Environmental Management
and Engineering Consultants

PO Box 128
Beaconsfield Tasmania 7270
Telephone: (003) 94 7392
Facsimile: (003) 94 7382

Other Offices:
20 Rowntree Street
Balmain New South Wales 2041
Telephone: (02) 810 8100
Facsimile: (02) 810 5542



Principal Office ; GPO Box 659G,
Hobart, Tasmania 7001
41 *Tasma Street*
North Hobart, Tasmania 7000,
Telephone 002 311509,
Facsimile 002 311548

JOHN MIEDECKE
AND
PARTNERS PTY LTD



King Island Scheelite

# REHABILITATION PLAN

**AMG REFERENCE POINTS ADDED**

July 1991

**ISG COORDINATES
REFER REPORT 70-0676**

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# 1.0 INTRODUCTION

## 1.1 BACKGROUND

King Island Scheelite ( a Division of Peko Wallsend Operations Ltd) is the operator of the King Island Scheelite Mine. Warman Services Ltd is the owner. All are fully owned subsidiaries of North Broken Hill Peko Ltd. The mine is located near Grassy, King Island. In November 1990 Kings Island Scheelite (KIS) in the face of declining mineral prices closed down the mining operations and tried to sell the complete mining operation. Following the failure to sell the mine, KIS has begun a progressive programme to sell the mining and processing plant and equipment, the associated infrastructure (including the town of Grassy), and to rehabilitate the site and abandon the mine in the medium term. Expressions of interest in purchasing the town of Grassy were advertised in January 1991 and the Company is negotiating with an interested purchaser.

An underground resource of 2.7 million tonnes at 1% grade (measured and indicated) remains in the Dolphin Mine and other areas of exploration interest remain within the lease area. The Company is therefore seeking to retain the mining lease area in the expectation that mineral prices will improve and exploration and possibly future mining can be recommenced some time in the future .

The location of the mine, concentrator facilities and township are shown in Figure 1.

The Company holds a Licence to Operate Scheduled Premises (Licence No. 1661) under the Environmental Protection Act 1973, and a Mining Lease (Number 17M/79) for 21 years from 1979.

The history of mining operations is described in Section 1.4.

The current mine lease area occupies approximately 2298ha. Of this area, approximately 75ha is affected by the mine and facilities, approximately 60ha requiring rehabilitation. The balance of the lease area is agricultural land and natural vegetation.

This Rehabilitation Plan has been prepared on behalf of KIS for submission to the Department of Environment and Planning and the Department of Resources and Energy. It presents a rehabilitation plan for the Lease area and proposes a rehabilitation programme which which will be implemented over the next twelve months.

## 1.2 APPROACH

The report is organized so that Section 2 provides a general description of the statutory requirements for rehabilitation. Section 3 sets out the objectives of the Plan and Section 4 describes the general rehabilitation principles used for assessing rehabilitation, and the general rehabilitation procedures. The description of the site and the rehabilitation plans for each site identified is described in Section 5. Water quality and the tailings dam abandonment issues are discussed in Sections 6 and 7. Section 8, the final section, describes the plan's implementation and on-going monitoring and maintenance. The Appendices contain detailed specific information in relation to rehabilitation and site revegetation specifications.

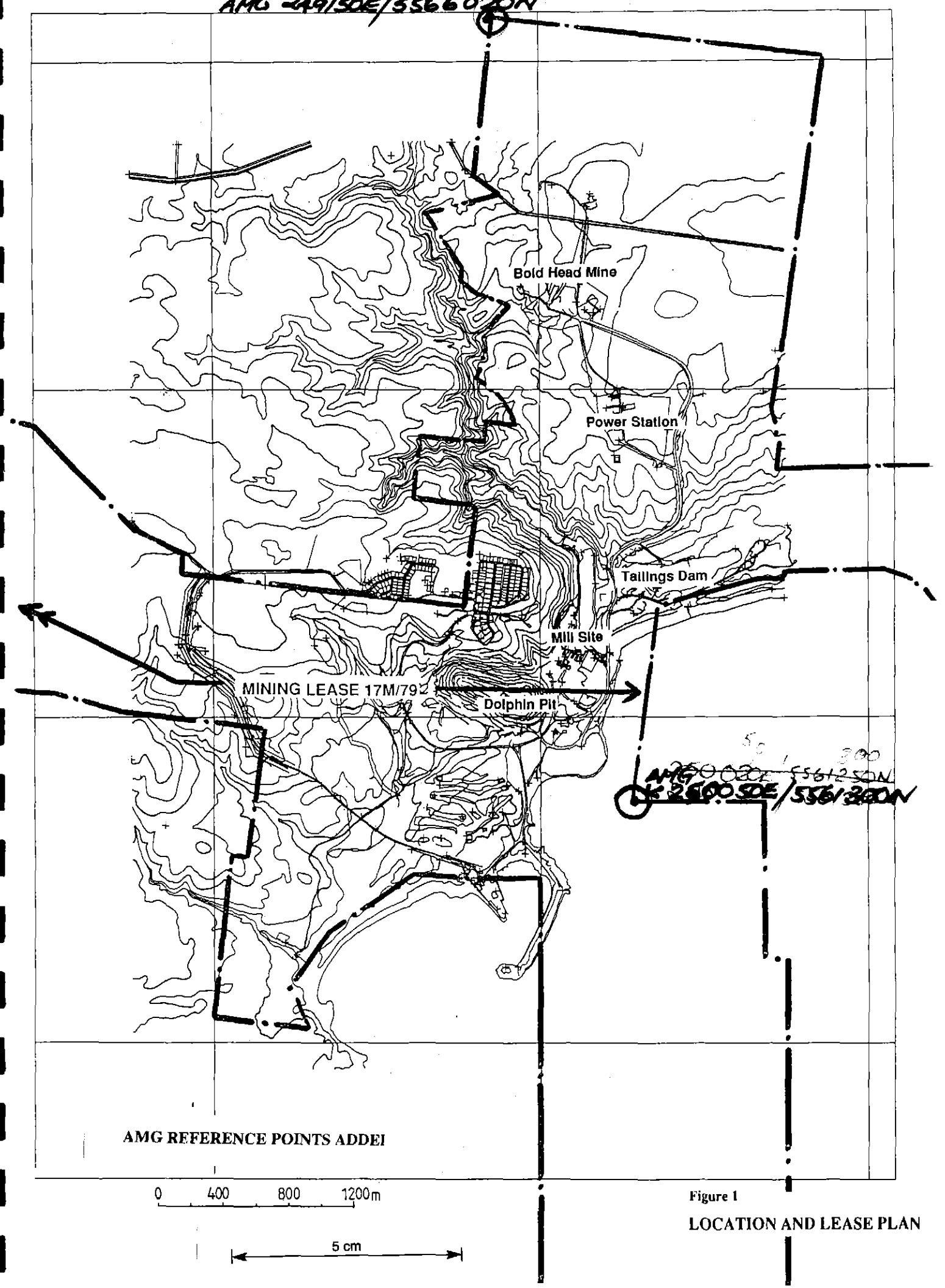


Figure 1

LOCATION AND LEASE PLAN

## 1.3 MAPPING

The following maps accompany the Plan.

- A location plan at scale of 1:20,000 showing the lease boundaries, and other plans relating to the site are included in the text.
- An aerial photograph of the Mine and Township Area with an overlay illustrating the location of the Rehabilitation Site Plans. This is located in a pocket at the rear of the report.

## 1.4 MINE HISTORY

The original discovery of scheelite on the Island was made in 1911 by a Tasmanian Prospector, Mr. Tom Farrell. He discovered a tungsten bearing specimen on the beach near the site of the present open cut, and further prospecting revealed a significant tungsten deposit beneath a sand cover of approximately 15 m.

In 1917 the King Island Scheelite Development Company N.L. was incorporated and a plant capable of treating 200 tonnes of ore per week was erected. Mining operations were continued until mid 1920 when the mine was forced to close when the price of tungsten had fallen to an uneconomic level.

The mine was revived in 1937 when King Island Scheelite N.L. was formed. A treatment plant with a capacity of 500 tonnes per week was installed and production commenced in 1938. Prior to 1943 ore was bogged by hand from the faces, but with Commonwealth Government financing (due to World War II) power shovels and six ton trucks became available. In 1944 a new mill was established which increased annual ore production from 30,481 tonnes in 1943 to 129,038 tonnes in 1946.

In 1947 the Company was voluntarily wound up and reconstructed as King Island Scheelite (1947) Ltd. The Company prospered in the early 1950's due to the Korean War which created a huge industrial demand and precipitated the creation of the United States Strategic Stockpile which was built up by a series of high priced contracts. As the United States Government contracts lapsed, the market price of tungsten declined and the King Island Mine was placed on a care and maintenance basis in August 1958. The mine re-opened on limited production in early 1960 and production has continued to the present.

During 1969 King Island Scheelite (1947) Ltd became a part of the Peko-Wallsend Group of Companies and mill throughput was increased to 300,000 tonnes per year. The mill throughput was subsequently increased to 420 000 tonnes a year.

In conjunction with this latter expansion, an artificial scheelite plant was erected. The first batch of this high purity calcium tungstate was produced in June 1978. Molybdenum tri-sulphide was produced as a by-product from this plant.

Until October 1972, mining was by open cut methods, and until it was closed in October 1974 production from the open cut was 6,459,700 tonnes of ore averaging 0.53% tungstic oxide, and 21,169,000 tonnes of overburden. The Bold Head underground mine was commenced in 1972 and this was followed by the Dolphin under-ground mine in June 1973.

All ore was produced from these two underground mines after 1974 until the Bold Head Mine closed in 1984. Following a decline in world tungsten prices KIS announced its intention to sell or close the mine in July 1990. When no purchaser was found the Dolphin mine was closed in November 1990 .

The township of Grassy is almost entirely Company owned, and is situated in the south east of King Island overlooking Little Grassy Bay. The township provided housing for married personnel and single accommodation. Power, water, sewerage, schooling and other community facilities were also provided by the Company.

The main Port for King Island is at Grassy and was constructed for the Tasmanian Government by Peko-Wallsend Ltd with King Island Scheelite managing the construction.

## 1.5 MINING TENEMENTS AND LAND TENURE

Warman Services Ltd are the holders of ML 17M/79. This lease area occupies approximately 2298ha. It is the Company's intention to retain the lease.The lease boundaries are indicated in Figure 1.

The majority of land tenure in the lease area is private land owned by Warman Services Ltd. Areas of Crown Land are the coastal reserve which adjoin the coastline. Other area of private land in other ownership are in the Grassy Township, which are within the lease area. Land tenure is shown in Figure 2.

The areas of reclaimed land in the vicinity of the Dolphin Open Cut and the Mine Office which adjoin the coastline are assumed to be Crown Land.

If and when the mining lease is relinquished, the ownership and land responsibilities will pass to the land owner.

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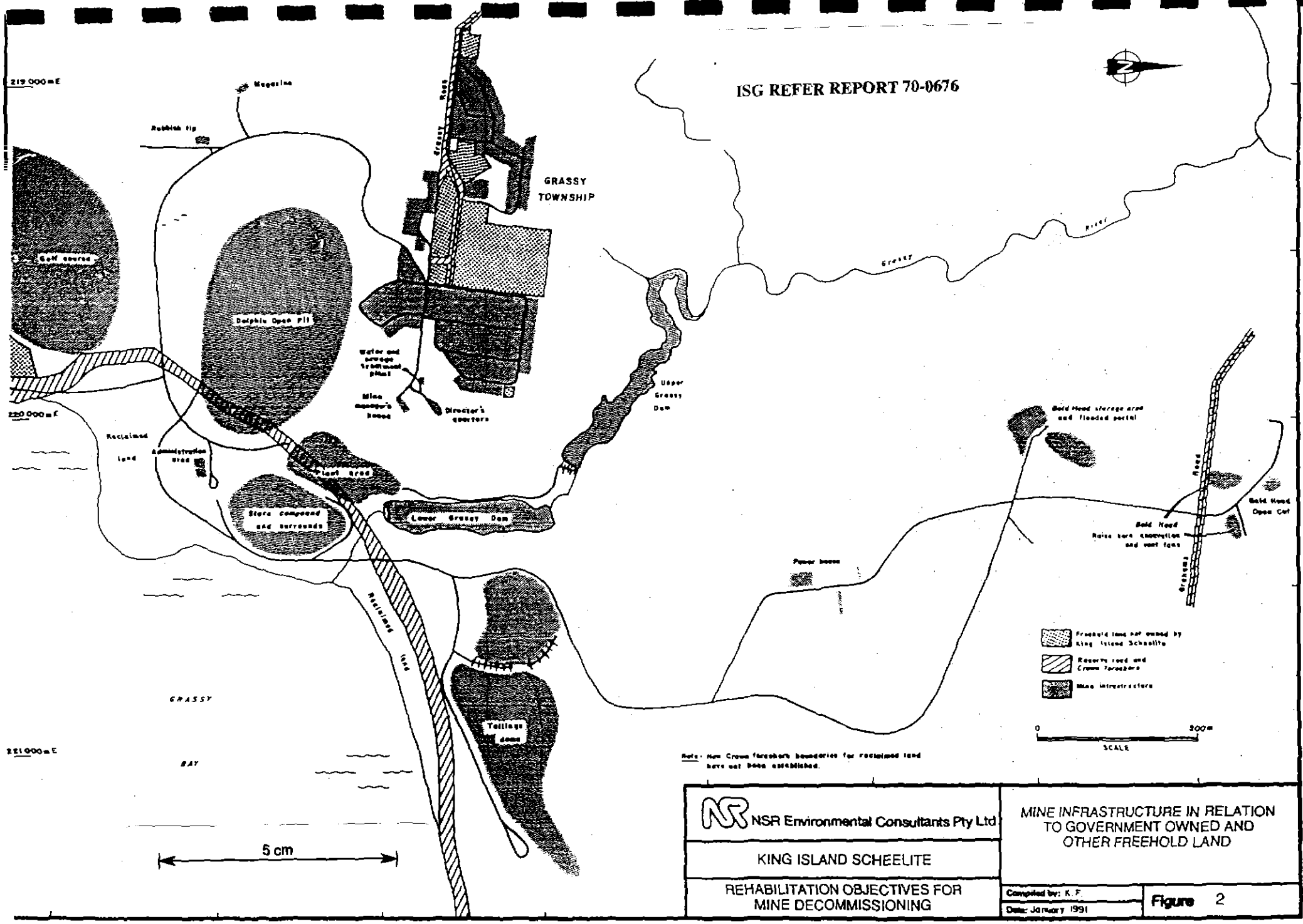


| | |
|---|---|
| NSR Environmental Consultants Pty Ltd | *MINE INFRASTRUCTURE IN RELATION TO GOVERNMENT OWNED AND OTHER FREEHOLD LAND* |
| KING ISLAND SCHEELITE | |
| REHABILITATION OBJECTIVES FOR MINE DECOMMISSIONING | Compiled by: K. F. Date: January 1991 — **Figure** 2 |

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# 2.0 REHABILITATION REQUIREMENTS

The principal acts with relevance to the rehabilitation are;

Mining Act , 1929
Mines Inspection Act, 1968
Environment Protection Act, 1973

The Mining Act and conditions of the lease require the company to " To rehabilitate the surface of the demised land to a condition satisfactory to the Director".

The Environment Protection Act (1973), and amendments (Environment Protection Amendment Act (No.2) 1984) have specific provision for the rehabilitation of land disturbed during the operation of scheduled premises, the timetable for completion after completion of operations, and certificates relating to the completion of rehabilitation. The Licence to Operate is to be retained and conditions on the Licence will relate to this document and rehabilitation requirements.

The Mines Inspection Act has provisions for the decommissioning of the mineral lease to a permanently safe condition. This includes a dams abandonment review.

# 3.0 PLAN OBJECTIVES

## 3.1 GENERAL OBJECTIVES

The broad long term rehabilitation objective is, after stabilizing disturbed areas, to provide an environment which allows ecological succession and stability.

The specific objectives of the plan are to leave disturbed areas at the termination of the operation in a condition which achieve the following;

- Environmental Stability - The long term stabilisation of all disturbed surfaces. This will be achieved by covering, revegetation, flooding, erosion protection and/or containment.

- Satisfy Statutory Obligations - To revegetate all disturbed surfaces to the satisfaction of the Director of Environmental Control and the Director of Mines.

- Minimise Visual Impact - To minimise the visual impact of disturbed areas from the major vantage points. This will be achieved by revegetation and screening.

- Public Safety - To ensure the disturbed areas are safe for anticipated after uses of these areas. This will be achieved by restricting public access, fencing, capping of shafts and safety signs in accordance with the Department of Mineral Resources and Energy requirements.

- Compatible Land Use - To return the disturbed land to a compatible land use. Rehabilitation plans acknowledge potential future land uses. These are discussed below.

## 3.2 LAND USE OBJECTIVES

The mineral lease area is privately owned by KIS except for the coastal reserve. The predominant land use in these areas is grazing, with beef cattle the major agricultural product. Only remnants of the natural vegetation remain, mainly in the areas near the coast with poor or sandy soils, and in drainage lines.

The major disturbance associated with the mine site is in proximity to the coast. This location limits future land uses and the only practical land use is considered to be a return to native vegetation cover. Other areas in proximity to grazing land uses can adopt this use as a land use objective, where site conditions are suitable.

The mine area also contains features and technical and historical interest to the general public - such as the open pit and the mill area foundations. These are sites which are a permanent historical record of the largest single enterprise on the Island, which was the basis of its economy for almost a century.

There are also assets which may have on-going social and economic value to the community.These include the township of Grassy and its infrastructure, the golf course and the Upper Grassy Dam.

The Rehabilitation Plan seeks to recognise these values.

# 4.0 REHABILITATION PRINCIPLES AND PROCEDURES

## 4.1 REHABILITATION PRINCIPLES

### 4.1.1 INTRODUCTION

The general principles and criteria for establishing the need and priority for rehabilitation are described in this section. These were developed from guidelines provided by the Department of Environment and Planning, the Company's experience, current industry practice and also from the experience of the consultants.

In Section 3.0, the objectives of the plan were identified as achieving environmental stability, minimizing visual impact, maintaining public safety and providing a compatible land use.

By placing areas within a stability and visual classification system, a priority rating can be given to their stabilisation and visual treatment and the main resources focussed on these areas.

By considering the 'Revegetation Potential', areas with a high probability of success for revegetation can be identified and considered with the stability and visibility classification. In this way the available rehabilitation resources can be planned in a manner such that the maximum benefit can be achieved.

This information has been used to develop the Site Rehabilitation Plans (Section 5.0). The priority of rehabilitation considers all the factors.

A broad description of the criteria is discussed below. The Rehabilitation Site Plans include a description of these criteria.

### 4.1.2 STABILITY

The products of erosion and/or land instability (slips, subsidence etc) are potentially, the major detrimental effect of the mine.

To ensure long-term stability and to prevent contamination of major water-ways, unstable sites and those materials with contamination potential have been identified and given a high priority for rehabilitation, particularly adequate disposal, covering and revegetation. This includes hazardous waste disposal.

Public safety is also a major consideration and where a potential hazard exists specific provision is made in the Site Plans.

### 4.1.3 VISIBILITY

In order to minimise the visual impact of the disturbed areas associated with the Mine, those areas viewed from major vantage points have been identified and given priority for treatment.

### 4.1.4 REVEGETATION POTENTIAL

The majority of limited topsoil associated with the development of the Mine and associated facilities is no longer available.

In order to plan the most suitable rehabilitation treatment, an assessment of the site conditions and available materials to support a vegetation cover has been made. This

is called the 'Revegetation Potential'. Treatments have then been identified which can remedy site deficiencies and improve the revegetation potential .

Areas with the highest probability of successful revegetation can also be identified. This identifies areas where the most cost effective rehabilitation is possible, and was considered with the stability and visibility classification in developing site plans..

## 4.2 REHABILITATION PROCEDURES

Rehabilitation consists not only of the act of revegetation, but also includes all the activities required to provide an environment suitable for the establishment of a vegetation cover, or if this is not feasible, some other method of stabilising the site.

For vegetation to establish successfully on any disturbed site, the environment must satisfy four simple requirements which are common to all plants;

the plant roots must be able to penetrate the ground surface
there must be an adequate but not excessive supply of moisture
there must be an adequate supply of nutrients
there must be limited toxicity.

In normal soils these are all satisfied, but in mine areas and materials they are frequently not. The art of successful rehabilitation depends on understanding which requirements are not being met, and taking remedial measures to alter conditions so that they are, where technically and economically feasible. In some circumstances, alternatives to revegetation may have to be considered.

The basic strategic rehabilitation procedures which will be adopted for rehabilitation are outlined below by individual topics. They are not site or area specific but are broad guidelines. Detailed specifications have been developed from these major topics and are included in Appendix A. The specifications are indexed to the Rehabilitation Site Plans discussed in the next Section.

### 4.2.1 SITE PREPARATION

The initial preparation of the site is frequently essential to effective revegetation. It aims at providing a rooting medium for successful vegetation establishment, and providing a stable surface.

It includes;

- **Planning**

Developing an appropriate site preparation plan for each site in order to determine constraints and requirements. These have been identified in Section 5.

- **Demolition and Cleanup**

As much of the area contains redundant buildings and machinery the first step will be the demolition and cleanup of the site. Specifications in Appendix A cover the sale and removal of buildings and machinery, disposal of asbestos and wastes and site cleanup.

- **Earthworks**

Earthworks include all the physical earthwork activities required to prepare the site for revegetation. Detailed specifications are in Appendix A and indexed to the Site Plans.

Earthworks include;

### *Profiling and Reshaping*

Overburden and other mine or construction waste dumps (but not stable waste dumps), road embankments and excavation slopes will be contoured and profiled as required to minimise steep slopes, control erosion, maintain slope stability and improve aesthetics. This will be achieved by the judicious use of a small bulldozer or excavator. It is not envisaged that this will require major earthworks, except in areas identified in the Site Plans.

### *Concrete Treatment*

Many areas of the site contain extensive concrete works, both in the form of concrete structural foundations (such as mill machinery etc) and more general building slabs. This concrete requires treatment to prepare the site for further earthworks and revegetation. Treatments (specified in the Site Plans and in the specifications in Appendix A) will range from complete removal to disposal site, to removal of metal protrusions and partial covering.

### *Tailings Treatment*

Extensive areas of tailings occur on the site. Treatment specifications have been developed to control wind erosion and allow effective revegetation.

### *Batter Treatment*

Batters vary in size and also in materials. Treatment specifications have been developed according to their stability and revegetation potential. Treatment varies from none required, to benching and covering with soil.

### *Ripping*

Extensive areas of compaction exist in the area. Ripping is required for revegetation to be effective and also to assist drainage and erosion control .

### *Soil/Overburden Placement*

Heavily compacted sites, plant sites, storage areas, rubbish dumps and concrete foundations which do not provide a suitable substrate for plant development, even after ripping, will be treated with either clay from the borrow areas or other loose less suitable materials followed by the application of clay. Compacted sites which cannot be ripped and/or are composed of concrete will be similarly treated in accordance with the site prescriptions and the specifications.

### *Miscellaneous Treatment*

Other treatments are included in this category. They include road gripping (treatment to control drainage), diversion banks, drainage works, benching, and wetland establishment ( as a means of rehabilitation).

## 4.2.2 REVEGETATION

Revegetation will involve the re-establishment of local provenance native species in areas surrounded by existing natural plant communities. Disturbed sites adjacent to improved agricultural land will be revegetated using exotic grass species.

- **Seed**

Four seed treatments have been specified for stable sites and areas subjected to erosion . The appropriate mixes are listed in Appendix A.

- **Seedlings**

The planting of seedlings is an expensive labour intensive method of revegetation, and is only recommended in specific areas (visible/unstable) where immediate establishment is required, or where adverse germination conditions exist. These areas are specified in the Site Rehabilitation plans (next Section).

- **Fertiliser**

The disturbed sites are nutrient deficient. Sources of plant nutrients are soil minerals and decaying organic matter. Once the topsoil had been removed or disrupted the major source of nutrients available to the plants is lost. This condition applies for virtually all the mine site. Plants will not readily establish without a supply of nutrients.

Therefore, if areas deficient in topsoil are to be revegetated adequately, nutrients will have to be supplied in the form of fertiliser. An on-going application of fertiliser is also required until a self sustaining vegetation cover and nutrient reservoir is established.

Fertiliser mixes are included in Appendix A .

