of decisions which may be made following the consideration of this Report.

CHAPTER 10

THE ENVIRONMENTAL ASPECTS OF THE MAKING OF DECISIONS IN RELATION TO THE EXPORT OF THE MINERALS OF FRASER ISLAND

10.1 Introduction

The chapters assessing the evidence on the environmental significance of Fraser Island and the environmental effects of sandmining operations there provide the basis for the analysis, in this chapter, of

> the environmental aspects of the making of decisions by or on behalf of the Australian [Commonwealth] Government in relation to the exportation from Australia of minerals (including minerals that have been subjected to processing or treatment) extracted or which may hereafter be extracted from Fraser Island

In order to make Findings and Recommendations on their environmental aspects, it is desirable to be clear about the nature of the decisions which may be made on the subject of the export of the minerals of Fraser Island. The ultimate decisions are made under Regulation 9 of the *Customs (Prohibited Exports) Regulations*. The effect of this Regulation is to prohibit, *inter alia*, the export from Australia of *all* rutile and zircon unless written export approval is granted and produced to the Collector of Customs. The *Banking (Foreign Exchange) Regulations* have a similar effect. It is thus necessary for exporters to apply for approval to export minerals extracted from Fraser Island, and for decisions to be made on their applications.

Evidence was also given to the Commission concerning the making of decisions of an administrative or policy nature, apparently without any specific statutory basis, relating to the approval and review of proposed contracts to sell rutile and zircon extracted from Fraser Island to overseas purchasers. The effect of such decisions was to indicate whether particular export proposals were likely to be approved before exporters committed themselves contractually to purchasers (Exhibit 611).

Bearing in mind that the Commission must also report on the environmental aspects of the making of decisions on the export of minerals 'which may hereafter be extracted from Fraser Island', it may well be that the decisions already mentioned do not comprise a complete list of pending or potential 'decisions' within the terms of the Direction establishing the Inquiry and defining its subject matter. It is also possible that the type and form of decisions -- particularly those of a policy nature -- will

change from time to time. It is therefore impossible for the Commission to have evidence about every conceivable decision that might in future be made affecting the export of minerals extracted from Fraser Island. Nonetheless, it is important to identify the nature of the broad category of decisions referred to in the Direction establishing the Inquiry: the evidence indicates that it is whether or not to permit the export of minerals extracted from Fraser Island, though the form, content and source of legal authority for particular decisions may vary from time to time. Thus it is appropriate to concentrate on the environmental aspects of two sorts of decisions: the first prohibiting exports, the second permitting them. While the ingenuity of man could devise innumerable decisions which might be made in relation to the export of minerals extracted from Fraser Island, the essence of them all is whether or not to permit exports. These decisions are at present made within a legal framework which has the effect of prohibiting the export of rutile and zircon extracted from Fraser Island, but containing a discretion to waive this prohibition in particular cases. The High Court of Australia has recently held that environmental factors may be taken into account in the exercise of this discretion (Murphyores Incorporated Pty Ltd and Another v. The Commonwealth and Others, unreported, 1976).

The environmental aspects of the making of decisions about the export of minerals extracted from Fraser Island include, but are not confined to, their consequences or effects on the environment. They comprise, for the most part, the significant environmental implications of possible decisions and those environmental matters of importance which might be considered or looked at during the course of the making of decisions (*Environment Protection (Impact of Proposals) Act*, 1974-1975, Sub-sections 5.(1) and 11.(1)).

This chapter now considers, in turn, the environmental aspects of the making of decisions not to waive the legal prohibition on the export of minerals extracted from Fraser Island (Section 10.2) and the environmental aspects of the making of decisions waiving the prohibition (Sections 10.3 and 10.4). These sections deal with the environmental aspects of the fundamental decisions relating to the export of minerals extracted from Fraser Island, including those relating to the present operations of Queensland Titanium Mines Pty Ltd and D M Minerals, mining leases as yet unmined, and areas which, at the present time, are not covered by mining leases.

Those specific decisions considered in Section 10.3 which involve permitting the export of minerals extracted from particular sites above the mean high-water mark on Fraser Island fall into the same category as the other decisions considered in that Section.

10.2 The environmental aspects of the making of decisions not to waive the legal prohibition on the export of minerals extracted from Fraser Island

At present the only minerals extracted from Fraser Island for export in commercially significant quantities are rutile and zircon. No Australian market for rutile or zircon exists which would justify the extraction of these minerals on Fraser Island, nor was there evidence of the likelihood of the development of such a market in the foreseeable future. Although the ilmenite produced in association with the extraction of rutile and zircon from Fraser Island is currently being stockpiled, the extraction of minerals from the Island for such a purpose would not, at present, be economically viable. Hence a decision prohibiting the export of minerals extracted from Fraser Island would lead to the termination of sandmining there. The principal environmental impact of such a decision, therefore, would be to encourage, in the national interest, the conservation and maintenance of those qualities assessed in previous chapters which make it of great environmental significance to the people of Australia.

Sandmining on Fraser Island represents only a very small part of the nation's total economic activity (Chapter 8); moreover, there are alternative sources of rutile, zircon and ilmenite (which may eventually be substituted for rutile in many uses) elsewhere on this Continent (Section 8.11). Hence, decisions absolutely prohibiting the export of minerals extracted from Fraser Island are unlikely to have more than a very marginal impact on the level of economic activity in Australia, and would have no significant effects on its balance of international payments or on its capacity to meet overseas demands for rutile and zircon. There was no evidence to suggest that the prohibition of the export of minerals extracted from Fraser Island would be an act of economic chauvinism.

Such a prohibition would not adversely affect the present system on Fraser Island of closely supervised sustained-yield logging, which is important to the economy of the region and consistent with the maintenance of those environmental qualities which make the Island of great value to the people of Australia. Indeed, such a prohibition would ensure that no conflict between the interests of sandminers and loggers occurred in the future. Nor would this prohibition have any adverse effects on tourist activity on the Island. Although the evidence failed to establish that, in the short term, such a prohibition would actually stimulate tourist activity, it did suggest that the continuation of sandmining would eventually adversely affect the tourist potential of Fraser Island by destroying those values which make it so attractive to many visitors. Having regard to the whole body of evidence before the Commission, including the evidence on the economic effects of Fraser Island sandmining, the absolute prohibition of the export of minerals extracted from Fraser Island would be in the overall interests of the people of Australia as a whole.

Even so, the regional economy would suffer some adverse effects if the export of all minerals extracted from the Island were prohibited (Chapter 9). These adverse regional effects -- which would not be felt by the timber or tourist industries -- could be redressed by suitable economic or other assistance. Such assistance would not be the same as compensation to mining firms.

There was no evidence of any practice of paying compensation to mining firms following the rejection of applications to waive the legal prohibition on the export of rutile and zircon. In any case, it will be recalled from Sections 8.5 and 8.6 that D M Minerals will probably recover its capital outlay in a relatively short period of mining activity. The evidence before the Commission indicates that Queensland Titanium Mines Pty Ltd had recovered a substantial amount of its initial capital expenditure by mid-1975 (Exhibit 317, p.9) and subsequent operations would have contributed further to the recovery of the initial investment and to the Company's profits.

Though this prohibition on the export of minerals extracted from Fraser Island may remove the incentive of mining lessees to rehabilitate those areas already mined, they would still be bound by the rehabilitation provisions of the relevant leases, and liable to the forfeiture of their guarantees and securities in the event that they were not satisfactorily performed (cf. Mining Lease 102 Special Condition 3; Mining Lease 84 First Schedule, Clause 4). In the circumstances, this rehabilitation would require close supervision by the appropriate authorities.

10.3 The environmental aspects of the making of decisions waiving the legal prohibition on the export of minerals extracted from Fraser Island

The extraction of minerals from Fraser Island is absolutely dependent upon decisions (under the Regulations discussed in Section 10.1) waiving the prohibition on the export of rutile and zircon derived from the Island. The immediate consequence of such decisions will be the continued extraction of minerals, and the environmental aspects of the making of such decisions encompass the environmental effects of this extraction.

The immediate environmental consequences of mining, as well as important environmental aspects of decisions permitting exports, are the certain destruction of all the existing vegetation in mined areas and major alterations to the topography. A similar degree of certainty exists as to the impossibility of the restoration of the original vegetation in the sense of re-establishing the original number and distribution of species in their former relationships with one another (Section 6.1). The restoration of the original topography after mining may be technically possible but is quite impracticable on Fraser

Island as well as being prohibited by the Special Conditions of the mining leases in the case of those dunes which originally had side slopes greater than twenty degrees from the horizontal. The importance of the Island to Australians depends to a great extent on the qualities of its natural vegetation and topography. The environmental aspects of decisions waiving the prohibition on the export of minerals extracted from Fraser Island involve not only the destruction of these qualities on mined areas but also the certainty that they will never be restored.

Turning to rehabilitation, that is the reinstating of mined areas by reforming and revegetating them (Section 6.1), the degree of probability of actually achieving particular results on Fraser Island falls far below the level of certainty attached to the destruction of its original vegetation and the permanent alteration of its topography by mining. It must be asked about such areas on the Island as foredunes and hind-dunes, where the rehabilitation of vegetation is ecologically possible, whether such rehabilitation will, in fact, be successful in the sense of attaining self-sustaining plant communities with a reasonable representation of the pre-existing structure, species and functions (Section 6.1). Here there are a range of variables which cannot be precisely quantified but which, on the whole, tend against successful rehabilitation. These include climatic factors like cyclones and droughts; human factors such as varying degrees of perseverance and skill in carrying out programmes of rehabilitation extending well beyond the economic life of the ore deposits; and economic factors including the increasing costs of successful rehabilitation in times of inflation and fluctuating profitability. Accordingly, an important environmental aspect of any decision permitting the export of the minerals from Fraser Island is that the successful rehabilitation of the vegetation of foredunes and hind-dunes is unlikely. The disastrous consequences of unsuccessful rehabilitation are set out at length in Chapter 6.

The evidence did not establish the ecological possibility of the successful rehabilitation of vegetation on steep dunes on Fraser Island after mining, but rather the probability that the steep dunes of Fraser Island cannot be successfully rehabilitated after mining. It follows that an environmental aspect of any decision permitting the export of minerals extracted from the steep dunes of Fraser Island is that their rehabilitation is even more unlikely than is the case for foredunes and hind-dunes.

The evidence establishes that rain-forest areas cannot be successfully rehabilitated after mining. Rain-forests exist within some mining leases and lease application areas. It is quite likely that economic ores will be found in some of these rain-forests, though there was some evidence before the Commission that, as at June

1975, D M Minerals was not intending to mine the rain-forests on ML 102. Nevertheless, an environmental aspect of any decision having the effect of permitting the export of minerals produced from rain-forests on Fraser Island is that the rehabilitation of those rain-forests actually affected by mining will not be successfully accomplished.

Continued sandmining, with the exception of sandmining below the mean high-water mark on the beach south of Indian Head (Section 10.4), is inconsistent with the conservation of the Island's natural environment. Sandmining will cause, or be directly associated with, major permanent and irreversible environmental harm to the landscape, vegetation and lakes of the Island. This harm will be inevitable even if -- despite overwhelming evidence to the contrary -- rehabilitation after mining should be found to be ecologically possible and achieved in practice on all mined sites on the Island. Continued mining will destroy the unifying impression of wilderness that at present is such an important characteristic of the Island, and will harm, or detract from the value of, many of its striking natural features such as its perched lakes. The successful rehabilitation of the Island's vegetation (which, in any event, is unlikely to occur) on a landscape made flatter and more uniform by mining cannot involve the re-creation of the natural wilderness qualities of mined areas, which will be lost forever by mining.

Decisions permitting the export of minerals extracted from Fraser Island do not have entirely adverse environmental implications since there would be certain benefits to the regional economy associated with activity generated by sandmining on the Island (Chapter 9).

Sustained-yield logging on the Island will not be significantly affected by sandmining within existing mining leases though it may be adversely affected if sandmining were permitted elsewhere. Sandmining will ultimately adversely affect tourist activity on the Island since it will eventually make the Island less attractive to tourists.

Although the regional economy would benefit from continued sandmining on Fraser Island, this sandmining would have, at most, only a very marginal impact on the level of economic activity in Australia as a whole, and no significant effects on the capacity of Australia to meet overseas demands for rutile and zircon or on Australia's balance of international payments. It is also possible that exports of rutile and zircon from Fraser Island will reduce the export income from other Australian sources and thus significantly reduce, or even eliminate, the net national benefits to be derived from exports from the Island (Chapter 9). Even if no such reduction occurs, the overall interests of the people of Australia as a whole will be worse served by continued sandmining than if decisions were made encouraging the conservation of the Island by prohibiting the export of minerals extracted from it.

Having regard to the evidence as a whole, no management plan can be (or has been) devised which would conserve the environmental qualities of the Island and its value to the Australian people while at the same time permitting the extraction of minerals from *any* site above mean high-water mark. Thus, the environmental aspects of any decision having the effect of confining extraction to any particular site or sites really comes within the category considered in this section, namely: the environmental aspects of decisions waiving the legal prohibition on the export of minerals extracted from Fraser Island. Nevertheless, as there was evidence relating to the environmental aspects of particular decisions in this category, and submissions that specific decisions should be made, consideration is given in the succeeding sub-sections to the environmental aspects of particular decisions which would have the effect of dividing up the Island into mining and non-mining 'zones'.

The environmental aspects of the making of decisions waiving the legal prohibition on the export of minerals extracted from MLs 102 and 95

There was evidence of a decision in 1975 confining approvals of D M Minerals' export contracts to those relating to the sale of minerals extracted from MLs 102 and 95. The main source of this evidence was a letter dated 9 June 1975 (Exhibit 56) written by the then Minister for Minerals and Energy to Mr C. E. Mustchin of D M Minerals which stated, *inter alia*, that

> The Australian Government has decided that no further export contracts for mineral sands from Fraser Island, whether from leases granted before or after 9th July, 1974, other than leases 102 and 95, will be considered by the Government, until after the public Environmental Inquiry on Fraser Island is completed and the Commissioner's [*sic*] report is considered.

Though, in the passage quoted, this decision is expressed as being of an interim nature, the same letter concludes with words suggesting that consideration was being given to the desirability of applying it on a permanent basis. Its environmental aspects will therefore be examined.

The immediate consequence of a decision approving all export contracts relating to MLs 102 and 95 would be that most, if not all, the economic ores of these leases would be extracted, as the decision is not formulated in terms limiting D M Minerals to any particular tonnage. It could not, of itself, involve any comprehensive restraint on sandmining conducted on the Island since it would have no effect on the present mining operations of Queensland Titanium Mines Pty Ltd on leases adjoining ML 102, or their harmful environmental consequences. The environmental

aspects of such a decision involve those permanent alterations to the landscape, topography and vegetation of the areas mined which have already been described generally in this section and in more detail in Chapter 6. However, its environmental aspects are not confined to the environmental effects of sandmining within the boundaries of the mined leases, significant though these effects are, particularly since MLs 102 and 95 occupy some 6,118 ha extending approximately fifty-two kilometres along the popular east coast of the Island (Fig. 3.3(a); Exhibits 75 and 76).

The fundamental question is whether the environmental aspects of a decision confining exports to the products of MLs 102 and 95, and the completion of the mining of most of the heavy minerals found in these leases, involves the destruction, or significant diminution, of those qualities which make the entire Island worthy of conservation in the national interest. It is necessary to have regard to the extent of the areas likely to be mined following such a decision as well as their position on the Island generally and in relation to important features such as the eastern beach, lakes, Beauty Spots and Lookouts. It has already been mentioned that the combined area of MLs 95 and 102 is approximately 6,118 ha. In the event of a decision limiting D M Minerals' exports to the products of these leases it would be unreasonable to assume that any economic ores found in them would remain unmined, because there would no opportunity to pursue richer ore-bodies elsewhere on the Island. Nor would it be reasonable to assume that large areas within these leases would be unaffected by mining.

The position of these leases is of great significance (Fig. 3.3). ML 102 is adjacent to the southern portion of ML 95, and both are close to the popular east coast of the Island. The mined areas of ML 102 are already partly visible from the foredunes between them and the beach, as well as from the vicinity of Markwell's and Ocean Lookouts from which a panorama of the east coast may be seen. When the Commission viewed the mined areas from the vicinity of Markwell's and Ocean Lookouts, in February 1976, they were of such a comparatively small scale in relation to the huge sweep of sea and landscape visible from that place as to be neither remarkable nor offensive. Mining was then, of course, confined to the southern part of ML 102 and to dunes of relatively low altitudes. The evidence indicates that economic ore bodies extend very close to Ocean Lookout (Fig. 2.2), while ML 95 either includes it or is adjacent to it. If both leases are worked, a wide strip mined by D M Minerals could extend as far as seventeen kilometres southwards from these Lookouts where it would join the areas mined by Queensland Titanium Mines Pty Ltd. Instead of the natural landscape and vegetation now seen from these high places the observer, looking to the south, would see a coastal strip permanently affected by mining for what would seem to be virtually its entire length. These fundamental changes to the landscape and vegetation of Fraser Island would extend northwards from these Lookouts for as far as ML 95 was mined.

Bearing in mind the topographical changes and destruction of natural vegetation associated with sandmining on the Island, and the improbability of successful rehabilitation, the mining of the economic ores on MLs 95 and 102 would involve significant changes to the environmental qualities of the Island as an entity. This would be particularly apparent from the eastern beach opposite the mined areas, to people looking southwards from the vicinity of the two Lookouts, and from the air.

ML 102 is adjacent to Lake Boemingen, a Beauty Spot, and a perched lake of great attraction and scientific importance. The attractiveness of Lake Boemingen to a great extent lies in its wilderness setting. This wilderness would be destroyed altogether on the southeast side of the Lake, and adversely affected at a somewhat greater distance on its eastern approaches. Reference has already been made to the arbitrary, and largely ineffective, legal barrier imposed between the Lake and the permitted mining path (Section 6.6), as well as to the risks of polluting the Lake, altering its water-table, and harming its ecosystems by the continued working of ML 102. The wilderness setting of Lake Wabby will also be affected by mining in its vicinity on ML 95. Conceivably, D M Minerals might voluntarily refrain from working areas it is entitled to mine in order to ensure that the effects of its operations could not be seen from the lake shores. Such stand-off distances would be additional to the buffer zones contained in mining lease Special Conditions. This kind of voluntary restraint would not, however, preserve the wilderness setting of these lakes in any meaningful way; their attractiveness lies to a great extent in being approached through an extensive wilderness as well as by their relationship to that wilderness. Apart from its effects on the wilderness setting of Lake Boemingen and Lake Wabby, the mining of MLs 102 and 95 would destroy the present overall impression of wilderness which is fundamental to the Island's importance to the Australian people.

Looking at the evidence as a whole, it is difficult to identify any more environmentally significant and fragile area on the Island than that covered by MLs 102, 95 and the nearby mining leases of Queensland Titanium Mines Pty Ltd, MLs 84, 104 and 105. The environmental aspects of decisions having the effect of permitting the mining of all or any of these leases will involve major permanent and irreversible environmental harm to the landscape, vegetation and lakes of the Island and, consequently, substantially damage its value to the Australian people.

SMH 14/11/76

The environmental aspects of the making of decisions waiving the legal prohibition on the export of 175,000 tonnes extracted from MLs 102 and 95

There was evidence that by June 1975 D M Minerals had been permitted to enter into export contracts for the sale of 175,000 tonnes of minerals to be extracted from MLs 102 and 95, and that the partnership had been encouraged to supply as much as possible (if not all) of this quantity from ML 102. This approval, which does not seem to be based on any statutory power, does not exempt D M Minerals from the requirement of applying for permits under the *Customs (Prohibited Exports) Regulations* for the export of individual shipments in satisfaction of these contracts. There was also evidence that D M Minerals had applied for and been granted such permits for specific shipments in 1975. The High Court of Australia has recently held that in making decisions on such applications the Minister is entitled to take environmental factors into account (Murphyores Incorporated Pty Ltd and Another v. The Commonwealth and Others, unreported, 1976). Such decisions are clearly within the terms of the Direction establishing the Inquiry and are decisions involving the consideration of matters affecting the environment to a significant extent (*Environment Protection (Impact of Proposals) Act*, Sub-section 5.(1)). It is therefore necessary to consider their environmental aspects.

Permit decisions allowing the export of 175,000 tonnes of minerals from MLs 102 and 95 will be followed by the disturbance by mining of a sufficient area of land within these leases to meet this tonnage. Although, in 1975, D M Minerals was clearly being encouraged to meet this tonnage from ML 102, on the evidence before the Commission it was not then required to do so. Subject to the terms of the leases, D M Minerals was entitled to supply this tonnage from anywhere within the combined areas of MLs 95 and 102. In the event that the partnership was limited overall to the exportation of 175,000 tonnes from Fraser Island and had no expectation of being permitted to export any minerals in excess of this quantity, it could hardly be expected to confine its operations to ML 102 if richer and more accessible ores are available in ML 95. If it followed a policy of mining the economic ores of ML 102 before proceeding to ML 95 there is some uncertainty whether 175,000 tonnes could be extracted from ML 102. Data derived from the Company and exhibited at the Inquiry suggest that this tonnage could be extracted entirely from ML 102, a view shared by the then Minister for Minerals and Energy in May 1975 (Exhibit 56). Nevertheless, there was sufficient doubt on this point for the approval to enter into the export contracts being related to both leases without any formal requirement to mine ML 102 before starting operations on ML 95.

There are thus several possibilities relating to the area which might be disturbed by mining if D M Minerals were limited overall to the export of 175,000 tonnes from MLs 102 and 95. The most likely of these are that:

(a) most of the economic minerals of ML 102 would be extracted and the mining path would then move northwards from ML 102 into ML 95 in the direction of Ocean and Markwell's Lookouts without actually extending north of those places;

(b) all (or almost all) the economic minerals of ML 102 would be extracted, and ML 95 would remain unmined;

(c) the richer and more accessible deposits of minerals on both leases would be extracted.

The environmental aspects of these can each be considered in turn.

(a) Mining on ML 102 and ML 95 south of the Lookouts

The effects of mining MLs 102 and 95 south of the Lookouts have already been discussed in some detail in this section. It has been pointed out, *inter alia*, that from these high places an observer, looking to the south, might ultimately see a landscape fundamentally altered by mining for up to seventeen kilometres, bearing in mind that the decision under consideration would have no effect on the operations of Queensland Titanium Mines Pty Ltd on leases close to ML 102. Taking into account the topographical changes associated with sandmining above mean high-water mark on the Island, the permanent destruction of the natural vegetation, and the improbability of its successful rehabilitation, the mining of 175,000 tonnes of ores from ML 102 and ML 95 south of the Lookouts would involve significant and harmful changes to the environmental qualities of the Island as a whole.

As also explained earlier in this section, the wilderness setting of Lake Boemingen would be destroyed on the southeast and adversely affected to the east of that Lake by the mining of this area. The water-table of Lake Boemingen would be affected by these mining operations while the Lake itself would probably be polluted by nutrients and, as a result, harm would be caused to its ecosystems. The mining of this area would probably result in the loss of that unifying impression of wilderness which is one of the Island's greatest attractions.

Given the environmental significance of this area in relation to the Island as a whole any limitation of D M Minerals' exports to 175,000 tonnes mined from this area would be undoubtedly an unsuccessful compromise between economic development and the maintenance of the Island's environmental quality.

(b) Mining ML 102 without mining ML 95

This would probably result in the mining of almost all the economic ores of ML 102. The detailed effects of mining ML 102 on Lake Boemingen and on the topography and vegetation of mined areas have already been set out in this section of the Report. It will be recalled that ML 102 adjoins the leases being worked by Queensland Titanium Mines Pty Ltd so that, ultimately, the mining of ML 102 would result in a wide mined strip extending southwards from Lake Boemingen to the southern end of the Island. This case is obviously distinguishable from the former example involving partial mining of ML 95 in that different areas would be mined in order to satisfy the necessary tonnage. Nevertheless, on the evidence, the Commission is unable to conclude that by confining D M Minerals' operations to ML 102 the overall environmental qualities of the Island will somehow remain unimpaired. Given its environmental significance and, in particular, its strategic setting close to Lake Boemingen and the east coast of the Island, it would be very likely indeed that the Island's unifying impression of wilderness would be lost, following the mining of ML 102.

(c) The extraction of the richer and more accessible deposits on ML 95 and ML 102

It is not possible to estimate with any precision what areas would ultimately be affected by mining in this case. However, it is likely that, in order to minimize the costs and loss of time associated with shifting the primary extraction plant from place to place, mining would be largely concentrated on a series of contiguous and readily accessible sites rather than scattered throughout the full length and breadth of those leases. On this basis it would be improbable that mining would proceed on ML 95 north of the two Lookouts, given that the present operations are now located on ore bodies well to the south of the Lookouts, on ML 102. Thus it is quite likely that the overall result would be the mining of sufficient areas of ML 102 and ML 95 south of the Lookouts to satisfy the necessary tonnage. The environmental effects of such operations would be therefore similar to those described in possibility (*a*).