An initial application will be applied with maintenance fertiliser treatments as required. These are specified in the maintenance specifications.

- **Seed and Fertiliser Application Methods**

The options available for seed and fertiliser application are;

hand broadcasting
aerial application
mechanical hydro-seeding/mulching.

Hand application is inclined to result in uneven distribution but is necessary for small areas with difficult access.

The most cost effective seed and fertilizer application method is by the hydromulching/seeding technique. Hydromulch (seed + fertilizer + mulch +binder +water ) will be applied to areas prone to wind and water erosion and including unconsolidated sands and exposed sites.

Hydroseeding (seed + fertilizer + water) will be applied to non-erodible sites including areas covered with clay.

Application methods are specified in Appendix A and in the individual site specifications.

- **Planting/Application Time**

Native seed, seedling plantings and fertiliser will only be applied in late Autumn to early Spring to ensure ready moisture availability.

# 5.0 SITE DESCRIPTION AND REHABILITATION PLAN

## 5.1 INTRODUCTION

The long term rehabilitation goal is first to stabilise disturbed areas, and then to provide an environment which assists and promotes ecological succession and stability. Natural colonization and plant diversity will be promoted and enhanced wherever feasible. Although re-seeding with native and exotic species where appropriate is the major goal, it must be recognised that because of the relationship between physical, chemical and biological factors coupled with lack of topsoil, some areas will not sustain vegetation growth of any quality.

Modifications or amendment to the plan may be required to take into account a range of circumstances including changed site conditions, results of monitoring, and inspections.

## 5.2 REHABILITATION SITE PLANS

The mine area has been divided into discrete sites, and broad rehabilitation, priorities, objectives and rehabilitation prescriptions are given for each site. These sites were identified using the rehabilitation priority procedures developed in Section 4.3.

Table 1 illustrates the Plan. Figures 3, 4 and 5 shows the location of each site listed in Table 1, and these are shown on the aerial photograph of the area which accompany's the Plan.Table 2 sets out the detailed revegetation specifications for each site. Each table is indexed to the rehabilitation specifications in Appendix A.

## 5.3 SITE DESCRIPTION AND REHABILITATION PRESCRIPTIONS

General rehabilitation guidelines for each of the mine areas are summarized below in terms of the individual elements of the mine. This includes a general description of the areas listed in Table 1 and shown in Figure 3, 4 and 5.

### 5.3.1 DOLPHIN OPEN PIT DP (Figure 3)

#### 5.3.1.1 Description (Figure 3)

The Dolphin open pit is the result of mining dating back to 1917 and is the most visually striking feature of the mining operation. The pit is composed of a series of benches and steep cuts (Figure 3). Access to the pit is via one road which provides access to the portal and mine decline.

Mining practice is that the pit walls are cut to the steepest possible angle in order to safely reduce to a minimum the amount of waste rock required to be excavated in recovering the ore body. Typical benches are 15 metres wide and 10 metres high. Over time, some of the benches and slopes have weathered and consist of bare rock and ravelling (scree) slopes. Weathering will continue to occur in the pit area and will hasten natural sloughing of pit roads, benches, and outcrops. Plate 5.1 shows a view of the pit (rear of the report).

TABLE 1; KINGS ISLAND SCHEELITE - REHABILITATION PLAN

| Mapl. | LOCATION * | Area^ ha | SITE PREPARATION DESCRIPTION | SITE PREPARATION SPECIFICATION# | REVEGETATION TREATMENT (all with fertilizer) | REVEGETATION SPECIFICATION# | MAINTENANCE & MONITORING#. | TIMETABLE |
|---|---|---|---|---|---|---|---|---|
| DP | DOPHIN OPEN PIT | 7.00 | Lower benches to be used for refuse disposal. Pit allowed to flood to groundwater table. Accessible benches to be clay covered and revegetated. Pit perimeter in proximity to township to be bunded. Access removed. | D 2,3,4 E 1,4,5,7,8 | Native sp, hydroseed/mulch | R 3,5,6 | M 1,2,3,4 | |
| MA | MILL AREA | | All buildings and structures demolished except for coarse ore bin. | D 1,2,3,4,5 | Native sp, hydromulch steep sites | R 3,5,6,9 | M 1,2,3,5 | |
| 1 | MILL SITE | 7.50 | Concrete treated. Major foundations left intact, with all steel protrusions cutoff. Asbestos sheeting disposal to rubbish tip. Above-ground services removed. Steel and solid uncontaminated wastes disposed of in open cut. Contaminated areas removed to special dump, creek area profiled, drainage channels constructed. Area clayed, ripped. Vent shaft capped | E 1,2,3,4,5,7,8,9 | hydroseed other, seedlings | | | |
| 2 | OFFICE SITE | 0.50 | Buildings and above ground services removed, area ripped, clay replaced. | D 2,3,4 E 1,4,5,7,8 | Native sp, hydroseed, seedlings | R 4,5,9 | M 1,2,3 | |
| | Car Park | 0.30 | Area clayed and ripped | E 7,8 | Native sp, hydroseed, seedlings | R 4,5,9 | M 1,2,3 | |
| 3 | SEA DUMP | 7.00 | Source of fill for mill area. Outer face to be flattened and rip rapped. Refuse recovered. Balance of area soiled and ripped. | E 1,7,8 | Grass sp, hydromulch, seedlings | R 2,6,9 | M 1,2,3,5 | |
| 4 | SAND DEPOSITS/GEN. AREA | 4.40 | Coarse tailings, general area to be cleaned up, profiled and covered with soil. | E 1,8 | Native sp, hydroseed, seedlings | R 4,5,9 | M 1,2,3,5 | |
| 5 | CREEK AREA | 0.20 | General area to be cleaned up, profiled, overflow channel excavated. | D2,3,E1 | Native sp, hydroseed | R4,5 | M 1,2,3,5 | |
| RD | REFUSE DISPOSAL | | | | | | | |
| 1 | DOLPHIN PIT | | Clean refuse disposal only, in lower levels off access road. No cover. | none required | none required | | | |
| 2 | MILL SITE | | Cover with fill compact, clay cover, profile, drainage control. | REFER SURROUNDING AREA | | | | |
| 3 | HAZ. WASTE DUMP | 0.50 | Special dump, clay lined, fill and clay cover. | E1,8,9 | Nat seed, hydromulch/seedlings | R3,6,9 | M 1,2,3,5 | |
| 4 | ASBEST. DUMP | 0.50 | Special dump, covered . | E1,8,9 | Nat seed, hydromulch/seedlings | R3,6,9 | M 1,2,3,5 | |
| 5 | EXISTING DISPOSAL SITE | 1.20 | Refuse recovered fromcreek, bury in sand dune, cover, profile and clay cover. | D 3,5,6 E 1,7,8 | Native sp, hydromulch | R 4,6 | M 1,2,3,5 | |
| UG | UPPER GRASSY DAM | 0.1 | Dam to be left intact. Cleanup and demolition of pumps and buildings, if no longer required, outlet channel construction . Soil replacement, rip | D 2,3 E 7,8 | Native sp, hydroseed/mulch | R 3,5,6 | M 1,2,3,5 | |
| LG | LOWER GRASSY DAM | | Dam to be left intact. Weir structure buttressed. General cleanup. | REFER CREEK AREA MA5 | | | | |
| TD | TAILINGS DAMS | | | | | | | |
| 1 | SEA WALL TAILINGS DAM | 16.50 | Tailings surface to be covered with fill from embankments, clay. | E 6,8 | Native sp, hydroseed | R 4,5 | M 1,2,3,5 | |
| 2 | SEA WALL | 0.50 | Wall to be used as surface cover on tailings. Eroding area to be benched, clay covering on benches | E 8, 14 | Grass sp, hydromulch, seedlings | R 2,6,9 | M 1,2,3,5 | |
| 3 | SEPARATION WALL | | Separation wall to be removed to FSL, used as cover on tailings surface. | | | | | |
| 4 | BOLD HILL RD DAM | 0.50 | Left intact with downstream buttressing, exposed areas to be clayed. | E 1,8,15 | Native sp, hydroseed, slash, wetland | R 4,5,7,8 | M 1,2,3,5 | |
| 5 | SAND BORROW PIT | 0.40 | Ripped, clay replacement | E 7,8,16 | Native sp, hydroseed | R 4,5 | M 1,2,3 | |
| 6 | ACCESS ROADS, DISTURB. | 1.20 | Ripped, gripped, clay replacement. Closed | E 7,8,10,12,16 | Native sp, hydroseed/mulch, slash | R 4,5,6,7 | M 1,2,3 | |
| 7 | PIPELINE | 0.40 | Removed, cleanup, ripped, gripped, clay replacement. Closed | D23 E 7,8,10,12,16 | Native sp, hydroseed, slash | R 4,5,7 | M 1,2,3 | |
| CB | CLAY BORROW AREA | | | | | | | |
| 1 | BORROW PIT I | 1.00 | Area to be developed in benches, profiled and topsoil returned. | E 1,7,8 | Grass sp, hydroseed | R 1,5 | M 1 | |
| 2 | SEA DUMP | | Select clay removal | REFER MA3 | | | | |
| 3 | OVER. DUMP PIT | 0.80 | Source of cover material, benched, part soiled, ripped. | E 1,7,8,14 | Native sp, hydromulch, seedlings | R 3,6,9 | M 1,2,3 | |
| PC | POWER COMPLEX | | | | | | | |
| 1 | POWER STATION | | Buildings, structures to be removed, site cleaned up, foundations, site treated. | | | | | |
| 2 | WAREHOUSE | | Remains, general cleanup. | | | | | |
| 3 | GENERAL AREA | 1.50 | Buildings, refuses and services removed (incl transmission lines). Area to be cleaned up, concrete treated, profiled, ripped and clay placed as required. | D 1,2,3,4,5 E 1,2,3,4,5,7,8 | Grass sp, hydroseed | R 1,5 | M 1 | |
| 4 | SEWERAGE POND | 0.10 | To be filled, site profiled, area ripped and clayed | D 23 E 1,4,5,7,8 | Grass sp, hydroseed | R 1,5 | M 1 | |
| 5 | OIL FIRE TRAINING AREA | 0.10 | Structures removed, site cleaned up, area ripped and clay covered. | D 2,3,6 E 1,4,5,7,8 | Grass sp, hydroseed | R 1,5 | M 1 | |
| BH | BOLD HEAD MINE SITE | | | | | | | |
| 1 | VENT SHAFTS AND PIT | 1.50 | Ventillation shaft concrete capped and marked. Machinery/buildings removed. Spoil removed to pit area, profiled and soiled. | D 2,3 E 1,4,5,13 | Grass sp, hydroseed | R 1,5 | M 1 | |
| 2 | PORTAL AREA | 2.20 | Portal to remain as a water body. Buildings/ machinery removed, concrete treated , site cleanup, area clay covered and ripped. | D 1,2,3,4 E 1,3,4,5,7,8,15 | Native sp, hydroseed | R 3,5 | M 1,2,3 | |
| | Batters | 0.40 | Refuse recovered, clay tipped over batter | D 3 E 11 | Native sp, hydromulch | R 3,6 | M 1,2,3 | |
| | Roads | 0.20 | Ripped, clay cover, closed | E 78 | Native sp, hydroseed | R 3,5 | M 1,2,3 | |
| 3 | EXPLOSIVES YARD | 0.10 | Fences, buildings removed, clay cover and rip. | D 2,3 E 78 | Grass sp, hydroseed | R 1,5 | M 1 | |
| MD | MISC. DISTURBANCES | | | | | | | |
| 1 | GATE HOUSE AREA | 2.00 | Buildings, fences etc removed, concrete treated, part clay cover, ripped | D 2,3,4 E 1,4,5,7,8 | Native sp, hydroseed, seedlings | R 3,5,9 | M 1,2,3 | |
| 2 | OVERBURDEN DUMP | 0.30 | Exposed faces to be benched, part clay cover | E 8,14 | Grass sp, hydromulch, seedlings | R 2,6,9 | M 1,2,3 | |
| 3 | GRAVEL PIT | 0.60 | Rock pack erosion gullies,cover, diversion banks, grip tracks, rip site | E 7,8,17 | Native sp, hydromulch, seedlings | R 3,6,9 | M 1,2,3,5 | |
| 4 | GOLF COURSE - TAILINGS | 1.00 | Rock pack erosion gullies, part cover with fill and clay. | E 8,13,16,17 | Grass sp, hydromulch | R 2,6 | M 1,2,3,5 | |
| 5 | FIRE TRAILS | 0.40 | Tracks gripped and ripped | E 7,10,12 | Native sp, hydroseed, slash | R 4,5,7 | M 1,2,3,5 | |
| 6 | BH CUT BATTER | 1.00 | No preparation required | | Native sp, hydromulch | R 3,6 | M 1,2,3 | |
| 7 | EXPLOSIVES MAGAZ. | 0.60 | Buildings removed, ripped part clay cover, tracks ripped and gripped. | D 2,3 E 1,4,7,8, 10,12 | Native sp, hydroseed, slash | R 3,5,7 | M 1,2,3 | |
| GT | GRASSY TOWNSHIP | | To be sold as complete township. | | | | | |
| | TOTAL AREA^ to be treated | 62.50 | | | | | | |