<u>The environmental aspects of the making of decisions waiving the legal prohibition on the export of minerals extracted from existing mining leases subject to the performance of their environmental Special Conditions</u>

There was evidence of the making of decisions in 1975 permitting the export of particular shipments of minerals extracted from ML 102, subject to the performance of its 'environmental' Special Conditions (Exhibit 457, pp.12, 16 and 17; Exhibit 54; Transcript pp.2052-9). It would seem that, in the absence of an Environmental Impact Statement and prior to the submission of this Report, the Commonwealth Government sought to take environmental matters into account when making decisions on applications by D M Minerals

for the export of such shipments by relying on the Queensland environmental controls already contained in the Special Conditions of ML 102. This reliance, however, was not passive. By the time the Commission had finished its public hearings, at least one inspection of ML 102 had been made by Commonwealth officers with a view to ascertaining whether the Special Conditions of ML 102 were being performed. Following this inspection a shipment (or shipments) was permitted. As the evidence falls short of establishing that these decisions were of a purely interim kind pending the submission and consideration of this Report, it is necessary to consider their environmental aspects.

There was no evidence of similar decisions having been made in respect of the operation of Queensland Titanium Mines Pty Ltd on Fraser Island. Accordingly, like the proposed decisions confining D M Minerals' exports to minerals extracted from MLs 102 and 95, the decisions considered in this sub-section of the Report would not have any influence on the sandmining of Queensland Titanium Mines Pty Ltd on Fraser Island, or its environmental effects.

The environmental obligations contained in the Special Conditions of ML 102 were discussed in Chapter 6. Several were given specific consideration, and it was concluded that the performance of the Special Conditions would not prevent significant environmental harm occurring to the Island. This damage would include permanent topographical change to the areas mined, the destruction of their vegetation and, very likely, the pollution of Lake Boemingen. The Special Conditions cannot compel lessees to perform ecologically impossible, or unlikely, tasks such as the rehabilitation of rain-forests or vegetation on high dunes. They do not seek unattainable goals such as the restoration of landscape and vegetation after mining. Special Conditions directed at preventing the pollution of Lake Boemingen cannot restrain the percolation of fertilizers, essential in the rehabilitation process, through the permeable sands of the Island into the waters of the Lake or the resulting pollution. Nor could environmental obligations defined more stringently than the present Special Conditions of ML 102 compel the performance of results which are physically or ecologically unlikely, or even impossible.

A distinction must be made between environmental harm caused by the lessee which constitutes a legal breach of the Special Conditions of ML 102, and sandmining leading to environmental harm even though the lessee is not found to be in breach of the lease. Although it has been assumed throughout this Report that the lessee will not be found to be in legal breach of the Special Conditions of ML 102 relating to its environmental obligations, it is possible that events will show this assumption to be false. In such circumstances the environmental harm associated with sandmining could be expected to be substantially greater

than that described herein. In any event, the issue is not so much whether a lessee has incurred legal liability in respect of a breach of the Special Conditions as whether continued sandmining above mean high-water mark is consistent with the maintenance of the environmental quality of Fraser Island. On the evidence before the Commission, significant and irreversible environmental harm will be caused to the Island by the mining of ML 102 even if the lessee is not found to be in breach of the Special Conditions of the lease, and even if the Special Conditions are performed to the satisfaction of the lessor.

There is, however, a further complication. On the evidence before the Commission, which is, admittedly, incomplete on the precise details of the contractual arrangements binding the partners in the firm of D M Minerals (Exhibit 265, p.785), the management of the mining and rehabilitation operations on ML 102 is in the hands of Dillingham Constructions Pty Ltd rather than the lessee, Murphyores Incorporated Pty Ltd. There is no evidence that the former Company is bound by the lease. The Commission is not able to conclude that Murphyores Incorporated Pty Ltd is in a position *vis-a-vis* its partner to compel it, in working the lease, to observe the Special Conditions. However, as it is possible that an agreement exists between the partners requiring Dillingham Constructions Pty Ltd to observe the Special Conditions the Commission has in no way based its Findings and Recommendations on the absence of evidence of such an agreement.

There are other environmental aspects of a Commonwealth decision relying on, or intervening in, the supervision of the performance of Special Conditions not purporting to set out in complete detail all the environmental obligations of the lessee, and which leave a great deal to the discretion of the Queensland Minister for Mines and the officers of his Department. Most of the covenants and conditions relating to rehabilitation are to 'be carried out to the satisfaction of the Minister [for Mines] and/or his officers' (ML 102, Special Condition 5), while a number of matters of detail also require their intervention. The spreading of topsoil over reformed dunes, the subsequent planting of a cover crop, the maintenance of trees until their growth is established and the maintenance of vegetation on rehabilitated frontal dunes are all matters to be done 'to the satisfaction of the Minister and/or his officers' (ML 102, Special Conditions 16.(c) and (d), and 22.(g)). The Minister may require the laying of brush matting or other approved types of cover upon the surface of the mined area as part of the rehabilitation process (ML 102, Special Condition 18.(a)), waive some of the requirements specifically mentioned in the lease (ML 102, Special Conditions 14 and 21), and approve variations of any of the Special Conditions (ML 102, Special Condition 2). A significant variation of Special Condition 24.(b) of ML 102 has already been made (Section 6.2). Furthermore, the lessor may waive a breach of the lease.

The main subject of these discretionary powers -- rehabilitation -- is one on which a range of conflicting views is held. From time to time the Commonwealth, in supervising the performance of the Special Conditions, might take a different view of the performance of the lessee in relation to the rehabilitation of mined areas on ML 102 than that taken by the Queensland Minister for Mines. Should the Commonwealth seek indirectly to enforce a different standard of rehabilitation to that required by the Minister for Mines, conflicts could arise because of what might be regarded as unnecessary interference with the functions of the Queensland Mines Department -- the authority directly concerned with the supervision of a lease granted under the Queensland *Mining Act*. The Commonwealth is not a party to ML 102 and cannot enforce it in the Courts.

Alternative methods of reliance on the performance of Special Conditions of ML 102 are not attractive. They include the Commonwealth presuming the satisfactory performance of these Special Conditions, or otherwise failing to form an independent view of their performance, and conducting inspections of the lease which become either mere formalities or unnecessary duplications of the Queensland Mines Department's supervision.

Another problem is associated with Commonwealth attempts to supervise rehabilitation through intervention ultimately based on and linked with its power to prohibit exports of minerals extracted from Fraser Island. This problem flows from the need to make particular licensing decisions before the appropriate time has come for the assessment of the ecological success of rehabilitation on the sites from which the minerals in question were extracted. This merely emphasizes the point that the supervision of rehabilitation on mining leases on Fraser Island is essentially the function of the lessor.

Fundamental problems in Commonwealth reliance on the Special Conditions

The fundamental difficulty lies in relying on the performance of the Special Conditions of ML 102, or any other Fraser Island mining lease, in attempting to discharge the environmental obligations of the Commonwealth. The enforcement of these Special Conditions is a State function which takes place after the making of the important State decisions. These decisions were whether to grant an Authority to Prospect and, subsequently, a Mining Lease over the lands now covered by ML 102 (cf. Cudgen Rutile (No. 2) v. Chalk (1975) 49 *Australian Law Journal Reports* 22). The enforcement of the Special Conditions of the mining lease is the final stage of State environmental control (cf. Sinclair v. Mining Warden (Maryborough) (1975) 49 *Australian Law Journal Reports* 166).

The consideration of environmental factors of national significance is effectively avoided by limiting Commonwealth intervention to a duplication of the final stage of State environmental control. Decisions permitting the export of minerals extracted from Fraser Island above the mean high-water mark will encourage sandmining inevitably associated with major permanent irreversible environmental harm, irrespective of whether reliance is placed on the performance of the Covenants, Conditions or Special Conditions of particular mining leases. To rely on the performance of Special Conditions of a mining lease is to concede that mining on it should take place, but it is the process of mining itself (however supervised and made subject to Special Conditions) which is inconsistent with the maintenance of the environmental quality of the Island.

The Commission has illustrated its conclusions about the effects of reliance on the Special Conditions of existing Fraser Island mining leases over land above mean high-water mark by reference to the Special Conditions of ML 102. This has been done here (and in Chapter 6) because the decision made in 1975 to rely upon the performance of the Special Conditions has been a decision with practical application to ML 102, the lease then (and now) being worked by D M Minerals. There is, however, some detailed consideration of the Special Conditions of other mining leases in Section 6.5, while earlier in this section consideration is given to the Special Conditions of ML 95 in relation to Lake Wabby. The Special Conditions of ML 102 (and ML 95) are typical of those contained in existing mining leases above mean high-water mark on Fraser Island, particularly in their approach to the rehabilitation of mined areas and the protection of specific natural features, such as those found within Beauty Spots.

In considering the evidence on the environmental aspects of decisions relying on the performance of the Special Conditions of ML 102, the Commission is not criticizing the absence of Commonwealth environmental intervention at any earlier stage in the State decision-making process. Nor is it suggesting that the Commonwealth should have attempted to intervene in the Mining Warden's Court in Maryborough in May 1971, when the application for ML 102 was heard (Exhibit 418), or at any other time before the notification of the grant of the lease on 24 August 1973 (Exhibit 19). Indeed, the *Environment Protection (Impact of Proposals) Act* did not come into operation until 17 December 1974. This was the first Commonwealth statute to impose a general requirement in the making of decisions to fully examine and take into account 'matters affecting the environment to a significant extent' (Sub-section 5.(1)). The Commission's conclusions relate to the form rather than the timing of this method of piecemeal environmental control. In the circumstances, it was impracticable for the Commonwealth to give any general consideration to the environmental aspects of decisions relating to the export of Fraser Island minerals prior to the granting of a

significant number of mineral leases on the Island. At least four current leases were approved in 1956 (Exhibit 318). It is the practice of sandmining firms to reserve ores in this way long before their extraction is proposed or perhaps even economically feasible, but this is irrelevant to the consideration of the environmental aspects of Commonwealth decisions on the export of minerals extracted from Fraser Island.

In this analysis of the environmental aspects of reliance on the Special Conditions of Fraser Island mining leases, the Commission is not attempting to enunciate any principle of general application outside the Island. It may well be that on mainland locations lacking outstanding environmental significance such Special Conditions can serve as an adequate means of environmental control, though the Commission has not come to any conclusion on this point.

10.4 The environmental aspects of the making of decisions waiving the legal prohibition on the export of minerals extracted from the eastern beach

A submission was made to the Commission on behalf of the Australian Conservation Foundation that the Commonwealth might make decisions having the effect of permitting sandmining on part of the eastern beach of the Island for a time, in order to avoid some of the adverse economic effects for the sandmining firms and their employees of the total cessation of mining on the Island implicit in decisions prohibiting all exports of minerals extracted from it (Transcript p.3394). Both Queensland Titanium Mines Pty Ltd and Murphyores Incorporated Pty Ltd control leases covering almost all the eastern beaches of the Island from Sandy Cape south to Hook Point. In considering the environmental aspects of possible decisions waiving the prohibition on the export of minerals extracted from the eastern beach it is necessary to make a distinction between the beaches north and south of Indian Head. Separate consideration will be given to these two areas.

The beach north of Indian Head

Decisions having the effect of permitting sandmining on the beach north of Indian Head would be likely to be associated with significant environmental harm to the Island. A National Park already exists in the northern part of the Island, although its boundary, at this stage, does not include the beach. The natural environment of the Island would be likely to be adversely affected as a result of beach mining north of Indian Head, largely because it would seem necessary in mining that beach to construct an access road across the Island north of Indian Head - Waddy Point -- and therefore through the National Park -- in order to transport the heavy minerals to a suitable point on the relatively sheltered west coast for barging to the mainland.

Apart from the dangers of erosion being caused by such a road (Section 6.2), its presence would be inconsistent with the maintenance of the integrity of the National Park if it passed through, or close to it, essentially because it would impair its wilderness qualities. If located to the south of the park such a road might well become, or be regarded as, a natural barrier to its southward extension. Such an extension was advocated by a number of witnesses and was unopposed.

It is less likely that vehicles transporting these minerals would traverse the Indian Head - Waddy Point area in a southerly direction because of the great distance to any suitable barging point at the southern end of the Island. In any event, as the nature of the coastline adjacent to Indian Head and Waddy Point makes it impossible to pass these features on the seaward side, it is unlikely that vehicles transporting minerals could pass them in a southerly direction for any period without running the risk of causing serious erosion and other harm to this Beauty Spot or its environs.

The beach south of Indian Head

Having regard to the evidence, the overall interests of the people of Australia as a whole would be *better* served by decisions having the effect of confining sandmining to below the mean high-water mark on the beach south of Indian Head than by decisions having the effect of permitting any form of sandmining above the mean high-water mark or on the beach north of Indian Head. Nevertheless, the overall interests of the people of Australia as a whole would be *best* served by a total prohibition on the export of all minerals extracted from the Island.

The activities associated with sandmining on the eastern beach south of Indian Head would need careful siting and supervision to avoid any harmful environmental impact largely because a number of them -- notably extraction -- are conducted above mean high-water mark. The best solution, and perhaps the only one consistent with the avoidance of damage to the natural environment, would be to locate the extraction plants on a limited number of carefully chosen sites above mean high-water mark which have already been mined, either on ML 102 or on other areas nearby mined by Queensland Titanium Mines Pty Ltd. It would also be necessary to make use of existing mining roads constructed by D M Minerals and Queensland Titanium Mines Pty Ltd to avoid the use of forestry tracks by heavily-laden mineral trucks or fresh environmental damage associated with the construction of new roads to the barging point or points. Assuming that mining is closely confined to the actual beach and does not extend to the foredunes, even though parts of the foredunes are actually included in beach leases, the environmental aspects of decisions confining exports from the Island to minerals extracted from the beach below mean high-water mark south

of Indian Head are not likely to involve any significant permanent alteration to the vegetation and topography of the Island. If the overburden and tailings are replaced quickly after the removal of the heavy minerals in the first stage of the extraction process, wave action and tidal processes quite soon obliterate evidence of mining on the beach.

There is little evidence of the likelihood of any serious permanent effects on the flora and fauna of the Island resulting from mining conducted below the mean high-water mark on the beach south of Indian Head. Furthermore, such mining would be unlikely to affect seriously the marine environment, providing no pollution or erosion was caused by carelessness. However, sandmining on beaches undoubtedly causes temporary disturbance in those areas being mined and traversed by vehicles carrying the sand to the extraction plant. It is likely that this temporary disturbance will be regarded as unsightly and displeasing by many.

The environmental aspects of a decision prohibiting the export of minerals extracted from Fraser Island, with the exception of those extracted below the mean high-water mark on the beach south of Indian Head, would be somewhat different from those involved in a total prohibition, as far as the regional economy was concerned, in the event that the sandmining firms now operating on Fraser Island found it profitable to begin the mining of their beach leases south of Indian Head without first totally dispersing their existing workforce. In that event, sandmining on the eastern beach may provide the opportunity to employ at least part of the labour force for some time.

There is insufficient evidence before the Commission as to the precise number of persons likely to be employed in sandmining on the eastern beach south of Indian Head. If, in fact, a decision restricting exports of minerals to those extracted from the beach south of Indian Head was followed by a dispersal of, or a significant reduction in, the workforce now employed in sandmining on the Island, the environmental aspects of such a decision would include adverse regional economic effects, although these cannot be precisely quantified at this stage. However, they would be less serious in the short-term than if all sandmining on the Island ceased and the workforce was dispersed altogether. These adverse regional effects -- which would be environmental aspects of the making of decisions benefiting the nation as a whole -- could be redressed by suitable economic and other assistance to the affected region.

10.5 Conclusion

Though it was impractical to make Commonwealth decisions taking into account the environmental significance of Fraser Island before part of it was covered with mining leases, the existence of these leases heightens the importance and urgency of such decisions. Irrespective of the intentions of the decision-maker, it is impossible to make a decision about whether or not to waive the legal prohibition on the export of Fraser Island minerals which is devoid of significant environmental aspects or implications. It is impossible to make such a decision in an environmental vacuum. It will have significant environmental aspects, whether they are intended or not. They will follow as a matter of objective fact, irrespective of the subjective intentions of the decision-maker. Decisions to permit the export of minerals extracted from Fraser Island, as well as decisions to prohibit them, have significant environmental aspects.

The duty of the Commission is to report both Findings and Recommendations (*Environment Protection (Impact of Proposals) Act*, Sub-section 11.(4)). As it is stated in the Direction establishing the Inquiry that its purpose is to achieve the object of the Act, it is clear that the Recommendations of the Commission, as well as its Findings, must be directed towards this goal (cf. Sub-section 11.(1)). In the present context, the object of the Act is

> to ensure, to the greatest extent that is practicable, that matters affecting the environment to a significant extent are fully examined and taken into account in and in relation to

the making of decisions on the export of minerals extracted from Fraser Island (Sub-section 5.(1)). The object of the Act is twofold. In the making of decisions, matters affecting the environment to a significant extent are to be both fully examined and taken into account. Whereas the Findings of the Commission seem to relate more specifically to the first of these objects -- fully examining matters affecting the environment to a significant extent in the making of decisions -- the Recommendations of the Commission appear to relate more to the second object -- taking these matters into account 'to the greatest extent that is practicable'. In other words, the Commission, in reporting its Recommendations, must recommend what is the greatest extent it is possible (that is, capable of being accomplished) to take into account matters affecting the environment to a significant extent in the making of decisions on the export of minerals extracted from Fraser Island.

The evidence establishes the social, scientific and aesthetic significance of Fraser Island to the present community and future generations. Accordingly, the Commission recommends that it be recorded in its entirety as part of the National Estate as soon as possible in order to encourage its conservation in the interests of the people of Australia.

Having regard to the evidence, the Commission recommends that *all* exports of minerals (including minerals that have been subjected to processing or treatment) extracted from Fraser Island be absolutely prohibited, except for those minerals extracted from the eastern beach south of Indian Head below the mean high-water mark. In making this Recommendation, the Commission is not criticizing the Australian sandmining industry at large, or generalizing about the environmental effects of sandmining on mainland locations lacking the special environmental qualities and importance of Fraser Island.

This recommendation that all exports be prohibited except for those minerals extracted from the eastern beach south of Indian Head below the mean high-water mark includes minerals extracted by Queensland Titanium Mines Pty Ltd and D M Minerals from leases now being worked, as well as all minerals that may be extracted in the future from any site on the Island other than from the eastern beach below mean high-water mark south of Indian Head. In this evaluation the Commission has taken into account the whole body of evidence relating to the environmental aspects of the making of decisions on the export of minerals extracted from Fraser Island, including the evidence relating to the effects of sandmining on the regional and the national economy. This consideration of the evidence before the Commission has led it to recommend that the export of minerals extracted from below mean high-water mark on the eastern beach south of Indian Head be permitted, largely to provide an opportunity to minimize the disadvantageous implications for the region implicit in decisions totally prohibiting the export of minerals extracted from the Island in the only circumstances where sandmining can be conducted on the Island without causing major environmental harm. Had the Commission confined its consideration of the evidence to that relating to Fraser Island's natural environment, it would have been necessary to recommend the total prohibition of the export of minerals extracted from the Island. It is clear, however, that the environmental aspects of decisions relating to the export of minerals extracted from the Island are by no means confined to the effects of sandmining on the natural environment of Fraser Island.

The Commission is not entitled to assume that environmental action in the national interest can always be taken without some economic disadvantages resulting. In this case, it is quite likely that the implementation of the Recommendation to prohibit the export of minerals extracted from the Island (with the exception of the eastern

beach south of Indian Head below the mean high-water mark) would have some adverse regional consequences, though the evidence establishes that this prohibition would be in the interests of the people of Australia as a whole. In the event of such regional disadvantages actually occurring, the Commission recommends that appropriate assistance be given to the region by the Commonwealth, in the light of the special circumstances surrounding the nature and timing of its decisions in this matter.

The Recommendation that exports be permitted from the eastern beach south of Indian Head, however, is not conditional upon one or both of the sandmining firms now operating on Fraser Island actually working its beach leases south of Indian Head prior to or immediately after ceasing operations above mean high-water mark. There may be economic or other factors inhibiting one or both of these firms from taking this course, although both lessees presumably had some expectation of eventually mining on the eastern beach south of Indian Head in order to make it worthwhile to take leases over these areas. It may well be, however, that the reserves of ore on the beach leases south of Indian Head are considerably smaller than those originally contained in the leases now being worked above mean high-water mark. If, following the recommended prohibition, all sandmining ceased on the Island and no operations began on the eastern beach south of Indian Head, the sandmining firms would be acting consistently with the interests of the people of Australia as a whole.

This Report concludes with the formal Findings and Recommendations of the Commission.

FRASER ISLAND ENVIRONMENTAL INQUIRY

FINAL REPORT

FINDINGS

Having regard to the evidence in respect of all of the environmental aspects of the making of decisions by or on behalf of the Australian [Commonwealth] Government in relation to the exportation from Australia of minerals (including minerals that have been subjected to processing or treatment) extracted or which may hereafter be extracted from Fraser Island in the State of Queensland, THE COMMISSION FINDS THAT:

1. FRASER ISLAND, whose particularly sensitive and delicately-balanced environment will be affected by all such decisions,

   (a) is of great importance to the people of Australia;

   (b) is a component of the natural environment of Australia having outstanding social, aesthetic and scientific significance and other special value for future generations as well as for the present community;

   (c) is worthy of being recorded in its entirety as part of the National Estate in order to encourage its conservation in the national interest; and

   (d) is of international environmental significance.

2. THE environmental aspects of the making of decisions prohibiting the exportation from Australia of *all* minerals (including minerals that have been subjected to processing or treatment) extracted from Fraser Island and thus involving the termination of sandmining for heavy minerals on the Island are that:

   (a) the conservation of those environmental qualities which make Fraser Island of great significance and importance to the people of Australia as a whole will be encouraged;

   (b) there will be at most only a very marginal impact on the level of economic activity in Australia and on Australian national income;

   (c) there will be no significant impact on the capacity of Australia to meet overseas demands for rutile and zircon, or on Australia's balance of international payments;

   (d) the overall interests of the people of Australia as a whole will be better served than if exports of minerals extracted from Fraser Island were permitted and sandmining continued on the Island;

   (e) the present system of closely supervised sustained yield logging on the Island (which is consistent with the maintenance of its environmental quality) will not be adversely affected;

   (f) the tourist activity on the Island will not be adversely affected;

   (g) the regional economy will suffer some adverse effects (which could be redressed by suitable assistance) flowing from a reduction in the level of activity associated with sandmining on Fraser Island.

3. IRRESPECTIVE of whether mining lease special conditions are performed or breached, the environmental aspects of the making of decisions permitting the exportation from Australia of minerals extracted from Fraser Island and thus involving the continued extraction of minerals from the Island are that:

   (a) there will be at most only a very marginal impact on the level of economic activity in Australia and on Australian national income;

   (b) there will be no significant impact on the capacity of Australia to meet overseas demands for rutile and zircon, or on Australia's balance of international payments;

   (c) the overall interests of the people of Australia as a whole will be worse served than if exports of minerals extracted from Fraser Island were prohibited and sandmining ceased on the Island;

   (d) the present system of closely supervised sustained yield logging will not be significantly affected by the extraction of minerals on existing leases;

(e) the tourist activity on the Island will ultimately be adversely affected;

(f) the region will enjoy economic benefits associated with activity generated by sandmining on the Island;

(g) the vegetation and other components of the ecosystems of mined areas will be completely destroyed and, as a result, the vegetation and other components of ecosystems on contiguous areas will be subjected to greater exposure and consequential harm;

(h) major topographical changes will be wrought on mined areas, resulting overall in the creation of a flatter, more subdued and more uniform topography;

(i) the *restoration* (defined in Section 6.1 of the text) of vegetation on mined areas will be impossible;

(j) the successful *rehabilitation* (defined in Section 6.1 of the text) of any rain-forests affected by mining will be impossible;

(k) the successful *rehabilitation* (defined in Section 6.1 of the text) of other vegetation affected by mining will be unlikely;

(l) on the balance of the probabilities, changes in the hydrological balance of perched and water-table window lakes, creeks and swamps will take place which are likely to result in changes of water level and harm to ecosystems;

(m) on the balance of the probabilities, substances will be added to water-bodies which are very likely to affect significantly their ecosystems;

(n) sites of archaeological and geomorphological significance will be destroyed;

(o) the unifying impression of wilderness which is fundamental to the environmental significance of the Island as a whole will be lost;

(p) most of those environmental characteristics which make the Island of great significance and importance to the people of Australia as a whole will be destroyed.

4. IRRESPECTIVE of whether Mining Lease Special Conditions are performed or breached the environmental aspects of the making of decisions permitting the exportation from Australia of minerals extracted from Mining Leases 84, 104 and 105 on Fraser Island and thus involving the continued extraction of minerals from these Mining Leases are that:

   (a) all those matters set out in paragraphs (a) to (k) inclusive and (m) and (n) of Finding 3 will be environmental aspects of such decisions;

   (b) on the balance of the probabilities, changes in the hydrological balance of creeks and swamps will take place which are likely to result in changes of water level and harm to ecosystems;

   (c) the value of the Island to the Australian people as a whole will be seriously impaired in that, directly or indirectly, major permanent and irreversible environmental harm to the landscape, vegetation and water-bodies of one of its most sensitive, fragile, accessible and frequently traversed areas, will inevitably occur.

5. IRRESPECTIVE of whether Mining Lease Special Conditions are performed or breached, the environmental aspects of the making of decisions permitting the exportation from Australia of minerals extracted from Mining Leases 102 and 95 on Fraser Island and thus involving the extraction of minerals from these Mining Leases are that:

   (a) all those matters set out in paragraphs (a) to (o) inclusive of Finding 3 will be environmental aspects of such decisions;

   (b) the wilderness settings of Lake Boemingen and Lake Wabby will be adversely affected;

   (c) on the balance of the probabilities, Lake Boemingen, Lake Wabby, wetlands and creeks will be polluted and their ecosystems adversely affected;

   (d) the value of the Island to the Australian people as a whole will be seriously impaired in that, directly or indirectly, major permanent and irreversible environmental harm to the landscape, vegetation and water-bodies of several of its most environmentally significant and sensitive areas, including those listed in Finding 5 (c) will inevitably occur.

6. IRRESPECTIVE of whether Mining Lease Special Conditions are performed or breached the environmental aspects of the making of decisions permitting the exportation from Australia of minerals extracted from Fraser Island to the extent of no more than 175,000 tonnes of minerals extracted from Mining Leases 102 and 95 and thus involving the continued extraction of minerals on Mining Lease 102 and the possibility of the extraction of minerals from Mining Lease 95 are that:

(a) all those matters set out in paragraphs (a) to (o) inclusive of Finding 3 will be environmental aspects of such decisions;

(b) the wilderness setting of Lake Boemingen will be adversely affected;

(c) on the balance of the probabilities, Lake Boemingen, wetlands and creeks will be polluted and their ecosystems adversely affected;

(d) the value of the Island to the Australian people as a whole will be seriously impaired in that, directly or indirectly, major permanent and irreversible environmental harm to the landscape, vegetation and water-bodies of several of its most environmentally significant and sensitive areas, including those listed in Finding 6 (c) will inevitably occur;

(e) in the event that mining proceeds in the vicinity of Lake Wabby

(i) its wilderness setting will be adversely affected, and,

(ii) on the balance of the probabilities, it will be polluted and its ecosystems adversely affected.

7. IRRESPECTIVE of whether Mining Lease Special Conditions are performed or breached the environmental aspects of the making of decisions permitting the exportation from Australia of minerals extracted from Mining Lease 102 on Fraser Island and thus involving the continued extraction of minerals from this Mining Lease are that:

(a) all those matters set out in paragraphs (a) to (o) inclusive of Finding 3 will be environmental aspects of such decisions;

(b) the wilderness setting of Lake Boemingen will be adversely affected;

(c) on the balance of the probabilities, Lake Boemingen, wetlands and creeks will be polluted and their ecosystems adversely affected;

(d) the value of the Island to the Australian people as a whole will be seriously impaired in that, directly or indirectly, major permanent and irreversible environmental harm to the landscape, vegetation and water-bodies of several of its most environmentally significant and sensitive areas, including those listed in Finding 7 (c), will inevitably occur.

8. THE environmental aspects of the making of decisions permitting the exportation from Australia of minerals extracted from mining leases above mean high-water mark on Fraser Island *subject to the performance of their special conditions*, and thus involving the extraction of minerals on these leases are that:

(a) all those matters set out in paragraphs (a) to (o) inclusive of Finding 3 will be environmental aspects of such decisions;

(b) the performance of the special conditions will nevertheless involve significant environmental harm associated with sandmining occurring to the Island in that these Special Conditions are an unsuitable and unsuccessful device for maintaining the environmental quality of the Island;

(c) reliance on the performance of the special conditions of Fraser Island mining leases would involve the continuance of sandmining above mean high-water mark inconsistent with the maintenance of the environmental quality of the Island;

(d) reliance on *any* mining lease special conditions which involve the continuance of sandmining above the mean high-water mark on Fraser Island will be inconsistent with the maintenance of the environmental quality of the Island.

9. IRRESPECTIVE of whether mining lease special conditions are performed or breached the environmental aspects of the making of decisions restricting the exportation from Australia of minerals extracted from Fraser Island to those minerals extracted from below the mean high-water mark on the eastern beach *north* of Indian Head, which are followed by the extraction of minerals from that beach, are that:

(a) all those matters set out in paragraphs (a), (b), (d) and (e) inclusive of Finding 3 will be environmental aspects of such decisions;

(b) the regional economy will suffer some adverse effects (which could be redressed by suitable assistance) flowing from a reduction in the level of activity associated with sandmining on Fraser Island, though these effects will be less severe than if sandmining ceased altogether;

(c) all sandmining above mean high-water mark would cease;

(d) the extraction of minerals from sites below the mean high-water mark on the eastern beach of the Island *north* of Indian Head is likely to be associated with significant permanent environmental harm to the Island;

(e) the overall interests of the people of Australia as a whole would be worse served than if *all* exports of minerals extracted from Fraser Island were prohibited and sandmining ceased on the Island;

(f) the overall interests of the people of Australia as a whole would be worse served than if decisions were made restricting the export of minerals extracted from Fraser Island to those minerals extracted from below the mean high-water mark on the eastern beach *south* of Indian Head.

10. THE environmental aspects of the making of decisions restricting the exportation from Australia of minerals extracted from Fraser Island to those minerals extracted from below the mean high-water mark on the eastern beach *south* of Indian Head, which are followed by the extraction of minerals from that beach, are that:

(a) all those matters set out in paragraphs (b), (c) and (e) of Finding 2 will be environmental aspects of such decisions;

(b) the tourist activity on the Island will not be significantly affected;

(c) the regional economy will suffer some adverse effects (which could be redressed by suitable assistance) flowing from a reduction in the level of activity associated with sandmining on Fraser Island, though these effects will be less severe than if sandmining ceased altogether;

(d) all sandmining above mean high-water mark would cease;

(e) the extraction of minerals from sites below the mean high-water mark on the eastern beach of the Island *south* of Indian Head is unlikely to be associated with significant permanent environmental harm to the Island PROVIDED THAT sandmining operations and all activities on the Island associated with them are conducted in such a way as to minimize their environmental impact, and, in particular, so as to avoid all direct or indirect harm to the foredunes and other sand masses of the Island;

(f) the overall interests of the people of Australia as a whole will be worse served than if *all* exports of minerals extracted from Fraser Island were prohibited and sandmining ceased on the Island;

(g) the overall interests of the people of Australia as a whole will be better served than if decisions were made permitting the export of minerals extracted from above the mean high-water mark on Fraser Island or from the beaches *north* of Indian Head.

FRASER ISLAND ENVIRONMENTAL INQUIRY

FINAL REPORT

RECOMMENDATIONS

Having regard to the evidence in respect of all of the environmental aspects of the making of decisions by or on behalf of the Australian [Commonwealth] Government in relation to the exportation from Australia of minerals (including minerals that have been subjected to processing or treatment) extracted or which may hereafter be extracted from Fraser Island in the State of Queensland, THE COMMISSION RECOMMENDS THAT:

1. ALL exports of minerals (including minerals that have been subjected to processing or treatment) extracted or which may hereafter be extracted from Fraser Island be absolutely prohibited EXCEPT for minerals extracted from below the mean high-water mark on the eastern beach south of Indian Head.

2. APPROPRIATE economic and other assistance be given to the extent that adverse regional economic effects follow the implementation of Recommendation 1.

3. THE whole of Fraser Island be recorded as part of the National Estate as soon as possible.

APPENDIX 1

PHOTOGRAPHS

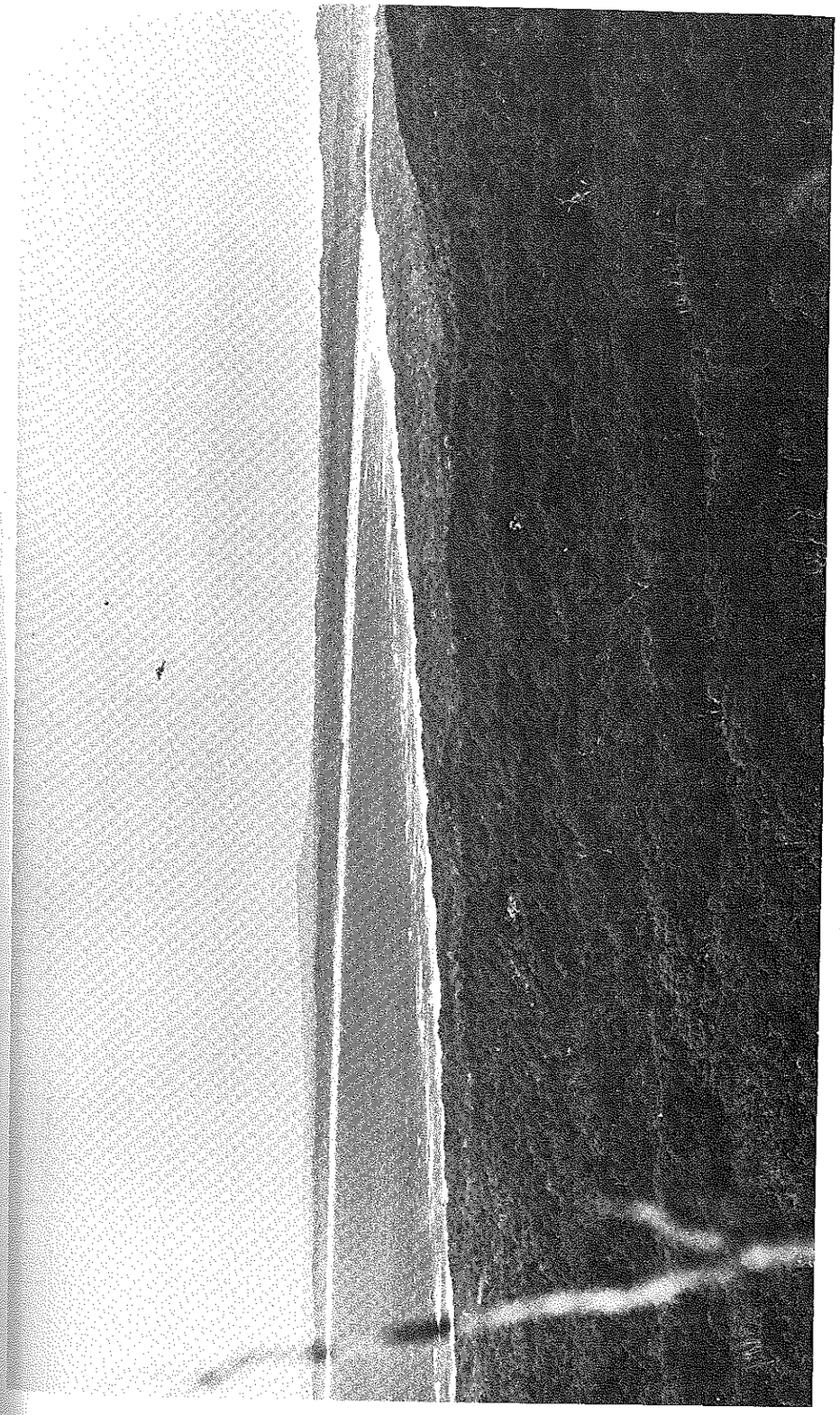
The following photographs, all of which have been taken by the Commission, have been selected to show some of the natural features of Fraser Island and some of the effects of man -- chiefly in relation to sandmining.

With the exception of the blackbutt forest, the rain-forest and Lake McKenzie, all of the scenes depicted are located within, adjacent to or overlooking areas held under existing mining leases or subject to mining lease applications.

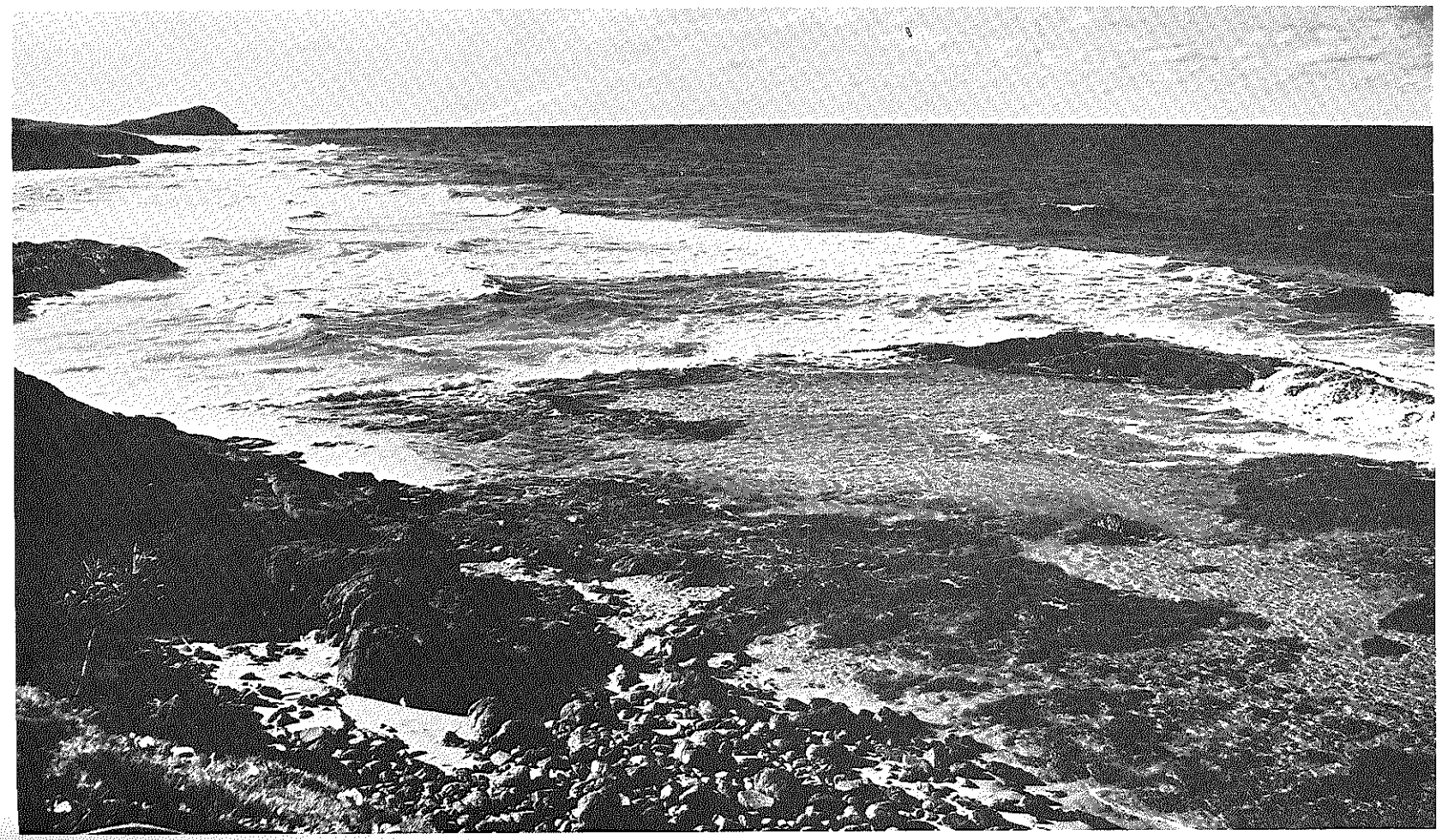
Each of the scenes depicted in the first section of this appendix is intended to illustrate the beauty of one of the many facets of Fraser Island,

.... its beaches ....

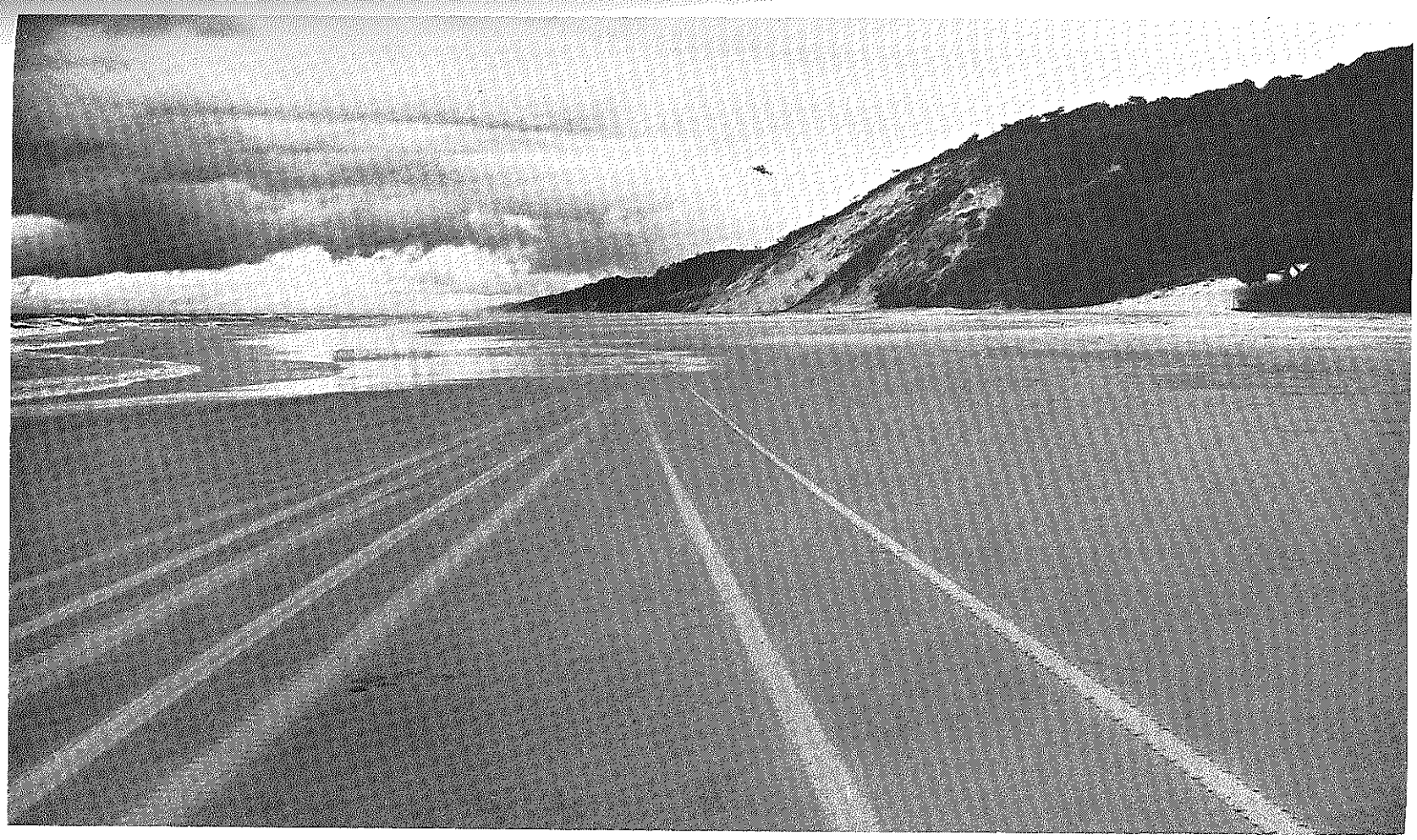
The ocean beach looking north -- Timbered to the beach -- ideal for fishing, camping and recreation



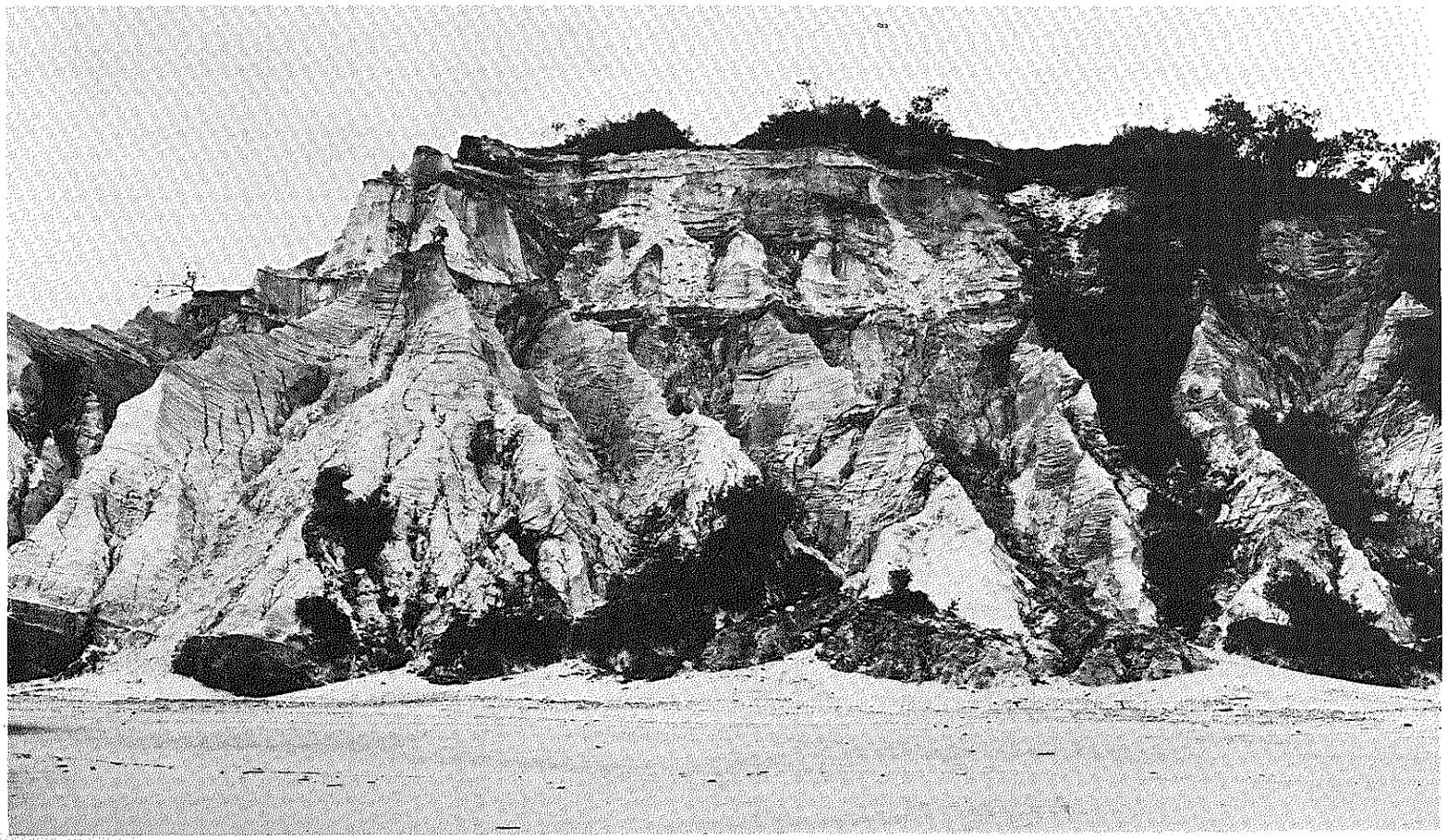
The southern beach from Markwell's Lookout -- an impressive sweep of coastline and forest



Champagne Pool at the Waddy Point - Indian Head Beauty Spot -- A rugged rocky coast

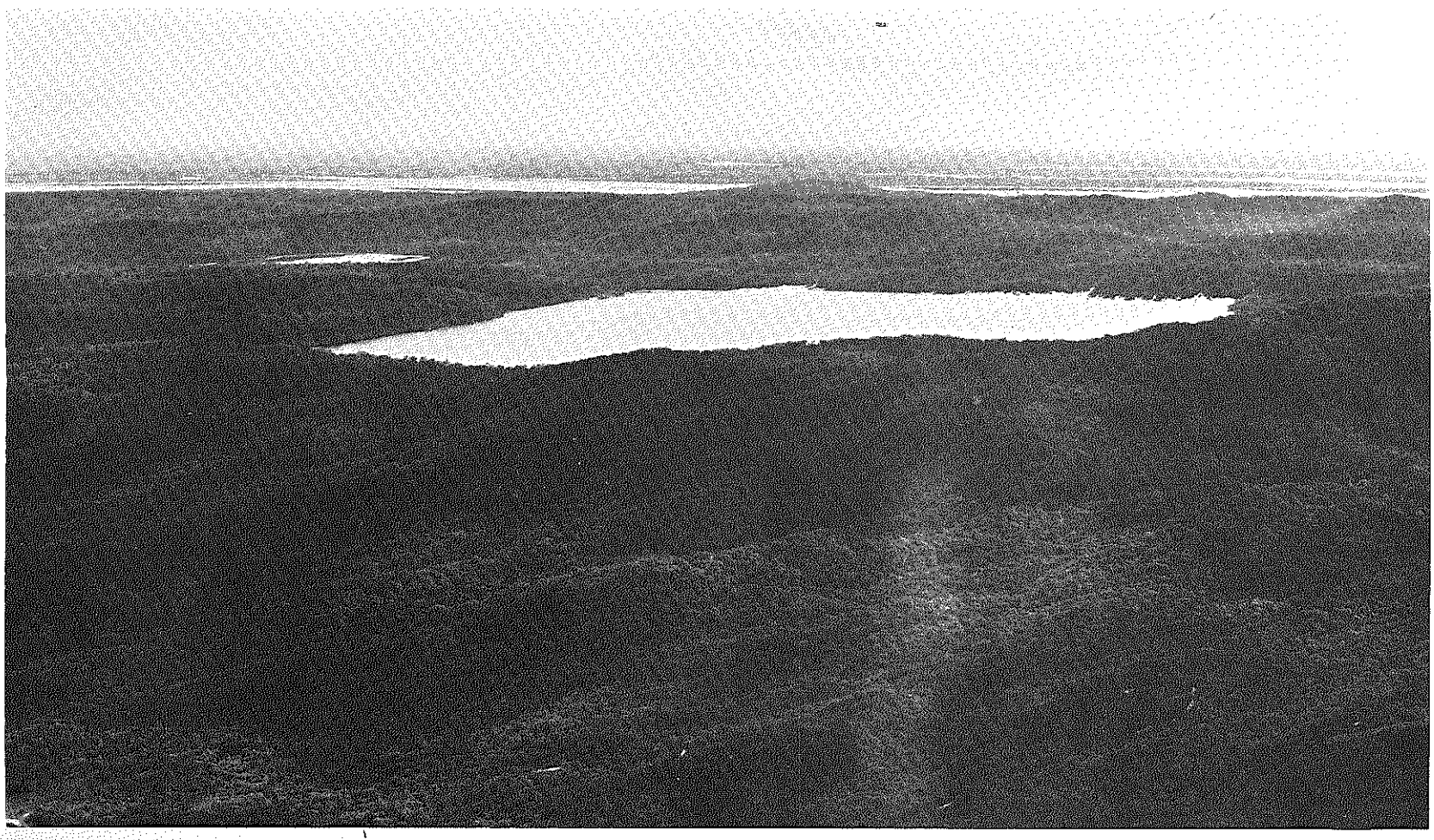


The ocean beach at low tide -- A fishing mecca, a playground and a tourist highway