* refer REHABILITATION SITE PLAN FOR LOCATION # refer SPECIFICATIONS

^ area to be rehabilitated

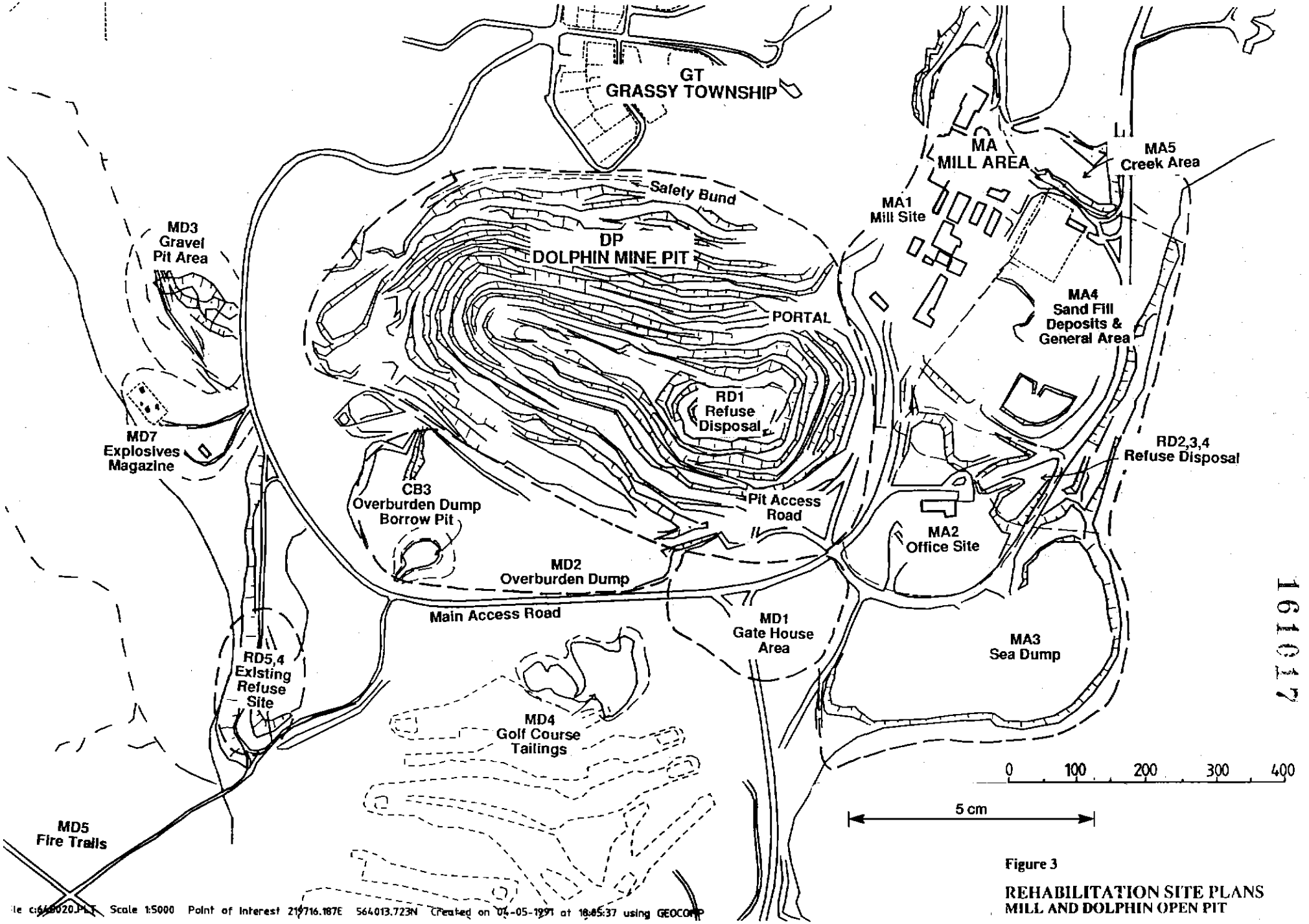


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Figure 3

REHABILITATION SITE PLANS
MILL AND DOLPHIN OPEN PIT

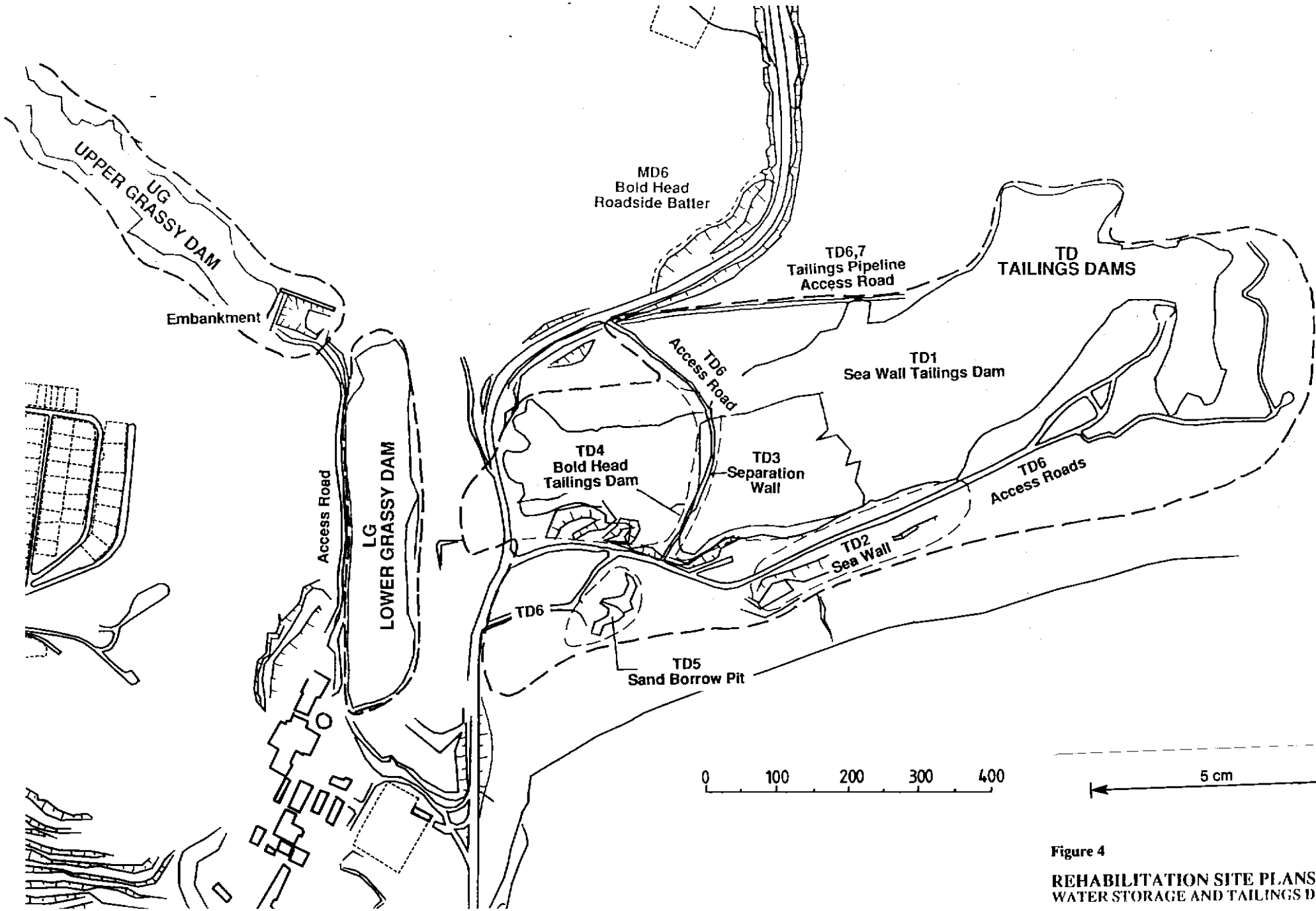


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**Figure 4**

**REHABILITATION SITE PLANS**
**WATER STORAGE AND TAILINGS DAMS**

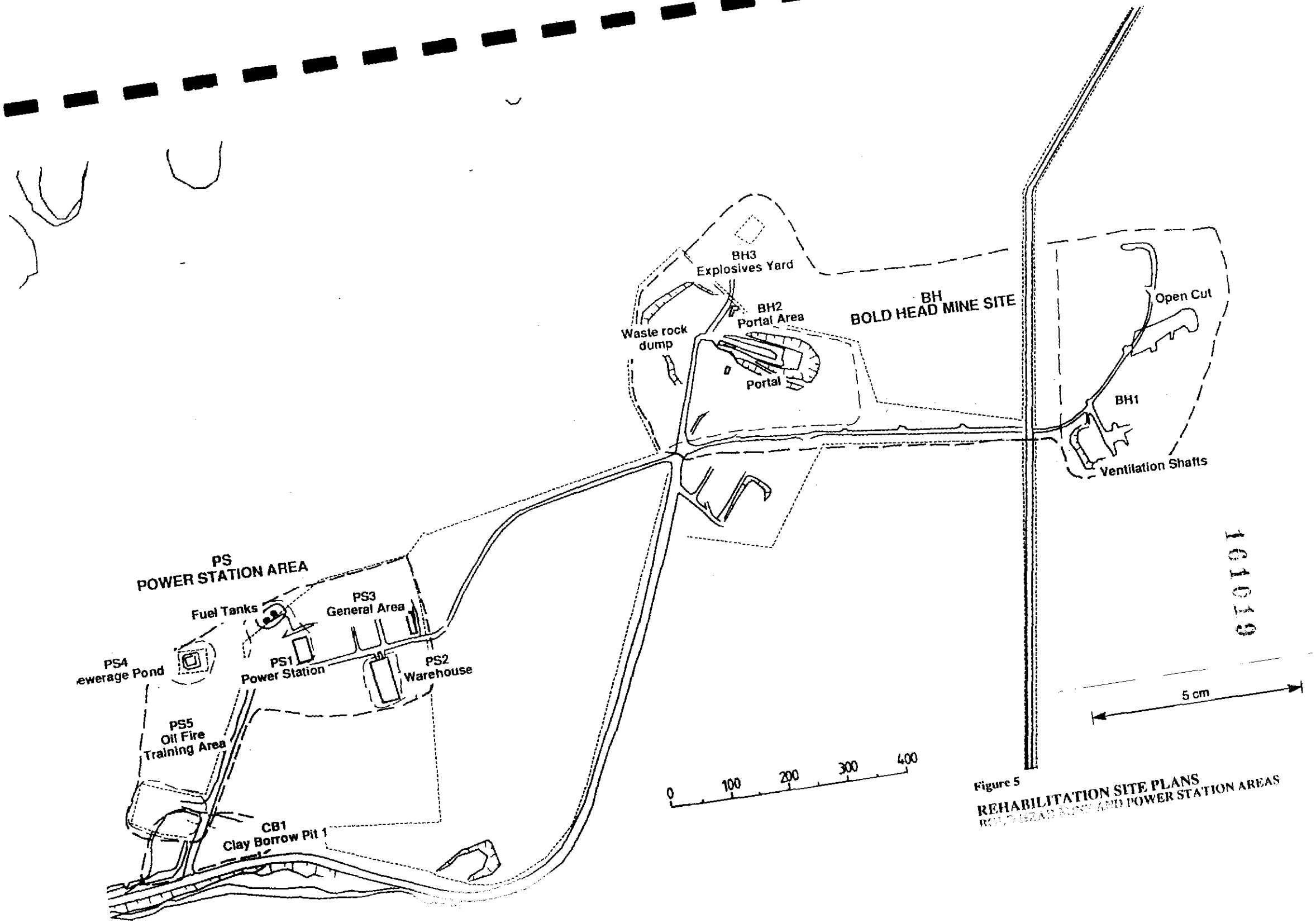



Figure 5

REHABILITATION SITE PLANS
BOLD HEAD MINE AND POWER STATION AREAS

TABLE 2 ; KINGS ISLAND SCHEELITE - REVEGETATION PLAN

| Mapl. | LOCATION * | Area^ ha | SEED & FERT MIX# | APPLIC METHOD# | SEED QUANT kg | FERT QUANT kg | SEEDLINGS No. |
|---|---|---|---|---|---|---|---|
| DP | **DOPHIN OPEN PIT** | 7.00 | R3 | R5,6 | 28N | 2100 | |
| MA | **MILL AREA** | | | | | | |
| 1 | MILL SITE | 7.50 | R3 | R5,6 | 24N | 1890 | 1200 |
| 2 | OFFICE SITE | 0.50 | R4 | R5 | 0.8N | 70 | 150 |
| | Car Park | 0.30 | R4 | R6 | 1.2N | 105 | 150 |
| 3 | SEA DUMP | 7.00 | R2 | R6 | 540E | 3000 | 400 |
| 4 | SAND DEPOSITS/GEN. AREA | 4.40 | R4 | R5 | 16N | 1400 | 800 |
| 5 | CREEK AREA | 0.20 | R4 | R5 | 0.8N | 70 | |
| RD | **REFUSE DISPOSAL** | | | | | | |
| 1 | DOLPHIN PIT | | REFER SURROUNDING AREAS | | | | |
| 2 | MILL SITE | | REFER SURROUNDING AREAS | | | | |
| 3 | HAZ. WASTE DUMP | 0.50 | R3 | R6 | 2.0N | 150 | 150 |
| 4 | ASBEST. DUMP | 0.50 | R3 | R6 | 2.0N | 150 | 150 |
| 5 | EXISTING DISPOSAL SITE | 1.20 | R4 | R6 | 4.0N | 350 | |
| UG | **UPPER GRASSY DAM** | 0.1 | R3 | R5,6 | 0.4N | 120 | |
| LG | **LOWER GRASSY DAM** | | | | | | |
| TD | **TAILINGS DAMS** | | | | | | |
| 1 | SEA WALL TAILINGS DAM | 16.50 | R4 | R5 | 66N | 5775 | |
| 2 | SEA WALL | 0.50 | R2 | R6 | 45E | 250 | 200 |
| 3 | SEPARATION WALL | | | | | | |
| 4 | BOLD HILL RD DAM | 0.50 | R3 | R5 | 2N | 150 | |
| 5 | SAND BORROW PIT | 0.40 | R4 | R5 | 1.6N | 140 | |
| 6 | ACCESS ROADS, DISTURB. | 1.20 | R4 | R5 | 4.8N | 420 | |
| 7 | PIPELINE | 0.40 | R4 | R5 | 1.6N | 140 | |
| CB | **CLAY BORROW AREA** | | | | | | |
| 1 | BORROW PIT I | 1.00 | R1 | R5 | 78.0E | 500 | |
| 2 | SEA DUMP | | REFER SURROUNDING AREA | | | | |
| 3 | OVER. DUMP PIT | 0.80 | R3 | R6 | 3.2E | 240 | 200 |
| PC | **POWER COMPLEX** | | | | | | |
| 1 | POWER STATION | | | | | | |
| 2 | WAREHOUSE | | | | | | |
| 3 | GENERAL AREA | 1.50 | R1 | R5 | 117.0E | 750 | |
| 4 | SEWERAGE POND | 0.10 | R1 | R5 | 7.8E | 50 | |
| 5 | OIL FIRE TRAINING AREA | 0.10 | R1 | R5 | 7.8E | 50 | |
| BH | **BOLD HEAD MINE SITE** | | | | | | |
| 1 | VENT SHAFTS AND PIT | 1.50 | R1 | R5 | 117.0E | 750 | |
| 2 | PORTAL AREA | 2.20 | R3 | R5 | 8.8N | 660 | |
| | Batters | 0.40 | R3 | R6 | 1.6N | 120 | |
| | Roads | 0.20 | R3 | R5 | 0.8N | 60 | |
| 3 | EXPLOSIVES YARD | 0.10 | R1 | R5 | 7.8N | 50 | |
| MD | **MISC. DISTURBANCES** | | | | | | |
| 1 | GATE HOUSE AREA | 2.00 | R3 | R5 | 8N | 600 | 600 |
| 2 | OVERBURDEN DUMP | 0.30 | R2 | R6 | 27E | 150 | 150 |
| 3 | GRAVEL PIT | 0.60 | R3 | R6 | 2.4N | 180 | 150 |
| 4 | GOLF COURSE - TAILINGS | 1.00 | R2 | R6 | 90E | 500 | 500 |
| 5 | FIRE TRAILS | 0.40 | R4 | R5,7 | 1.6E | 140 | |
| 6 | BH CUT BATTER | 1.00 | R3 | R6 | 4.0N | 300 | |
| 7 | EXPLOSIVES MAGAZ. | 0.60 | R3 | R5,7 | 2.4N | 180 | |
| GT | **GRASSY TOWNSHIP** | | | | 199.8N | 22465 | |
| | TOTAL | 62.50 | | | 1121.4E | 22465 | 4800 |

* refer REHABILITATION SITE PLAN FOR LOCATION # refer SPECIFICATIONS

^ are to be rehabilitated

N Native species

E Exotic species

The pit is expected to gradually fill with regional groundwaters (fresh) to a level approximately 2/3 depth as indicated in the photograph. The upper benches will remain exposed and will remain visually striking.

### 5.3.1.2 Rehabilitation Potential

The pits are a difficult site for effective rehabilitation, with extensive areas of bare rock, few fines, and open to scouring from wind and rainfall in the winter, and dessication in the summer. Where fines (weathered material) has accumulated on the bedrock which compose the benches, the rehabilitation potential is relatively high but where there is a lack of this material the potential is low.

### 5.3.1.3 Stability

Where erosion is occuring on benches the material is contained within the open cut and will not affect other sites.

Areas of physical instability and the upper benches adjoining the township constitute a potential safety hazard.

Water quality in existing pit drainage is good, being alkaline, slightly saline and with slightly elevated levels of iron. Mercury exceeds the aquatic receiving water standards and is believed to be inherent in the natural groundwaters. This appears to be regional and not influenced by the mine. As the groundwater level rises, the water quality is expected to change.

### 5.3.1.4 Rehabilitation Treatment

Flooding of the bottom 2/3 section of the open pit will occur following pump shut down and a fresh water lake will be created after the groundwater table recovers. After filling the groundwaters are expected to flow out through a services rise near the mill area. All ventilation shafts and manways will be concrete capped and a 300mm diameter pipe for the services rise capping will be the release point for the groundwater.

The lower levels adjoining the access road will be used for solid plant site and general rubbish disposal, mainly steel, if required, as indicated in Figure 3. This material will not be covered with overburden and no contaminated wastes, or liquid wastes will be disposed of in the pit. (this includes redundant plant and equipment containing oils and greases). The access road will remain open to allow access to the portal in the future.

Accessible benches will be revegetated to eventually produce a more natural appearance and reduce visual contrasts. Clay will be returned to the accessible benches and tipped over the lower inaccessible benches where possible.

The inland native seed mix and general fertiliser will be applied by the hydromulching/seeding technique. Only sections of the open cut composed of fines or covered by clay will be treated.

An earth safety bund will be constructed where the open pit adjoins the township and where public access is likely ( at the lower levels where there is road access). Figure 3 shows the approximate location. Other safety provisions will include blocking of vehicular access to the pit benches and the erection of warning signs in accordance with Department of Resource and Energy requirements.

## 5.3.2 MILL SITE FACILITIES MA1 (Figure 3)

### 5.3.2.1 Description

These are the processing plant structures, buildings and associated facilities. They are located in the area adjoining the Dolphin pit and the access road. The major components are shown in Figure 6 and Plate 5.2, and consist of the following;

Primary crusher
Coarse ore bin,
Tertiary Crusher,
Fine Ore Bin
Mill building
Artificial scheelite building
Thickeners
Power House
Transformer Compound
Workshops - mechanical, plumbers and carpenters
Store buildings, paint shop, Linatex shop etc
Cement sandfill plant
Sand fill complex.
Miscellaneous services, pipelines, electrical cables etc.

The buildings and structures are generally located on concrete slab foundations and/or hardstanding areas and are composed of steel framing for the main structures, with either metal or asbestos sheet cladding. Some buildings have major reinforced concrete structural foundations of considerable height. These include the coarse ore bin, the primary and secondary crushers (see Plate 5.3) , the ball mills, the gravity concentrate table floor foundations and the artificial scheelite building.

Contaminated materials are also present on the site - these consist of oils and greases, process chemical and ore and treatment residues - such as concentrates, and plant spillages.

### 5.3.2.2 Stability and Revegetation Potential

The foundations of the majority of the mill area consists of hard compacted surfaces and/or concrete foundations.

While the site is stable there are a number of potential contaminant sources, as identified above. These are considered separately under waste disposal.

### 5.3.2.3 Rehabilitation Treatment

Buildings and equipment will be dismantled for sale and removal by the purchaser or prepared for disposal. All hazardous materials and refuse will be cleared from the site, and disposed of in accordance with the procedure described in the hazardous waste disposal prescriptions.

A large amount of scrap and general refuse is expected to remain on the site after salvage. This will include cladding, building materials and unsalvageable plant and equipment. Many of these materials will be large and difficult to handle and transport. This material will therefore be disposed of on site, or in close proximity, by excavation of pits and burial.

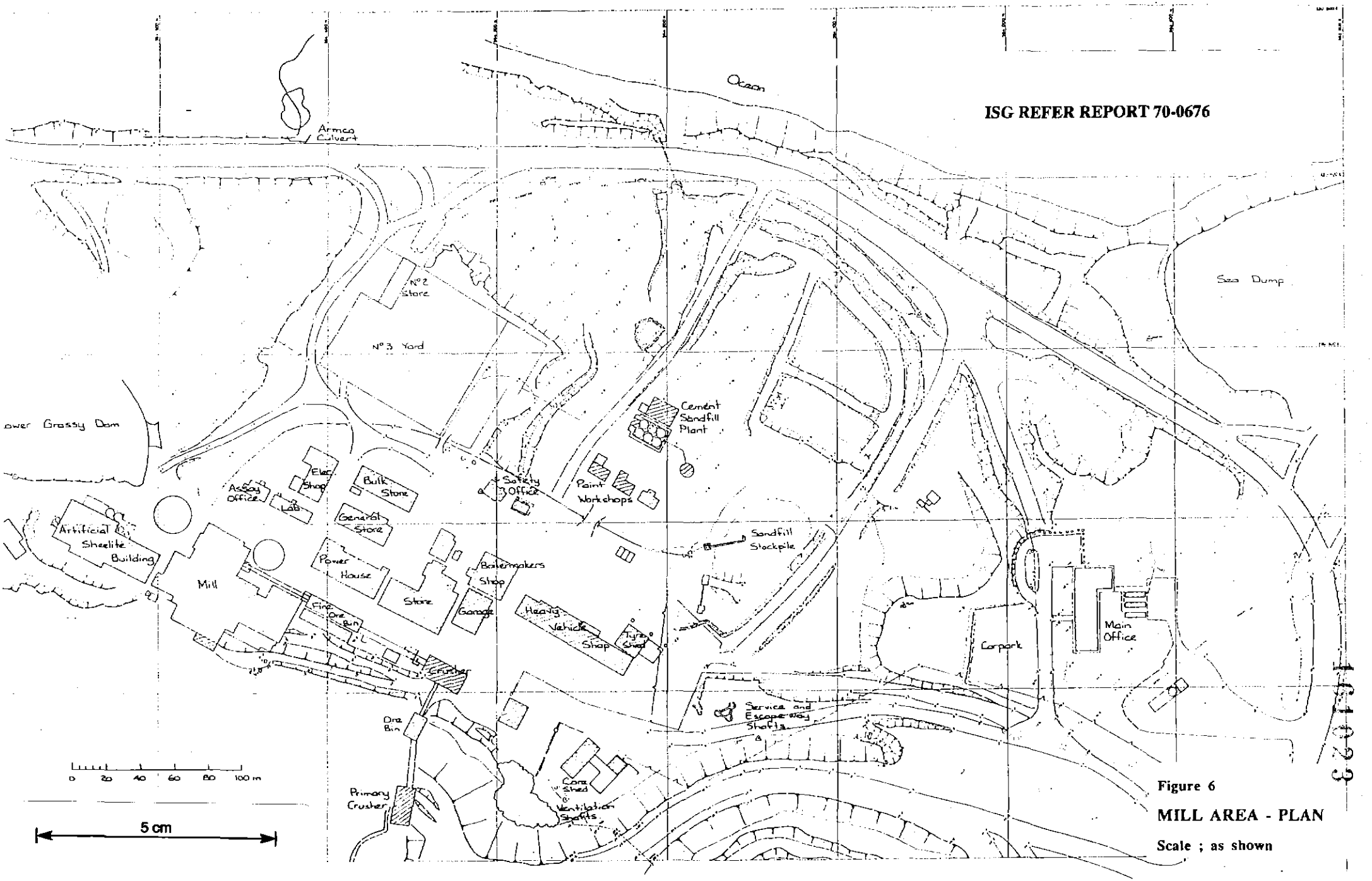



**Figure 6**

**MILL AREA - PLAN**

**Scale ; as shown**

After clearing of the site the remaining concrete slabs and foundations will be;

broken-up and covered by 0.3 m of general fill followed by 0.2-0.3 m of clay, or

left intact and covered with 0.5 m of fill followed by 0.2-0.3 m of clay, or

removed to the designated dump, or

if large and of likely historic or technical interest, included in the final landform .

The latter are likely to include the concrete sections of the coarse ore bin, the primary and tertiary crusher, fine ore bin and the mill and artificial scheelite building foundations. The method and final treatment of these foundations can only be addressed after the buildings have been removed and the foundations exposed. A conceptual landscaping plan is shown in Figures 7A and 7B.

Any hazardous exposed metal such as reinforcing bars etc will be cut from the concrete structures which will not be covered.

The general area will be graded and profiled and compacted surfaces will be ripped. If substrate material is not suitable for revegetation, clay will be placed on the surface. Drainage control will be provided by ripping, profiling or the provision of erosion control structures such as contour banks and drains. Revegetation will consist of fertiliser and the general inland native seed mix applied by hydroseeding low erosion potential areas or hydromulching high potential areas.

All ventilation shafts and manways will be concrete capped and a 300mm diameter pipe for the services rise capping (or similar) will be the release point for the groundwater.

A site drainage plan is shown in Figure 8. This includes the provision for the long term groundwater drainage (from the Dolphin Pit and underground workings) which will flow from the services rise and an overflow channel for the possible blocking of the river culvert. Flow rates in the vicinity of 1to 2 L/sec are anticipated.

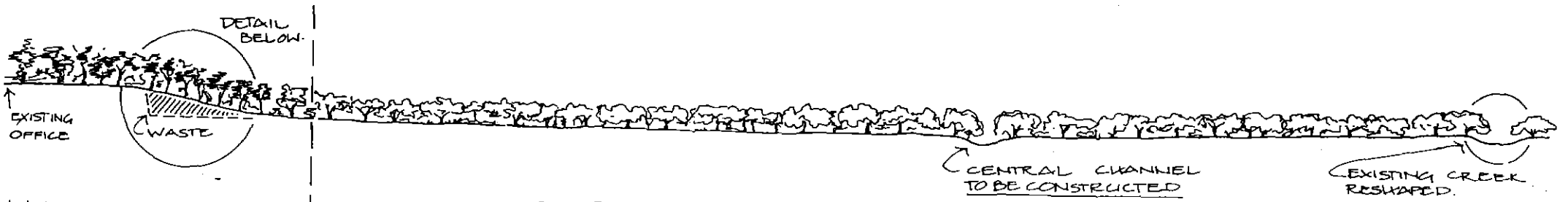
An access road will be left through the mill area to the Lower and Upper Grassy dams. Other roads will closed and rehabilitated.

### 5.3.3 SAND FILL DEPOSITS AND GENERAL AREA MA 4 (Figure 3)

#### 5.3.3.1 Description

The balance of the area consists of settling basins, lay down and storage areas, scrap material dumps and general disturbance. A large area is covered by sand and tailings type deposits.

This latter area consists of the mine sand fill complex which includes the cyclone, steel structures together with the sand deposits, settling dams and also includes other disturbed areas adjoining the Bold Hill access road.




INLAND MIX

Gradually rises from 5-10m and changes character from a coastal scrub to forest.

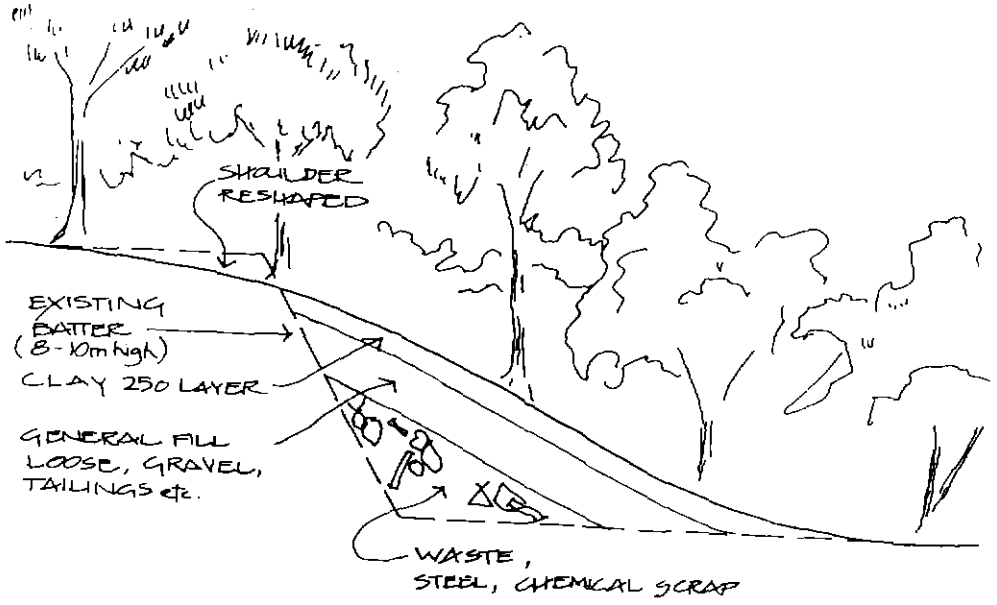
CHANGE OF SEED MIX ROUGHLY CORRESPONDS TO BASE OF PROFILED BANK.

COASTAL SEED MIX

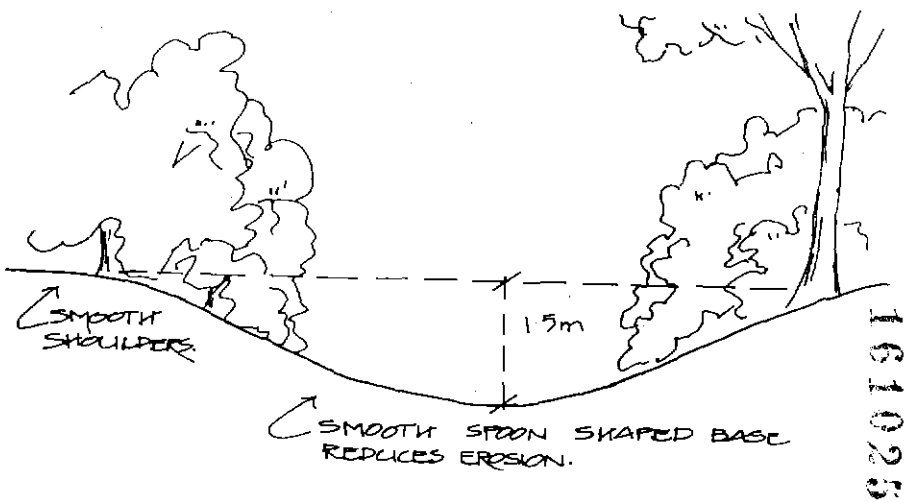
Gradually rises from tough grasses and ground hugging shrubs to a coastal scrub of 5m.

S/SE . . . . . INDICATIVE SECTION . . . . . N/NW

APPROXIMATELY 1:1000



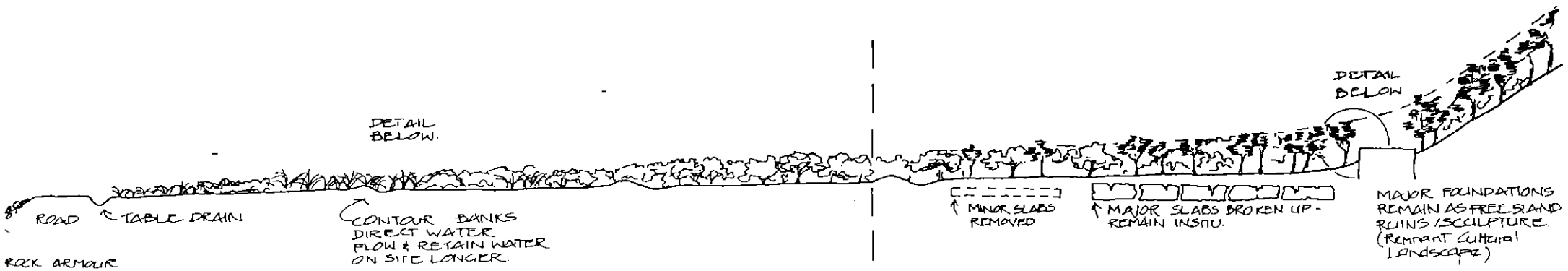

SECTION
TYPICAL RESHAPED BATTER
EX. OFFICES AREA
NOT to scale




SECTION
- RESHAPED CREEK
&
- CENTRAL CHANNEL TO BE CONSTRUCTED
Not to scale

**Figure 7A**

**MILL AREA - LANDSCAPE PLAN North - South Section**




COASTAL SEED MIX

Gradually rises from tough grasses and ground hugging shrubs to a coastal scrub of 5m.

INLAND SEED MIX

Gradually rises from 5 - 10 m and changes character from a coastal scrub to forest.

PITS etc.

CHANGE OF SEED MIX ROUGHLY CORRESPONDS TO THE EXISTING BOUNDARY OF BUILDINGS

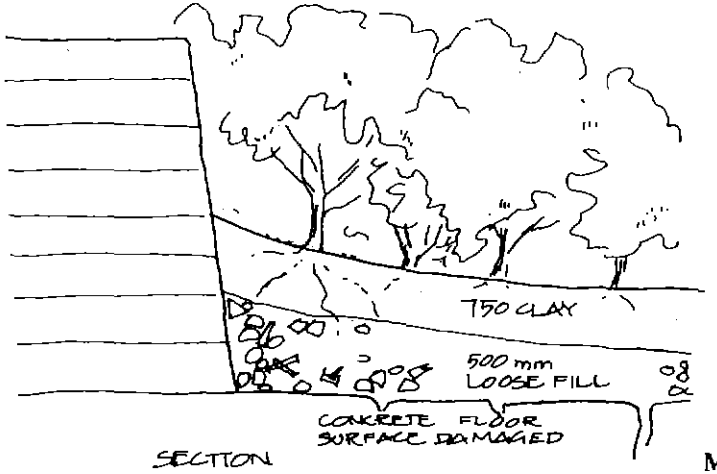
BUILDINGS.

E/NE . . . . . INDICATIVE SECTION . . . . . W/SW

APPROX 1:1000


CONTOUR BANKS SECTION.

NOTE Water flows along contour banks at gentle grade 1-3% At NO point should wall of contour bank be level or lower than any point in the drainage swale, as this can result in a breach.




SECTION LARGE REMAINING CONCRETE STRUCTURES

Figure 7B

**MILL AREA - LANDSCAPE PLAN East- West Section**

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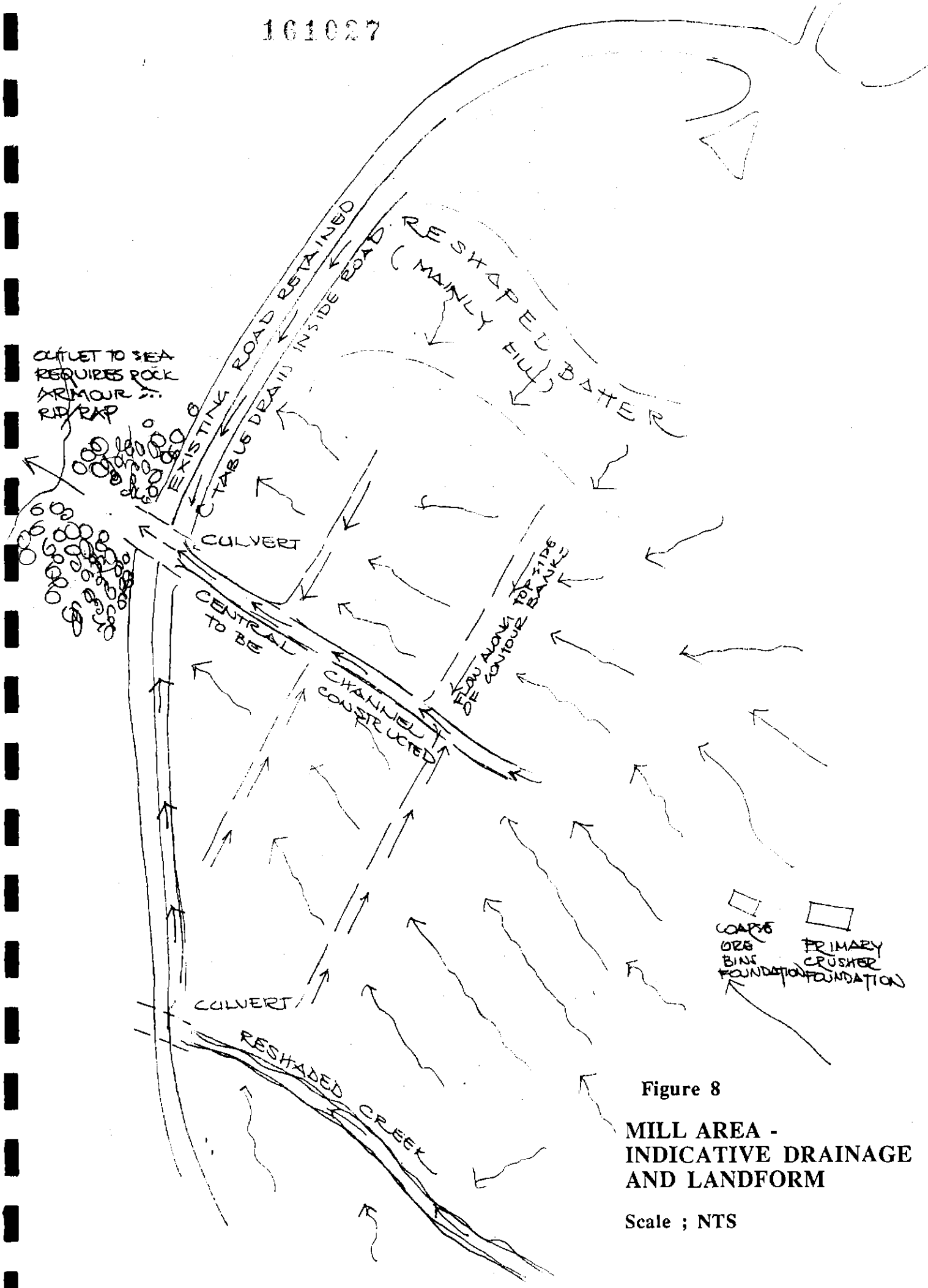



**Figure 8**

**MILL AREA - INDICATIVE DRAINAGE AND LANDFORM**

**Scale ; NTS**

INDICATIVE DRAINAGE & LANDFORM

#### 5.3.3.2 Rehabilitation Potential and Stability

The sand materials themselves which are generally coarse sand sized particles which have been separated for sand fill. They are of limited particle size and are actively being eroded by wind. Other areas are settling dams and waste rock and fill dumps which are all stable.

#### 5.3.3.3 Rehabilitation Treatment

All mechanical equipment and refuse will be sold or disposed of in the refuse dump. The sand deposits will either be used as a source of fill for the plant site, or profiled insitu.

Other areas including the fill batters and settling dams will be profiled and contoured in accordance with the landscape plan (Figures 7A and 7B). Unsuitable materials will be covered with clay, and compacted areas ripped.

Revegetation will involve the application of the coastal stabilization mix and applied by hydroseeding.

### 5.3.4 CREEK AREA MA 5 (Figure 3)

#### 5.3.4.1 Description

The Grassy River flows over the weir at the Lower Grassy dam mill area to the north-east of the mill area. The river bed has been encroached by areas of fill and refuse prior to a Armco culvert under the Bold Head access road. The river then flows a short distance to the sea. Plate 5.4 shows the Creek above the culvert.

#### 5.3.4.2 Rehabilitation Potential and Stability

The river course is stable but interupted by site fill batters and deposits in the floor. The culvert is more than adequate to cope with river flows, however provision is required for any future collapse or blocking.

#### 5.3.4.3 Rehabilitation Treatment

All refuse will be removed from the creek area and taken to the disposal site.

The banks and bottom will be profiled and an overflow diversion channel constructed to direct river flows to an alternative discharge point. This is shown in Figure 7B and 8.

Revegetation will involve the application of the coastal native mix and applied by hydroseeding.

### 5.3.5 OFFICE SITE MA2 (Figure 3)

#### 5.3.5.1 Description

This area comprises the main mine office, car park and refueling facilities. These are located on the access road near the Dolphin pit. The area is basically flat and many areas have been grassed.

### 5.3.5.2 Rehabilitation Potential and Stability

Except for some grassed areas, the site is compacted and therefore with a low rehabilitation potential.

The fuel tanks and site spillages are a potential contamination source.

### 5.3.5.3 Rehabilitation Treatment

The office building and all other surface structures will be sold and removed, or disposed of in the refuse dump. Concrete foundations will be treated by either removal or cracking and covering. The fuel tanks will be removed. Contaminated materials will be removed and replaced with general fill.

The whole site including roads and grassed areas will be ripped. Clay will be placed on non - grassed areas.

Revegetation will involve the application of the coastal stabilization mix to the non grassed area and applied by hydroseeding. Existing grassed areas will have seedlings planted.

## 5.3.6 SEA DUMP (MA3) (Figure 3)

### 5.3.6.1 Description

The sea dump has served as the overburden dump for the Dolphin open cut. It is composed of mixed overburden materials which vary from large rock boulders to weathered unconsolidated clays .

The outer face of the dump has been eroded by wave action and the dump face is gradually retreating. This process is expected to continue until the face is stabilised by the establishment of a rock armoured face. Plate 5.5 shows the sea dump face.

### 5.3.6.2 Rehabilitation Potential

The sea dump contains a high proportion of rock waste, the surface is compacted and the site is exposed to saline conditions. The rehabilitation potential is therefore low.

### 5.3.6.3 Stability

Wave action is constantly undercutting the exposed face of the dump and therefore the outer faces cannot be considered stable. Remedial action is required.

### 5.3.6.4 Rehabilitation Treatment

Some of the sea dump will be removed for the coverage of areas such as the mill foundations and also as a source rock rip rap. The angle of the recontoured face will be similar to the existing beach slope (Figure 9). During the removal of the outer face of the dump the larger rock will be sorted for the armouring of the shoreline and the smaller and finer materials will be used as general site fill (Figure 9).The clays will also be separated for the rehabilitation of the site, and elsewhere if there are sufficient quantities.

Surface refuse and refuse exposed on the outer face will be recovered and disposed of either in the general waste dump, or in a pit dug on site.

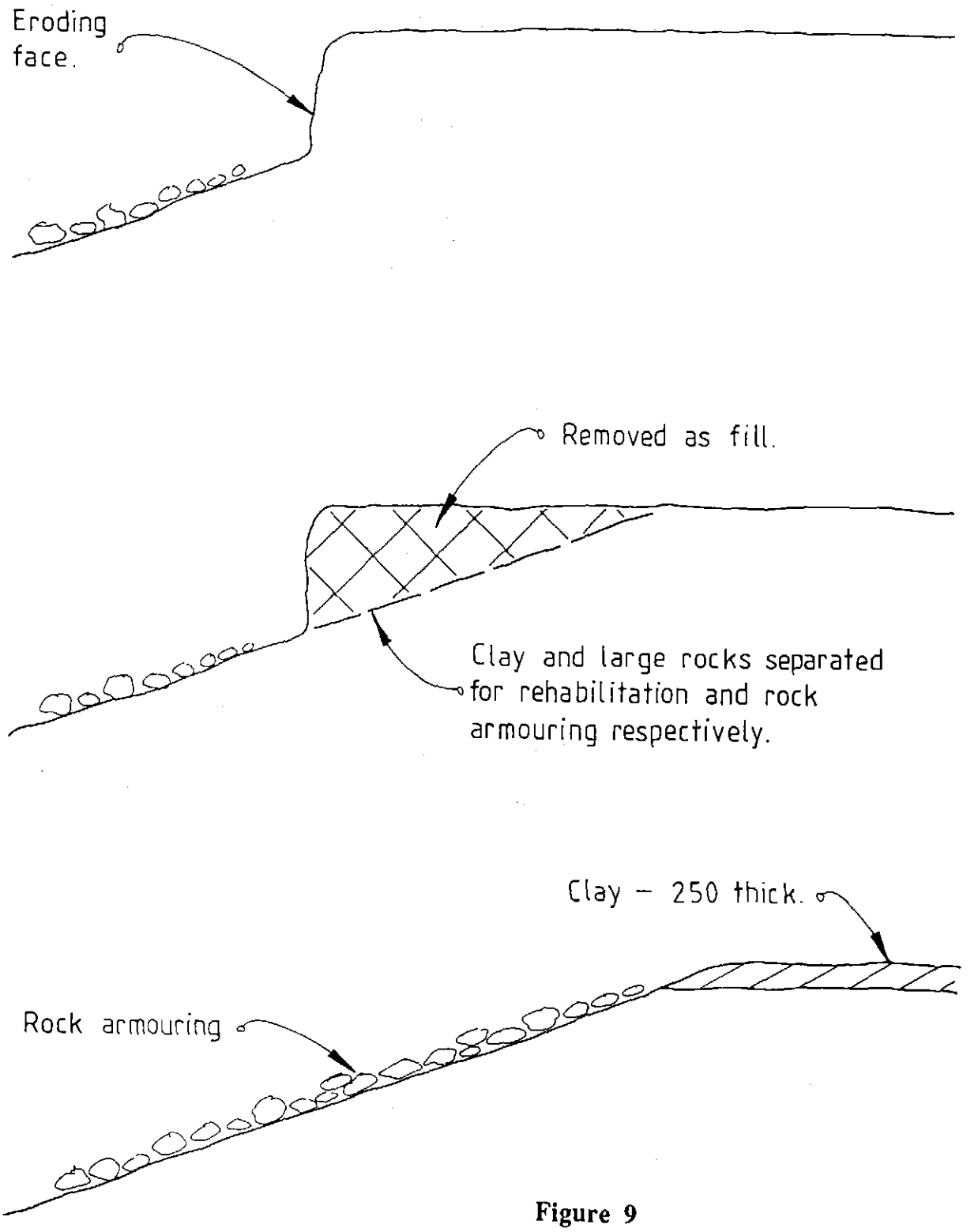



**Figure 9**

**SEA DUMP FACE TREATMENT**

**Scale ; not to scale**

Materials unsuitable for revegetation will be covered with clay and the area ripped parallel to the shoreline.

Revegetation will involve the application by hydromulching of the grass and fertilizer stabilisation mix for coastal areas covered with clay .

### 5.3.7 REFUSE DISPOSAL RD (Figure 3)

### 5.3.7.1 HAZARDOUS WASTE DISPOSAL RD 3,4

#### Description

These wastes include some fuel oils and petroleum products, used containers, and asbestos products.

All radioactive sources have been returned to AMDEL, supervised by the State Radiation Officer. Capacitors containing P.C.B material have been removed from service and stored in sealed plastic lined drums.These drums have been removed from the Island by a contractor. Explosives have been sold and/or destroyed.

#### Disposal / Treatment

Distillate, petrol, lubricants, solvents and chemicals have been run down in stock level during the latter stages of the close-down period and remaining stocks are being returned to the vendor, sold or if in small quantities disposed of at the hazardous waste dump or buried in the tailings dam. Used containers will be washed, crushed and buried at the waste dump.

The waste dump will be clay lined pit, or a pit excavated in impervious material. It may be located at a convenient site in proximity to the mill area and kept separate from other refuse. Its location will be marked on a plan for location purposes.

All underground fuel storage tanks will have the tops removed and be filled with general fill. Above ground tanks will be removed.

The asbestos-cement sheet cladding of all site buildings will be removed during demolition and disposed of at the disposal site, in accordance with the specifications.

All stocks of ore, process spillage and concentrates will be cleaned from the mill area and disposed of in the contaminated waste dump or buried on-site beneath a minimum of 0.5m of cover.

Oil or fuel contaminated materials will be excavated for disposal to the hazardous waste dump, or buried on site.

#### Rehabilitation Treatment

The rehabilitation of the hazardous waste dump will firstly involve the covering with a minimum of general fill to a depth of 1.5 metres and a clay cover to minimum depth of 0.5 metres.

Revegetation will involve the application by hydromulching and/or hydroseeding of the native coastal mix.

### 5.3.7.2 GENERAL REFUSE DISPOSAL RD 1,2,3,5 (Figure 3)

**Description**

General site refuse will vary from large structural steel members, including building frames and tanks to general site rubbish. These materials will not be hazardous and will not contain oils, such as lubricating oils or fuels. All hazarous materials will be kept separate in an identified disposal area.

Three sites have been identified in Figure 3 for general refuse disposal. In addition, refuse can also be buried on site when this is the most efficient and cost effective manner, as discussed in Section 5.3.2.3.

The Dolphin Pit may be used for uncontaminated materials. These will be dumped in the lower levels off the access road. They will not be covered.

There are existing waste dumps adjoining the office area fill batter (see RD 2,3,4 on Figure 3). These area will used as required.

The existing disposal site (RD5), which also includes the domestic rubbish from Grassy may also be used. Asbestos material is being disposed of at this site.

**Rehabilitation Treatment**

The rehabilitation of the new disposal sites (but not the Dolphin pit) will involve compacting of steel protrusions by machinery and if necessary cutting. The area will be covered with a minimum of general fill to a depth of 1.5 metres and compacted by the passage of a large bulldozer. A final clay cover to minimum depth of 0.25 metres will be provided prior to revegetation.

Revegetation will involve the application by hydromulching and/or hydroseeding of the appropriate native mix.

The existing refuse site will have existing refuse retrieved from the creek, refuse covered with sand, profiled and clay covered. Revegetation will involve the application of the native coastal mix by hydromulching.

### 5.3.8 UPPER GRASSY DAM UG (Figure 4)

#### 5.3.8.1 Description

The Upper Grassy dam is of earth and rockfill construction and was built in 1956. This served as a water supply for the mine and mill and also the township of Grassy. The storage is attractive and tree fringed and reported as a habitat for platypus as well as water birds.

The dam is approximately 16 m in height with a clay core and rockfill protection. A concrete lined spillway is provided on the left abutment. Pumping equipment is provided by submersible electric pumps located on a barge and also electric and diesel backup in a pump house located at on the decant pipeline. Some site disturbance and bank erosion exists in the vicinity of the dam receiving the decant outflow.

#### 5.3.8.2 Rehabilitation Potential

If drained the impoundment walls will be exposed to natural erosion forces and have a low revegetation potential because of the poor access and lack of vegetative cover.

The embankment and surroundings area already sustain a vigorous tree cover. Hardstanding areas are compacted and have a medium revegetation potential because of protection and available seed sources.

#### 5.3.8.3 Stability

The stability of the dam embankment and the adequacy of the spillway was considered as part of the water supply and tailings dams abandonment review.

Section 7 addressed this issue.

This study concluded that the spillway was adequate and that very little work was required to bring the dam up to a standard for safe abandonment. This is limited to a general cleanup and the provision of an outlet channel from the decant pipe.

#### 5.3.8.4 Rehabilitation Treatment

The storage area is a of long term value as a water supply both for the Grassy township and any possible future mining operations.

The dam is therefore to remain intact and the storage will remain. The ownership and responsibility will pass to the landowner. The access road will also remain.

The pumps and any other equipment/structures no longer required will be removed and the general area cleaned up. The pump house area will be ripped and covered with clay and revegetated. The bund will be breached.

Revegetation will involve the application of the native inland seed mix applied by hydroseeding. The erosion at the decant pond will be hydromulched.

### 5.3.9 LOWER GRASSY DAM LG (Figure 4)

#### 5.3.9.1 Description

This dam consists of a low rockfill (approximately 2m high) embankment with a concrete outlet structure . The storage receives drainage from the Upper Grassy Dam and the tailings dams. It acts as a settling dam for drainage from the latter, and is fringed with Cumbungi and native vegetation.

#### 5.3.9.2 Rehabilitation Potential and Stability

The banks of the storage and the outlet weir are all stable and only buttressing the weir is recommended in the abandonment review. If the weir is removed the exposed sediment could be expected to erode.

The water quality is presently adversely affected by tailings dam drainage and suspended solids levels are high. The water quality is expected to gradually improve as the suspended solids settle or are diluted by water inflows. The water quality is then expected to meet drinking water standards and ambient criteria for aquatic ecosystems (see Section 6). The exception may be mercury which is slightly elevated in natural waters.

#### 5.3.9.3 Rehabilitation Treatment

This storage is to remain with the overflow weir to be buttressed with rock. The storage will continue to act as settling area for any sediment originating from the tailings dams.

Refuse will be cleared from the embankment area and the area generally profiled.

### 5.3.10 TAILINGS DAMS TD 1-7 (Figure 4)

#### 5.3.10.1 Description

There are two tailings dams in the lease area. They are the Bold Head Road tailings storage which adjoins the Bold Head Road and the Seawall Tailings storage which has been constructed near the coastline Plate 5.6 shows the tailings storage surface. The latter contains the majority of the residue from the processing operations. The storages are shown in Figure 4. Access to the dams is via the main access road and the foreshore road between the Mill and the coastline. Also associated with the tailings dams are the access roads, tailings pipelines and the sand borrow pit (see Figure 4).

#### Seawall Tailings Dam TD1

The Seawall tailings dam is the main tailings impoundment. The tailings surface covers an area of approximately 16 ha and the tailings are retained by embankments to the south and the west. The other boundaries are all natural surface - principally sand dunes.

The storage is bounded on the western side by a separation wall which separates the two tailings storages, and the sea wall which adjoins the coastline.

The Separation Wall **TD3** is a rockfill embankment which was built in the early 1970's and is approximately 13 metres high, with tailings fill 9 metres deep on the eastern side and 7 metres on the western side.

The Sea Wall **TD2** is a rockfill embankment with a clay upstream zone. It forms the southern embankment of the main tailings storage between sand dunes to the east and west as shown in Figure 4. The dam is approximately 25 metres high. A section of the seawall is actively eroding.

Surface drainage is towards the centre of the storage and then in a westerly direction through a gap in the Separation Wall to the Bold Head Road tailings dam and then to the Lower Grassy Dam. The total catchment is only 3.2 $km^2$.

The tailings disposal pipeline **TD7** follows an access track along the northern side of the tailings storage. Access roads **TD6** have also been constructed to the Separation Wall from the Bold Head Access road and also along the southern side of the storage.

#### Bold Head Road Tailings Dam TD4

This dam consists of a rockfill embankment approximately 9 metres high. The dam was believed to have been commenced in the early 1970's when an upstream clay zone was constructed upstream of the road embankment. The small storage behind the embankment (0.2ha) has acted as a secondary settling pond for tailings spilled from the main tailings dam and is now virtually full with only a shallow water covering.

Surface drainage is towards the western end of the storage where an Armco pipe discharges over the embankment and to the Lower Grassy Dam. Some erosion has occurred at the downstream headwall.

The access road **TD6** to the Seawall passes to the south of the storage and there is also a separate access road to the sand borrow pit **TD5**.

### 5.3.10.2 Revegetation Potential

The principle concern with any tailings are any acid producing potential and possible acid mine drainage. The other concern is their susceptability to erosion and structural stability.

#### Physical Characteristics

The No 1 tailings storage has been constructed using tailings deposited from various locations around the storage. The coarser particles have accumulated near the perimeters while the fines have extended from the deposition point. This particle classification has produced a limited range of particle sizes, and the tailings are structureless and prone to erosion. Wind erosion is prevalent across the tailings dam surface and tailings movement in surrounding vegetation and sand dunes is occurring.

#### Geochemistry

Two samples of the tailings material were collected for tailings geochemical testwork. They were samples of coarse and fine tailings which were analysed to determine the nutrient and potential fertility status and to identify any significant toxicity to plants. The results (included in Appendix C) indicate that the two tailings are similar and they have a high pH and a high salinity. The salinity is due to high concentrations of soluble sodium, calcium and sulphate, and to a lesser extent elevated chloride. The cation exchange capacity and exchangeable cation content in both tailings were very low, and the nitrogen and phosphorus concentrations extremely low.

The total sulphur content of the samples is less than 0.5%S and consistent with the results discussed by NSR (Appendix B) . Although the acid neutralising capacity was not determined on the samples, the low sulphur content and very high inherent pH indicates that the tailings materials are non-acid forming and unlikely to result in acid conditions even in the long term.

Overall the results show that the tailings have a very low nutrient and fertility status and have a high salinity. These materials have a very low nutrient holding capacity and for direct revegetation it would be necessary to build up the organic matter content of the surface layer and leach salt from the surface. Regular applications of a complete fertilizer would be required.

The results of previous multi-element analyses by NSR Consultants (Appendix B) indicate that molybdenum (Mo), bismuth (Bi) and tungsten (wolfram) (W) are the only elements which are significantly elevated in tailings. These elements have a low toxicity status and are generally considered not to be environmentally significant unless present in extremely high concentrations and available to plants or soluble. Although molybdenum is an essential element for plants and animals, excessive uptake of Mo by plants can result in toxicity problems in grazing animals.

Investigation criteria for concentrations of W and Bi in soils are not available in the literature which reflects the low toxicity of these elements. The investigation criteria for Mo is 20mg/kg and the concentration in the tailings is in the order of 250 - 350 mg/kg. However, the clay cover will restrict the availability to plants and animals, although monitoring should be carried out to see if unacceptable levels are accumulating in vegetation.

### 5.3.10.3 Stability

A tailings dam abandonment review has been conducted. Section 7 addressed this issue.

#### Seawall Tailings Dam

The surface of the Sea Wall Tailings storage is actively eroding and wind blown tailings are encroaching on areas of native vegetation adjoining the tailings storage. A section of the sea wall composed of tailings is also actively eroding by wind and water. The remaining sections of the sea wall are well vegetated and do not require additional works.

The abandonment review concluded that both the Separation Wall and the Sea Wall are stable.

#### Bold Head Road Tailings Dam

The surface of the storage is mostly water covered with some areas of exposed tailings. Because this area is relatively sheltered these tailings are not eroding. Active wind erosion is evident in the sand borrow pit.

The abandonment review concluded that the embankment is stable, but with some erosion occuring on the downstream headwall.

### 5.3.10.4 Rehabilitation Treatment

#### Seawall Tailings Dam TD1

The principal concern with the tailings is the physical stability of the tailings dam surface, as the tailings are chemically inert. A cover is required to both stabilize the surface against wind erosion and to provide a medium for revegetation.

The Separation Wall and the Sea Wall embankments will be used as a source of cover for the tailings surface. Overburden and clay from these sources will be placed in mounds (0.3-1.0 m in height) across the tailings deposit in a north-south direction perpendicular to the prevailing wind condition, at 15-20 m intervals. (see Figures 10 and 11). The principal reason behind the parallel mounds is to gain access on the tailings surface. The mounds will also act to control exposure to wind.

As the tailings dry they may become more accessible and they may be able to support vehicular traffic. If this situation arises, fewer mounds will be required.

The mounds will provide access for the placement of clay from the designated soil pit, into the sections between the mounds to a depth of 0.3m.

Other materials will be sourced from additional borrow areas. This will include the main clay borrow pit near the Power Station access road, areas adjoining the Bold Head access road, and any other suitable materials located in proximity to the tailings surface.

Revegetation works will involve the application of the coastal native seed mix applied by hydroseeding.