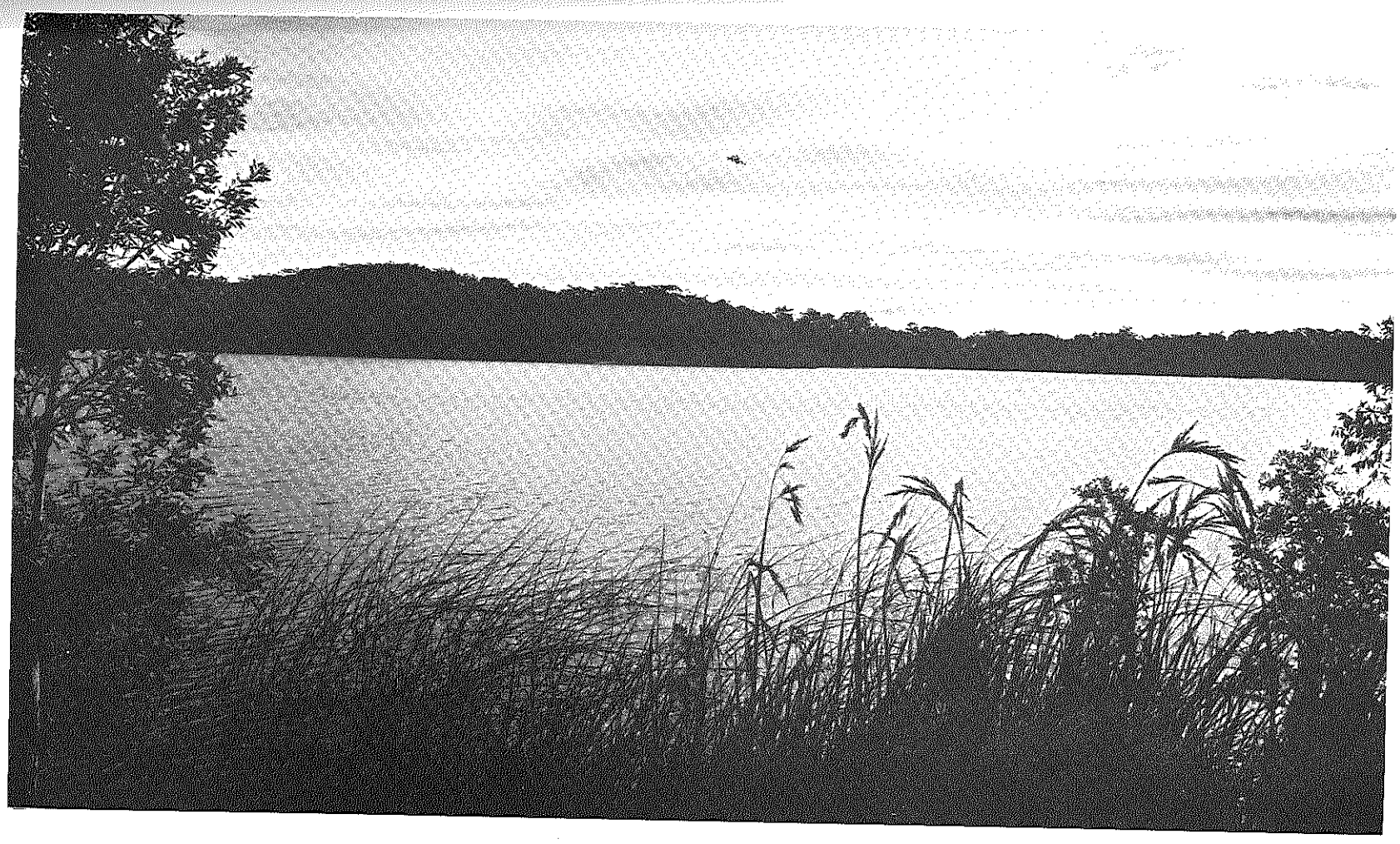


The Cathedrals -- Brilliantly coloured sands sculptured by wind and water

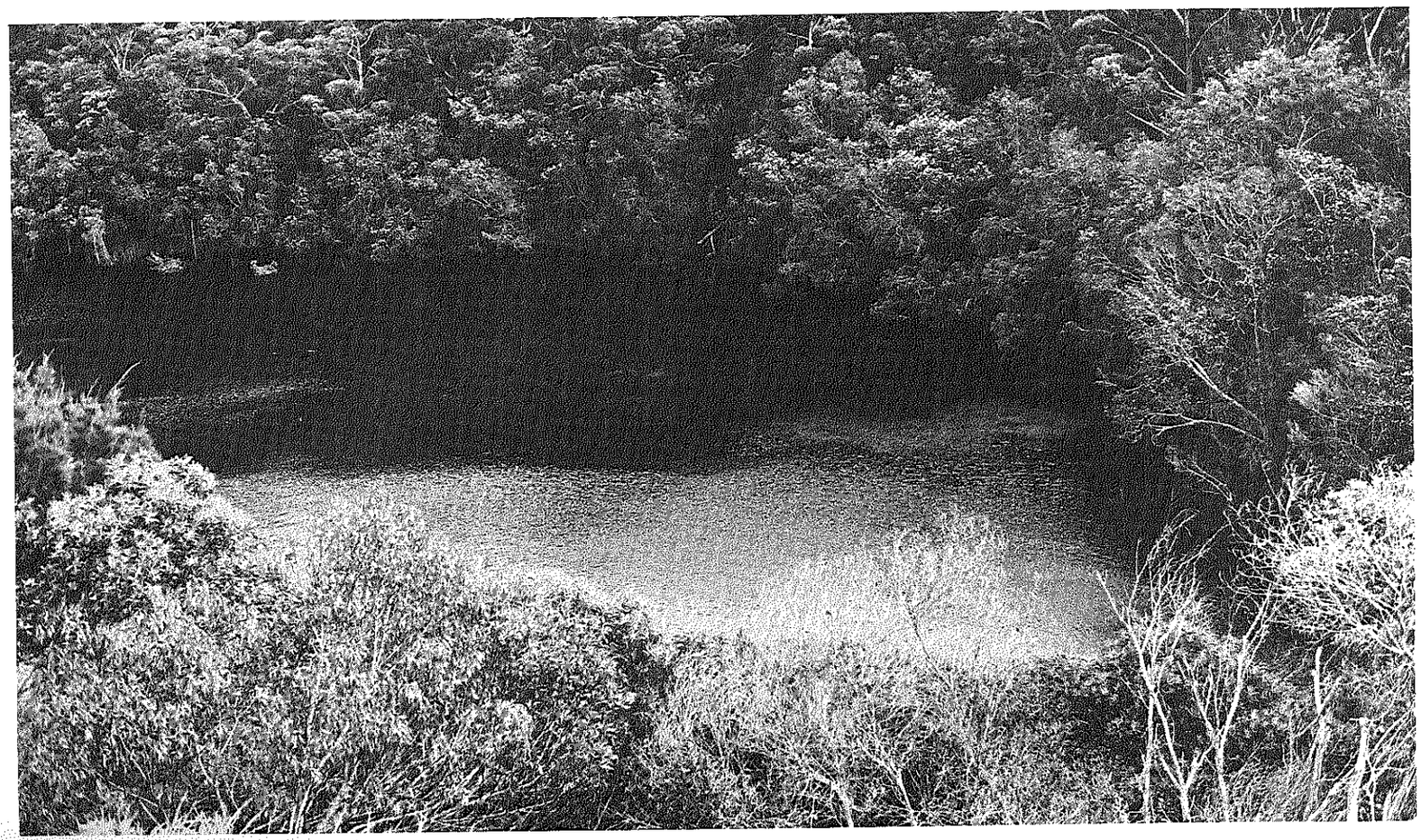
.... its lakes ....



Lake Boemingen -- A freshwater lake perched high amongst steep wooded dunes



Lake McKenzie -- Tranquility



Lake Wabby -- A sparkling jewel nestling between forests and the wall of a sandblow

.... its creeks ....

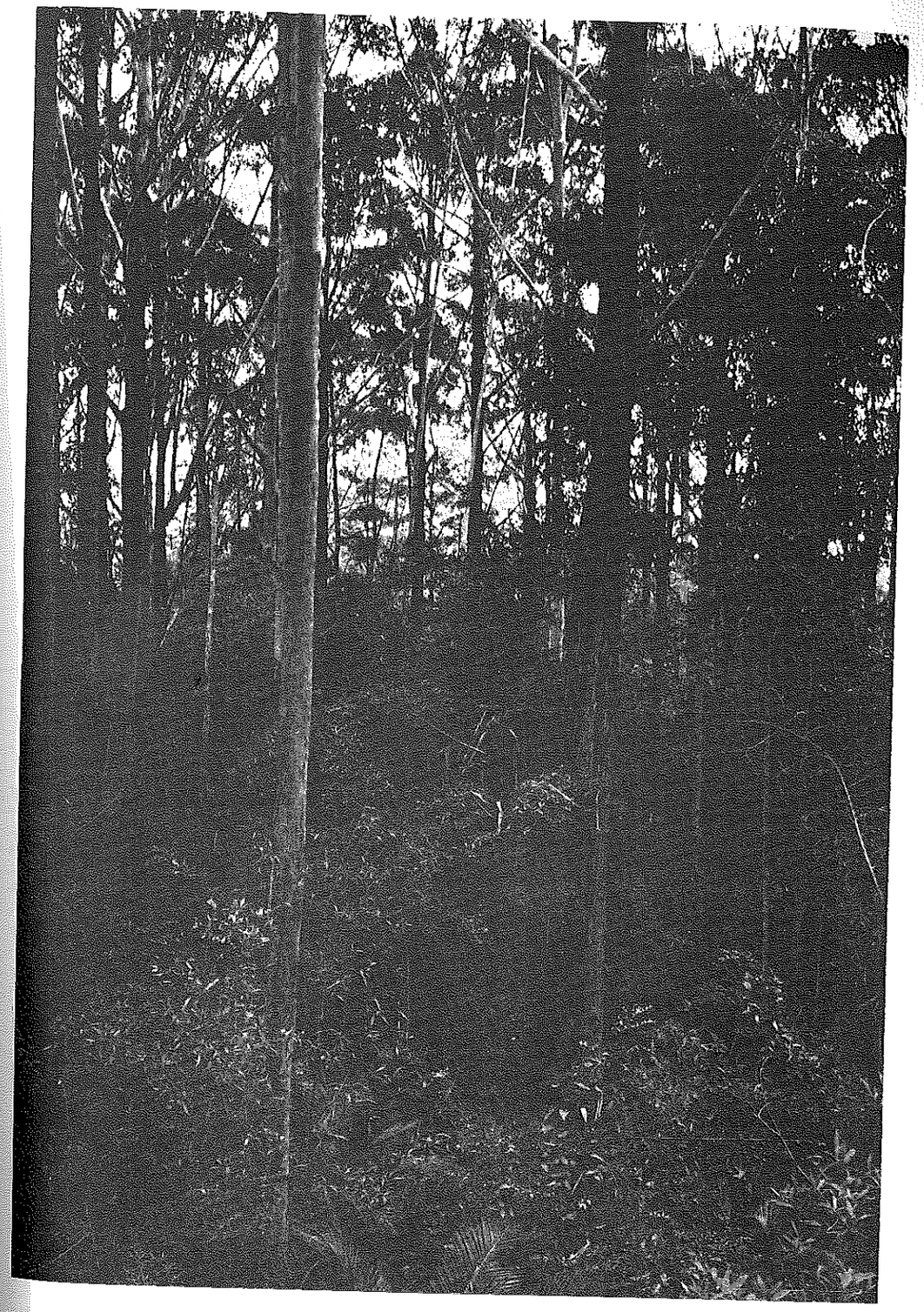
First Creek -- Clear pure fresh water next to the ocean beach

Eii Creek -- Swift flowing water and dense vegetation among the sand dunes -- fragile and fascinating

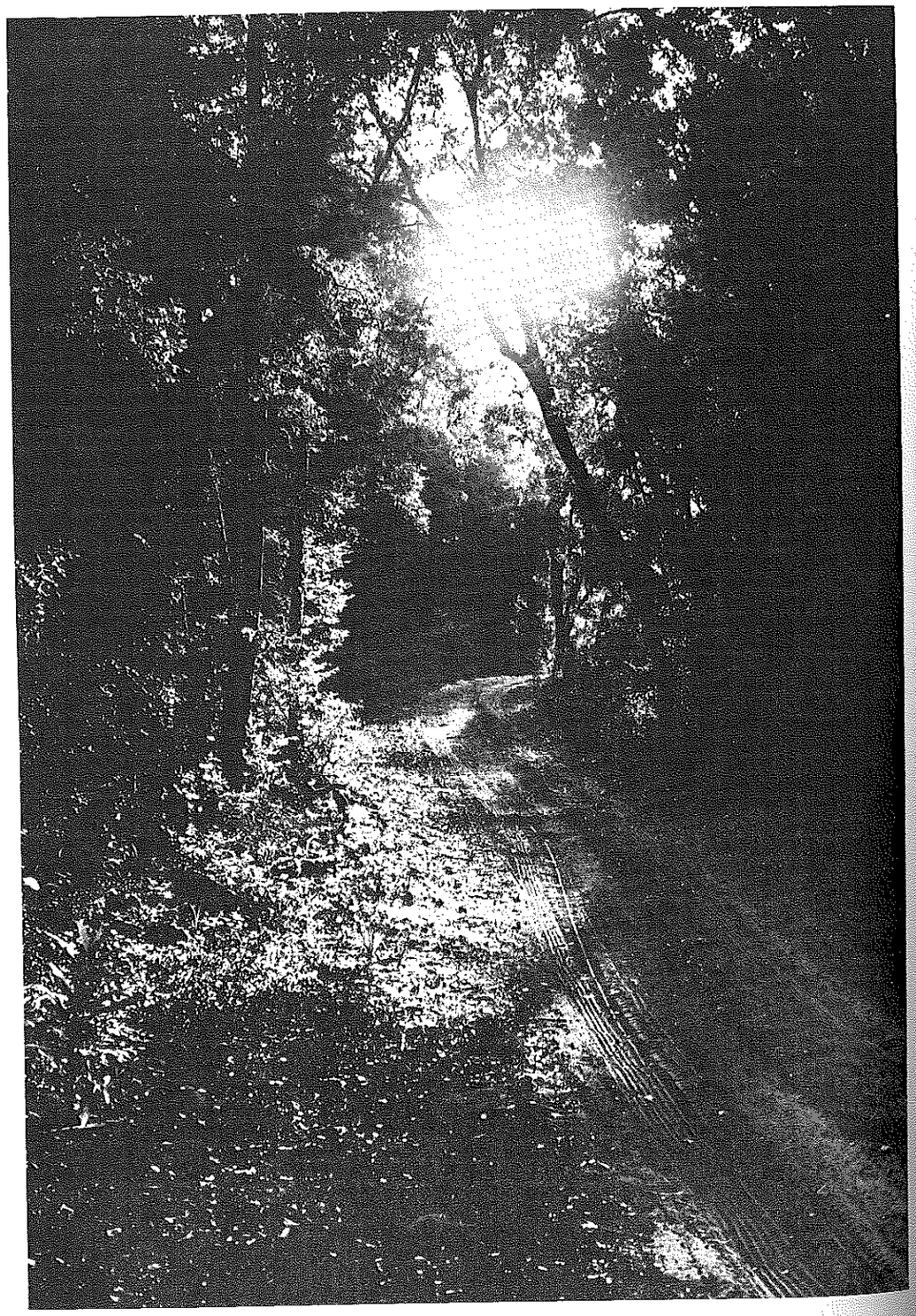
Mining Lease 102 -- Typical low open forest on mining leases

.... its forests ....

Typical low closed forest on mining leases



Blackbutt forest -- Tall timber growing on sand



Rain-forest -- Lush and peaceful

The photographs in the second section of this appendix have been selected to illustrate -- in a qualitative rather than quantitative manner -- some of the extant effects of man upon Fraser Island.

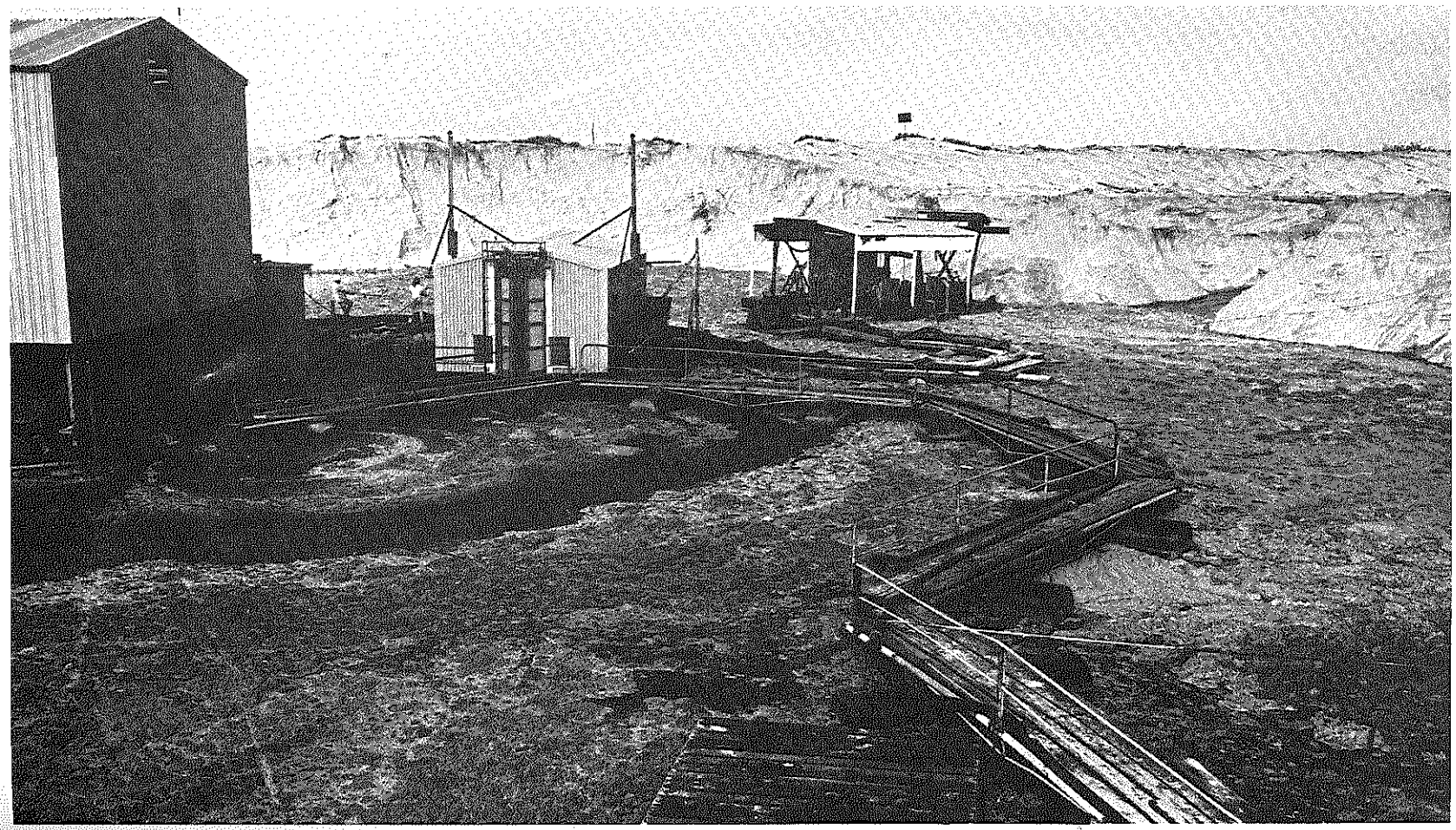
Forestry practices are specifically excluded for reasons outlined elsewhere.

.... people create litter ....

Rubbish dump near Eurong village

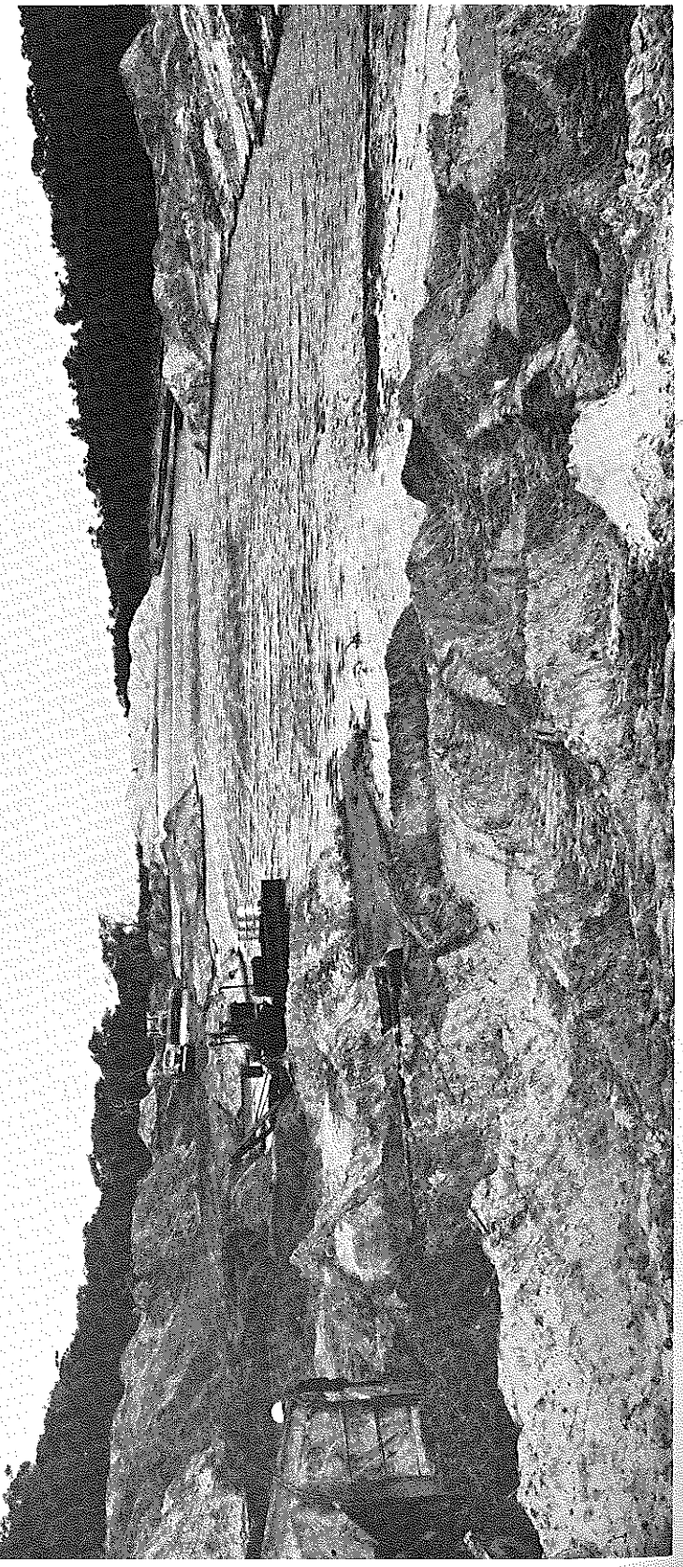
Sandmining requires

.... dredging ....

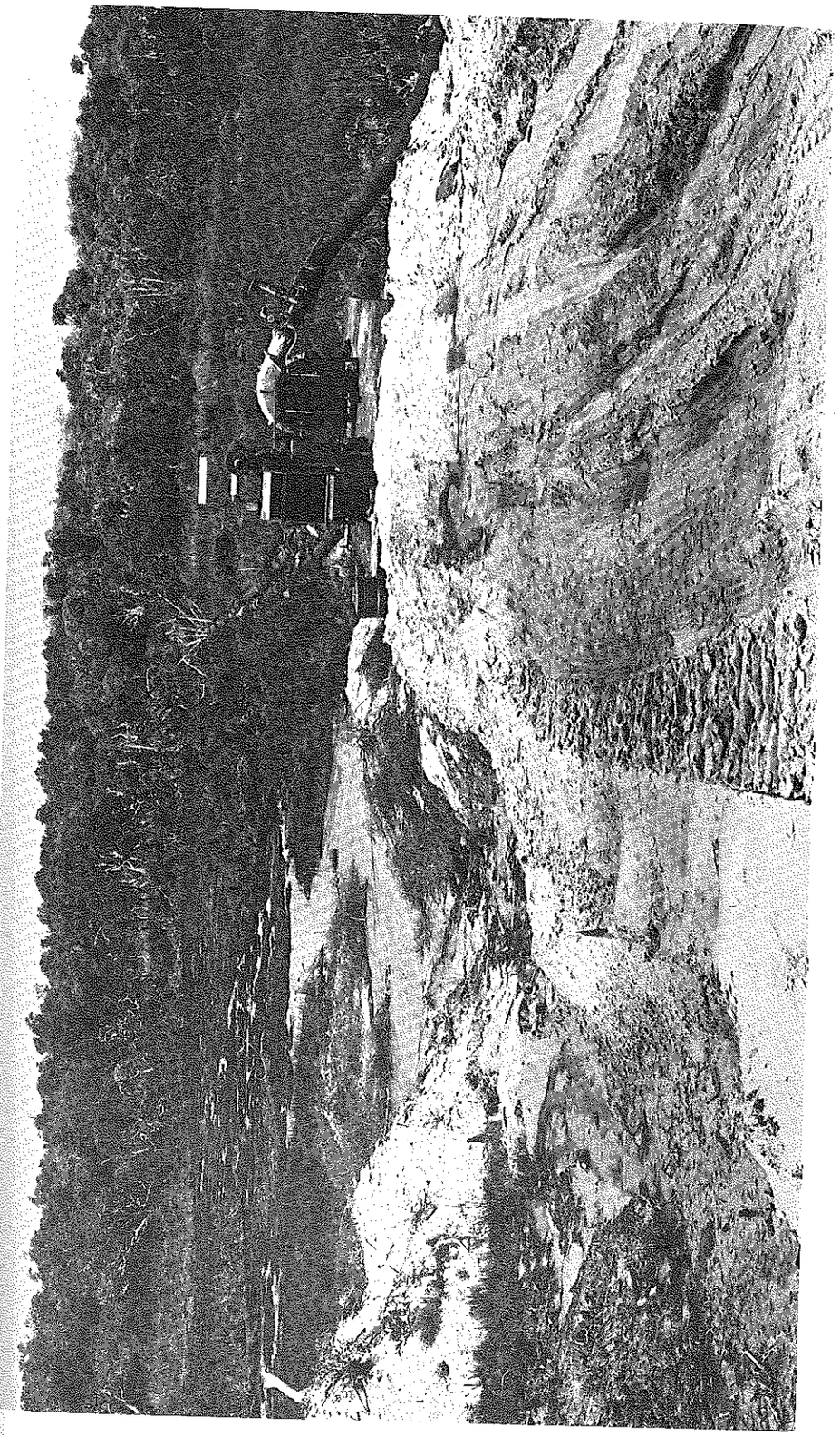


Dredge pond at the Queensland Titanium Mines Pty Ltd operation

Tailings being placed behind the Queensland Titanium Mines Pty Ltd floating plant



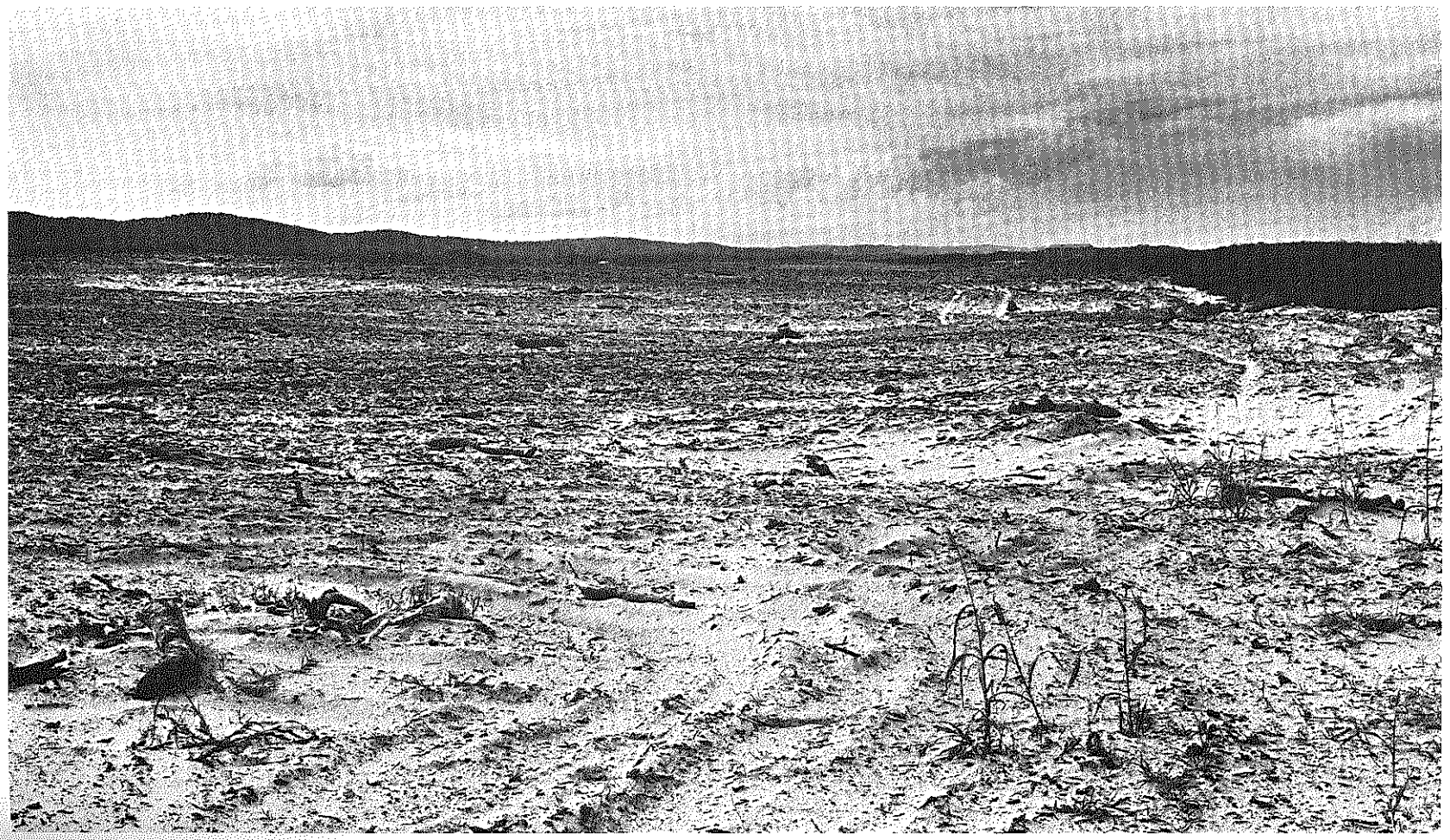
Sandmining at the D M Minerals' site



Pumping 'make-up' water from Second Creek

.... reforming ....

Spreading stockpiled topsoil on ML 102



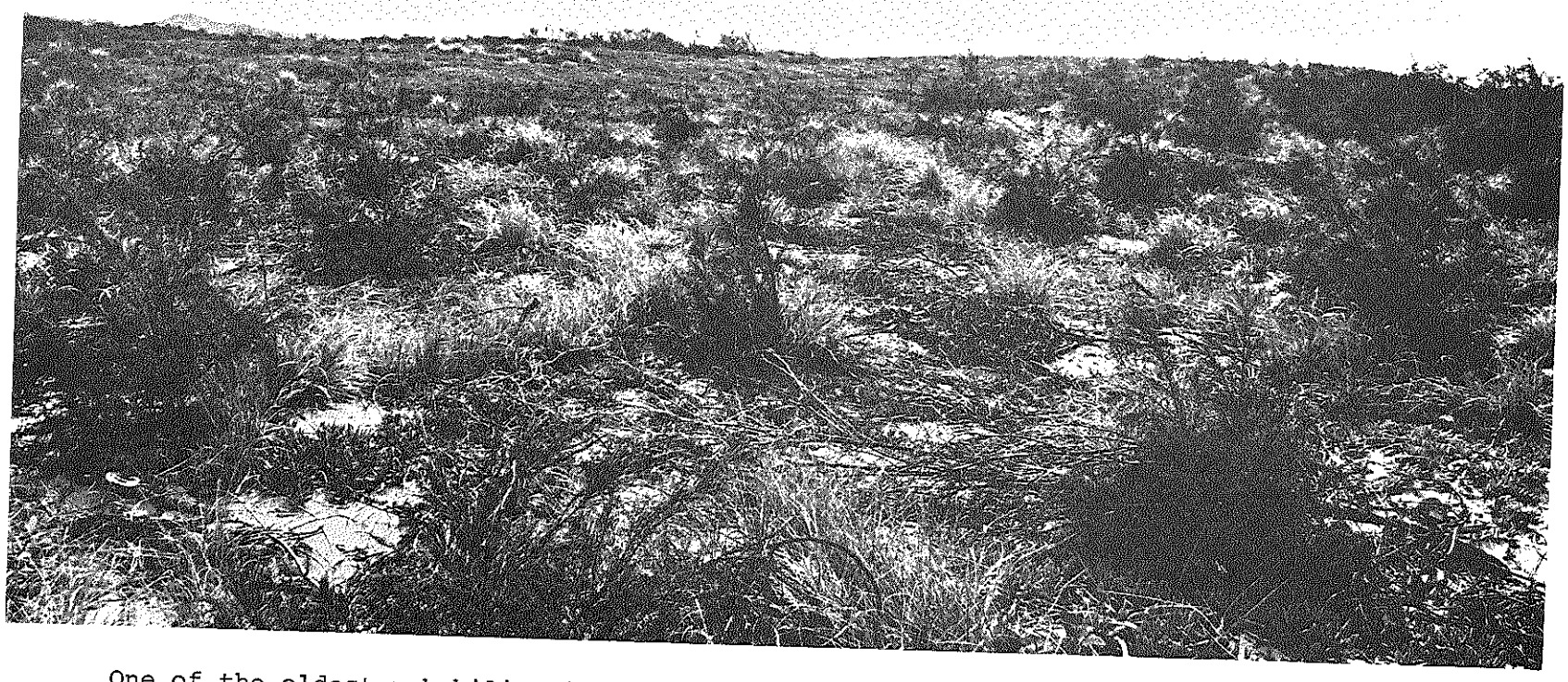
The end of reforming and the start of rehabilitation on a Queensland Titanium Mines Pty Ltd's lease

.... rehabilitation ....

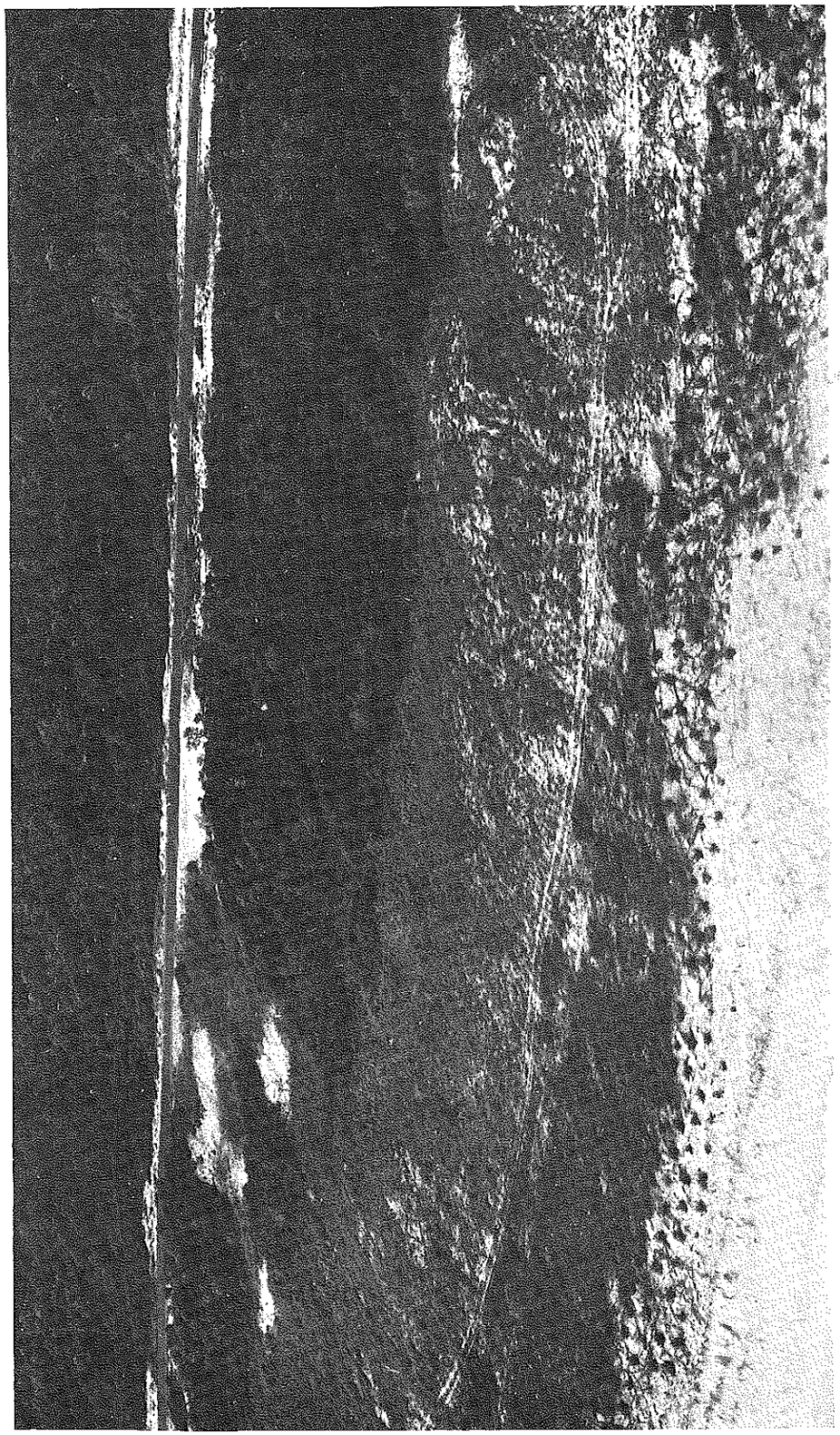
Brushing (on left of photograph) and planting during rehabilitation on an area mined by Queensland Titanium Mines Pty Ltd

An early stage of rehabilitation on ML 102 (D M Minerals) showing an adjacent unmined area

An early stage of rehabilitation on ML 102 (D M Minerals)



One of the oldest rehabilitation areas on Fraser Island (about four years after mining)



An aerial view of part of Queensland Titanium Mines Pty Ltd's mined strip adjacent to the coast, with an unmined area and the Company's road in the background

APPENDIX II

Environment Protection (Impact of Proposals) Act 1974-1975

FRASER ISLAND ENVIRONMENTAL INQUIRY

FOR achieving the object of the *Environment Protection (Impact of Proposals) Act* 1974-1975, I, EDWARD GOUGH WHITLAM, the Minister of State for Environment, in pursuance of sub-section 11.(1) of that Act, hereby direct that an inquiry be conducted in respect of all of the environmental aspects of the making of decisions by or on behalf of the Australian Government in relation to the exportation from Australia of minerals (including minerals that have been subjected to processing or treatment) extracted or which may hereafter be extracted from Fraser Island in the State of Queensland,

AND in pursuance of the powers conferred on me by sub-section 11.(2) of the said Act, I appoint John Francis Hookey and Arthur Blamey Hicks as Commissioners to be a Commission to conduct the said inquiry,

AND in pursuance of the powers conferred on me by sub-section 11.(3) of the said Act, I appoint the said John Francis Hookey to preside at the said inquiry.

Dated this Twelfth day of July 1975.

E. G. WHITLAM
Minister of State
for Environment

Source: *Australian Government Gazette*, No. S147, Canberra, Wednesday, 16 July 1975

APPENDIX III

THE FINDINGS CONTAINED IN THE FIRST REPORT OF THE FRASER ISLAND ENVIRONMENTAL INQUIRY

From its consideration of the evidence before it

1. THE COMMISSION FINDS THAT, of the Special Conditions of Mining Lease 102:

   (a) Special Condition 24 (b) prohibiting the extraction of water from Second Creek has been radically altered.

   (b) (i) Special Condition 24 (a) (iii) prohibits interference with the area of Second Creek and the land abutting it.

   (ii) Environmental harm has nevertheless been caused to Second Creek and its environs by sandmining operations.

   (c) (i) Special Condition 24 (c) (iii) prohibits the return of water to the area of Second Creek and the land abutting it.

   (ii) Water has nevertheless been returned to Second Creek.

   (d) (i) Special Conditions 24 (c) (i) and (iii) prohibit the return of water to, or discharge of any other substances onto the areas of Lake Boemingen, Second Creek and the lands abutting them.

   (ii) If mining proceeds as planned, water and other substances, particularly plant nutrients, will almost certainly be returned to the areas of Lake Boemingen, Second Creek and the lands abutting them.

   (e) Depending upon the interpretation placed on Special Condition 19, which prescribes the maximum area which may remain unrehabilitated at any one time, either the prescribed maximum area is being exceeded, or the extent of the area permitted to remain unrehabilitated is so great as to be environmentally hazardous.

   (f) Special Conditions 16 (a) and (b) can reasonably be interpreted as permitting the reshaped surface of a mined area to be virtually flat, at least over the majority of a mined area.

   (g) Other Special Conditions are also of environmental concern and will be considered in a later Report.

2. THE COMMISSION FINDS THAT the Special Conditions of Mining Lease 102

   (a) have been altered, after the lease was granted, in an environmentally significant manner,

   (b) have not, and will not, prevent actions during sandmining operations which will be significantly damaging to the environment,

   (c) do not represent adequate environmental safeguards whether fulfilled to the letter or not.

3. THE COMMISSION FINDS THAT there are significant environmental risks should mining proceed on Mining Leases 102 and/or 95, in respect of:

   (a) pollution of lakes, swamps and creeks,

   (b) exposure of sand areas to wind erosion if rehabilitation fails,

   (c) disturbance of scenic attractions,

   (d) exposure of rainforests and other sensitive plant communities to salt laden winds.

4. THE COMMISSION FINDS THAT should mining proceed on Mining Leases 102 and/or 95:

   (a) the topography of mined steep dune areas will be forever substantially subdued with a reduction in diversity of plant communities and their accompanying fauna,

   (b) restoration of most mined areas, including all steep dune areas, is not possible in any sensible human time scale,

   (c) rehabilitation of mined areas in the sense of merely establishing a permanent self-sustaining vegetative cover cannot be guaranteed but can be successful in certain areas, such as foredunes, provided that the necessary care is taken.

5. THE COMMISSION FINDS THAT the acceptability of successful rehabilitation, as opposed to restoration, would depend upon the later use to which the land is to be put, and if Fraser Island is recorded as part of the National Estate, even successful rehabilitation would be generally unacceptable.

6. THE COMMISSION FINDS THAT the whole of Fraser Island is worthy of being recorded as part of the National Estate.

APPENDIX IV

THE RECOMMENDATIONS CONTAINED IN THE FIRST REPORT OF THE FRASER ISLAND ENVIRONMENTAL INQUIRY

THE COMMISSION RECOMMENDS that

(1) All decisions within the terms of the Direction dated 12 July 1975 of an executive or administrative nature relating to the review of D M Minerals' export contract, and, in particular, any proposed decision as to whether to grant blanket approval for the exportation of minerals from Mining Leases 102 and/or 95 in the twelve months following 13 December 1975 subject to the performance of the environmental Special Conditions of these leases, be deferred until after the Commission's Final Report is presented.

(2) If it is considered necessary to make a decision of the kind described in Recommendation (1) before the presentation of the Final Report of the Commission, then blanket approval for the exportation of minerals from Mining Leases 102 and/or 95 for the twelve months following 13 December 1975 be not granted.

(3) Fraser Island be recorded as part of the National Estate as soon as possible.

APPENDIX V

LIST OF PERSONS WHO PRESENTED EVIDENCE TO THE INQUIRY

Where evidence was presented on behalf of an organization, the name of the organization is also listed

Mr G. Alison MLA, Maryborough, Qld, firstly as a private witness and later representing the Fraser Island and Maryborough Citizens' Action Group.
Ms M. M. Barson, North Carlton, Vic., Australian Conservation Foundation.
Mr G. M. Bavington, Maryborough, Qld, Maryborough City Council.
Dr I. A. E. Bayly, Toorak, Vic.
Mr K. L. and Mrs A. M. Bedford, Moggill, Qld.
Mr C. J. E. Bell, St Lucia, Qld.
Dr J. D. Bell, Melba, A.C.T., Environmental Systems Division, Australian Department of Environment.
Mr D. C. Beu, Maryborough, Qld.
Mr H. G. Bezant, Maryborough, Qld, Maryborough Chamber of Commerce.
Ms E. M. Bourne, Yeerongpilly, Qld, University of Queensland Bushwalking Club.
Mr W. H. C. Boyle, Surfers Paradise, Qld.
Mr J. G. Cameron, Ascot, Qld.
Mr P. R. Campbell, Ashgrove, Qld, Wildlife Preservation Society of Queensland.
Mr L. St J. Carter, Torquay, Qld.
Dr A. G. Christie, Garran, A.C.T., Australian Department of Urban and Regional Development.
Dr S. S. Clark, Chatswood, N.S.W.
Mr C. J. Corben, Bardon, Qld, Wildlife Preservation Society of Queensland.
Mr P. J. Creyke, Waramanga, A.C.T., Australian Department of Manufacturing Industry.
Ms B. A. Cuthbertson, North Redcliffe, Qld, Wildlife Preservation Society of Queensland.
Mr J. Cuthbertson, Taringa, Qld, Honorary Rangers Association.
Mr L. V. Dephoff, Carlingford, N.S.W., Carlingford and North Rocks Bushland Trust.
Ms E. Durbidge, Stradbroke Island, Qld.
Mr G. V. Elmer, Rainbow Beach, Qld.
Mr C. R. Faine, Hamilton, Qld.,
Dr R. G. Florence, Hughes, A.C.T.
Mr N. E. Gardiner, Bardon, Qld, Australian Department of Labor and Immigration.
Mr B. C. Gentner, Clontarff, Qld, Griffith Environmental and Conservation Organization.
Mr C. E. Greenhalgh, Granville, Qld.
Mr L. A. Greensill, Pialba, Qld.
Mr W. A. Groom, Beechmont, Qld, International Park Tours Pty Ltd.
Mr W. F. J. Hamilton, Yeronga, Qld.
Dr A. G. Harrold, Noosa Heads, Qld, Cooloola Committee.
Mr E. J. Hegerl, Kenmore, Qld, Australian Littoral Society.
Dr D. A. Henderson, Brisbane, Qld.
Dr G. E. Heinsohn, Townsville, Qld.
Mr R. J. Henricks, Avana Hills, Qld, Brisbane Trades and Labor Council.
Mr R. J. Hinton, Nathan, Qld.
Mr A. C. and Mrs R. Hogg, Moggill , Qld.
Mr T. J. A. Hundloe, Indooroopilly, Qld, Queensland Conservation Council.
Mr W. G. S. Huxley, Wooloowin, Qld, Cooloola Committee.

Mr W. H. Hyne, Maryborough, Qld, Maryborough and Bundaberg Timber Merchants Association.
Dr P. M. James, Chelmer, Qld.
Mr S. G. Jarvis, Maryborough, Qld.
Mr E. R. Jurss, Maryborough, Qld, Maryborough - Hervey Bay and District Development Board.
Mr J. F. Keays, Ascot, Qld.
Miss D. M. M. Kelly, Nathan, Qld.
Mrs J. Kelsey, Nambour, Qld.
Dr H. L. Kesteven, Gympie, Qld.
Dr P. K. P. Lauer, Mount Ommaney, Qld.
Mr J. W. Lewis, Chapel Hill, Qld, Consultant to Queensland Titanium Mines Pty Ltd.
Mr G. E. Light, Mitchelton, Qld, Australian Department of Police and Customs.
Mr I. P. Little, Kenmore, Qld.
Mr W. P. Lucas, Rochedale, Qld.
Miss A. M. Marles, Nathan, Qld.
Mr G. J. Millar, Dorrington, Qld, Australian Littoral Society.
Mrs O. E. Miller, Moura, Qld.
Mr C. J. Moore, Taringa, Qld, Australian Union of Students.
Mr D. B. Morrison, Nerang, Qld, Queensland Titanium Mines Pty Ltd.
Dr J. G. Mosley, Lower Templestowe, Vic., Australian Conservation Foundation.
Mr J. W. J. McLatchey, Bundaberg, Qld, Australian Workers Union.
Miss D. O'Donnell, Wavell Heights, Qld, King & Co., Solicitors, Brisbane.
Mr I. S. Olsen, Thornleigh, N.S.W., The New South Wales Federation of Bushwalking Clubs.
Mr I. G. Owens, Urangan, Qld.
Mr S. K. Pennycuick, Gympie, Qld, Queensland Titanium Mines Pty Ltd.
Mr G. R. Ponting, Maryborough, Qld, Maryborough and Bundaberg Timber Merchants Association.
Mrs H. M. Postan, Maryborough, Qld.
Prof. B. N. Richards, Armidale, N.S.W.
Mr L. J. Rogers, Graceville, Qld, Queensland Institute of Foresters.
Mr N. J. Roffey-Mitchell, Brisbane, Qld, Wildlife Preservation Society of Queensland.
Mr A. S. Rundle, Church Point, N.S.W.
Ms P. J. Schindler, Mansfield, Qld.
Mr R. M. Seymour, Camp Hill, Qld, Australian Department of Transport.
Mr J. Sinclair, Maryborough, Qld, Fraser Island Defence Organisation.
Mrs F. E. Smith, Maryborough, Qld.
Dr P. H. Springell, Rockhampton, Qld.
Mrs E. M. Stamp, Grange, Qld.
Mr J. P. Stanton, Victoria Point, Qld, Consultant to Fraser Island Defence Organisation.
Mr M. J. Sullivan, Northgate, Qld.
Mrs V. M. Tarrant, Black Rock, Vic., Australian Conservation Foundation.
Mr C. J. Taylor, St Lucia, Qld.
Mr J. L. Tedder, Adelaide, S.A., Conservation Council of South Australia.
Dr B. G. Thom, Hawker, A.C.T.
Miss J. A. Thompson, Nathan, Qld.
Mr J. G. Tracey, Indooroopilly, Qld.
Mr J. B. Trigger, Nathan, Qld.
Mr A. R. Trist, Nundah, Qld, Queensland Timber Board.
Mr J. Ward, Ainslie, A.C.T., Australian Bureau of Resources.
Mr T. Ward, Turner, A.C.T.
Mr W. T. Ward, The Gap, Qld.
Mr G. Washington, Hawker, A.C.T., Australian Department of Tourism and Recreation.
Dr L. J. Webb, Wilston, Qld, Wildlife Preservation Society of Queensland.
Mr J. E. Wilcox, Aspley, Qld.
Prof. W. D. Williams, Crafers, S.A.
Mr R. A. Wilson, Northgate, Qld, Australian Department of Transport.
Mrs J. A. Wright-McKinney, North Tambourine, Qld, Wildlife Preservation Society of Queensland.
Mr W. J. Wylie, Callide Valley Line, Qld.
Mr D. G. D. Yencken, South Yarra, Vic., Interim Committee on the National Estate.
Dr P. C. Young, Hunters Hill, N.S.W.