The outer face of the Seawall Embankment will have a bench constructed in the eroding tailings, inorder to control existing erosion. The bench will be constructed by a excavator reaching down from the access road as indicated in Figure 12. The bench and created batters will be covered by clay.

General fill (0.3-1.0m) operating as firm standing for clay replacement

Clay replacement between mounds to a depth of 0.3m

FOR SECTION DRAWING SEE FIGURE 11

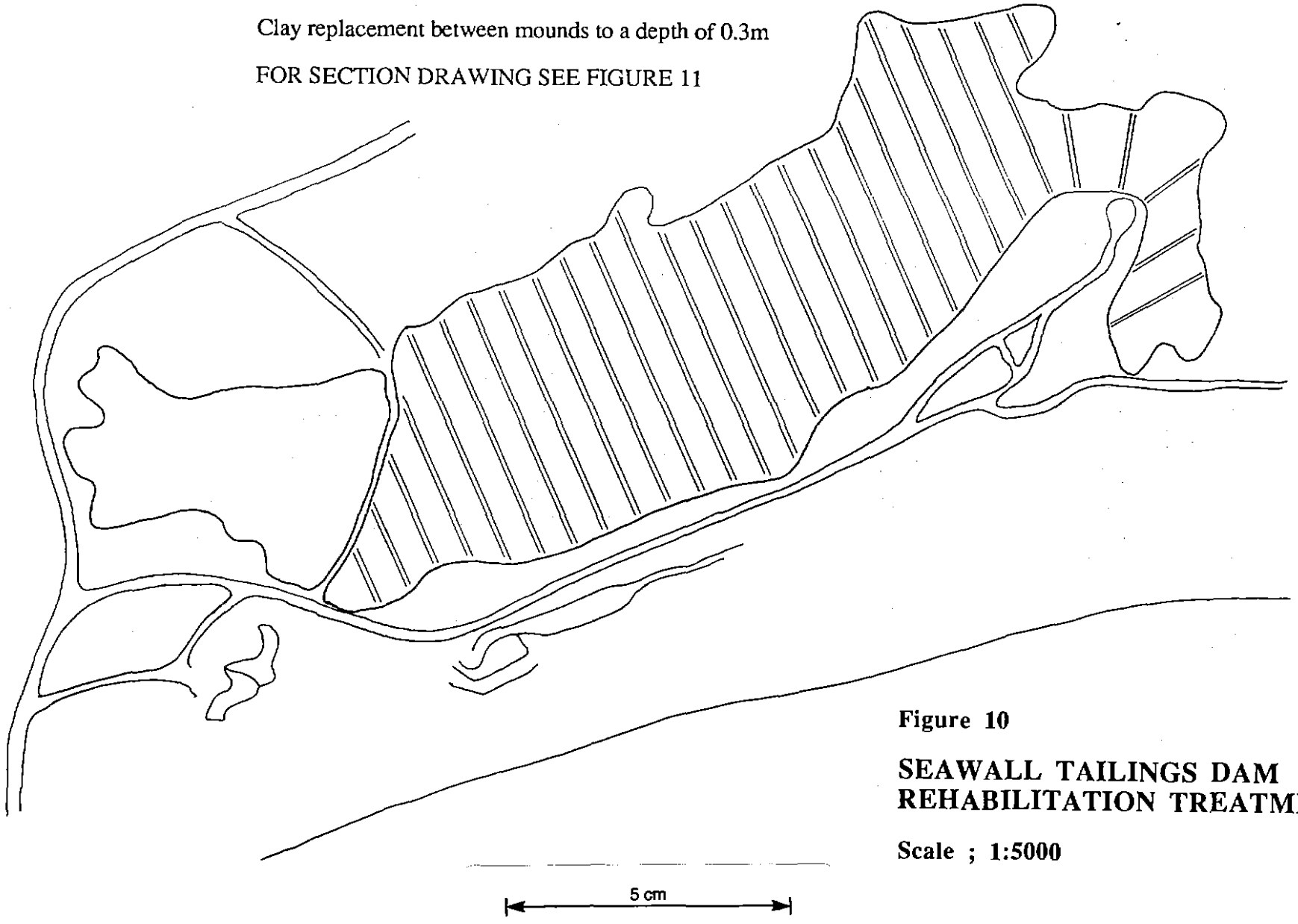



**Figure 10**

**SEAWALL TAILINGS DAM REHABILITATION TREATMENT**

**Scale ; 1:5000**

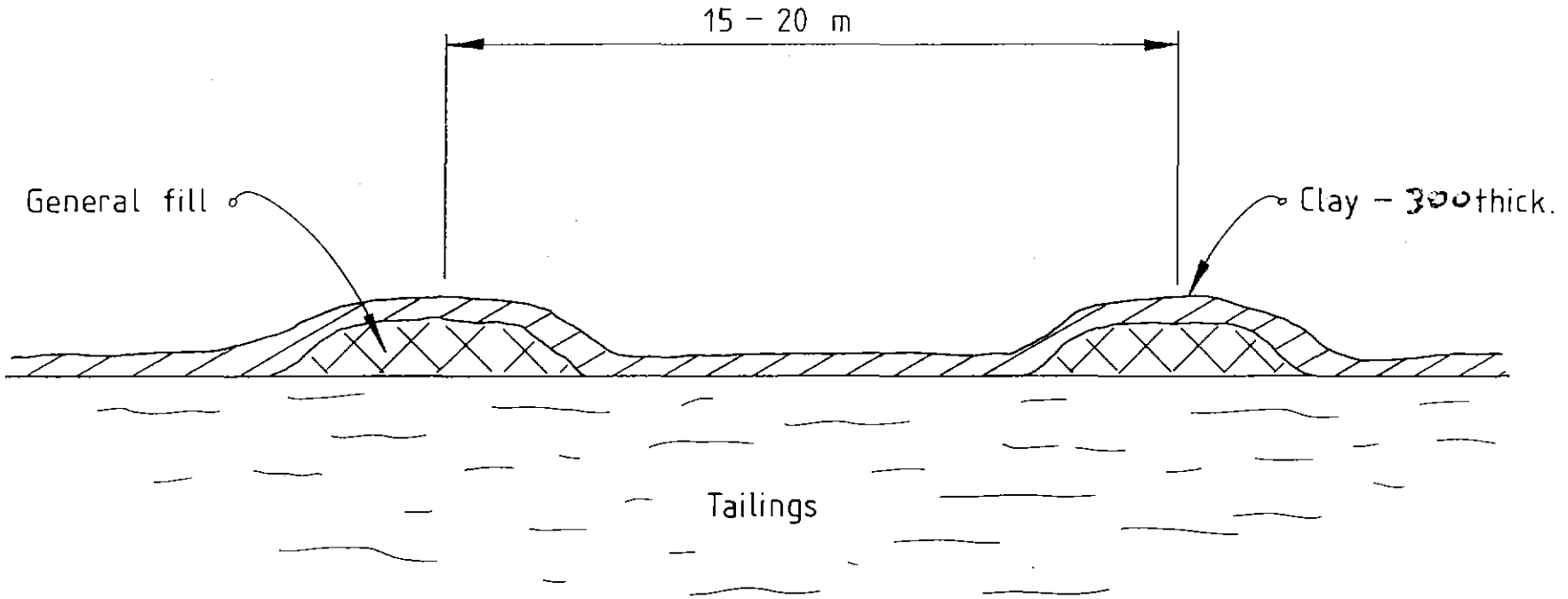



**Figure 11**

**SEAWALL TAILINGS DAM**
**REHABILITATION TREATMENT - Section**

**Scale ; not to scale**

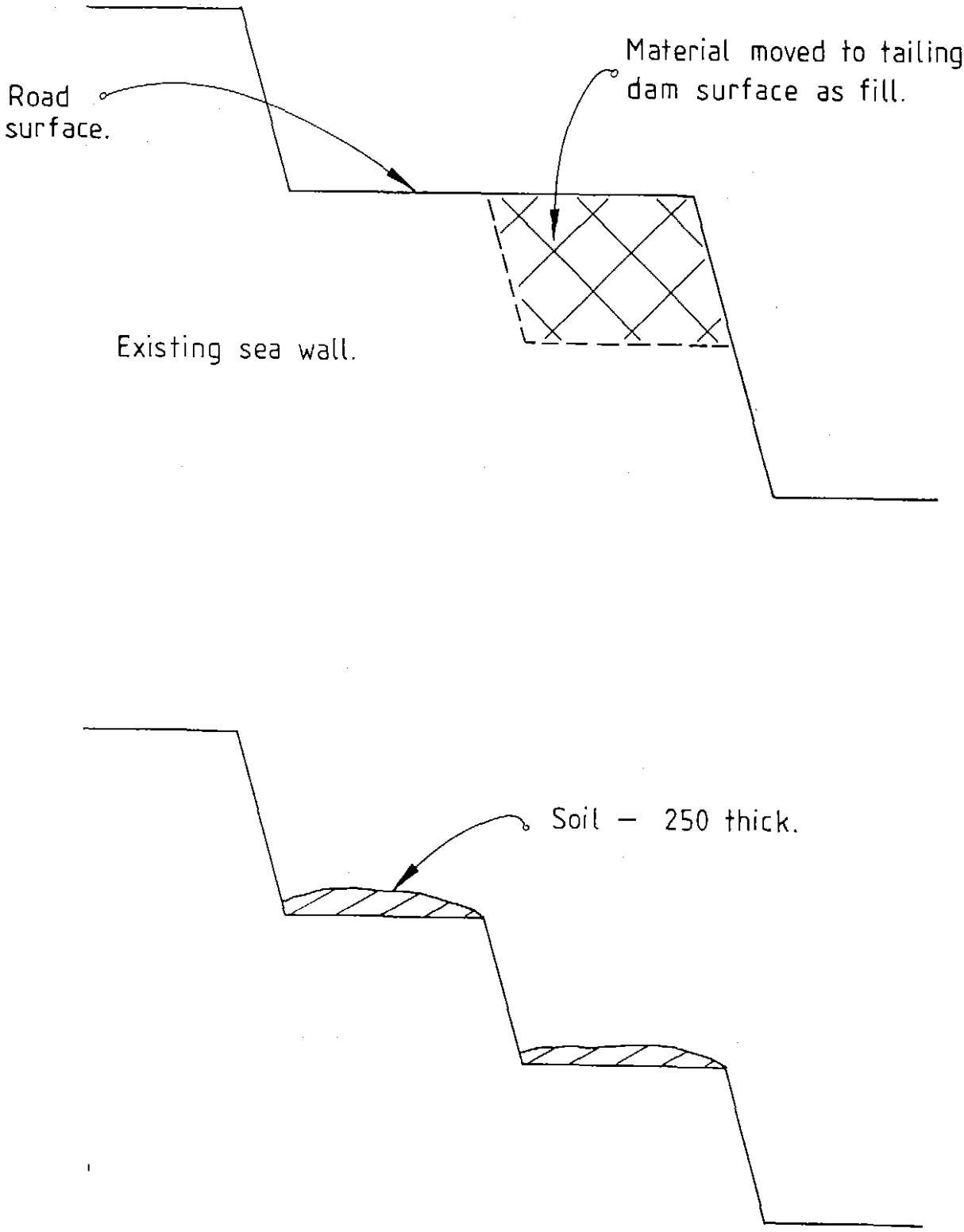



**Figure 12**

**SEA WALL BENCH TREATMENT**

**Scale : not to scale**

The coastal grass stabilisation mix will be sown by hydromulching. Seedlings will also be planted.

The tailings pipeline will be removed and rubbish removed to the disposal site. The access roads and disturbed areas will be soiled, especially where wind erosion is evident, the sites ripped and revegetated by hydroseeding with the coastal native seed mixture, and access closed

The main access road to the sea wall will remain for maintenance.

### Bold Head Road Tailings Dam TD 4

The rehabilitation aim for this storage is to maintain the current water impoundment and to create a wetland.

Any accessible exposed tailings above the water level will be covered by clay to a minimum depth of 0.25 m.

Revegetation will involve the placement of rooted Juncus cuttings in the storage and the direct seeding of disturbances above the water level with the coastal native mix applied by hydroseeding.

The road embankment and culvert will remain with some additional rockfill protection on the downstream side near the culvert exit.

The sand borrow pit and access roads will be soiled, especially where wind erosion is evident, the floor ripped and revegetated by hydroseeding with the coastal native seed mixture. Access will be closed, unless required for maintenance.

## 5.3.11 CLAY BORROW AREAS CB1, 2, 3 (Figures 3,5)

Large amounts of clay materials will be required for final cover for many areas as a rooting medium, prior to revegetation. The required clay characteristics are defined in the specifications (E8). The location of the borrow areas are shown in Figures 3 and 5.

### 5.3.11.1 Description

### Borrow Area 1 CB1

A new borrow pit will be developed in the area adjoining the Power Station access road in order to provide a clay cover for sites within a radius of approximately 2 km. This will include the tailings dam surface, and also probably the mill area (this will depend on the amount of suitable material recovered from the other borrow areas).

A test pit in this location indicated that the material in question is orange-red in colouration and up to 3 m in depth.

Approximately 30,000 m3 of clays will be required to complete the cover for the tailings surface and for general cover in the Mill area, Dolphin open cut, and other areas.

### Borrow Area 2 Sea Dump- MA3

The Sea Dump contains pockets of orange clay that will be suitable for final cover. These materials will be stockpiled separately during the reshaping and recovery of

fill from the Sea Dump and will be used for covering the surface if not required elsewhere.

### Borrow Area 3 CB3

Borrow Area 3 is located on the south-eastern side of the Dolphin Open Cut in the original overburden dump.

The quality of this material is poorer than that from Borrow Area 1. However, it will support plant growth.

The removal of material from this site will require supervision to ensure the quality of material is suitable for rehabilitation. As a general guideline any material composed of less than 50% clay will be avoided. These materials will be used for clay cover in this proximity.

The material composed of a large proportion of rock can be used to pack erosion gullies such as those that exist at the gravel pit (MD3).

#### 5.3.11.2 Borrow Pit Rehabilitation Treatment

Any topsoil will be stripped to the sides of the excavation, for later replacement. The full depth of clays will be removed, by benching (at a maximum 3m intervals), but a thickness of at least 150mm should be left above any rock or indurated material to assist revegetation. The pits will be revegetated by profiling, deep ripping, topsoil replacement, seeding and fertilising. A barrier mound or drain will divert water from around the pits.

Borrow area 1 will be hydroseeded with the inland pasture mix, Borrow area 2, the Sea Dump by hydromulching with the coastal grass stabilisation mix and Borrow area 3 by hydromulching the inland natives grass mix.

### 5.3.12 GENERAL FILL BORROW AREAS

#### 5.3.12.1 Description

General fill is required for an intermediate cover over rock or compacted materials and/or concrete prior to the placement of a clay cover, in order to conserve the latter materials.

Suitable materials will consist of generally unconsolidated materials, such as sands, gravels, rock fragments or a mixture. It will generally have less than 50% clay. These materials will be sourced from the local area where required - such as in the mill area, general fill areas, and the sea dump. In most cases it is expected that this material will be found in proximity to the site where it is required in order to reduce cartage costs.

The major areas where general fill will be required is the tailings dam surface, and for the covering of concrete foundations in the mill area.

#### 5.3.12.2 Borrow Area Rehabilitation Treatment

The borrow area rehabilitation treatment will be appropriate to the site from which it is taken, and the treatment specified.

## 5.3.13 GRASSY TOWNSHIP (GT)

### 5.3.13.1 Description

The township consists of the houses and associated facilities and services located on the hill overlooking the mine site. It consists of ;

residences
school
picture theatre
tennis, basketball, squash and badminton courts
stores
indoor swimming pool
single men's quarters
staff quarters

The township has the typical urban services, such as stormwater pipelines, roads, gutters, electrical and water supply, including a water treatment plant. The township is sewered with a sewerage treatment plant.

The Company has progressively been selling houses in the township. The majority of these sites have been rehabilitated.

### 5.3.13.2 Stability and Revegetation Potential

Soil is available in the gardens and lawns for the rehabilitation of the residences and therefore the rehabilitation potential is high.

The shops and recreational facilities, their associated car parks and the roads and curbing have a low rehabilitation potential due to compaction and large areas of concrete and bitumen.

The conversion of the site towards a native vegetation cover is reduced by the presence of exotic grasses.

As the site is relatively level and is proportionally well vegetated, the stability of the site is satisfactory with low erosion potential. There are no long term concerns with the site, other than the potential for contamination from fuel tanks at the commercial centre, and possibly one other location.

### 5.3.13.3 Rehabilitation Treatment

KIS is currently in final negotiations with a prospective purchaser of the township, as a whole. When these are concluded the freehold title to the land enclosing the township area will be sold and the Mining Lease over the area relinquished.

The rehabilitation responsibilities will then reside with the purchaser, who may be required to provide some form of guarantees to satisfy the Council and Government authorities.

## 5.3.14 POWER STATION COMPLEX PS 1,2,3,4,5 (Figure 5)

### 5.3.14.1 Description

The Power Station is located on the hillside overlooking the tailings dams. The complex is comprised of;

Power Station 11.4MW, comprising an asbestos sheet clad steel framed building housing the diesel generation units, transformer yard and steel fuel tanks.
Two large above ground fuel tanks
Warehouse Store /Workshop building- asbestos cement clad, steel framed
Steel clad and framed workshop, with an associated salvage machinery dump.
Sewerage Pond
Oil Fire Training area

Services associated with the complex included fencing and electrical transmission lines.

#### 5.3.14.2 Rehabilitation Potential and Stability

The area is stable with revegetation potentials low for the concrete foundations and hardstanding compacted areas. Fuel and oil contaminated areas are common around the fuel facilities.

#### 5.3.14.3 Rehabilitation Treatment

Some of the buildings may remain intact for farm use. In particular the warehouse buildings will remain. All salvageable materials are to be recovered and sold or removed to the rubbish dump with other waste products. Surface services such as power cables, fences etc will be removed. Concrete foundations will be treated by covering and /or removal. The sewage pond will be filled in and the oil training pond similarly filled. These areas will then be profiled.

Fuel and oil contaminated gravels and soils will be excavated and buried in a clay pit dug on site.

Compacted areas will be covered with clay and ripped and the area revegetated hydroseeding with the inland grass mix.

The major access road will remain for access to the buildings and farm use.

### 5.3.15 BOLD HEAD MINE SITE BH 1,2,3 (Figure 5)

#### 5.3.15.1 Description

The Bold Head mine site consists of the underground access portal, waste rock dump, ventilation shaft, open cut, crusher, and associated surface facilities such as an explosives magazine, and site buildings.

#### 5.3.15.2 Rehabilitation Potential and Stability

The area is stable with revegetation potentials low for the hardstanding compacted areas and waste rock dumps. Stockpiles of soil are available for revegetation purposes.

The portal and ventilation shafts are a potential safety hazard.

#### 5.3.15.3 Rehabilitation Treatment

Safety provisions for abandonment will involve the bunding of the portal area, and the capping of the ventilation shaft.

Buildings, structures and fences will be removed and general refuse cleaned up and either buried on site or dumped in the portal below water level. This includes refuse

over the waste rock dump batter. The portal itself will remain as a water resource. Concrete slabs will be broken up and removed or cracked and covered in accordance with the specifications.
The open cut will be used as a disposal site for waste materials including adjacent rock. The area will be profiled and topsoil placed on the finished surface.

The stockpile area and access roads in the portal area will be covered with clay and ripped. The face of the waste rock batter will be treated by tipping clay over the batter to a depth of 0.15 to 0.2 meters.

Revegetation will consist of hydroseeding of pasture species and native species as identified in Tables 1 and 2.

Access roads will remain to the portal and to Graham's Road. The other roads will be closed and rehabilitated.

### 5.3.16 ACCESS ROADS (Figures 3,4,5)

#### 5.3.16.1 Description

These are the main access roads to the Dolphin mine site and mill area, the Power Station, Bold Head mine site and other minor access roads to the water storage dams, the tailings storages and miscellaneous services.

The roads vary from wide and well constructed with good drainage control to narrow unmade tracks.

Some of these roads will be retained for permanent access, and some to remain temporarily open for maintenance purposes. The remainder will be closed and rehabilitated.

The roads nominated for permanent and temporary retention are shown on Figure 13.

The roads to remain as permanent access are:

The main road from Grassy Township through the mine to the Power Station and Bold Head area and surrounding farm lands.
Access through the mill site to the Upper Grassy Dam.
The Sand Blow Road for general access and fire control.
Access to the top of the Open Cut as a viewing area

The roads to be retained for maintenance and later rehabilitation are:

Access along the sea wall.
Access to the Bold Head Mine Site

Roads nominated for closure are :

All other Mill and Office access roads.
All Dolphin Open Cut access roads.
Sea Dump access roads.
Access from the Dolphin Open Cut works office to the Grassy Port facility

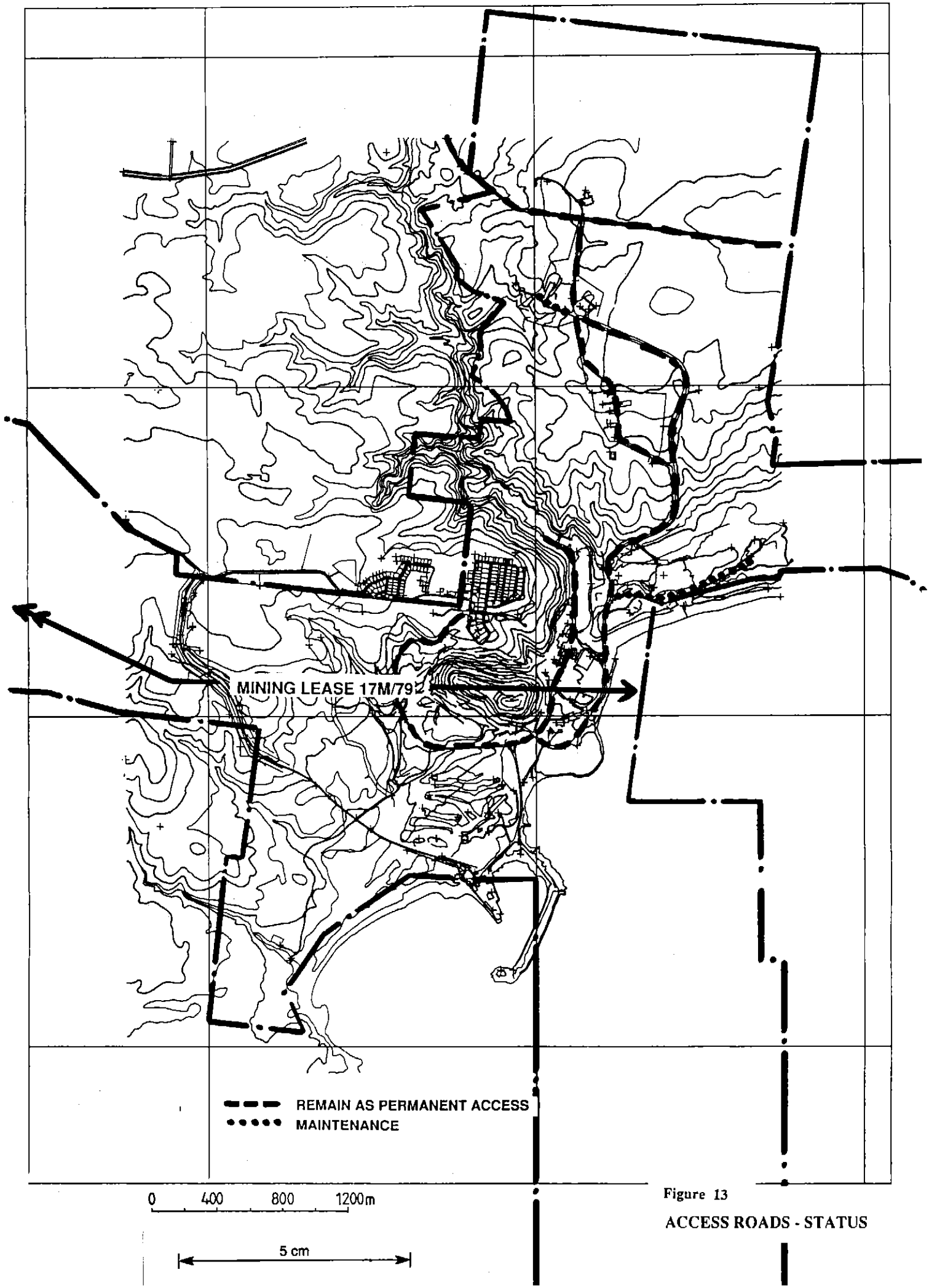



Figure 13

ACCESS ROADS - STATUS

### 5.3.16.2 Rehabilitation Potential and Stability

Roads by their nature are compacted and therefore they have a low rehabilitation potential. Their potential can be increased by ripping, drainage construction and soiling.