APPENDIX VI

EXHIBIT LIST

1 Australian Conservation Foundation, *The Australian Conservation Foundation*, Melbourne: n.d.
2 Australian Conservation Foundation, *Annual Report 1973-74*, Melbourne: 1974.
3 'Special Issue Incredible Fraser Island', *Australia Habitat*, vol. 2, October 1974.
4 A note on the objects and membership of the Australian National Parks Council.
5 National Parks and Wildlife Service of N.S.W., *Kosciusko National Park: Plan of Management*, Sydney: 1974.
6 Copy letter, Dr Moss Cass to Dr J. G. Mosley, 21 May 1975.
7 Australian Committee of Inquiry into the National Estate, 'Convention for the Protection of the World Cultural and Natural Heritage', *Report of the National Estate*, Canberra: Australian Government Publishing Service, 1974, pp.352-358.
8 Extracts from Maryborough Mining Warden's records. SMLs 95 and 102, 1975.
9 J. P. Stanton, *A Report on Fraser Island - Natural History, Land Use, Land Classification and a Proposed Framework for its Management*, Brisbane: 1975.
10 A. E. Newsome *et al.*, 'The Effects of an Extensive Wildfire on Populations of Twenty Ground Vertebrates in South East Australia', *Proceedings of the Ecological Society of Australia*, vol. 9, 1974, pp.107-123.
11 Australian Railways Historical Society, Queensland Division, map, 'Fraser Island Tramways', *Sunshine Express*, May 1975.
12 Queensland Department of Forestry, map of Fraser Island, contoured to show vegetation types and some ore bodies, 1:50,000, 3 sheets, 1972.
13 Murphyores Incorporated Pty Ltd, Overlay to Exhibit 12, showing MLs and MLAs.
14 Copy ML 93, Murphyores Incorporated Pty Ltd.
15 Copy ML 94, Murphyores Incorporated Pty Ltd.
16 Copy ML 95, Murphyores Incorporated Pty Ltd.
17 Copy ML 96, Murphyores Incorporated Pty Ltd.
18 Copy memorandum and attachments relating to ML 101, 24 August 1973.
19 Copy memorandum and attachments relating to ML 102, 24 August 1973.
20 Copy memorandum and attachments relating to ML 114, 5 July 1974.
21 Copy memorandum and attachments relating to ML 115, 5 July 1974.
22 Copy memorandum and attachments relating to ML 116, 5 July 1974.
23 Copy memorandum and attachments relating to ML 117, 5 July 1974.
24 Copy memorandum and attachments relating to ML 118, 5 July 1974.
25 Copy memorandum and attachments relating to ML 119, 14 June 1974.
26 J. E. Coaldrake *et al.*, *Fraser Island Ecology in Relation to the Mining Proposed by D M Minerals*, Brisbane: A. A. Heath & Partners Pty Ltd, 1975.
27 J. E. Coaldrake, *Ecosystems of the Coastal Lowlands of Southern Queensland*, Melbourne: CSIRO, 1961.
28 Overlay to Exhibit 12, indicating land systems.
29 D. H. Barry, *Fraser Island - An Environmental Assessment of the Wildlife on Mining Leases 93-96, 101 and 102, and Lease Applications 126-130*, Brisbane: 1975.
30 J. E. Coaldrake, ed., 'The Natural and Social History of Cooloola', reprint from *Proceedings of the Ecological Society of Australia*, vol. 9, 1975, pp.307-335.
31 J. E. Coaldrake, 'Conservation Problems of Coastal Sand and Open Cast Mining', reprint from *Nature Conservation in the Pacific*, Canberra: Australian National University Press, 1973, pp.299-314.
32 J. E. Coaldrake, 'Minerals, Land and Landscape', *Hemisphere*, vol. 17, June 1973, pp.9-15.
33 Photograph 27/24 : wheel tracks on loose sand, 1975.
34 Photograph 35/28 : brumbies near Happy Valley, 1975.
35 Photograph 22/24 : south side of Indian Head, accumulation of sand.
36 Photograph 22/17 : as Exhibit 35.
37 Photograph 24/13 : camp on front edge of sand dune.
38 Aerial photograph : Lake Wabby and environs.
39 Overlay to Exhibit 38, showing boundaries between land systems.
40 Aerial photograph : Yankee Jack Lake and environs.
41 Overlay to Exhibit 40, showing boundaries between land systems.
42 J. E. Coaldrake, *Proposed Development - Wathumba Inlet, Fraser Island*, Brisbane: A. A. Heath & Partners Pty Ltd, 1974.
43 J. E. Coaldrake, slides and sound track on cassette, 'Sandmining and Conservation'.
44 A. C. Thatcher and W. E. Westman, 'Succession Following Mining on High Dunes of Coastal Southeast Queensland', *Proceedings of the Ecological Society of Australia*, vol. 9, 1975.
45 Photograph 33/7 : ramp leading from beach.
46 J. E. Coaldrake *et al.*, *Annotated Bibliography on the Ecology and Stabilisation of Coastal Sand Dunes, Mining Spoils and other Disturbed Areas*, Canberra: CSIRO, 1973.
47 J. E. Coaldrake *et al.*, *Annotated Bibliography on the Ecology and Stabilisation of Coastal Sand Dunes, Mining Spoils and other Disturbed Areas*, Supplement No. 1, Canberra: CSIRO, 1974.
48 Photograph : Jabiru on Fraser Island, 1974.
49 I. R. Binch, *The Impact of Proposed Sand Mining Operations on the Geohydrology of Fraser Island*, Brisbane: Coffey and Hollingsworth Pty Ltd, 1975.
50 T. T. Heywood, *Report on the Investigation of Mining Proposals by Dillingham Mining Company of Australia to be Implemented on Fraser Island, Queensland*, Sydney: Robertson Research (Aust.) Pty Ltd, 1971.
51 P. M. James, *Report on the Water Supply for Sand Mining Operations SML 102, Fraser Island*, Brisbane: Dillingham Mining Company of Australia, 1974.
52 P. M. James, *Report on the Geohydrology of Lakes Boemingen and Wabby, Fraser Island*, Brisbane: 1975.
53 I. R. Binch, list of projects undertaken by Coffey & Hollingsworth Pty Ltd, 1964-75.
54 Copy telex, Australian Department of Minerals and Energy to D M Minerals, 13 December 1974.
55 Extract from *Hansard* for the House of Representatives, Canberra, 21 April 1975, p.1916.
56 Copy letter from Federal Minister for Minerals and Energy to Mr C. E. Mustchin, D M Minerals, 9 June 1975.
57 Copy telex, Federal Minister for Environment to Mr Everson, D M Minerals, 16 April 1975.
58 Copy telex, D M Minerals to Federal Minister for Environment, 16 April 1975.
59 Map, 1:63,360, of northern section of Fraser Island, showing D M Minerals' drill lines, June 1971.
60 Map, 1:63,360, of southern section of Fraser Island, showing D M Minerals' drill lines, June 1971.
61 Queensland Department of Forestry, map, 1:126,000, of Fraser Island, showing location of D M Minerals' MLs and MLAs.
62 Table of Ore Reserves showing figures for MLs and MLAs held by D M Minerals.
63 Copy of Applications (23-28) by New South Wales Rutile Mining Co. Pty Ltd for MLs 114-119, 13 October 1961.
64 Copy memorandum from Queensland Under Secretary for Mines to Maryborough Mining Warden, 11 September 1963.
65 Copy letter and attachments from Queensland Irrigation and Water Supply Commission to Murphyores Incorporated Pty Ltd, 12 February 1975.
66 Copy letter from Queensland Under Secretary for Mines to D M Minerals, 18 June 1975.
67 Cross sections and plan, Boemingen ore bodies, June 1975.
68 Two cross sections of part of ML 102, 21 June 1974.
69 Bore plan of part of ML 102.
70 Bore log sheets, Nos. 21740 and 21741.

71 Occupation permit for D M Minerals, Buff Creek loading site.
72 Copy letters, Queensland Land Administration Commission to Murphyores Incorporated Pty Ltd, 5 September 1974, and D M Minerals to Land Administration Commission, 25 September 1974.
73 Copy letters, Murphyores Incorporated Pty Ltd to Queensland Department of Forestry, 5 April 1972, and Queensland Department of Forestry to Murphyores Incorporated Pty Ltd, 4 May 1972.
74 Copy MLA 101.
75 Copy MLA 102.
76 Copy letters re endorsement to ML 96.
77 Copy MLAs 126, 127, 128, 129, 130, Murphyores Incorporated Pty Ltd.
78 Fraser Island Defence Organisation, *Constitution*, 1974.
79 Fraser Island Defence Organisation, Membership Form, 1975.
80 Fraser Island Defence Organisation, leaflet showing sandmining leases.
81 *Moonbi*, No. 8, 12 May 1972, Fraser Island Defence Organisation.
82 *Moonbi*, No. 9, 10 July 1972, Fraser Island Defence Organisation.
83 *Moonbi*, No. 10, 25 September 1972, Fraser Island Defence Organisation.
84 *Moonbi*, No. 11, 12 December 1972, Fraser Island Defence Organisation.
85 *Moonbi*, No. 13, 28 May 1973, Fraser Island Defence Organisation.
86 *Moonbi*, No. 14, 31 July 1973, Fraser Island Defence Organisation.
87 *Moonbi*, No. 15, 22 October 1973, Fraser Island Defence Organisation.
88 *Moonbi*, No. 16, 10 December 1973, Fraser Island Defence Organisation.
89 *Moonbi*, No. 17, 25 February 1974, Fraser Island Defence Organisation.
90 *Moonbi*, No. 18, 22 April 1974, Fraser Island Defence Organisation.
91 *Moonbi*, No. 19, 30 June 1974, Fraser Island Defence Organisation.
92 *Moonbi*, No. 20, 16 September 1974, Fraser Island Defence Organisation.
93 *Moonbi*, No. 21, n.d., Fraser Island Defence Organisation.
94 *Moonbi*, No. 22, 7 February 1975, Fraser Island Defence Organisation.
95 *Moonbi*, No. 23, 4 April 1975, Fraser Island Defence Organisation.
96 *Moonbi*, No. 24, 27 June 1975, Fraser Island Defence Organisation.
97 Copy partnership agreement Murphyores Holdings Limited and others, 6 April 1970.
98 Murphyores Holdings Limited, *Fifth Annual Report, 1972*.
99 Murphyores Holdings Limited, *Sixth Annual Report, 1973*.
100 Murphyores Holdings Limited, *Seventh Annual Report, 1974*.
101 Sydney Stock Exchange Ltd, two Company Reviews, Murphyores Holdings Limited, 21 December 1972 and 12 December 1974.
102 *Jobson's Mining Year Book for 1974/75*, photocopy p.433, 'Murphyores Holdings Ltd'.
103 Company Search, Murphyores Holdings Ltd, 1975.
104 Company Search, Dillingham Constructions Pty Ltd, 9 March 1971.
105 Company Search, Dillingham Constructions Pty Ltd, 1975.
106 Company Search, Queensland Titanium Mines Pty Ltd, 9 March 1971.
107 Company Search, W. Hyne & Son Pty Ltd, 1975.
108 Company Search, Wilson Hart & Co. Ltd, 1975.
109 Fraser Island Defence Organisation, *Fraser Island - Its Past, Present and Future*, Pialba: 1971.
110 J. Sinclair, 'Fraser Island - A Case Study', reprint from *Wildlife in Australia*, vol. 8, December 1971.
111 Queensland Co-ordinator General's Department, *Survey of Fraser Island, Round Hill Head*, Brisbane: 1971.
112 Fraser Island Defence Organisation, leaflet, *Fraser Island; Priceless Pearl or Political Pawn*, n.d.
113 Queensland Co-ordinator General's Department, *Survey of Major Islands of Moreton Bay*, Brisbane: 1972.
114 Fraser Island Defence Organisation, leaflet, *Diary of the Fraser Island National Park*, n.d.
115 Fraser Island Defence Organisation, circular, *Urgent - re Fraser Island Sandmining*, 28 May 1973.
116 Fraser Island Defence Organisation, pamphlet, *Greetings from Fraser Island*, Maryborough: n.d.
117 Fraser Island Defence Organisation, leaflet, *What will Fraser Island be in the year 2000 AD?* Pialba: n.d.
118 Fraser Island Defence Organisation, leaflet, *Fraser Island Attractions* Maryborough: n.d.
119 Fraser Island Defence Organisation, 'Full High Court Judgement', supplement to Hervey Bay *News*, 6 June 1975.
120 Jules L. Tardent, *Fraser Island and its Timbers*, address to Royal Geographical Society of Australia, (Queensland), 7 May 1948.

121 J. Sinclair, 'A Leftover National Park? Fraser Island', *Community*, No. 5, November 1974, pp.7-8.
122 Copy notice by Council of the Shire of Burrum under the Interim Development By-Law.
123 Copy application for special consent for land development to Burrum Shire Council by Oakleigh Colliery Pty Ltd.
124 Copy letter to Burrum Shire Council, Fraser Island Defence Organisation, 26 July 1974.
125 Copy letter to Fraser Island Defence Organisation, Council of the Shire of Burrum, 23 August 1974.
126 Copy letter to Fraser Island Defence Organisation, Council of the Shire of Burrum, 4 October 1974.
127 Photograph 35/20 : hut near Happy Valley campsite, 1975.
128 Photograph 22/19 : as Exhibit 127.
129 Photograph 28/21 : dwelling near Third Creek.
130 Reprint from Matthew Flinders' Journal of the voyage of the *Norfolk*, 1799.
131 Reprint from Matthew Flinders' Journal of the voyage of the *Investigator*, 1802.
132 Copy SML 84, The Titanium Alloy Manufacturing Co., 25 May 1972.
133 Certificates of Application for MLs 131, 132, 134 and 136, *Maryborough Chronicle*, 16 May and 20 September 1973.
134 Copy Form of Objection or Representation under *Mining Act* 1968-1971.
135 Form of Objection under *Mining Act* 1968-1971.
136 Three sheets of wind roses, vicinity of Fraser Island.
137 Coastal Observation Data, Eurong Beach, February-March 1972.
138 CSIRO Ski Club Ltd, *Memorandum and Articles of Association*, Sydney: 1951.
139 Copy letter Australian Railway Historical Society, Queensland Division, to President, Fraser Island Defence Organisation, 18 June 1975.
140 'FIDO Seeks to Boost Tourism, Find Jobs', *Maryborough Chronicle*, 12 March 1974.
141 Donald McLeod Consulting Services Pty Ltd, questionnaire, *Fraser Island Land Use Study - Tourism Survey*, Brisbane: 1975.
142 High Court of Australia, Queensland Registry, *Appeal...between John Sinclair and the Mining Warden at Maryborough and Queensland Titanium Mines Pty Ltd, Record of Proceedings*, 1975.
143 National Parks and Wildlife Service, *Kosciusko National Park, Ski Club Lease - A Guide to Lessees*, n.d.
144 Federal House of Representatives Standing Committee on Environment, Sub-Committee, Softwoods Forestry Inquiry, *Transcript of Evidence Taken at Maryborough, Parts I and II*, 14 March 1975.
145 Federal House of Representatives Standing Committee on Environment and Conservation, *Transcript of Evidence*, taken at Canberra, 22 May 1975.
146 'Company's $300,000 Plan : Fraser Is. Sands', *Maryborough Chronicle*, 23 March 1975.
147 Copy letter, Queensland Minister for Mines and Main Roads to President Fraser Island Defence Organisation, 1 October 1973.
148 Maryborough Mining Warden, Minute, *re Special Mineral Lease Applications Nos. 101 and 102 Maryborough, Special Mineral Lease Applications Nos. 97 and 98 Bundaberg*, 11 June 1971.
149 Warden's Court, Maryborough, *Transcript of Proceedings, D. F. Jackson and J. Sinclair*, 6 August 1973.
150 Copy letter Federal Minister for Environment and Conservation to President, Fraser Island Defence Organisation, 12 July 1973.
151 'Island Mining Exemption is Recommended', *Maryborough Chronicle*, 11 August 1973.
152 V. G. Bennett & Associates Pty Ltd, two photographs of flight path plans for D M Minerals.
153 'Battle on Fraser Island Sandmining Ends', *Maryborough Chronicle*, 5 March 1974.
154 Maryborough Mining Warden's Court, *Transcript of Proceedings*, 25 March 1974.
155 'The Fisheries Habitat Reserves Regulations of 1968', *Queensland Government Gazette*, 23 January and 4 December 1969.
156 Archibald Meston, *Report on Fraser Island*, Brisbane: Government Printer, 1905.

157 Submissions of Deputation to Federal Minister for Environment and Conservation by Dr P. Stocker *et al.*, 20 February 1973.
158 Copy letter to Maryborough Mining Warden to Murphyores Incorporated Pty Ltd, 14 June 1973.
159 Queensland Co-ordinator General's Department, *Survey of Fraser Island and Round Hill Head*, Brisbane: 1971.
160 Questions Upon Notice, *Queensland Parliamentary Debates*, 15 April 1975, p.642.
161 Copies of Correspondence re Proposed Fisherman's Reserve, Queensland Department of Forestry to Queensland Department of Primary Industries, 20 April 1971; Queensland Department of Primary Industries to District Forester, Maryborough, 20 April 1971; Queensland Department of Primary Industries to Queensland Department of Forestry, 24 March 1971; Queensland Department of Forestry to District Forester, Maryborough, 12 May 1971.
162 Copy letter President, Fraser Island Defence Organisation to Co-ordinator General, Brisbane, 21 June 1973.
163 Fraser Island Defence Organisation, *Press Release*, 13 July 1973.
164 Copy letter and annexure Fraser Island Defence Organisation to Committee of Inquiry into National Estate, Brisbane, 10 September 1973.
165 Question Upon Notice to the Hon. the Premier by Mr Blake, Queensland *Hansard*, House of Representatives, 10 October 1973.
166 Fraser Island Defence Organisation, *Press Release*, 2 May 1974.
167 Queensland Department of Forestry, National Parks Section, *Commonwealth Assistance in Extending the National Estate - National Parks of Queensland - General Situation*, with Wathumba Paris map, 1:50,000.
168 Copy letter President, Fraser Island Defence Organisation, to Editor, *Maryborough Chronicle*, 13 May 1974.
169 Copy letter Council of the Shire of Burrum to Fraser Island Defence Organisation re Wathumba Creek Subdivision, 27 February 1975.
170 Copies correspondence between Fraser Island Defence Organisation and Queensland Minister for Lands and Forestry, 1973.
171 Copies correspondence between Fraser Island Defence Organisation and Queensland Minister for Lands and Forestry, 1974.
172 Copies correspondence between Fraser Island Defence Organisation and Queensland Minister for Lands and Forestry, re 'Squatters on Fraser Island', 1974.
173 Copies correspondence between Fraser Island Defence Organisation and Queensland Minister for Lands and Forestry re 'Fraser Island National Park'.
174 Copy letter Queensland Minister for Conservation, Marine and Aboriginal Affairs to Fraser Island Defence Organisation, 17 May 1974.
175 Copies correspondence between Fraser Island Defence Organisation and Queensland Minister for Lands and Forestry, 1973-74.
176 Fraser Island Defence Organisation, *Summary of Submissions to Hon. W. A. R. Rae, Queensland Minister for Lands*, Maryborough, 24 September 1972.
177 Copy letter Fraser Island Defence Organisation to Queensland Minister for Lands, Forestry and National Parks and Wildlife Service, 12 May 1975.
178 Fraser Island Defence Organisation, *Submissions to Maryborough/Burrum Boundaries Tribunal*, n.d.
179 Boundaries Tribunal, *Fraser Island*, n.d.
180 J. Walker, petition on behalf of Fraser Island ratepayers, 10 June 1975.
181 Copies correspondence between Fraser Island Defence Organisation and Queensland Minister for Education, 1966.
182 Copies correspondence between Federal Minister for Science and Fraser Island Defence Organisation, 1973-75.
183 Fraser Island Defence Organisation, 'Building the Greatest Sand Island in the World', Supplement to Hervey Bay *News*, 9 May 1975.
184 Copies correspondence between Fraser Island Defence Organisation and Queensland Conservator of Forests, Brisbane, 1974-75.
185 Fraser Island Defence Organisation, *A Grim Fairy Tale (Without a happy ending)*, Brisbane: n.d.

186 Letter, students of Watson Primary School, A.C.T., to J. Sinclair, 5 June 1975.
187 Fraser Island Defence Organisation, *Transforming the High Dunes*, n.d.
188 Correspondence between Fraser Island Defence Organisation and Queensland Department of Aboriginal and Island Affairs, Archaeological Division, June 1975.
189 Copy letter, Fraser Island Defence Organisation to Committee of Inquiry into the National Estate, 4 July 1973.
190 Correspondence between Fraser Island Defence Organisation and Queensland Minister for Lands and Forestry, 1973-74; Fraser Island Defence Organisation and Beach Protection Authority, Brisbane, 1973.
191 Correspondence between Fraser Island Defence Organisation and Beach Protection Authority, Brisbane, 1974.
192 Copy letter, J. F. Keays, Gutteridge Haskins & Davey, to Fraser Island Defence Organisation, with attached statement, 30 May 1974.
193 Copies correspondence between Hyne & Son Pty Ltd and Queensland Department of Forestry, June 1975.
194 'National Parks', *Conservator of Forests Annual Report 1974*, pp.24-26.
195 Map, 1:126,000, showing areas logged in Southern Fraser Island.
196 Queensland Titanium Mines Pty Ltd, *Profit and Loss Account for the Year ended 31st December 1972*, with *Balance Sheet - 31 December 1972*.
197 Copies correspondence between Land Administration Commission, Brisbane and Fraser Island Defence Organisation, 1974.
198 Maryborough-Moonaboola Branch Wildlife Preservation Society of Queensland and Fraser Island Defence Organisation, *Submission to Land Tenures Commission*, Maryborough: n.d.
199 Queensland Department of Forestry, *Permit to Traverse a State Forest, National Park or Timber Reserve*, 23 May 1975.
200 Photograph 33/2 : abandoned motor vehicles.
201 Photograph 31/34 : signboard, *Dump Rubbish Here*.
202 Photograph 31/35 : rubbish tip.
203 'Sewerage Move for Fraser Island', *Maryborough Chronicle*, 7 February 1975.
204 'State May Sell Fraser Island', *Maryborough Chronicle*, 9 May 1975.
205 I. A. E. Bayly, 'Queensland's Coastal Dune Lakes and their Life', *Wildlife in Australia*, vol. 3, December 1966, pp.154-7.
206 Queensland Naturalist, *Fraser Island Number*, Brisbane: 1968.
207 J. Sinclair, 'Conservation Can be Fun', *Wildlife in Australia*, vol. 11, No. 3, September 1974, pp.88-90.
208 *Heybob*, vol. 13, 1971, University of Queensland Bushwalking Club.
209 *National Parks Journal*, June/July 1975, National Parks Association of N.S.W.
210 V. Tarrant, 'Fraser Island, Queensland', *Conserving Australia*, pp.18-26, Melbourne: n.d.
211 L. J. Webb and W. T. Williams, 'Island of Sand', *Hemisphere*, vol. 15, December 1971, pp.2-6.
212 Fraser Island Defence Organisation *et al.*, *Submissions to Australian Government on Coastal Sandmasses of Eastern Australia*, September 1974.
213 L. E. Skinner, 'The Search for the Sea Belle Castaways on Fraser Island', *Queensland Heritage*, vol. 2, May 1974, pp.3-14.
214 W. Reeves, *The Legends of Moonie Jarl*, Brisbane: Jacaranda Press, 1964.
215 Queensland Tourist Bureau, four tourist brochures.
216 Maryborough Chamber of Commerce, *Submission on Fraser Island*, with *Constitution and Rules*, 1967.
217 Whitaker Pty Ltd, Maryborough, *Charter Rates*, July 1974.
218 J. Wilson, Speech, *Financial Assistance for the Development of Tourist Features*, Maryborough: 1974.
219 Photograph 22/13 : archaeological relics.
220 D. P. Vernon and D. H. Barry, 'Birds of Fraser Island and Adjacent Waters', reprinted from *Memoirs of the Queensland Museum*, vol. 16, No. 2, pp.223-232.
221 Summary of Conclusions of Address to Fraser Island Defence Organisation re aboriginal artifacts, April 1975.
222 F. J. Watson, *Some Notes on the Manners and Customs of the Aborigines of South East Queensland*, n.d.

223 Copy letter Dr I. A. E. Bayly, Department of Zoology, Monash University to Federal Minister for Science, with enclosed submission to the National Estate Committee of Inquiry, *The Case for Special Measures Being Taken to Protect the Lakes on Fraser Island, Queensland*, November 1973.

224 Dr W. E. Westman, *Submission to the Fraser Island Environmental Inquiry*, 1975.

225 E. C. F. Bird, 'Dune Stability on Fraser Island', *Queensland Naturalist*, vol. 1, No. 2, 1974.

226 Correspondence from various students to Fraser Island Defence Organisation, 1975.

227 Correspondence to Fraser Island Defence Organisation, 1975.

228 Correspondence between Wildlife Preservation Society of Queensland Inc. and Queensland Minister for Primary Industries, 1973-74.

229 Copy letter, Patrick White to J. Sinclair, 10 February 1974.

230 *The Fraser Island Song*, cassette.

231 Copies letters, D M Minerals to Bundaberg Airport Control Centre, Whitaker Air Charters and Henebery Aviation Co., 1 May 1975, 1 May 1975 and 2 May 1975 respectively.

232 Maryborough/Hervey Bay and District Development Board, *Constitution*, 1972.

233 Copy letter, Queensland Minister for Conservation, Marine and Aboriginal Affairs to Queensland Minister for Labour and Tourism, 17 September 1969.

234 A. Strong and E. R. Jurss, *Report of Inspection of some sandmining areas on Fraser Island*, 16 April 1971.

235 Copy letter, Ms Maree Fowler to Maryborough City Council, 30 May 1973, and 'Tourist attractions at Fraser Is.', *The Australian*, 30 May 1973.

236 'Analysis of Population & Qualifications of Population. Provincial cities of Queenansland', extract from *Characteristics of the Population & Dwellings, Local Government Areas Queensland 1971 Census of Population*.

237 Copy letter, Australian Tourist Commission to Maryborough & District Promotion Bureau, 9 November 1970.

238 Tables, Burnett and Adjacent Areas, Average Monthly and Yearly Rainfall.

239 Maryborough-Hervey Bay & District Development Board, reply to questionnaire, Total Wide Bay/Burnett Statistics Division.

240 Withdrawal of statement by Editor, Hervey Bay *News*, 13 June 1975.

241 'Angered and Amazed at Island Takeover Talk', Hervey Bay *News*, 27 March 1975.

242 'Fraser Island Battle Begins', Hervey Bay *News*, 13 June 1975.

243 'A Paradise in Turmoil', Brisbane *Courier Mail*, 22 May 1975.

244 H. Lunn, 'Into the Enchanted Valley', *The Australian*, 23 May 1975.

245 Rob MacDonald, 'He'll lead the fight to 'save' it', Brisbane *Courier Mail*, 11 June 1975.

246 Hunter Valley Research Foundation, *Regional Study - Mary Valley Region, Queensland*, n.d.

247 Copy letter Maryborough-Hervey Bay & District Development Board to Queensland Minister for Tourism and Marine Affairs, 12 June 1975.

248 Maryborough-Hervey Bay & District Development Board, Souvenir car or luggage sticker.

249 J. & A. Mills, tourist brochure, *Happy Valley Resort*, 1974.

250 Information sheet, *Fraser Island Information*, n.d.

251 Information sheet, *Fraser Island Accommodation*, n.d.

252 Queensland Government Tourist Bureau, five brochures.

253 Maryborough-Hervey Bay & District Development Board, *Ninth Annual Report, 1973-74*.

254 Maryborough & District Promotion Bureau, *Submission to Hon. J. A. Row, MLA, Minister for Primary Industries*, 28 September 1971.

255 Maryborough & District Promotion Bureau, *Manager's Report to Directors of Maryborough & District Promotion Bureau on Submissions Presented to Individual Ministers of the Crown... September 27th & 28th, 1971*.

256 Maryborough-Hervey Bay & District Development Board, *Tourist Survey Report, September/October 1974*.

257 Maryborough-Hervey Bay & District Development Board, *A Report of the first survey of Hervey Bay...by the Tourism Committee...1974*.

258 'Men Yes : Women Say No', Brisbane *Sunday Mail*, 6 July 1975.

259 Photograph : simulated sandmining plot after fourteen months rehabilitation, January 1974.

260 Photograph : same mining plot after thirty months rehabilitation.

261 Various papers and clippings relating to tourism on Fraser Island.

262 Letter, Queensland Department of Forestry to Land Administration Commission, 7 August 1970.

263 Surfari Tours, advertisement, *Fish Fraser with Surfari Tours, freeze your fillets and bring them home*, n.d.

264 CSIRO, Submission to Fraser Island Environmental Inquiry, 20 June 1975.

265 Fraser Island Environmental Inquiry, *Transcript of Proceedings, 11 June - 8 July 1975*.

266 W. T. Ward, *Geology and Geomorphology of Fraser Island*, n.d.

267 Copy letter from M. Sullivan to Fraser Island Environmental Inquiry, 12 July 1975.

268 Diagram showing cross sections of sand dune.

269 Dr P. H. Springell, Submission to Fraser Island Environmental Inquiry, n.d.

270 Copy letter from Queensland Alumina to Dr Springell, 24 June 1974.

271 W. E. Dunn, *High Temperature Chlorination of T_1O_2 Bearing Minerals, II*, 1972.

272 W. E. Dunn, *The Re-cycle Concept as an adjunct to replacement beneficiation*, 1975.

273 Submission by Dr I. A. E. Bayly, 11 June 1975.

274 I. A. E. Bayly, *et al.*, 'Studies on the Lakes of Fraser Island, Queensland', *Australian Journal of Marine and Freshwater Research*, No. 26, 1975, pp.1-13.

275 I. A. E. Bayly, 'Chemical and Biological Studies on Some Acidic Lakes of East Australian Sandy Coastal Lowlands', *Australian Journal of Marine and Freshwater Research*, vol. 15, July 1964, pp.56-72.

276 I. A. E. Bayly, 'Queensland's Coastal Dune Lakes and Their Life', *Wildlife in Australia*, vol. 3, December 1966, pp.154-7.

277 J. R. Burton and B. N. Richards, *Social and Environmental Aspects of Land Use Practices on Fraser Island*, n.d.

278 Letter from Prof. Burton to Fraser Island Environmental Inquiry, 6 August 1975.

279 Wildlife Preservation Society of Queensland Inc., *Submission to the Environmental Inquiry on Fraser Island*, 1975.

280 Queensland Trades and Labor Council, *Proposed...Submission to Fraser Island Land Use Inquiry*, 1975.

281 'Sand Miners get the Sack', Brisbane *Courier Mail*, 8 August 1975.

282 Dr R. Murray, *Changing Patterns of Work and Leisure*, Oxford: 1974.

283 Dr T. L. Burton, *Changing Patterns of Work and Leisure*, Oxford: 1974.

284 Dr T. Lambo, *Industry and the Environment*, Oxford: 1974.

285 Sir Frederick Warner, *Industry and the Environment*, Oxford: 1974.

286 Walkers Ltd, advertisement, Brisbane *Courier Mail*, 6 August 1975.

287 Institute of Foresters of Australia Inc., Queensland Division, *Submission to Fraser Island Environmental Inquiry*, Brisbane: 1975.

288 B. Cuthbertson, *Economic Aspects of Mining and Tourism on Fraser Island*, n.d.

289 Errata sheet relating to Exhibit 288.

290 G. P. Koo, *Titanium Dioxide Pigments*, 1975.

291 M. Alexander, *Mrs Fraser on the Fatal Shore*, London: Michael Joseph, 1971.

292 L. J. Webb, *Edaphic Differentiation of Some Forest Types in Eastern Australia : Soil Chemical Factors*, Oxford: Blackwell, 1969.

293 R. F. Thorne, *Seen or Collected in Dunwich Vicinity, Stradbroke Island, Moreton Bay, 13 - 16 July 1959*.

294 UNESCO, *Programme on Man and the Biosphere (MAB)...Perception of Environmental Quality : Final Report*, Paris: 1973.

295 A. Leopold, *A Sand Country Almanac*, pp.261-264, n.d.

296 A. W. Moore, *Land Use Pressures in the Coastal Fringe of Southern Queensland*, n.d.

297 R. G. Downes, 'Conservation in Relation to Land and its Use', *The Last of the Lands*, Brisbane: 1971, pp.11-17.

298 Margalof, *Perspectives in Ecological Theory*, Chicago: University of Chicago Press, 1968, pp.2, 3, 48 and 49.

299 N. Calder, statement, *UNESCO News*, vol. 25, No. 4, 1974, p.14.
300 C. Cameron, speech, *Towards New Perspectives for Science, Technology and Consumerism in Australia*, 18 July 1975.
301 Australian Committee of Inquiry into the National Estate, *Report of the National Estate*, Canberra: Australian Government Publishing Service, 1974.
302 Maryborough Employment Office, *Unemployment from 1965-74 Maryborough City and Surrounding Shires.*
303 G. Alison, *Submission to the Fraser Island Environmental Inquiry*, 12 July 1975.
304 D. C. Beu, *Submission to the Fraser Island Environmental Inquiry*, 12 July 1975.
305 C. E. Greenhalgh, *Submission to the Fraser Island Environmental Inquiry*, 12 July 1975.
306 H. L. Kesteven, *Submission to the Fraser Island Environmental Inquiry*, 12 July 1975.
307 H. G. Bezant, *Submission to the Fraser Island Environmental Inquiry*, 12 July 1975.
308 Mrs F. E. Smith, *Submission to the Fraser Island Environmental Inquiry*, 12 July 1975.
309 L. A. Greensill, *Submission to the Fraser Island Environmental Inquiry*, 12 July 1975.
310 Mrs H. M. Postan, *Submission to the Fraser Island Environmental Inquiry*, 12 July 1975.
311 J. W. J. McLatchey, *Submission to the Fraser Island Environmental Inquiry*, 12 July 1975.
312 G. V. Elmer, *Submission to the Fraser Island Environmental Inquiry*, 12 July 1975.
313 Questions on Notice to Ms B. Cuthbertson.
314 C. J. Corben, *Fraser Island and the Acid Frogs*, July 1975.
315 J. G. Cameron, *Submission to the Fraser Island Environmental Inquiry*, 15 August 1975.
316 I. P. Little, *Fraser Island Water Quality*, Brisbane: 1975.
317 Fraser Island Environmental Inquiry, *Statutory Declarations of S. K. Pennycuick and J. W. Lewis*, 17 July 1975.
318 Documents attached to Exhibit 317, (marked with letter 'A').
319 Documents as above, (marked with letter 'B').
320 Document as above, (marked with letter 'C').
321 Documents as above, (marked with letter 'D').
322 Documents as above, (marked with letter 'E').
323 Documents as above, (marked with letter 'F').
324 Documents as above, (marked with letter 'G').
325 Documents as above, (marked with letter 'H').
326 Documents as above, (marked with letter 'I').
327 Sample of rutile.
328 Sample of zircon.
329 Sample of titanium sponge.
330 Sample of alloy sheeting.
331 Sample of fabricated metal, expanded mesh.
332 D. Henderson, *Conservation or Development? - Fraser Island*, n.d.
333 Map of Fraser Island, 1:74,000, showing lakes and roads.
334 Copy letter from J. & A. Hogg to Fraser Island Environmental Inquiry, 25 June 1975.
335 Photograph : part of SML 84, n.d.
336 Photograph : SML 84, mouth of Fourth Creek, area through which dredge path has moved, n.d.
337 Mineral Deposits Ltd, Research and Engineering Department, *Mineral Deposits Ltd*, n.d.
338 Queensland Department of Transport, *Aviation Activities Fraser Island*, and letter of transmittal to Fraser Island Environmental Inquiry, 5 August 1975.
339 Fraser Island Environmental Inquiry, *Transcript of Evidence*, 13 June 1975.
340 *Great Barrier Reef*, s.l, n.d., pp.323-326.
341 Copy letter and cheque from Patrick White to J. Sinclair, 15 July 1975.
342 Fraser Island Defence Organisation, copy *Fraser Island Petition*, signed by Sidney Nolan.

343 E. H. Macdonald, *Manual of Beach Mining Practice Exploration and Devaluation*, Canberra: Australian Government Publishing Service, 1973.
344 Planet Metals Ltd, *The Search for Off-shore Minerals, Progress Report*, Sydney: 1970.
345 *Australian Mineral Industry Quarterly Review, Quarterly Statistics*, vol. 19, September 1966.
346 *Australian Mineral Industry Quarterly Review, Quarterly Statistics*, vol. 19, June 1967.
347 *Australian Mineral Industry Quarterly Review, Quarterly Statistics*, vol. 23, December 1970.
348 *Australian Mineral Industry Quarterly Review, Quarterly Statistics*, vol. 23, June 1971.
349 *Australian Mineral Industry Quarterly Review, Quarterly Statistics*, vol. 25, December 1972.
350 *The Australian Mineral Industry*, vol. 16, December 1963.
351 'Mineral Sands', *Jobson's Mining Year Book for 1974/75*, pp.28-118.
352 D. H. Irvine, 'Science for Development in Guyana', *Chemistry in Britain*, vol. 8, No. 12, 1972.
353 Correspondence and clippings concerning rates of Burrum Shire on Fraser Island, July 1975.
354 Questions Upon Notice, Queensland *Hansard*, House of Representatives, 21 March, 26 August and 9 September 1971.
355 Statutory Declaration of S. G. Jarvis, 29 July 1975.
356 Statutory Declaration and statement of I. G. Owens, 26 July 1975.
357 Letter and enclosed clipping from the Wildlife Preservation Society of Queensland to J. Sinclair, 21 July 1975.
358 Copies correspondence between President, Fraser Island Defence Organisation and Queensland Parliamentarians, 1971.
359 R. C. Camm, *Speech*, Maryborough, 20 July 1967.
360 Fraser Island Defence Organisation, *Submissions of Proposed... Sandmining Leases...to Queensland Mines Minister, 15 August 1972.*
361 Company Search, Dillingham Constructions Pty Ltd, year ended 31 December 1972.
362 Murphyores Holdings Ltd, *Notice...of an Extraordinary General Meeting*, 8 March 1970.
363 Wilson, Hart & Co. Ltd, Profit and Loss Accounts and Balance Sheets for 1972-74.
364 Copies minutes from Department of Labor and Immigration, Queensland, to Employment Office Manager, Maryborough, January, February, March, May and June 1975.
365 'F.I.D.O's Management Plan', supplement to Hervey Bay *News*, 25 July 1975.
366 Membership by region of the Fraser Island Defence Organisation, 10 July 1975.
367 Letter, McNair Anderson Associates Pty Ltd to Fraser Island Defence Organisation, with enclosed Public Opinion Poll, 22 July 1975.
368 Copy letter from Queensland Minister for Lands, Forestry, National Parks and Wildlife Service to Fraser Island Defence Organisation, 3 July 1975.
369 Queensland Department of Forestry, circular, *Tree Marking of Hardwoods, Fraser Island*, Brisbane: 1966.
370 Chapters 17, 18 and 19, *Blue Coast Caravan*, s.l,: n.d.
371 V. McCristal, 'A Farewell to Fraser', *Australian Angler*, October 1974.
372 Maryborough and Bundaberg District Timber Merchants' Association, *Submission to Fraser Island Environmental Inquiry*, 26 August 1975.
373 Queensland Department of Forestry, *Notice for Timber Sale at Maryborough, 6 September 1974.*
374 *ibid.*, as an example of a typical sale notice.
375 Queensland Department of Forestry, documents relating to Timber Case No. 740810, 24 March 1975.
376 C. W. Dare, 'The hidden environmental costs of alternative materials available for construction', *Journal of Forestry*, December 1972, pp.734-736.
377 Wilson, Hart & Co. Ltd, *84th Annual Report, Financial Statement, Notice of Annual General Meeting 1974*, Maryborough.
378 Circular letter from A. Brown to employees of Hyne & Sons Ltd, 1 August 1975.

379 G. E. Heinsohn, *Importance of the Fraser Island area, particularly Great Sandy Strait and Hervey Bay as critical Dugong Habitats*, submission to the Fraser Island Environmental Inquiry, 26 August 1975.
380 Griffith Environmental and Conservation Organisation, *Outline of Submission to the Federal Government Fraser Island Inquiry*, 1975.
381 Documents submitted by W. F. J. Hamilton to the Fraser Island Environmental Inquiry.
382 Cooloola Committee and Noosa Parks Association, *Submission...Fraser Island Environmental Inquiry*, 1975.
383 'Concern on Land Buy', Nambour *Chronicle*, 21 August 1975.
384 'Minister refutes lakeland claim', Nambour *Chronicle*, 26 August 1975.
385 Four photographs : Cooloola - King's Bore Road, November 1974.
386 Five photographs : Stradbroke Island, June 1975.
387 Eight photographs : Sunshine Beach, February 1972 to April 1974.
388 A. G. Harrold, *Interim Report on the Vegetation of the Western Noosa River Basin*, Maryborough: 1974.
389 'Some Hot News', *Moonbi*, No. 1, 6 April 1971, pp.4-6.
390 R. Faine, Submission to Fraser Island Environmental Inquiry, 27 August 1975.
391 Six photographs : Sandmining, Double Island Point, 1974.
392 Photocopy of composite photograph of mining lease area of Double Island Point.
393 Map, 1:32,000, showing locations referred to in Exhibits 391 and 392.
394 Photograph : vehicle trapped in backfilled area.
395 A. G. Rundle, *Report on Sandmining at Fraser Island, Queensland*, North Ryde, N.S.W.: 1975.
396 Film : *The Beach a River of Sand*, Encyclopaedia Britannica Films and American Geological Institute, 1966.
397 Coastal Observation Programme, Engineering, *Coastal Data Sheet*.
398 Computer data analysis for Beach Protection Agency, Eurong, Fraser Island.
399 Further computer analysis of Exhibit 398.
400 Circular letter from the Beach Protection Authority, Queensland, 12 February 1975.
401 Newspaper clippings, *Sand Mining*, 1973.
402 Noosa Parks Association, *Discussion Regarding Likely Damage to the Coloured Sands Following Mining of the Beach*, February 1975.
403 Letter from D. J. Sherrington to J. Sinclair, 15 March 1972, with enclosures relating to sandmining advertising campaign.
404 'Sheer Cliffs, Rushing Rapids, Green Glens...and a Strip Mine', *Audubon*, March 1971, pp.51-53.
405 *Motor Vehicles Control Bill*, 1975, Brisbane: Government Printer.
406 'The Australian Aborigine', special edition of *Yoga Pracharak*, vol. 10, October 1974.
407 University of Queensland Bushwalking Club, *Submission to the Fraser Island Environmental Inquiry*, 2 September 1975.
408 Letter from the Queensland Federation of Bushwalking Clubs to M. Molloy (Secretary, Fraser Island Environmental Inquiry), 28 June 1975.
409 Copy letter from the Brisbane Bushwalkers to M. Molloy (Secretary, Fraser Island Environmental Inquiry), 28 June 1975.
410 Queensland Conservation Council Inc., *A Submission to the Fraser Island Environmental Inquiry*, 2 September 1975, together with related documents.
411 Environmental Control Council, *Procedural Manual for Environmental Impact Studies in Queensland*, Brisbane: Queensland Co-ordinator General's Department, 1975.
412 Submission by Ms E. Durbidge to Fraser Island Environmental Inquiry, 7 May 1975.
413 C. J. E. Bell, statement and related documents, 28 August 1975.
414 J. Ward, 'Monazite', *Annual Mining Review*, Canberra: Bureau of Mineral Resources, 1975, together with memo. by J. Harrison.
415 C. J. Taylor, *Submission to the Fraser Island Environmental Inquiry*, 16 August 1975.
416 Copy, search, King & Company, Special Mining Leases 93, 94, 95 and 96, 21 July 1975.

417 L. F. Wyvill, *Submission Regarding the Validity of Current Mining Leases on Fraser Island*, 2 September 1975.
418 Maryborough Mining Warden's Court, *Transcript of Proceedings*, May 1971.
419 Copy letter from Australian National University, Department of Forestry, to Fraser Island Environmental Inquiry, 24 June 1975.
420 Australian National University, Department of Forestry, *Submission to the Fraser Island Environmental Inquiry*, 3 September 1975.
421 Fifteen photographs : Results of Sandmining, Fraser Island.
422 T. Ward, *Submission to Fraser Island Environmental Inquiry*, August 1975.
423 P. Schindler, *Fraser Island Inquiry Submission*, 3 September 1975.
424 B. G. Thom, *Proposal to Establish Geomorphologic (Landform) Reserves in Australia*, 1975.
425 B. G. Thom, 'Coastal Erosion in Eastern Australia', *Search*, vol. 5, May 1974, pp.198-209.
426 New South Wales Committee of Enquiry on Differences and Conflicts Between Interests of Parks and Conservation Authorities, Scientific Bodies and Mining Companies, *Report*, Sydney: Government Printer, 1969.
427 Aerial photographs : Wide Bay Series C.A.B.
428 Aerial photographs : Sandy Bay Series C.A.B.
429 W. Bunning, *Report, Shire of Great Lakes: Proposed Mining of High Dunes Adjoining the Myall-Smith Lakes...*, Sydney: 1974.
430 Photograph : The Cathedrals and Happy Valley environs.
431 R. F. Fling, 'Three Theories on Time', *Quaternary Research*, vol. 4, 1974, pp.1-8.
432 Press clippings relating to brumbies on Fraser Island.
433 W. Lucas, *Submission to Government Environmental Inquiry, Mining Fraser Is.*, 9 September 1975, together with related documents.
434 Honorary Rangers Organisation, *Submission*, 9 September 1975, together with letter of despatch.
435 Photographs : Lamington National Park, Rainforest, Springbrook.
436 J. F. Marshall, *Morphology of the East Australian Continental Margin Between 21°S and 33°S*, Canberra: B.M.R., 1972.
437 H. A. Jones, *Submerged Shorelines and Channels on the East Australian Continental Shelf Between Sandy Cape and Cape Moreton: Heavy-Mineral Prospects*, Canberra: B.M.R., 1973.
438 H. A. Jones, *Morphology of the East Australian Continental Shelf Between Cape Moreton and Tweed Heads in Relation to Offshore Heavy-Mineral Prospects*, Canberra: B.M.R., 1973.
439 H. A. Jones, *Morphology of Part of the Central New South Wales Continental Shelf in Relation to Offshore Heavy-Mineral Prospects*, Canberra: B.M.R., 1974.
440 A. L. Washburn, *Interdisciplinary Quaternary Research and Environmental History*, Washington: 1970.
441 A. P. Kershaw, 'A Long Continuous Pollen Sequence from North Eastern Australia', *Nature*, vol. 251, September 1975, pp.222-223.
442 B. Thom and J. Chappell, 'Holocene Sea Levels Relative to Australia', *Search*, vol. 6, March 1975, pp.90-93.
443 J. P. May, 'Selective Transport of Heavy Minerals by Shoaling Waves', *Sedimentology*, vol. 20, 1973, pp.203-211.
444 J. R. Woolsey *et al.*, 'Backshore Heavy-Mineral Concentration on Sapelo Island, Georgia', *Journal of Sedimentary Petrology*, vol. 45, March 1975, pp.280-284.
445 J. W. Laycock, *North Stradbroke Island - Hydrological Report*, Brisbane: Department of Mines, 1975.
446 Royal Society of Queensland, *Proceedings...86*, Brisbane: 1975.
447 Queensland Department of Forestry, Map, 1:50,000, Fraser Island Forestry District, 1970.
448 Photograph : turgid water adjacent to mining operation.
449 Australian Department of Tourism and Recreation, *Submission to Fraser Island Environmental Inquiry*, July 1975, together with letter of despatch.
450 Australian Tourist Commission, *Survey of International Visitors: Travel within Australia*, Melbourne: 1974.
451 Australian Travel Research Conference, *Survey of Australian Tourism 1973/74*.