Roads are composed of compacted unconsolidated material which intersect catchment discharge. As a result roads are not stable in the long-term. Culvert blockage will also occur following the cessation of maintenance works and the erosion potential will increase.

### 5.3.16.3 Rehabilitation Treatment

The rehabilitation of the roads will involve the implementation of structures that will ensure long-term stability and finally, complete closure

The road surfaces will be ripped and drainage grips constructed at regular intervals along the road length in order to divert and disperse catchment discharge.

The major roads will have clays applied from the borrow pits while minor tracks will be re-soiled by the recovery of any windrows of material adjacent to the track side.

Revegetation of the roads will be related to the treatment of the surrounding site.

## 5.3.17 MISCELLANEOUS DISTURBANCES MD (Figure 3,4)

The balance of the area contains a number of miscellaneous disturbances.

These include the Gate House area, the overburden dump which adjoins the main access road, the gravel pit, the Golf Course tailings deposit, fire trails and the Bold Hill Road cut batter.

### 5.3.17.1 Gate House Area MD1 (Figure 3)

This comprises the buildings, and structures in the area near the gate house. This includes the gate, gatehouse and miscellaneous office buildings in the area. Also included are hardstanding areas and access roads.

The office building and all other surface structures will be sold and removed, or disposed of in the refuse dump. Concrete foundations will be treated by either removal or cracking and covering.

The whole site including roads and grassed areas will be ripped. Clay will be placed on grass deficient areas.

Revegetation will involve the application of the coastal stabilization mix and applied by hydroseeding. Existing grassed areas will have seedlings planted.

### 5.3.17.2 Overburden Dump MD2 (Figure 3)

The overburden dump is a stockpile of overburden from the original open cut workings it is formed in a high hill adjoining the access road. The dump is quite stable, except for some excavations and borrow areas near the Gate House.

The rehabilitation measures will involve the benching of the face followed by clay application.

Revegetation will involve the application of the coastal grass stabilisation mix by hydromulching. Seedlings will also be planted.

### 5.3.17.3 Gravel Pit Area MD3 (Figure 3)

The gravel pit is located to the south of the open cut with access off the main access road. Much of the disturbance has revegetated naturally, however persistent erosion gullies, recent disturbances the floor of the pit and the associated roads require rehabilitation.

Rehabilitation will involve the construction of diversion bank above the pit, the stabilisation of the gullies with rock, ripping and general drainage control. Access roads will also be closed and rehabilitated.

The revegetation works will involve hydromulching with the inland native mix.

### 5.3.17.4 Golf Course Tailings MD 4 (Figure 3)

This tailings deposit is located to the north of the golf coarse. Wind and water erosion is evident.

The rehabilitation works will involve the packing of erosion gullies with rock, the construction of a diversion bank and coverage with clay.

Revegetation will involve the application of the coastal grass stabilisation mix by hydromulching. Addition tree planting would be a benefit.

### 5.3.17.5 Fire Trails MD 5 (Figure 3)

The fire trail to the south of the lease will colonise naturally once closed and stabilised.

Stabilisation will involve ripping and gripping where required. Supplementary seeding with the coastal native seed mix and tea tree slashing will assist recovery.

### 5.3.17.6 Bold Head Cut MD6 (Figure 4)

The Bold Head cut is located on the roadside of the main access road to the Bold Head Mine, to the south-west of the main tailings deposit.

Vegetation is establishing comparatively slowly. The cover will be enhanced by the application of the native inland seed mix by hydromulching. The hydromulch will prevent the seed from being washed from the surface by catchment discharge.

### 5.3.17.7 Explosives Magazine MD7 (Figure 3)

The explosives complex incorporates the magazine and associated roads and is located to the south of the Dolphin Open Cut with access off the main access road.

The rehabilitation of the site will involve the removal of the magazine, the ripping and gripping of all tracks and associated roads and the application of clay on all soil deficient sites.

The area will be revegetated by the application of the inland native seed mix by hydroseeding.

# 6.0 WATER QUALITY ISSUES

Water samples were collected (together with sediment from the Lower Grassy storage) by NSR Consultants in the Dolphin Open Pit, Lower Grassy Dam, Upper Grassy Dam, Bold Hill Tailings Dam and the Bold Head Portal in February 1991. The results are included in their report in Appendix B.

Discharges from the mine have consisted of the tailings dams overflows which flow into the Lower Grassy Dam and then to the ocean. These discharges met the Tasmanian effluent standards for discharge to coastal waters. The water quality of the tailings dam waters also met the standards except for suspended solids.

Except for mercury (Hg), all results meet the AWRC ambient criteria for the protection of aquatic ecosystems. Mercury is elevated in the open pit, Bold Head portal and both the Upper and Lower Grassy Dams. The Upper Grassy Dam is filled by natural drainage except for a small proportion from Bold Hill mine water. Because this is also elevated, suggests that the Hg levels may be naturally elevated because of the geology of the area. However the Hg levels are all below drinking water standards. Elevated levels of bismuth and wolfram in the Bold Head tailings water and the Lower Grassy dam reflect both the levels of sediment in the water and some dissolved metals. Both elements are of low toxicity and not of concern.

The results confirm the tailings chemistry results which indicate (see Section 5.3.10.2) that there are no toxicity or leachate concerns with the tailings, except for molybdenum buildup in vegetation.

As the sediment in the Lower Grassy Dam settles and is diluted by the Grassy River flows, water quality will improve and is expected to meet drinking water standards and aquatic ambient criteria (with the exception of mercury which may be naturally elevated).

# 7.0 TAILINGS DAM ABANDONMENT ISSUES

A water supply and tailings dams abandonment review has been conducted for all the water supply and tailings dams on the lease area. The report, by Consulting Engineers Thompson and Brett Pty Ltd ( King Island Scheelite Water Supply and Tailings Dams Abandonment Review, May 1990) has been submitted to the Department of Resources and Energy.

The report considered the design, construction and performance of the dams, assesses their suitability for abandonment and where necessary recommended works required to bring the dams to a suitable standard for abandonment.

The recommendations in the report have been adopted and included in the Plan. They are identified in the relevant Site Plan. The major conclusions and recommendations are summarized below.

## Upper Grassy Dam

This dam was initially designated as high hazard by earlier dam safety reviews. Hazard ratings are based on the consequences of possible failure and the loss of life, economic loss, environmental effects and repair responsibility.

The current study has re-evaluated the dam hazard and given the dam a low hazard rating. Previous flood estimates were also re-evaluated and found to be too high.

The dam is now considered to be stable, have an adequate spillway capacity and to be suitable for abandonment with the following works;

general site cleanup

exposing the downstream outlet pipe valve and excavation of an outlet channel.

## Lower Grassy Dam

This dam has only a low embankment with a concrete outlet weir. It is stable and below the referable dam size. The weir is to be buttressed to form a safe spillway. The culvert under the Bold Hill access road is adequate but a bypass channel was recommended to divert flows should the culvert be blocked, or collapse.

## Bold Head Road Tailings Dam

This dam is also stable and outlet of sufficient size and in good condition, except for some downstream erosion around the outlet pipe. It was recommended that this area be buttressed with rock.

## Separation Wall

This embankment was constructed in stages and possibly over tailings. As the wall is to be removed as a source of cover no other recommendations were made.

## Sea Wall

This embankment is a rockfill embankment with an upstream clay zone. The embankment is stable and no specific works were recommended other than those for rehabilitation.

### Future Responsibility and Ongoing Survelliance Reports

Following final inspection and approval of works and eventual mining lease relinguishment, the dams will revert to private ownership and be subject to the requirements of legislation covering such dams. Both the Upper Grassy Dam and the Bold Head Road Tailings Dam will be classified as low hazard referable dams requiring surveillance reports at 5 year intervals.

# 8.0 PLAN IMPLEMENTATION, MONITORING AND MAINTENANCE

## 8.1 PLAN IMPLEMENTATION

KIS have commenced a programme of the sale of equipment and facilities, salvage and demolition of the remaining material. The Auction sale was held in April , and the purchasers have a three (3) month period to August 1991 to remove their purchases.

The proposed programme implementation of the Plan is as follows;

| | |
|---|---|
| Sale and removal of equipment, buildings, etc | April - Aug.1991 |
| Site demolition and cleanup, site preparation | Sept 1991- Jan 1992 |
| Revegetation | April 1992- June 1992 |

## 8.2 MONITORING

Monitoring will be required; firstly to establish the success of the rehabilitation work, secondly to determine any follow up maintenance required, and thirdly to determine whether the rehabilitation is satisfactory for the purposes of obtaining a certificate of acceptance (and release) from the Director of Environmental Control.

Monitoring will include revegetation success and also stability, in accordance with the criteria discussed in Section 4. This will include water quality monitoring.

### 8.2.1 Revegetation

Revegetation success can be measured by a plant survival rate - such as the general criteria adopted by the Department of Environment and Planning (they have a suggested a rate of 1 tree per 1to 3 $m^2$).

While such measures are a valuable guide, it is proposed that a less quantitative approach be adopted. This would involve initial inspections followed by annual inspection by representatives of the Department of Mines and Energy, Department of Environment and Planning, the Company (and its representatives), and other experts as appropriate. Such a group have the experience and expertise to determine on site the acceptability of the rehabilitation work and identify areas for additional treatment. It can also certify those areas which have satisfactorily been rehabilitated under Section 20B of the Environment Protection Amendment Act (No.2) 1984.

### 8.2.2 Water Monitoring

Water monitoring will include sampling from the Open Cut, tailings dam discharge, and at the road culvert. Principal concerns are with suspended solids and sampling will be undertaken to monitor changes in sediment levels as revegetation becomes effective. Selected samples will include metal levels.

## 8.3 MAINTENANCE

The task of stabilising and then establishing a permanent self sustaining vegetation cover will be followed by a maintenance period. KIS is proposing to retain a Mining Lease over the area and a Licence to Operate Scheduled Premises. While these leases and licences are current, they will be required by the conditions to both monitor the condition of the rehabilitated areas and to maintain these areas until they have been certified as satisfactorily rehabilitated and a certificate has been issued.

The maintenance programme will take into account the following;

- Replanting / reseeding - areas which have failed to revegetate will require a follow up treatment
- Fertiliser application - a single application is unlikely to be sufficient to maintain the plant nutritional needs in some areas.(see Sect 4.4)
- Erosion control and stability - affected areas impacting on water quality may need remedial works

Plate 5.1 Dolphin Open Pit

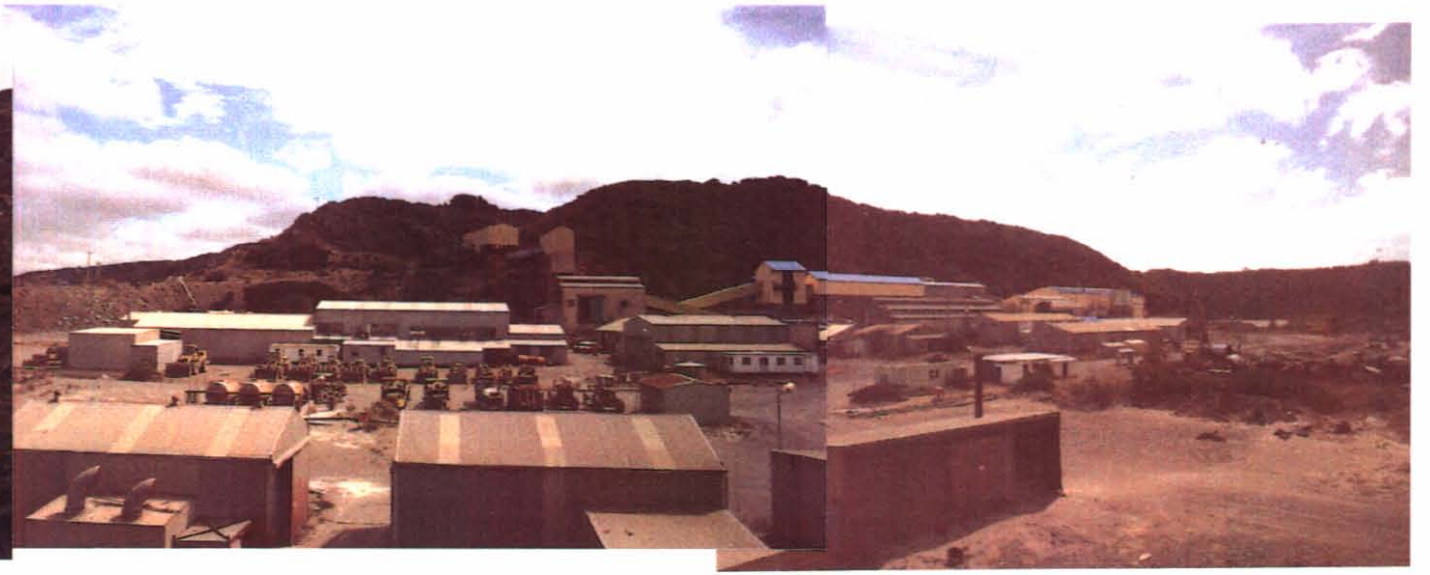


Plate 5.2 Mill Site - North View

Plate 5.3 Crusher Foundations

Plate 5.4 Creek Area

Plate 5.7 Seawall Embankment



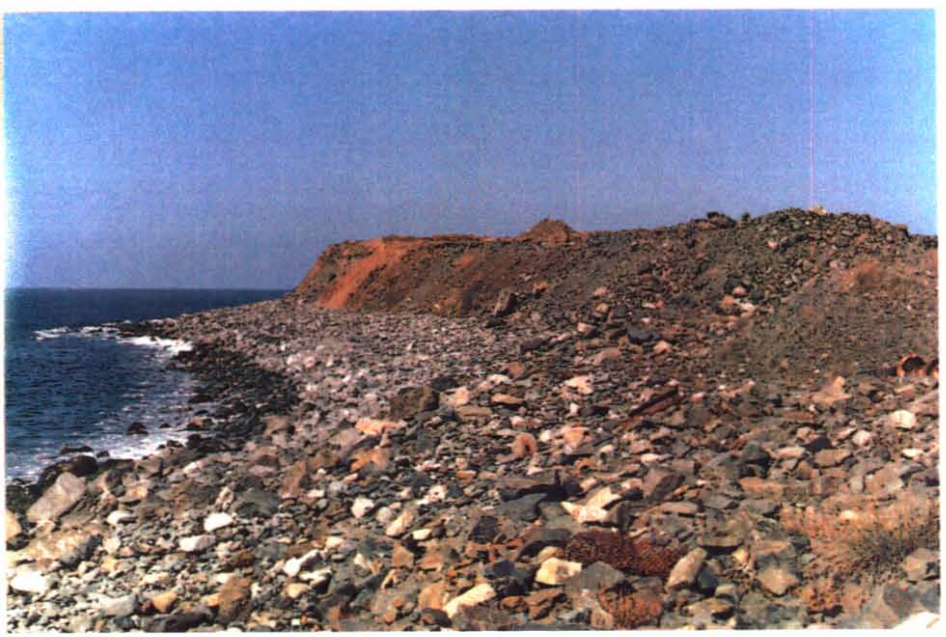


Plate 5.5 Sea Dump

Plate 5.6 Sea Wall Tailings Dam - Surface

# APPENDIX A - REHABILITATION SPECIFICATIONS

These specifications are indexed to Tables 1 and 2.

## DEMOLITION AND CLEAN UP = D

### D 1 : Asbestos Sheeting Removal

All asbestos based products will be removed for burial at the existing rubbish tip . The location of the dump is shown in Figure 3.

The existing tip site is adjacent to a 10 m exposed face composed of sand. The asbestos from the mill will be placed at the base of the exposed face. The face will be collapsed over the asbestos.

Prior to the placement of the asbestos the topsoil at the top of the dune is to be windrowed for future use in the rehabilitation of the site. Any soil deficiencies are be made up of material from the nearby borrow pit.

### D 2 : Salvageable Material

All valuable materials will be salvaged or sold.

### D 3 : Uncontaminated Waste Disposal

Unsaleable and unsalvageable plant, buildings and equipment will be demolished and removed from all sites requiring rehabilitation to a disposal site. These sites include;

the general rubbish dump
the Mill rubbish dump
the lower levels of the Dolphin Open Pit
the tailings dam
the Bold Head Portal and open cut
excavations for this purpose constructed on site

All rubbish disposed of on the surface will be covered with a minimum of 1.5 m of overburden followed by 0.25m of clay.

### D 4 : Services Removal

Services such as powerlines, pipelines, electrical cable and fences will be salvaged, recovered and disposed of at the waste disposal site. Services which are underground will be buried and in left in place.

### D 5 : Oil and Chemical Disposal

Oil and oil contaminated materials will be removed to the designated hazardous material disposal site. These sites will consist of an excavated or constructed clay lined rubbish dump.

These materials include contaminated materials and machinery and equipment containing petroleum products such as lubricating oils. Greases are stable and are unlikely to be a contamination hazard.

# EARTHWORKS = E

## E 1 : Profiling

Profiling involves the contouring and re-shaping of the mounds of waste and tailings in order to remove unnatural contrasts and to create a more natural landform. Profiling should be use to improve site drainage and reducing potential erosion problems.

## E 2 : Untreatable Concrete

Concrete structure too large to adequately cover, should remain intact. All metal protrusions will be cut off and buried. General fill will be pushed up to the structure as shown in Figure A1. The fill will then be covered with clay and revegetated.

## E 3 : Large Unbreakable Concrete Slabs

Large unbreakable concrete slabs are to be left intact and covered with 0.5 m of gravel/overburden followed by 0.2-0.3 m of clay.

## E 4 : Breakable Concrete Slabs

Shallow concrete slabs will be broken up by dozer or excavator and covered by 0.3 m of gravel/overburden followed by 0.2-0.3 m of clay.

## E 5 : Removable Concrete Slabs

Small concrete slabs will be removed to the waste disposal site.

## E 6 : Tailings

The tailings deposit is subjected to constant erosion by wind. The disturbance is extending with time. In order to combat wind erosion of the tailings, general fill and clay from the embankments and other sources will be placed in mounds (0.3-1.0 m in height) across the tailings deposit in a north - south direction perpendicular to the prevailing wind directions, at 15-20 m intervals, as indicated in Figures 10 and 11.

The mound will also provide access for the placement of clay from the designated clay pit into the sections between the mounds to a depth of 0.2m.

## E 7 : Ripping

Ripping assists plant development by aerating the soil, increasing water infiltration and removing the physical barrier to the plant roots. Surface runoff and consequently erosion is also reduced.

Areas composed of compacted fill such as the roads, and car parks etc. will be contour ripped at 1-2 m intervals to a depth 0.3-0.4m.

Where sand and wind blast is a major problem, such at the coastal fringe, all ripping is to be conducted parallel to the shoreline.

Contour ripping will be conducted where water runoff is a major source of erosion.

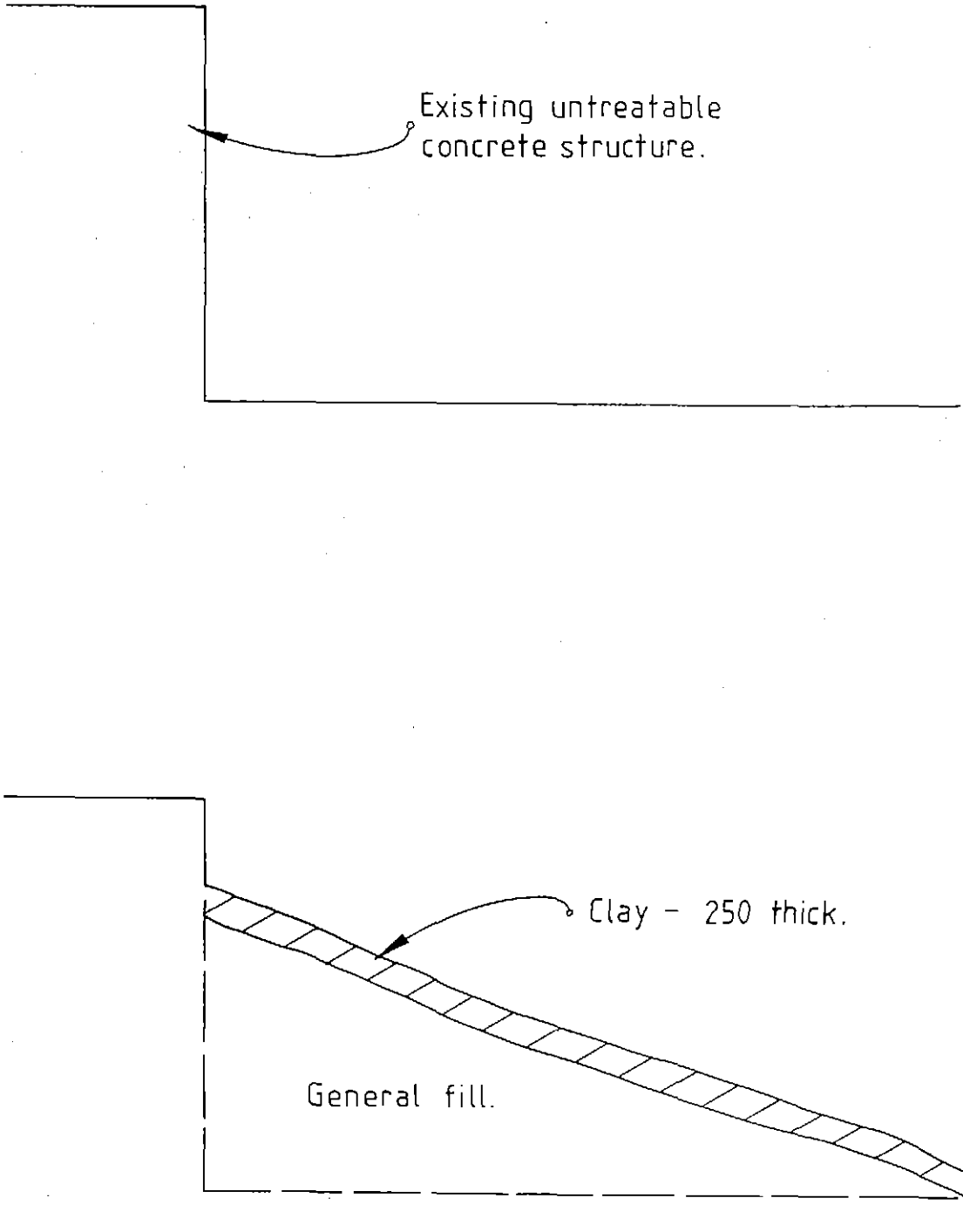



**Figure A1**

**CONCRETE FOUNDATION TREATMENT**

**Scale ; not to scale**

### E 8 : General Soil Replacement

Many of the areas composed principally of sand, tailings and gravel fill are either showing signs of wind erosion and/or they are nutrient and structurally poor. Clay from the designated borrow areas have a much greater capacity to support and sustain plant growth without continued maintenance. To help alleviate these problems clay will be spread to an average depth of 0.25m unless specified in the individual site prescriptions.

To assist in the recognition of the materials suitable for rehabilitation the following guidelines are provided.

"Clays" are those materials composed principally of well structured clay, containing little or no sand and gravel, that are weather yellow-orange-red in colouration and are obtained from the identified borrow pits in Figure 3,4,5.

The location of the clay borrow areas are shown in Figure 3,4,5 and they are discussed in greater detail under the individual Site Prescriptions.

### E 9 : General Fill Replacement

Areas composed of unrippable materials and/or concrete will be covered with general fill to a depth of 0.3m unless specified differently in the site prescriptions. Fill placement is to be followed by clay coverage for revegetation purposes.

"General Fill" are defined as those materials composed of tailings, rock, sand, gravel with less than 50% clay. While they may be composed of unconsolidated materials, they are generally unsuitable for plant growth.

### E 10 : General Soil Replacement on Track Surfaces

Windrowed soils at the perimeter of the track will be returned where possible. The tracks will then be ripped. (Note a continuous rip line is to be avoided as it may lead to erosion).

### E 11 : Soiling Fill Batters and Scree Slopes

Batters composed of coarse rock or scree will be lightly top-dressed from above with clay.