452 Australian Department of Tourism and Recreation, Cities Commission, *Holiday and Leisure Patterns and Attitudes to Growth Centres*, Canberra: 1975.
453 G. J. Miller, *The Potential Threat of Sandmining to the Nutrient Status of Fraser Island Lakes*, Australian Littoral Society, 1975.
454 Tables relating to locations of Fraser Island flora and fauna.
455 Statement of I. G. Ownes, n.d.
456 Copy letter from Australian Department of Environment to Fraser Island Environmental Inquiry, 9 September 1975.
457 Environmental Systems Division, Department of Environment, *Submission to the Fraser Island Inquiry*, 11 September 1975.
458 *Agreement between the Government of Japan and Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment*, n.d.
459 UNESCO, *Convention Concerning the Protection of the World Cultural and Natural Heritage*, Paris: 1972.
460 Australian Advisory Committee on the Environment, *Coastal Land*, Canberra: Australian Government Publishing Service, 1975.
461 J. McEachern and E. L. Tourle, *Ecological Guidelines for Island Development*, Morges: International Union for Conservation of Nature and Natural Resources, 1974.
462 Copy extract of Exhibit 458, listing affected birds.
463 Purpose and functions of the Australian Environment Council, n.d.
464 Statement of J. F. Keays, 1 September 1975, together with letter of despatch.
465 *Hansard*, House of Representatives, 17 April 1975, pp.1770-1777.
466 Thirty-eight photographs : rehabilitated sites, 22 June 1975.
467 Map, 1:50,000, showing site of D M's operations on Fraser Island, 22 August 1975.
468 *Water Finds its Own Level*, photographs, Lease 102, 16 August 1975.
469 Photograph : public inspection of D M Minerals' site.
470 Queensland Department of Labour and Tourism, *Queensland Tourist and Travel Industry 1969/70*, Brisbane: Government Printer, 1971.
471 Copy letter from Queensland Co-ordinator General's Department to Fraser Island Environmental Inquiry, 11 September 1975.
472 Queensland Timber Board, *Submission to Fraser Island Environmental Inquiry*, July 1975, together with letter of despatch.
473 Forwood Conference, *A survey of Australian Forestry and Wood-based Industries - Part II, Production Forestry Development plan*, s.l.: 1974.
474 Queensland Department of Forestry, *Annual Report 1974*, Brisbane: Government Printer, 1975.
475 Queensland Timber Board, *Membership*, n.d.
476 V. M. Tarrant, *Fraser Island, Queensland, Australia*, evidence to the Fraser Island Environmental Inquiry, 17 September 1975.
477 *Hollins Critic*, vol. 11, February 1974, together with copy letter from Patrick White to J. Wright-McKinney, 14 September 1975.
478 Statement by E. C. F. Bird *et al.*, to Fraser Island Environmental Inquiry, n.d.
479 J. L. O. Tedder, *Submission to the Fraser Island Environmental Inquiry*, 17 September 1975.
480 L. V. Dephoff, *Submission to the Fraser Island Environmental Inquiry*, 17 September 1975.
481 K. L. and A. M. Bedford, *Submission to the Fraser Island Environmental Inquiry*, 17 September 1975.
482 Interim Committee on the National Estate, *Submission to the Fraser Island Inquiry*, 18 September 1975.
483 Mineral Deposits Ltd., *Catalogue*, 1975.
484 Statutory Declaration of D. B. Morrison, 16 September 1975 and related documents.
485 Fraser Island Environmental Inquiry, *Transcript of Evidence*, 4-8 July 1975.
486 'Shadow Conservation Minister Has Close Look at Fraser Island', *Maryborough Chronicle*, 18 September 1975.
487 Maryborough/Burrum Industrial Promotion Committee, Sydney Promotion, *Financial Statement 30-11-73*.
488 Copy letter from Queensland Treasurer to Queensland Minister for Labour and Tourism, 22 November 1968.

489 Maryborough-Hervey Bay & District Development Board, *Estimate of Tourist Income on Fraser Island*.
490 Queensland Titanium Mines Pty Ltd, plan, 1:16,000, showing location of Mining Leases 131-134, 22 August 1975.
491 Copy letter from Queensland Department of Mines to Queensland Titanium Mines, 19 June 1975.
492 Fraser Island Defence Organisation, *Submission to Fraser Island Environmental Inquiry*, 19 September 1975.
493 Fraser Island Defence Organisation, *List of Exhibits supporting written submission*.
494 J. Cann, 'Notes on Some Tortoises Collected in Northern Australia', *Victorian Naturalist*, vol. 89, June 1972, pp.165-168, together with letter to J. Sinclair, 24 August 1974.
495 Photograph : tortoises at Lake Bowaraddy.
496 'District Development Board Needs Stronger Support', *Maryborough Chronicle*, 25 August 1975.
497 'Conservationists Have Had Fair Go from Chronicle', *Maryborough Chronicle*, 13 December 1974, and, 'Editorial Criticised', letter by J. Sinclair, *Maryborough Chronicle*, 19 December 1974.
498 Photographs by G. Wendt : various scenes on Fraser Island.
499 D M Minerals' statement to Queensland Trades and Labour Council Conservation Committee, n.d.
500 Transport Workers Union, *Fraser Island*, 1974.
501 Rutile & Zircon Development Association Limited, *Annual Report No. 3*, Sydney: 1970.
502 'Forfeiture of Leases Possible', *Maryborough Chronicle*, 11 September 1971.
503 Copy memorandum from Queensland Department of Mines to the Warden, Maryborough, 23 August 1973.
504 Search of SMLs 95 and 102.
505 P. L. Ellis, *Conservation: a Geological Rationale*, Parkville: Australasian Institute of Mining and Metallurgy, 1970.
506 Copy letter from D M Minerals to B. Whitaker, 1 May 1975.
507 D M Minerals, map of Fraser Island, 1:127,000, 1952.
508 Cooloola Mining Warden's Court, Evidence of A. F. Griffin, 1970.
509 Rutile and Zircon Development Association, *Facts about Queensland's Mineral Sands Industry*, Brisbane: 1973.
510 'Moonbi 25', supplement to Hervey Bay *News*, 15 August 1975.
511 Rutile and Zircon Development Association, *The Australian Mineral Sands Industry*, Sydney: n.d.
512 Rutile and Zircon Development Association, *The Australian Mineral Sands Industry*, Sydney: 1973.
513 *Wambaliman, Special Edition on Chemical Hormones*, Wildlife Preservation Society of Queensland, Maryborough and Bundaberg Branches, September 1974.
514 *Wambaliman*, vol. 8, August 1974, Wildlife Preservation Society of Queensland, Maryborough and Bundaberg Branches.
515 Questions Upon Notice, Queensland *Hansard*, House of Representatives, 12 September 1974, p.741.
516 G. F. Grimes and D. I. Bevege, *An Approach to Commercial Revegetation of Sand Mined Areas in Southern Queensland*, n.d.
517 'Fraser Island Divided in Boundary Change', *Maryborough Chronicle*, 26 August 1975.
518 Letter from Mining Warden, Maryborough, to J. Sinclair, 28 August 1975.
519 'Training exercises on Fraser Island', Hervey Bay *News*, August 1975.
520 Queensland Department of Lands, advertisement, *Government Sale - Residential Site on Fraser Island*, 12 August 1970.
521 Circular and brochure from Queensland National Parks and Wildlife Service to Rangers and Protectors, 26 August 1975.
522 Letter from Fraser Island Defence Organisation to Queensland Beach Protection Authority, 28 July 1975.
523 Questions Upon Notice, Queensland *Hansard*, House of Representatives, 28 August 1975, pp.241-242.
524 F. H. Talbot, 'The Impact of Human Activities on Coastal Zones', *UNESCO News*, vol. 24, November 1973, pp.2-3.
525 'Moonscapes and Angels', *The Australian*, 6 September 1975.
526 Sydney Stock Exchange, Research and Statistical Department, Company Review, *Wilson, Hart & Co. Ltd*, 2 April 1975.

Photographs : Views of Fraser Island.
28 Fraser Island and Maryborough Citizens' Action Group, *Submission to the Fraser Island Environmental Inquiry*, 23 September 1975.
529 Fraser Island and Maryborough Citizens' Action Group, *Balanced Development the Key to Prosperity*, n.d.
530 E. M. Stamp, *Submission to the Fraser Island Environmental Inquiry*, 23 September 1975.
531 'Keeping in Tune with the Ecology', *The Miner*, 12 May 1975.
532 *Queensland Government Mining Journal Special Centenary Issue, 1874-1974*, pp.67-71.
533 Sydney Stock Exchange, Research and Statistical Department, Company Search, *Murphyores Holdings Ltd*, n.d.
534 'White's Nobel Winner is his Best Yet', Brisbane *Courier Mail*, 10 November 1973.
535 'Profile of a Great Man's Privacy-David Rowbottom Meets Patrick White, Brisbane *Courier Mail*, 30 March 1970.
536 Australian Union of Students, Local Environment Office, Queensland, *A Submission to the Federal Government Commission of Inquiry into Sandmining on Fraser Island*, 23 September, 1975.
537 Letter from Federal Minister for Minerals and Energy to J. Sinclair, 15 April 1975.
538 Copy telex from Federal Minister for Minerals and Energy to J. Egerton *et al.*, 27 March 1975.
539 Letter from Federal Minister for Environment and Conservation to Australian Conservation Foundation, 1975.
540 Two photographs : D M Minerals' site, 5 September 1975.
541 Plan, 1:792, of Special Mineral Lease 96, showing the area to be excised.
542 'No opposition to Sand Mining', *Maryborough Chronicle*, 17 May 1973.
543 P. K. Lauer, *Ethnoarchaeological Observations on Fraser Island*, together with letter of despatch, 15 September 1975.
544 Photograph : Artifacts, Birds Bluff.
545 Photograph : Artifacts, Desert Area.
546 Photograph : Gunya tree near Happy Valley.
547 Photograph : Gunya tree showing scar from removal of bark.
548 Australian Customs Form G. 64, *Restricted Goods - Export Permit.*
549 G. E. Light, *Submission to the Fraser Island Environmental Inquiry*, 24 September 1975.
550 Burrum Shire Planning Scheme, n.d.
551 Munro, Johnson & Associates Pty Ltd, *Policy Plan Statement*, Shire of Burrum, 1975.
552 Copy Appeal No. 71/691, against refusal of permission to erect dwelling house.
553 Affidavit and written statement of I. A. E. Bayly, and letter of despatch, 17 September 1975.
554 J. D. Kelsey, *Submission to Fraser Island Environmental Inquiry*, 24 September 1975.
555 Cooloola Committee and Noosa Parks Association, *Submission to the Fraser Island Environmental Inquiry*, 25 September 1975.
556 W. G. S. Huxley, *A Criticism of Government Policy with Relation to the Sandmining of the Coastal Areas of Eastern Australia with Specific Reference to Queensland*, 1975.
557 Cooloola Committee, various documents.
558 Cooloola Committee, *Cooloola Calendar, 1963-1973*.
559 Copy letter and attachment from Wyong Shire Council to W. G. S. Huxley, 8 July 1975.
560 Copies correspondence between Queensland Department of Mines and Cooloola Committee, 19 August and 2 July 1975.
561 Queensland Department of Mines, Lease Location Map, 1:100,000, Brisbane (S.G. 56);
Queensland Department of Mines, Map of Townsville (3219), 1:100,000, December 1974;
Queensland Department of Mines, Clairmont (3234), 1:100,000, December 1974;
Queensland Department of Mines, Torres Strait (S.C. 54), 1:100,000, October 1972;
Queensland Department of Mines, Rockhampton (S.F. 56), 1:100,000, September 1972;

Queensland Department of Mines, Cooktown (S.D. 55), 1:100,000, September 1972;
Queensland Department of Mines, Queensland Exploration Series (Minerals), Map of Queensland, 1:250,000, August 1975;
Queensland Department of Forestry, Map of areas under Forestry Control, 1:250,000, 31 May 1967;
Queensland Department of Forestry, Map of areas under Forestry Control, Central Queensland, 1:63,360, 30 June 1969;
Queensland Department of Forestry, Map of areas under Forestry Control, North Queensland, 1:50,000, 30 June 1973.
562 Map, 1:31,680, proposed national park at Mt Funnell, n.d.
563 Photograph : Sandmining Double Island Beach, November 1974.
564 Photograph : North Stradbroke Island, n.d.
565 Photograph : Mining Lease 931, Stradbroke Island, n.d.
566 *North Coast Bulletin*, No. 6, March 1973, National Parks Association of N.S.W., North Coast Committee.
567 'Cabinet Will Not Act to Stop Coast Beach Mining', Brisbane *Courier Mail*, 2 May 1973.
568 International Union for Conservation of Nature and Natural Resources, *United Nations List of National Parks and Equivalent Reserves*, Brussels: 1971.
569 Map, 1:25,000, Inskip Point showing proposed Cooloola National Park, n.d.
570 Copy letter from G. M. Bavington to Fraser Island Environmental Inquiry, 10 June 1975.
571 T. G. Tracey, *Comment on Unique Features of Fraser Island Flora*, 1975.
572 Copy letter, Federal Department of Transport, Air Transport Group, Queensland Region to Fraser Island Environmental Inquiry, 8 September 1975.
573 Queensland Department of Mines, *Rehabilitation of Sand Mined Areas*, 1975.
574 Queensland Titanium Mines Pty Ltd, plan, 1:1,584, showing mining and rehabilitation operations, 25 September 1975.
575 Extract from A.B.C. news item; taped interview with Mr Everson, D M Minerals, 19 September 1975.
576 Copy letter from Fraser Island Defence Organisation to Federal Minister for Minerals and Energy, 30 July 1975, and reply, 9 August 1975.
577 Planet Metals, film, *Offshore Rutile, the First Discovery*, 1968.
578 Twenty-nine slides : various sites on Fraser Island and Stradbroke Island, showing rehabilitated areas and mining operations.
579 Set of 160 slides : areas of Fraser Island, 1972.
580 Tape used in conjunction with Exhibit 579.
581 W. A. Green, statement, *Tourism is Queensland's Fourth Most Important Industry...*, 1975.
582 N. Roffey-Mitchell, poem, *Nooesis*.
583 N. E. Gardiner, *A Note on the Effects of Mineral Sandmining (Fraser Island) on Employment in the Maryborough and Gympie Districts*, 1975.
584 W. D. Williams, *Submission to the Fraser Island Environmental Inquiry*, 30 September 1975, together with letter of despatch.
585 Copies correspondence between J. Sinclair and Federal Minister for Minerals and Energy, September 1973-September 1974.
586 Six photographs : D M Minerals' sites on Fraser Island, 19 September 1975.
587 Photograph : construction of road on D M Minerals' site, January 1975.
588 L. Halliwell, University of New England, Department of Social Studies, *Visit to Maryborough*, n.d.
589 Commonwealth Bureau of Census and Statistics, breakdown of population figures for the Maryborough area, 1968.
590 Commonwealth Bureau of Census and Statistics, breakdown of income statistics for the Wide Bay/Burnett area, 1968.
591 'Chamber of Commerce needs active support', *Maryborough Chronicle*, 25 September 1975.
592 R. Dubos, 'Conservation, Stewardship, and the Human Heart', *Audubon*, September 1972, pp.20-28.
593 R. Dubos, *So Human an Animal*, New York: Scribner, 1968.

594 S. Boyden, *The Recreational Uses of the Natural Environment*, n.d.
595 J. Ward, 'Titanium, including Rutile and Ilmenite', *Australian Mineral Industry Review*, 1974.
596 J. Ward, 'Zirconium', *Australian Mineral Industry Review*, 1974.
597 J. Ward, 'Monazite', *Australian Mineral Industry Review*, 1974.
598 Australian Department of Minerals and Energy, *Australian Mineral Industry 1973 Review*, Canberra: Australian Government Publishing Service, 1974.
599 J. Ward, 'Australian Resources of Mineral Sands', *Quarterly Review*, vol. 25, September 1972, pp.12-22.
600 Bureau of Mineral Resources, *Quarterly Bulletin of Mineral Sands Statistics*, March Quarter, Canberra: 1975.
601 H. A. Jones, *Submerged Shorelines and Channels on the East Australian Continental Shelf between Sandy Cape and Cape Moreton : Heavy-mineral Prospects*, Canberra: B.M.R., 1973.
602 H. A. Jones, *Morphology of the East Australian Continental Shelf between Cape Moreton and Tweed Heads in Relation to Offshore Heavy-mineral Prospects*, Canberra: B.M.R., 1973.
603 H. A. Jones, *Morphology of Part of the Central New South Wales Continental Shelf in Relation to Offshore Heavy-mineral Prospects*, Canberra: B.M.R., 1974.
604 *Bibliography*, Mineral Sands, 1975.
605 Federal Minister for Minerals and Energy, statement, 23 February 1973.
606 'Resources', *Hansard*, House of Representatives, 13 December 1973, pp.4747-4749.
607 'Sandmining on Fraser Island', *Hansard*, House of Representatives, 17 April 1975, pp.1174-1177.
608 'Sandmining on Fraser Island', *Hansard*, House of Representatives, 20 May 1975, pp.2473-2480.
609 'Sandmining on Fraser Island', *Hansard*, House of Representatives, 28 May 1975, p.2896.
610 Transcript, *Prime Minister's Press Conference*, Canberra, 20 May 1975.
611 Copy letter from Federal Department of Minerals and Energy to Fraser Island Environmental Inquiry, 26 September 1975.
612 U.S. Bureau of Mines, *Commodity Data Summaries 1975*, pp.74-75, 134-135, 140-141, 150-151, 176-177.
613 Photograph : sub-tropical rain-forest in lee of sand dunes, south of Kingscliff, N.S.W., 1959.
614 Photograph : Death of rain-forest near Kingscliff following exposure to salt-laden winds, n.d.
615 Four advertisements for silica leases near Sandy Cape, *Bundaberg News Mail*, 9 February and 23 April 1971.
616 Fraser Island Defence Organisation, *Submission on Breaches in Lease Conditions on Fraser Island*, 1975.
617 J. B. Gribble, *Aboriginal Life in Australia*, London: 1884.
618 A. Hall, *Dipple Dialect from Fraser Island (Gari) from the Badyala People*, 1970.
619 Press clippings concerning the formation of a conservation organisation in Maryborough, n.d.
620 Fraser Island Environmental Inquiry, *Transcript of Proceedings*, 11-13 June 1975.
621 Australian Conservation Foundation, *Submission to Fraser Island Environmental Inquiry*, 29 September 1975.
622 Harris, Kerr, Forster & Company, *Australia's Travel and Tourist Industry, 1965*.
623 J. G. Mosley, *Aspects of the Geography of Recreation in Tasmania*, n.d.
624 J. G. Mosley, *Books on the North American National Parks System*, 1 October 1975.
625 W. B. Beyers, *An economic impact study of Mt Rainier and Olympic National Parks, Summary of findings*, Washington: 1970.
626 W. B. Beyers, *An economic impact study of Mt Rainier and Olympic National Parks*, Washington: 1970.
627 'The Common Cents of Lock-ups', *Conservation News*, January 1970, pp.2-3.
628 S. Bambrick, 'The Economic Impact of National Parks', *National Parks Journal*, September-October 1975, p.17.

629 S. Bardwell, *Wilderness Use in South-west Tasmania - a pilot study*, Melbourne: Combined Universities Recreation Research Group, 1973.
630 Copy, pp.95-114 of Exhibit 629.
631 J. A. Wagar, *The Carrying Capacity of Wild Lands for Recreation*, Society of American Foresters, 1964.
632 List of non-Queensland organizations which made submissions to the first Fraser Island Environmental Inquiry, n.d.
633 *Resolutions of the Queensland Trades and Labour Council*, 1975.
634 *Resolution of the Executive A.C.T.U. at its meeting in Perth, May 1975.*
635 'Fraser Island Petition', Melbourne *Sun*, 20 October 1975.
636 Australian Department of Police and Customs, *Goods Subject to Export Prohibitions or Restrictions*, Canberra: 1975.
637 Australian Department of Police and Customs, *Additional Information and Answers to Questions*, n.d.
638 Australian Department of Police and Customs, *General Orders*, extracts.
639 Australian Department of Manufacturing Industry, various documents concerning assistance to non-metropolitan urban areas.
640 S. S. Clark, *The Effect of Sandmining on Coastal Heath Vegetation in New South Wales*, n.d.
641 *Analysis of Population and Qualifications of Population - Provincial Cities of Queensland*, 1971 Census of Population and Housing.
642 D. O'Connor, *Environmental Impact Statements*, n.d.
643 'Fraser Island the Last Wilderness', Brisbane *T.V. Times*, 27 September 1975.
644 I. S. Olsen, *Submission to the Fraser Island Environmental Inquiry*, 3 October 1975.
645 Statement and statutory declaration of W. G. S. Huxley, 1 October 1975.
646 Statutory declaration of L. St J. Carter, 29 September 1975, together with submission to Fraser Island Environmental Inquiry, 3 October 1975.
647 Australian Department of Services and Property, *Fraser Island Ownership Survey*, May 1975.
648 Australian Department of Environment, *Murphyores Mineral Leases on Fraser Island (ML Nos. 95 and 102, Maryborough) - Comments on Environmental Aspects of Lease Agreements*, 1975, together with letter of despatch.
649 Queensland Co-ordinator General's Department, four booklets:
(a) *Directory of Regional Co-ordination Councils*, 1974,
(b) *Regional Planning and Regional Co-ordination*, 1974,
(c) *Annual Report 1974*,
(d) *Queensland Government Gazette*, No. 30 of 6 October 1973.
650 Australian Department of Labor and Immigration, various documents supplementing submission to Fraser Island Environmental Inquiry.
651 Letter from Queensland Conservation Council Inc., to Fraser Island Environmental Inquiry, 3 October 1975.
652 Supplementary evidence from J. L. Webb to Fraser Island Environmental Inquiry, 3 October 1975.
653 University of Queensland, Department of Economics, various documents relating to ilmenite conversion and Western Australian output of mineral sands, together with letter of despatch.
654 Letter from Institute of Foresters of Australia to Fraser Island Environmental Inquiry, 6 October 1975, together with relevant copies of the Forestry and Principal Acts.
655 Supplementary evidence of J. C. Lissiman *et al.*, comprising various pamphlets.
656 Australian Department of Tourism and Recreation, *Trends in Visitations, Visitor Statistics for Representative National Parks and other Popular Areas*, 1975, together with letter of despatch.
657 Three maps, 1:250,000, indicating state of beaches between Fraser Island and Tweed Heads West.
658 Statement by E. C. F. Bird to Fraser Island Environmental Inquiry, 1 October 1975.

GLOSSARY

aquifer. A layer of more or less permeable rocks near the surface of the earth which conducts or contains reserves of water.

brushing. Placing a layer of cut brush over the ground.

Cretaceous. The Cretaceous Period, which occurred between approximately sixty-five and 136 million years ago.

ecology. (i) The study of organisms in relation to their environment, (ii) The interrelationships of organisms with their environment.

ecosystem. A biological community interacting with the biotic and abiotic environment at some given locality, and subject to gains, losses and redistributions of matter and energy across and within its invisible and hypothetical boundaries.

geomorphology. The systematic study of landforms, and the processes and stages of their development.

graininess. A term describing the diversity of environments in a given area. *'Coarse-grained environments'* exhibit numerous large patches of differing plant communities on varying landscapes which are unlikely to be uniformly affected by fire, and may thus provide suitable refuges for wildlife.

gross domestic product (or *gross domestic product at market prices*). The total market value of goods and services produced within a given period after deduction of the cost of goods and services used in the process of production but before deducting allowances for the use of capital equipment.

gross domestic product at factor cost. That part of the cost of producing the gross domestic product which consists of gross payments to the factors of production (labour, land, capital and enterprise). It represents the value added by these factors in the process of production and is equivalent to the gross domestic product at market prices less indirect taxes plus subsidies.

habitat. (i) A restricted and defined region, (ii) The environment of a particular individual or species.

horizontal vista. A view restricted by conspicuous bounding margins in a horizontal plane; cf. *vista*.

hydrological balance. The equilibrium achieved in a body of water between the amounts of water gained, lost and stored per unit of time.

hydrology. The study of water in vapour, liquid and solid states within the atmosphere, soils, rocks and exposed bodies of water.

indurated layer. A thin, relatively impermeable, hard stratum within or beneath the surface soil.

insolation. The amount of solar energy intercepted by an exposed surface.

Mesozoic. The Mesozoic Era, which occurred between approximately sixty-five and 225 million years ago.

mulch. A layer of finely chopped plant material placed on the ground.

national income. The net income accruing within a given period to residents of a nation from their services in supplying factors of production (labour, land, capital and enterprise). It is equivalent to the gross domestic product less depreciation allowances and net income payable overseas.

palynology. The study of fossil pollen in buried layers, usually within sediments of lake bottoms or in bogs.

panorama. A view in which breadth is a dominant characteristic.

prospect. (i) A view, (ii) An environmental condition, situation, object or arrangement conducive to the attainment of a view.

pyric climax. A plant community which develops at the end (or the climax) of a succession of other plant communities which is initiated by fire.

rhyolitic. Of rhyolite rock: an extrusive igneous rock rich in quartz.

sclerophyllous. Hard-leaved plants.

siliceous. Rocks, or rock deposits, containing high proportions of silica. Quartz is highly siliceous, usually entirely composed of silicon dioxide.

sorption. The movement and fixation of a chemical substance onto or into the surface of another substance.

stratigraphic. Relating to the layers (strata) of rocks on and under the surface of the earth.

tailings. The sand from which the heavy minerals have been extracted.

Tertiary. The Tertiary Period, which occurred between approximately 2.5 and sixty-five million years ago.

tertiary sector. Consists of service industries, including transport, storage and communications, wholesale and retail trade, public administration, and business and community services.

value-added. Conceptually equal to the contribution of the factors of production (labour, land, capital and enterprise) to the final value of goods and services produced. In a national accounting framework, gross domestic product is equal to total payments to the factors of production. Statistical measurement on an industry basis assumes that value-added is equal to turnover (adjusted for changes in the value of stocks) less purchases and selected expenses; however, the balance remaining after these calculations is not equal to value-added in the national accounting sense because some expenses are not taken into account.

vista. A view restricted by conspicuous bounding margins, generally vertical or near-vertical; but, cf. *Horizontal vista*.

water-table. The upper surface of the zone of saturation in permeable rock or sand. A perched water-table is an independent and isolated area of ground-water above the water-table proper and separated from it by unsaturated rock or sand.

R74/2373