### E 12 : Gripping

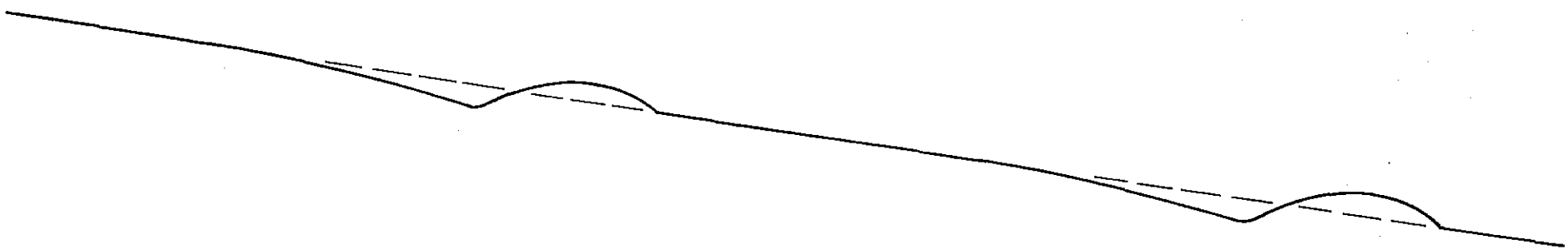
Track rehabilitation will also involve the implementation of drainage grips (see Figure A2). The grip is constructed perpendicular to the road and the lowest point of the grip must be higher than the discharge point.

As a general guide the road should be gripped at 10-20 m intervals on slopes greater than 10%, at 30-40 m intervals on slopes between 5-10% and on slopes less than 5%, at intervals of 50 m.

### E 13 : Diversion Banks

Diversion banks which divert water at 1-3% grade to stable sites will be constructed on slopping sites that are prone to erosion. These sites are identified in the site prescriptions.

# TYPICAL GRIPPING CONSTRUCTION



NOTES –

1. Water discharges 90° to road direction.
2. The lowest point of the grip mound must be higher than the discharge point.
3. ——— Denotes the original road surface.

**Figure A2**

**ROAD GRIPPING TREATMENT**

**Scale ; not to scale**

### E 14 : Benching

The development of the fill and clay pits will result in exposed faces. The faces will be benched at a vertical distance of 3 m. The bench surface will then be treated..

### E 15 : Water Storages

Some of the existing water storages will be left intact as either water supply, farm dam or for the creation of a wetland.

### E 16 : Wind "Blow-outs"

"Blow-outs" as a result of wind erosion will be packed with fill and clay to reduce additional erosion.

### E 17 : Erosion Gullies

Erosion gullies will be packed with coarse rock in order to prevent erosion.

# SAFETY = S

## S 1 : Bund construction

Pit and excavated areas will be bunded in accordance with the design shown in Figure A3.

## S 2 : Fence construction

Fences will be provided to restrict public and animal access.

## S 3 : Warning Signs

Warning signs will be erected in accordance with the Department of Mineral Resources and Energy requirements.

Bund wall minimum of 1.75m high . Side slopes 1:1.5
Constructed from excavated material and/or rock.
Covered with topsoil where available.

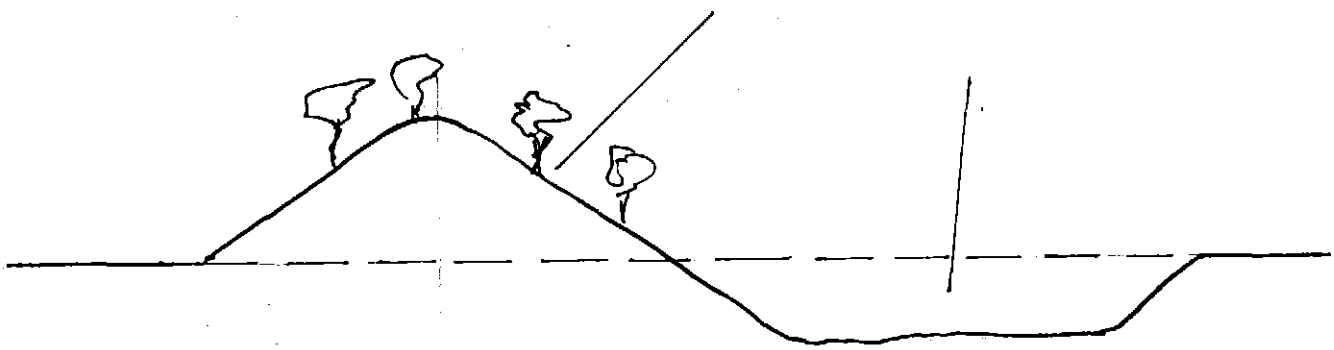


**Figure A3**

**DOLPHIN PIT BUND**

**Scale ; not to scale**

# REVEGETATION = R

## EXOTIC SPECIES AND FERTILIZER MIXES.

For continuity, the areas surrounded by improved pasture will be sown with similar species. However, the initial disturbance will be first treated with an exotic stabilisation mix which has the ability to rapidly colonise nutrient depleted sites. Once established after 2-3 years the sites are to be sown to an improved pasture mix.

Grasses will also be used for the stabilisation of coastal areas such as the Sea Dump.

### R 1 : Inland Stabilisation and Improved Pasture Mixes

### Stabilisation Mix

| | kg/ha |
|---|---|
| Browntop bent grass | 8 |
| Red creeping fescue | 5 |
| Ryegrass var. Victorian | 15 |
| Cocksfoot var. porto | 5 |
| White clover var. Huia | 10 |
| Sub clover var. Karradale | 10 |
| Ryecorn | 25 |

Apply the EZ, N:P:K fertilizer mix of 8:4:10 at 500kg/ha

### Improved Pasture Mix

| | kg/ha |
|---|---|
| Perennial ryegrass var Martlet | 9 |
| Hybrid ryegrass var Manawa | 2 |
| Cocksfoot var Porto | 2 |
| White clover var Huia | 2 |
| Red clover var Hamua | 2.5 |
| Sub clover var. Karradale | 3 |

Superphosphate + trace elements at 300kg/ha

### R2 : Coastal Stabilization Mix (to be applied to coastal sites covered with clay)

| | kg/ha |
|---|---|
| Seaside Bent | 5 |
| Ryegrass var. Victorian | 10 |
| Browntop bent | 10 |
| Red creeping fescue | 10 |
| White clover var Haifa | 10 |
| Sub clover var Karradale | 5 |
| *Ryecorn | 40 |

Apply the EZ, N:P:K fertilizer mix of 8:4:10 at 500kg/ha

## NATIVE SPECIES AND FERTILIZER MIXES

Native revegetation is best achieved by the use of the local provenance plant species, which are those species from the local area that are adapted to the local conditions. The gene pool is also preserved.

Native seed will be collected from the local area and used for direct seeding and the propagation of seedlings. The 1992 seedlings should be established from seed collected in 1991.

Two seed mixes are recommended one for sheltered areas away from coastal conditions and the other for exposed coastal sites..

Due to seasonal variation, some of the listed species may not be available. The short fall in seed from some species will be made up from the others listed.

Acacia seed should make up at least 25% of the applied seed mix and 50% of the seed will be heat treated prior to sowing.

In addition to the application of native seed, an exotic cover crop of either ryecorn (Secale cereale), Triticale or oats should be applied 10 kg/ha to the inland areas and 20 kg/ha for coastal sites.

The exact quantity of seed listed is only a guide based on the observed availability of local provenance material. Due to seasonal variation some of the listed species may not be available. The short fall in seed from some species will be made up from the others listed.

Seed short falls can be made up through the purchase of seed from commercial suppliers. However, the provenance of the seed must be similar to that of the Island.

**R 3 : Seed Mix for Inland Environs**

Rate of Application = 4 kg/ha

| | |
|---|---|
| Acacia melanoxylon | (blackwood) |
| Acacia mucronata | (narrow leaf wattle) |
| Acacia sophorae | (coastal wattle) |
| Dodonea viscosa | (native hop bush) |
| Eucalyptus globulus | (bluegum) |
| Eucalyptus ovata | (black gum |
| ~~Eucalyptus nitida~~ | ~~(Smithton peppermint)~~ |
| Eucalyptus viminalis | (white gum) |
| Leptospermum scoparium | (manuka) |
| Melaleuca ericifolia | (coastal paperbark) |
| Melaleuca squarrosa | (scented paperbark) |
| Myoporum insulare | (false boobyalla) |

+ Ryecorn @ 10kg/ha

Apply the EZ, N:P:K fertilizer mix of 8:4:10 at 300 kg/ha

**R 4 : Seed Mix for Coastal and Sandy Environs**

Rate of Application = 4 kg/ha

| | |
|---|---|
| Acacia mucronata | (narrow leaf wattle) |
| Acacia sophorae | (coastal wattle) |
| Dodonea viscosa | (native hop bush) |
| Eucalyptus globulus | (bluegum) |
| ~~Eucalyptus nitida~~ | ~~(Smithton peppermint)~~ |
| Eucalyptus viminalis | (white gum) |
| Leptospermum laevigatum | (coastal tea tree) |
| Leptospermum scoparium | (manuka) |
| Melaleuca ericifolia | (coastal paperbark) |

Myoporum insulare (false boobyalla)

+ Ryecorn @ 20 kg/ha

Apply the EZ, N:P:K fertilizer mix of 8:4:10 at 350 kg/ha

**R 5 : Seed and Fertilizer Application for Flat and Non - Erodible Areas.**

Hydroseeding (seed + fertiliser + water) is the proposed method for seed and fertilizer application on sites that are relatively stable that are not exposed or are covered with clay.

**R 6 : Seed and Fertilizer Application for Sloping and Potentially Erodible Areas.**

Hydromulching (seed + fertilizer + mulch + binder + water) is proposes for areas that may erode due to either wind or water, composed of sands and that are exposed to coastal conditions.

**R 7 : Tea Tree Slash**

Tea tree branches bearing fruit and if available on track sides, will be pulled over the track as a source of seed during site rehabilitation.

Seed application can be supplemented by the application of seed bearing tea tree brush. The branches act as a seed source and they will protect the germinating seedlings, even of other species.

The branches can also be used to protect against wind and water erosion.

**R 8 : Rooted Juncus Cuttings**

The revegetation of permanent wetlands will involve the placement of rooted Juncus cutting within the shallow sections of the storage.

**R 9 : Seedlings**

In order to apply an immediate treatment and to insure against harsh germination conditions such as drying coastal winds, some seedlings will be planted and protected by stakes and tree sleeves. Each seedling will be accompanied by a slow release fertilizer tablet.

# MAINTENANCE AND MONITORING = M

## M 1 : Annual Site Inspection

The areas undergoing rehabilitation will be monitored at regular intervals to determine if additional rehabilitation works are required. The inspections will include initial site inspections during and following site preparation and continue after 12 months on an annual basis and will continue until the site is suitably revegetated. The inspections will be conducted by representatives from the Company, the Mines Department and the Department of Environment and Planning and include safety aspects. Additional seed and fertilizer applications will be determined during this inspection. Areas of the Lease can also be deemed as "Satisfactorily Rehabilitated" and therefore not requiring additional works, following the combined inspection.

## M 2 : Supplementary Fertilizer

Applied fertilizers are often depleted from nutrient deficient soils within 1 to 2 years following initial application,particularly in sub-soils. Under such conditions additional maintenance fertilizer applications are required. As a general guide, maintenance fertilizer applications should be conducted at 2 to 3 year intervals on disturbed sites, for a period of up to 10 years.

The suggested mix is an EZ, N:P:K mix of an 8:4:10 at 250 kg/ha.

Maintenance fertilizer application will be determined at the annual site inspection.

## M 3 : Re-seeding

In some situations and due to harsh environmental conditions, certain areas of revegetation works may fail. Wind and water erosion may occur as a result of revegetation failure. If these situations arise remedial action will be required. The need for additional seeding should be assessed at the annual site inspection.

## M 4 : Water Quality Monitoring

Selected sites will be monitored to identify any changes in water quality . Monitoring will initially be two monthly and will be reduced to 6 monthly after the initial period. Monitoring will include general parameters, plus metals of interest - both dissolved and suspended.

## M 5 : Erosion and Drainage

Any areas of high erosion potential such as the Sea Dump and main drainage systems will require occassional checking for stability and erosion.

# APPENDIX B - NSR CONSULTANTS WATER QUALITY REPORT

King Island Scheelite Mine

# Water and Sediment Characterisation

## Attachment to Rehabilitation Objectives for Mine Decommissioning

CR 461
March 1991

Prepared by: NSR Environmental Consultants Pty Ltd
25 Burwood Road
Hawthorn, Victoria 3122

## Contents



## Figures



## Tables

## 1.0 Introduction

This report forms an attachment to the main report "Rehabilitation Objectives for Mine Decommissioning". The report identified a need for an assessment of the present quality of waters within the mineral lease for the following reasons:

- They are considered to be the most reliable indicators of future long-term quality.
- An estimate of long-term quality determines appropriate rehabilitation objectives and techniques for each water body.

Similarly, the quality of sediment contained in the Lower Grassy Dam was considered to be representative of material that may continue to be trapped there or eroded to the ocean if the embankment were decommissioned.

A sampling and analysis program was designed to characterise water and sediment within the mineral lease and this is described in the main report. The location of each sampling site is shown in Figure 1 of this report.

In addition, King Island Scheelite provided metallurgical data for use in predicting whether acid mine drainage from waste rock dumps or the tailings impoundment would be expected to occur. The prediction will be checked for agreement with present quality of waters within the mineral lease.

## 2.0 Results

### 2.1 Water

Environmental samples have been analysed for the following metals and general water quality indicators respectively:

- Iron (Fe), manganese (Mn), copper (Cu), cadmium (Cd), lead (Pb), zinc (Zn), arsenic (As), mercury (Hg), molybdenum (Mo), tungsten (W) and bismuth (Bi).

- pH, conductivity, alkalinity, total suspended solids (TSS), calcium (Ca), magnesium (Mg), sulphate (SO4); hardness has been calculated from the Ca and Mg data.

Results of water sample analysis are shown in Table 1 (metals) and Table 2 (general characteristics).

Assessment of the results for the water samples can be made by comparison with relevant standards and guidelines. These are:

- Tasmanian effluent standards: described in the Environment Protection (Water Pollution) Regulations 1974, these specify maximum permissible values for selected water quality indicators in effluent being discharged either to inland waters, bays or estuarine waters, or coastal waters.

- Australian Water Resources Council (AWRC) ambient criteria for the protection of aquatic ecosystems (1982): these are a set of criteria developed by the AWRC for nine trace metals. Maximum metal concentrations are specified to ensure acceptability for (i) domestic water supplies (ii) protection of Australian aquatic ecosystems (iii) livestock drinking waters and (iv) irrigation waters.

- National Health and Medical Research Council/Australian Water Resources Council (NHMRC/AWRC) guidelines for drinking water quality (1987): these are a set of criteria developed by the NHMRC/AWRC for a range of water quality indicators. Maximum concentrations are specified to ensure acceptability for domestic water supplies. These guidelines supersede the earlier AWRC criteria for domestic water supplies referred to above.

Major points to note from the results are:

- Highest total Fe, Mn, Cu, Pb, Zn, W and Bi values were obtained for samples from the Lower Grassy Dam and the Tailing Pond.

- The samples from the Lower Grassy Dam and the Tailing Pond also have the highest TSS levels, by at least a twenty-fold factor over the other samples; metals such as Fe, Mn and Pb are well known to be generally associated with particulate matter in aquatic systems.

- Filterable metal concentrations in samples, where both total and filterable levels were greater than detection limits, are generally considerably less (<50%) than the total concentrations. Exceptions to this are W levels in both the Lower Grassy Dam and the Tailing Pond, and Bi in the Tailing Pond.

A summary of comparisons between the analytical data and the relevant standards/guidelines (i.e., Tables 1 and 2) is shown in Tables 3 and 4.

In addition, multi-element scans were carried out on water samples from the Open Pit and Lower Grassy Dam and results are shown in Table 5. These results give a semi-quantitative indication of the elemental concentrations in the samples.

## 2.2 Sediment

The sediment sample from the Lower Grassy Dam was analysed for total Fe, Mn, Cu, Cd, Pb, Zn, As, Hg, Mo, W and Bi and the results are shown in Table 6. A multi-element scan was also carried out on the sediment sample and the semi-quantitative results are included in Table 6.

Assessment of the results for the sediment sample is by comparison with average crustal abundances and the calculation of elemental enrichment factors (EEFs), which are the ratios of the various elemental concentrations to the average crustal abundance of that element. An EEF greater than 5 is considered notable, but this is arbitrary and of no toxicological significance.

## 2.3 General

Average levels of sulphur in tailing and waste rock were between 0.06 and 0.08%, while average levels of carbonate in the same materials were between 16 and 18% (K. Ok, pers. comm.).

## 3.0 Discussion

The implications of the results are as follows:

### 3.1 Water

- The water quality is such that discharge is permissible under existing Tasmanian effluent standards for Open Pit, Upper Grassy Dam and Bold Head Portal water.

- The limiting parameter for the Lower Grassy Dam and Tailing Pond is TSS. The TSS concentration in the Lower Grassy Dam is such that compliance is attained for discharge to coastal, but not inland, waters. However, the stream running 200 m from the Lower Grassy Dam to the ocean is a storm water drain for part of the mine industrial area and it is probably most appropriate to adopt the coastal water standard for discharges in this case. The TSS level in the Tailing Pond is over five times the discharge standard for release to coastal waters; however, it is understood that the tailings are drying out and the dam area will not produce water in the long term.

- Apart from Hg, all quantitative analysis results meet AWRC ambient criteria for protection of aquatic ecosystems. Hg is up to seven times the AWRC criterion for the Open Pit, Bold Head and both the Upper and Lower Grassy Dam water samples. The Upper Grassy Dam is filled by natural drainage except for a small proportion of the total input that is supplied by Bold Head mine water. This suggests that Hg levels may be generally elevated in the natural drainage of the area.

- Elevated levels of Bi and W in the Tailing Pond and Lower Grassy Dam reflect tailings and tailings fines inputs respectively over many years, but neither are regarded as being of environmental concern. Bi is reported to have a low level of mammalian toxicity and, from an industrial point of view, is considered to be one of the least toxic of the heavy metals. There have been no reports of W toxicity to either terrestrial or aquatic biota, and it is not found in animal tissue.

- The metal concentrations comply with toxicological drinking water guidelines, but not with aesthetic values for domestic use; levels of Fe (all samples), Mn, conductivity, TSS and sulphate (selected samples) would probably preclude the latter on the basis of taste and appearance.

- Semi-quantitative Cr, Ni and Se values from the Open Pit and Lower Grassy Dam are close or equal to the levels of detection of the analytical method. These, in turn, are similar to the AWRC (1982) criteria for ecosystem protection (Cr and Se) and NHMRC/AWRC standards for drinking water, and are within the Tasmanian effluent discharge standards (Cr and Se).

- Semi-quantitative elemental scan results for other metals reveals generally low levels, either within or approaching the ranges reported for freshwater systems, as reported in CCREM (1987).

### 3.2 Sediment

- Elements in the sediment from the Lower Grassy Dam which occur at concentrations noticeably greater than average crustal levels, as determined by multi-element scans, are Mo, Cd, Sn, Cs, Bi, U, S, As and W.

- Specific (quantitative) analysis shows that Cd and As are low or not significant. The high levels of Mo, Bi and W reflect the input of tailing fines, but these and the other remaining metals are not considered to be environmentally significant.

- The bottom sediments of the Lower Grassy Dam would therefore be classed as "uncontaminated".

### 3.3 General

- The pH and alkalinity values are indicative of systems in which no sulphide oxidation has occurred; the elevated sulphate levels are probably of marine origin. Calculations from the metallurgical data indicate that only 1/64 of the total contained $CaCO_3$ would be consumed during neutralisation of the maximum $H_2SO_4$ that could theoretically be produced. Accordingly, acid mine drainage from waste rock dumps or the tailings impoundment is not expected to occur. This prediction is supported by the lack of evidence of acid mine drainage from these materials, such as iron-stained seeps.

- On the basis of present water quality and predicted potential for acid mine drainage, there appears to be no need for geochemical testwork of materials in areas to be rehabilitated.

## 4.0 Conclusions

The water quality investigation has identified the main potentially contaminated areas of the mineral lease, and water produced from these areas has been sampled and analysed. The samples are taken as indicative of the long-term quality of water likely to be produced in the future.

The results show water of generally good quality, posing no constraints on ecosystem protection, while constraints on drinking water are aesthetic rather than toxicological. It is concluded that rehabilitation works do not require special precautions to maintain adequate water quality within what will be the former mineral lease.

## 5.0 References

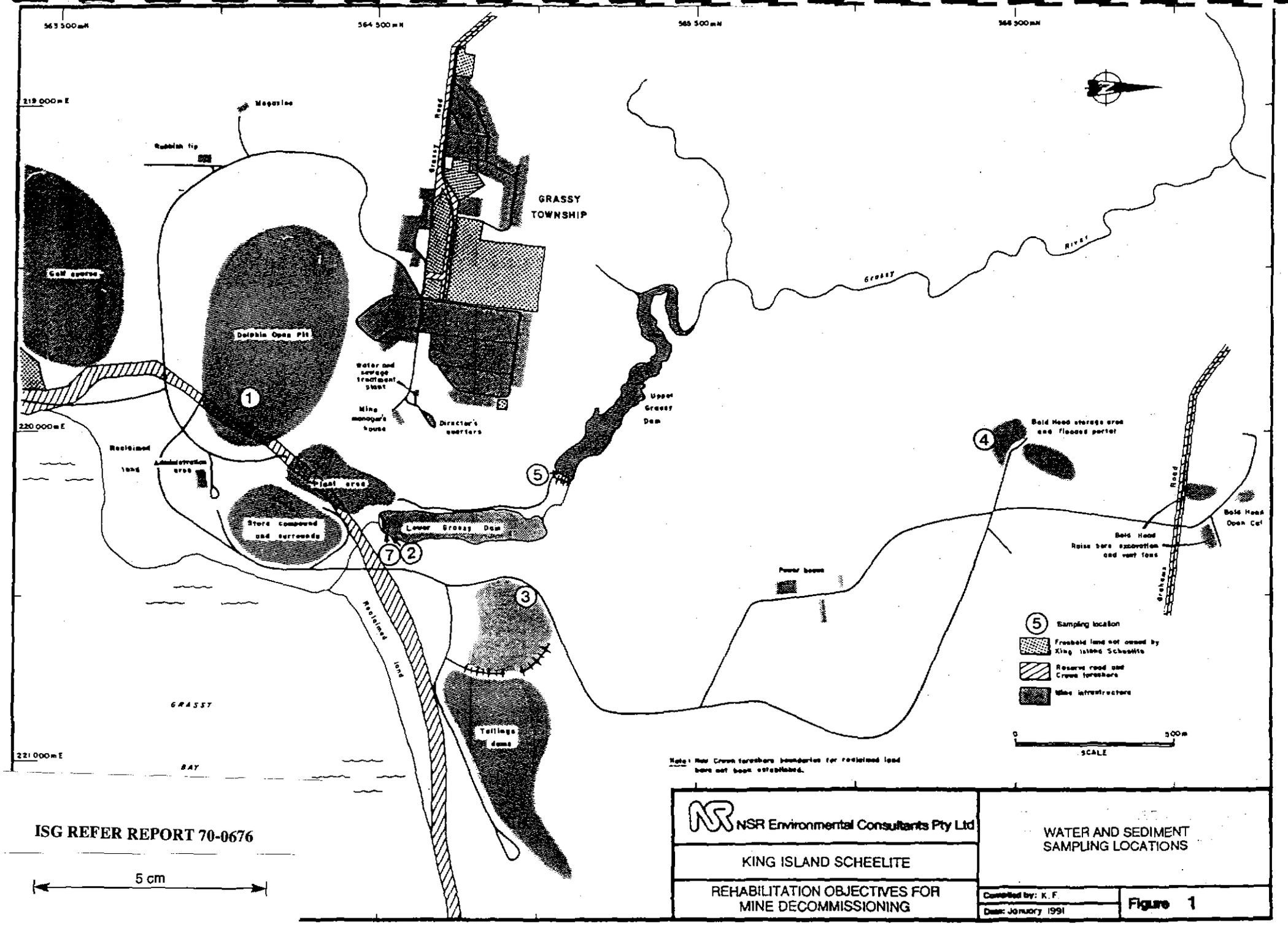
AWRC (1982). Australian water quality criteria for heavy metals. Australian Water Resources Council Technical Paper No. 77. Australian Government Publishing Service, Canberra.

CCREM (1987). Canadian water quality guidelines. Canadian Council of Resource and Environment Ministers. Environment Canada, Ottawa.

NHMRC/AWRC (1987). Guidelines for drinking water quality in Australia. National Health and Medical Research Council/Australian Water Resources Council. Australian Government Publishing Service, Canberra.

### Personal Communication

K. Ok, Metallurgist, King Island Scheelite.




NSR Environmental Consultants Pty Ltd

KING ISLAND SCHEELITE

REHABILITATION OBJECTIVES FOR MINE DECOMMISSIONING

WATER AND SEDIMENT SAMPLING LOCATIONS

Compiled by: K.F.

Date: January 1991

Figure 1

ISG REFER REPORT 70-0676

5 cm

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**Table 1**

**Trace metal results for King Island Scheelite water samples**

| Sample No. | Description | Fe(T) (mg/L) | Fe(F) (mg/L) | Mn(T) (µg/L) | Mn(F) (µg/L) | Cu(T) (µg/L) | Cu(F) (µg/L) | Cd(T) (µg/L) | Cd(F) (µg/L) | Pb(T) (µg/L) | Pb(F) (µg/L) | Zn(T) (µg/L) | Zn(F) (µg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Open Pit | 1.08 | -- | 110 | -- | 2.0 | -- | <0.05 | -- | <0.5 | -- | 4 | -- |
| | | -- | 0.002 | -- | 2.1 | -- | 1.3 | -- | <0.05 | -- | <0.5 | -- | <4 |
| 2 | Lower Grassy Dam | 25.5 | -- | 1330 | -- | 9.9 | -- | <0.05 | -- | 6.1 | -- | 25 | -- |
| | | -- | 0.45 | -- | 210 | -- | 4.9 | -- | <0.05 | -- | <0.5 | -- | <4 |
| 3 | Tailing Pond | 177 | -- | 8600 | -- | 77.2 | -- | 0.18 | -- | 29.6 | -- | 183 | -- |
| | | -- | 0.25 | -- | 71.2 | -- | 4.2 | -- | <0.05 | -- | <0.5 | -- | <4 |
| 4 | Bold Head Portal | 0.53 | na | 760 | na | <0.5 | na | <0.05 | na | <0.5 | na | 17 | na |
| 5 | Upper Grassy Dam | 2.14 | na | 70 | na | <0.5 | na | <0.05 | na | <0.5 | na | 4 | na |
| | *Tasmanian Effluent Standards* | | | | | | | | | | | | |
| | • discharge to inland waters | na | 1.0* | na | * | 1000 | na | 10 | na | 50 | na | 5000 | na |
| | • discharge to bays/estuaries | na | 3.0* | na | * | 1000 | na | 10 | na | 200 | na | 5000 | na |
| | • discharge to coastal waters | na | na | na | na | na | na | na | na | na | na | na | na |
| | AWRC ambient criteria for protection of aquatic ecosystems | na | na | na | na | na | 5 | 0.2 | na | na | 5 | na | 50 |
| | NHMRC/AWRC guidelines for drinking water quality | 0.3 | na | 1000 | na | 1000 | na | 5 | na | 50 | na | 5000 | na |

na = not analysed/not applicable

* The emission standard is a combined total filterable iron and manganese

(T) = Total

(F) = Filterable

Table 1 (cont.)

**Trace metal results for King Island Scheelite water samples**

| Sample No. | Description | As(T) (µg/L) | As(F) (µg/L) | Hg(T) (µg/L) | Hg(F) (µg/L) | Mo(T) (mg/L) | Mo(F) (mg/L) | W(T) (mg/L) | W(F) (mg/L) | Bi(T) (µg/L) | Bi(F) (µg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Open Pit | 6.0 | -- | 0.7 | -- | 0.4 | -- | <0.5 | -- | <0.2 | -- |
| | | -- | <0.2 | -- | <0.7 | -- | 0.2 | -- | <0.5 | -- | <0.2 |
| 2 | Lower Grassy Dam | 3.5 | -- | 0.7 | -- | <0.2 | -- | 6.0 | -- | 2.0 | -- |
| | | -- | <0.2 | -- | <0.7 | -- | <0.2 | -- | 5.5 | -- | <0.2 |
| 3 | Tailing Pond | 6.6 | -- | 1.3 | -- | 1.0 | -- | 41.0 | -- | 86.0 | -- |
| | | -- | 1.6 | -- | <0.7 | -- | 0.8 | -- | 41.5 | -- | 58.0 |
| 4 | Bold Head Portal | 0.4 | na | <0.7 | na | 0.3 | na | <0.5 | na | <0.2 | na |
| 5 | Upper Grassy Dam | 0.4 | na | <0.7 | na | <0.2 | na | <0.5 | na | 0.2 | na |
| | Tasmanian Effluent Standards | | | | | | | | | | |
| | • discharge to inland waters | 50 | na | 2 | na | na | na | na | na | na | na |
| | • discharge to bays/estuaries | 250 | na | 2 | na | na | na | na | na | na | na |
| | • discharge to coastal waters | na | na | na | na | na | na | na | na | na | na |
| | AWRC ambient criteria for protection of aquatic ecosystems | 50 | na | 0.1 | na | na | na | na | na | na | na |
| | NHMRC/AWRC guidelines for drinking water quality | 50 | na | 1 | na | na | na | na | na | na | na |

na = not analysed/not applicable
(T) = Total
(F) = Filterable

**Table 2**

**General water quality results for King Island Scheelite samples**

| Sample No. | Description | pH | Conductivity (µmhos/cm) | Alkalinity (mg CaCO3/L) | TSS (mg/L) | Ca (mg/L) | Mg (mg/L) | SO4 (mg/L) | Hardness (mg CaCO3/L) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Open Pit | 8.2 | 1820 | 174 | 6.6 | 91.1 | 58.3 | 562 | 468 |
| 2 | Lower Grassy Dam | 8.1 | 1040 | 142 | 154 | 25.4 | 9.96 | 183 | 104 |
| 3 | Tailing Pond | 8.6 | 3370 | 346 | 1120 | 13.1 | 7.74 | 973 | 65 |
| 4 | Bold Head Portal | 8.0 | 984 | 187 | 1.0 | 60.9 | 30.3 | 169 | 277 |
| 5 | Upper Grassy Dam | 7.4 | 461 | 57 | 2.0 | 15.1 | 11.6 | 34.2 | 85 |
| | Tasmanian Effluent Standards | | | | | | | | |
| | • discharge to inland waters | na | na | na | 30/60^ | na | na | na | na |
| | • discharge to bays/estuaries | na | na | na | 30/60^ | na | na | na | na |
| | • discharge to coastal waters | na | na | na | 200 | na | na | na | na |
| | NHMRC/AWRC guidelines for drinking water quality | 6.5 to 8.5 | 1500† | na | na | na | na | 400 | 500 |

na = not analysed/not applicable

^The *specified maximum* value is 60 mg/L where the lowest rate of flow of receiving waters is at least 50 times greater than rate of flow of emission

†Based on a TDS guideline value of 1000 mg/L

**Table 3**

**Compliance with relevant standards/guidelines for trace metals**

| Sample No. | Description | Fe(T) (mg/L) | Fe(F) (mg/L) | Mn(T) (µg/L) | Mn(F) (µg/L) | Cu(T) (µg/L) | Cu(F) (µg/L) | Cd(T) (µg/L) | Cd(F) (µg/L) | Pb(T) (µg/L) | Pb(F) (µg/L) | Zn(T) (µg/L) | Zn(F) (µg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *Open Pit* | √√X | -- | √√√ | -- | √√√ | -- | √√√ | -- | √√√ | -- | √√√ | -- |
| | | -- | √√√ | -- | √√√ | -- | √√√ | -- | √√√ | -- | √√√ | -- | √√√ |
| 2 | Lower Grassy Dam | √√X | -- | √√X | -- | √√√ | -- | √√√ | -- | √√√ | -- | √√√ | -- |
| | | -- | √√√ | -- | √√√ | -- | √√√ | -- | √√√ | -- | √√√ | -- | √√√ |
| 3 | Tailing Pond | √√X | -- | √√X | -- | √√√ | -- | √√√ | -- | √√√ | -- | √√√ | -- |
| | | -- | √√√ | -- | √√√ | -- | √√√ | -- | √√√ | -- | √√√ | -- | √√√ |
| 4 | Bold Head Portal | √√X | na | √√√ | na | √√√ | na | √√√ | na | √√√ | na | √√√ | na |
| 5 | Upper Grassy Dam | √√X | na | √√√ | na | √√√ | na | √√√ | na | √√√ | na | √√√ | na |

√ compliance attained/no standard
X compliance not attained

√√X
Tasmanian *effluent standards* — *NHMRC/AWRC drinking water guidelines*
AWRC ambient criteria for aquatic ecosystems

**Table 3 (cont.)**

**Compliance with relevant standards/guidelines for trace metals**

| Sample No. | Description | As(T) (µg/L) | As(F) (µg/L) | Hg(T) (µg/L) | Hg(F) (µg/L) | Mo(T) (mg/L) | Mo(F) (mg/L) | W(T) (mg/L) | W(F) (mg/L) | Bi(T) (µg/L) | Bi(F) (µg/L) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Open Pit | √ √ √ | -- | √ X √ | -- | na | -- | na | -- | na | -- |
| | | -- | √ √ √ | -- | √ √ √ | -- | na | -- | na | -- | na |
| 2 | Lower Grassy Dam | √ √ √ | -- | √ X √ | -- | na | -- | na | -- | na | -- |
| | | -- | √ √ √ | -- | √ √ √ | -- | na | -- | na | -- | na |
| 3 | Tailing Pond | √ √ √ | -- | √ X X | -- | na | -- | na | -- | na | -- |
| | | -- | √ √ √ | -- | √ √ √ | -- | na | -- | na | -- | na |
| 4 | Bold Head Portal | √ √ √ | na | √ ? √ | na | na | na | na | na | na | na |
| 5 | Upper Grassy Dam | √ √ √ | na | √ ? √ | na | na | na | na | na | na | na |

√ compliance attained/no standard

X compliance not attained

? *element detection limit greater than criterion*

√ √ X

Tasmanian effluent standards — NHMRC/AWRC drinking water guidelines

AWRC ambient criteria for aquatic ecosystems

**Table 4**

**Compliance with relevant standards/guidelines for general indicators**

| Sample No. | Description | pH | Conductivity (µmhos/cm) | Alkalinity (mg CaCO3/L) | TSS (mg/L) | Ca (mg/L) | Mg (mg/L) | SO4 (mg/L) | Hardness (mg CaCO3/L) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | *Open Pit* | √ √ √ | √√X | √ √ √ | √ √ √ | √ √ √ | √ √ √ | √√X | √ √ √ |
| 2 | Lower Grassy Dam | √ √ √ | √ √ √ | √ √ √ | X√X* | √ √ √ | √ √ √ | √ √ √ | √ √ √ |
| 3 | Tailing Pond | √√X | √√X | √ √ √ | XXX* | √ √ √ | √ √ √ | √√X | √ √ √ |
| 4 | Bold Head Portal | √ √ √ | √ √ √ | √ √ √ | √ √ √ | √ √ √ | √ √ √ | √ √ √ | √ √ √ |
| 5 | Upper Grassy Dam | √ √ √ | √ √ √ | √ √ √ | √ √ √ | √ √ √ | √ √ √ | √ √ √ | √ √ √ |

√ compliance attained/no standard

X compliance not attained

*Based on a turbidity guideline of 5 NTU.

Tas. effl. stds. (inland waters/bays & estuaries) — √√X — NHMRC/AWRC drinking water guidelines

Tasmanian effluent standards (coastal waters)

Table 5

Multi-element scans for water samples from Open Pit and Lower Grassy Dam (µg/L)

| Element | Open Pit | Lower Grassy Dam - Water | *Typical range for* fresh water systems (NOTE 1) | *Tasmanian discharge* limits for emission into inland waters | *Criteria* for protection of aquatic ecosystems (AWRC 1982) | Guidelines for drinking water quality (NHMRC/AWRC 1987) |
|---|---|---|---|---|---|---|
| Li | 78 | 21.5 | <10000 | — | — | — |
| Be | 0.2 | 2.8 | <1 | — | — | — |
| Co | 2 | 8 | 1—47† | — | — | — |
| Ga | 2 | 6 | — | — | — | — |
| Se | <20 | <20 | 0.01—0.35 | 20 | 10 | 10 |
| Rb | 38 | 23 | — | — | — | — |
| Sr | 1130 | 180 | — | — | — | — |
| Y | 0.2 | 1.8 | — | — | — | — |
| Zr | <2 | <2 | — | — | — | — |
| Nb | <1 | <1 | — | — | — | — |
| Mo | 455 | 310 | 0.03—10 | — | — | — |
| Pd | <5 | <5 | — | — | — | — |
| Ag | <5 | <5 | <0.3 | 100 | — | — |
| Cd | 5 | 4 | 0.01—0.4 | 10 | 0.2 | 5 |
| In | <0.2 | 0.4 | — | — | — | — |
| Sn | <2 | 10 | 1—2 | — | — | — |
| Sb | <1 | <1 | <1—9100† | — | — | — |
| Te | <2 | <2 | — | — | — | — |
| Cs | 17 | 19 | — | — | — | — |
| Ba | 28 | 12 | <1000 | 1000 | — | — |
| La | 0.4 | 2.8 | — | — | — | — |
| Ce | 0.7 | 6.0 | — | — | — | — |
| Pt | <5 | <5 | — | — | — | — |
| Au | <5 | <5 | — | — | — | — |
| Tl | <0.5 | <0.5 | 5.2—100† | — | — | — |
| Pb | <5 | 15 | 0.3—3 | 50 | 5 | 50 |
| Bi | 1 | 8 | — | — | — | — |
| Th | 0.2 | 1.0 | — | — | — | — |
| U | 14.5 | 9.4 | 0.1—2.14† | 5000 | — | — |
| Na | 210 mg/L | 165 mg/L | 1—10000 mg/L | — | — | 300 mg/L |
| Mg | 61 mg/L | 19 mg/L | 1—100 mg/L | — | — | — |
| Al | 0.31 mg/L | 4.3 mg/L | 0.01—9.3 mg/L† | — | — | 0.2 mg/L |
| P | <0.1 mg/L | 0.1 mg/L | 0.01—0.05 mg/L | 2000 | — | — |
| S | 190 mg/L | 58 mg/L | 10—80 mg/L# | 250 mg/L# | — | 400 mg/L# |
| K | 11.5 mg/L | 3.9 mg/L | <10 mg/L | — | — | — |
| Ca | 98 mg/L | 36 mg/L | 10—100 mg/L | — | — | — |
| Sc | <10 | <10 | — | — | — | — |
| Ti | <10 | 260 | 2—107^ | — | — | — |
| V | <10 | 20 | 0.3—200 | — | — | — |
| Cr | <10 | 20 | 0.1—1.5 | 50* | 10 | 50 |
| Mn | 100 | 1350 | <200 | NOTE 2 | — | 100 |
| Fe | 1130 | 25500 | 2—90000† | NOTE 2 | — | 300 |
| Ni | 10 | 30 | 1—10 | — | 25 | — |
| Cu | 10 | 10 | <5 | 1000 | 5 | 1000 |
| Zn | 10 | 60 | 1—20 | 5000 | 50 | 5000 |
| As | <50 | <50 | <10 | 50 | 50 | 50 |
| W | 230 | 7200 | =0.03 | — | — | — |
| Hg | <0.2 | <0.2 | 0.01—0.06 | 2 | 0.1 | 1 |

†Data for Canadian surface waters
^Data for Canadian and USA surface waters
#As sulfate
*The standard for Cr(VI) is 50 µg/L; that for Cr(III) is 500 µg/L.
NOTE 1: Sources - Canadian Water Quality Guidelines (1987), Canadian Council of Resource and Environment Ministers; Australian Water Quality Criteria for Heavy Metals (1982), Australian Water Resources Council *Technical Paper No. 77.*
NOTE 2: The standard for Fe and Mn is 1000 µg/L, combined total filterable.

Table 6

Results for sediment sample from Lower Grassy Dam

| Element | Lower Grassy Dam - Sediment (Multi-element scan) (mg/kg, dry weight) | Lower Grassy Dam - Sediment (Specific elemental analysis) (mg/kg, dry weight) | Average Crustal Abundance (mg/kg, dry weight) (NOTE 1) | Element Enrichment Factor |
|---|---|---|---|---|
| Li | 39 | — | 20 | 2.0 |
| Be | 6.5 | — | 2.6 | 2.5 |
| Co | 26 | — | 20 | 1.3 |
| Ga | 22 | — | 18 | 1.2 |
| Se | <20 | — | 0.05 | NOTE 2 |
| Rb | 29 | — | 90 | 0.3 |
| Sr | 63 | — | 370 | 0.2 |
| Y | 9.1 | — | — | — |
| Zr | 7 | — | 190 | 0.0 |
| Nb | <1 | — | — | — |
| Mo | 370 | 258 | 1.5 | 246.7 |
| Pd | <5 | — | 0.0006 | NOTE 2 |
| Ag | <5 | — | 0.07 | NOTE 2 |
| Cd | 2 | 0.32 | 0.11 | 18.2 |
| In | 1.6 | — | — | — |
| Sn | 25 | — | 2.2 | 11.4 |
| Sb | <1 | — | 0.2 | NOTE 2 |
| Te | <2 | — | 0.005 | NOTE 2 |
| Cs | 19.0 | — | 3 | 6.3 |
| Ba | 30 | — | 500 | 0.1 |
| La | 13.0 | — | 32 | 0.4 |
| Ce | 25.5 | — | 68 | 0.4 |
| Pt | <5 | — | 0.001 | NOTE 2 |
| Au | <5 | — | — | — |
| Tl | <0.5 | — | 0.6 | NOTE 2 |
| Pb | 18 | 13.7 | 14 | 1.3 |
| Bi | 63 | 123 | 0.048 | 1312.5 |
| Th | 3.1 | — | 12 | 0.3 |
| U | 13 | — | 2.4 | 5.4 |
| Na | 1130 | — | 23000 | 0.0 |
| Mg | 24000 | — | 23000 | 1.0 |
| Al | 19250 | — | 82000 | 0.2 |
| P | 750 | — | 1000 | 0.8 |
| S | 2675 | — | 260 | 10.3 |
| K | 2000 | — | 21000 | 0.1 |
| Ca | 122500 | — | 41000 | 3.0 |
| Sc | 5 | — | — | — |
| Ti | 1275 | — | 5600 | 0.2 |
| V | 158 | — | 160 | 1.0 |
| Cr | 48 | — | 100 | 0.5 |
| Mn | 4700 | 4700 | 950 | 4.9 |
| Fe | 100000 | 101000 | 41000 | 2.4 |
| Ni | 32 | — | 80 | 0.4 |
| Cu | 135 | 143 | 50 | 2.7 |
| Zn | 96 | 91 | 75 | 1.3 |
| As | 13 | 1.76 | 1.5 | 8.7 |
| W | 1875 | 4270 | 1.0 | 1875.0 |
| Hg | 0.08 | 0.3 | 0.05 | 1.6 |

NOTE 1: Source - Environmental Chemistry of the Elements (1979), H.J.M. Bowen.
NOTE 2: Element detection limit is greater than the average crustal abundance

# APPENDIX C - GEOCHEMICAL TESTWORK RESULTS

161086

SYDNEY ENVIRONMENTAL AND SOIL LABORATORY · PTY · LTD ·

Client: Environmental Geochemistry Services

Sample: KIS/S1

Date: 18-4-91

| TEST | Result |
|---|---|
| Code | 921 |
| pH in water | 8.7 |
| pH in CaCl2 | 7.9 |
| Salinity mS/cm | 0.82 |
| Chlorides ppm | 86.8 |

*Soluble Cations

| | meq/100g | ppm |
|---|---|---|
| Sodium | 1.12 | 256.7 |
| Potassium | 0.02 | 6.2 |
| Calcium | 0.18 | 36.8 |
| Magnesium | 0.05 | 6.3 |

* Soluble plus Exchangeable Cations

| | meq/100g | ppm | % of CEC |
|---|---|---|---|
| Sodium | 1.70 | 391.0 | 25.3 |
| Potassium | 0.05 | 19.5 | 1.5 |
| Calcium | 1.55 | 310.0 | 59.1 |
| Magnesium | 0.32 | 39.0 | 11.6 |

| | |
|---|---|
| * Sum of Exchangeable Cations | 2.3 |
| * Cation Exchange Capacity (CEC) | 2.3 |
| * Ca/Mg ratio | 4.8 |

| * Nutrient | ppm |
|---|---|
| Phosphorus | 0.5 |
| N as ammonium | 0.3 |
| as nitrate | 0.0 |
| Sulphate | 134.0 |
| Iron | 214.0 |
| Total S % w/w | 0.36 |

LOCH MAREE HOUSE
237 PENNANT HILLS RD
THORNLEIGH NSW 2120

TELEPHONE

161087

SYDNEY ENVIRONMENTAL AND SOIL LABORATORY · PTY · LTD ·

**Client:** Environmental Geochemistry Services

**Sample:** KIS/CT1

**Date:** 18-4-91

| TEST | Result |
|---|---|
| Code | 920 |
| pH in water | 8.0 |
| pH in CaCl2 | 7.6 |
| Salinity mS/cm | 1.30 |
| Chlorides ppm | 91.0 |

*Soluble Cations

| | meq/100g | ppm |
|---|---|---|
| Sodium | 1.50 | 345.9 |
| Potassium | 0.03 | 10.1 |
| Calcium | 0.93 | 185.6 |
| Magnesium | 0.11 | 13.7 |

* Soluble plus Exchangeable Cations

| | meq/100g | ppm | % of CEC |
|---|---|---|---|
| Sodium | 3.89 | 894.7 | 44.2 |
| Potassium | 0.10 | 39.0 | 1.4 |
| Calcium | 4.02 | 804.0 | 57.3 |
| Magnesium | 0.50 | 61.0 | 7.2 |

| | |
|---|---|
| * Sum of Exchangeable Cations | 5.9 |
| * Cation Exchange Capacity (CEC) | 5.4 |
| * Ca/Mg ratio | 8.0 |

| * Nutrient | ppm |
|---|---|
| Phosphorus | 0.5 |
| N as ammonium | 3.2 |
| as nitrate | -2.0 |
| Sulphate | 390.0 |
| Iron | 60.0 |
| Total S % w/w | 0.5 |

LOCH MAREE HOUSE
237 PENNANT HILLS RD
THORNLEIGH NSW 2120


Open Cut
BH1
Ventilation Shafts
BH
BOLD HEAD MINE SITE
BH3
Explosives Yard
Portal
BH2
Portal Area
Waste rock dump
PS3
General Area
PS2
Warehouse
PS
POWER STATION AREA
PS1
Power Station
PS4
Sewerage Pond
PS5
Oil Fire Training Area
CB1
Clay Borrow Pit 1
Road
Access
UG
UPPER GRASSY DAM
Embankment
MD6
Bold Head Roadside Batter
TD6.7
Tailings Pipeline Access Road
TD6
Access Roads
TD
TAILINGS DAMS
TD4
Bold Head Tailings Dam
TD3
Separation Wall
TD1
Seawall Tailings Dam
TD2
Sea Wall
TD8
Access Roads
TD5
Sand Borrow Pit
Access Roads
LG
LOWER GRASSY DAM
GT
GRASSY TOWNSHIP
MA
MILL AREA
MA5
Creek Area
MA1
Mill Site
MA4
Sand Fill Deposits and General Area
MA2
Office Site
MA3
Sea Dump
DP
DOLPHIN MINE PIT
Portal
RD1
Refuse Disposal
RD2,3,4
Refuse Disposal
Pit Access Road
MD3
Gravel Pit Area
MD7
Explosives Magazine
CB3
Overburden Dump Borrow Pit
MD2
Overburden Dump
Main Access Road
MD1
Gate House Area
MD4
Golf Course Tailings
RD5,4
Existing Refuse Site
MD5
Fire Trails
NORTH
APPROXIMATE PHOTO SCALE 1:6,000
0 100 200 300 400 500
METRES
AERIAL PHOTOGRAPHY FLOWN 23/1/1990
5 cm
KING ISLAND SCHEELITE
REHABILITATION PLAN
SITE PHOTO PLAN
John Miedecke & Partners
July 1991
93-347-1

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