EIS 397

AB019085

Environmental impact statement for the long term development of the Browns Creek Mine Blayney, New South Wales : (incorporating a mining, rehabilitation and environmental management plan)

BHP GOLD

ENVIRONMENTAL IMPACT STATEMENT FOR THE LONG TERM DEVELOPMENT OF THE BROWNS CREEK MINE BLAYNEY, NEW SOUTH WALES

Incorporating a Mining, Rehabilitation and Environmental Management Plan

Prepared by: R.W. CORKERY & CO. PTY. LIMITED

BHP GOLD MINES LIMITED

ENVIRONMENTAL IMPACT STATEMENT

FOR THE LONG TERM DEVELOPMENT OF THE BROWNS CREEK MINE

BLAYNEY, NEW SOUTH WALES

(INCORPORATING A MINING, REHABILITATION

AND ENVIRONMENTAL MANAGEMENT PLAN)

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December, 1987

R.W. CORKERY & CO. PTY. LIMITED

FORM 4

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

ENVIRONMENTAL IMPACT STATEMENT

This statement has been prepared on behalf of BHP Gold Mines Limited being the applicant making the development application referred to below.

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

- Mining by open cut and underground methods;
- Recovery of ore bearing gold, silver and other minerals (authorised under mining leases);
- Removal of existing plant and construction of a new plant and facilities;
- Disposal of overburden materials and process residues;
- Rediversion of Cowriga Creek and tributary.

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

Parish	County	Portions
Beaufort	Bathurst	2, 47, 48, 54, 55, 56, 57, 58, 59, 61, 64, 78, 146, 147, 148, 149, 169, 170, 330, 331, 332, 704.
Calvert	Bathurst	1, 2, 3, 4
Errol	Bathurst	360

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

Name, Qualifications and address of person who prepared Environmental Impact Statement: G.J.Summerhayes, B.Sc.,M.Env.Sc., P.O. Box 80 ORANGE NSW 2800

Certificate

I, Gregory Joseph Summerhayes of P.O. Box 80, Orange, NSW, hereby certify that I have prepared the contents of this Statement in accordance with clauses 34 and 35 of the Environmental Planning and Assessment Regulation, 1980.

.....
Signature

16th Dec 1987
.....
Date

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SUMMARY

INTRODUCTION

BHP Gold Mines Limited (the Company) own 100 per cent of the Browns Creek Mine following acquisition and transfer of the mining tenements and mine plant and equipment in September, 1986.

The Company has a proven and possible reserve of 640,000 tonnes of ore with an average gold content of 6.0 g/t. The probability of delineating additional reserves is considered high. These reserves will be recovered initially by open cut mining methods and if feasible by future underground mining operations.

To fully recover these reserves the removal of the existing crushing and treatment plant is required. To ensure continuous production and employment, a new crushing and treatment plant will be constructed during which time the mining and existing treatment plant will be kept operational. On completion and commissioning of the new plant, the existing plant will be removed from the site, and the open cut allowed to develop to the east.

The new treatment plant has been designed and located to minimise environmental impacts, and will have an installed treatment rate of 150,000 tonnes per year on hard skarn ore and 300,000 tonnes per year on the softer oxide ore. It is proposed that the treatment plant will predominantly treat the skarn ore.

This Environmental Impact Statement has been prepared to obtain development consent from Blayney Shire Council for the long term development and operation of the mine. To continue with the existing open cut operation, relocation of the treatment plant is essential.

Ancilliary to the continuation of the mining operations are requirements for an additional process residue dam, the extension of the overburden storage area and the rediversion of Cowriga Creek.

The document incorporates technical details appropriate to a Mining, Rehabilitation and Environmental Management Plan for the existing and continued operations to comply with a condition of the mining leases at Browns Creek.

THE BROWNS CREEK MINE SITE

The mine is located in the Central Tablelands of New South Wales within the Blayney Shire, approximately 13 km west of Blayney and adjacent to Cowriga Creek. The mine is accessed from Blayney via Platform Road.

The mine has had a history of sporadic mining activity for gold since 1876. The most recent mining activity at Browns Creek, initially by underground and then open cut methods, began in 1980 by the previous holder of the mining tenements. This area is currently covered by six mining leases and a prospecting licence, all of which are now held by the Company.

OUTLINE OF THE LONG TERM DEVELOPMENT

The long term development and continuation of the mining operations at Browns Creek will involve the following principal activities:

(i) Continued open cut mining with an extension of the open cut to the east and to a depth of approximately 90 m in depth. Underground mining is proposed at the completion of open cut mining.

(ii) Construction of a more efficient crushing and treatment plant in an area located 350 m south west of the existing facilities, and the removal of the existing facilities which are currently located on the ore body.

These activities will necessitate:

(i) The rediversion of Cowriga Creek around the eastern extremity of the main ore body to enable extraction of proven ore and to reduce groundwater inflows from the creek into the pit.

(ii) Extension of the existing overburden storage area to an area on the southern side of the existing overburden storage area.

(iii) Construction of an additional process residue storage area to store residues expected over the life of the known ore body.

Based on the current definition of ore reserves, the life of the open cut mine is approximately five years. An underground mining operation will provide an additional five years of mine life.

The proposed hours of operation are presented in Table (i). The mine currently employs 72 permanent Company and contractor personnel. A turnover of approximately 5 per cent is anticipated. The level of employment will increase during the construction period with up to 36 temporary contractors being required for a possible six month period.

The Company has proposed detailed rehabilitation of the site which is being implemented progressively over the mine life. The overburden storage area and process residue storage areas (once sufficiently dry and covered with a rock layer) will be covered with soil and revegetated to a grazing land use capability.

Environmental management procedures which are currently adopted at Browns Creek Mine will be supplemented in order to minimise the impacts of the long term development.

Mining, rehabilitation and environmental management activities will be monitored and reported annually to the Department of Mineral Resources.

ENVIRONMENTAL CONSTRAINTS

The principal environmental constraints to the continued operation and long term development of Browns Creek Mine are:

(i) The landform is undulating to rolling hills with a local relief of 50-60 m.

(ii) Site activities are predominantly located on midslopes that drain to Cowriga Creek which traverses the mining leases. Tributaries of Cowriga Creek are non-perennial.

(iii) Land Capability Classification describes the land at the site as Class V due to limitations of slope, soil erosion and rockiness.

(iv) Soils are predominantly red and yellow earths varying in thickness from 10 to 30 cm. The soils are moderately erodable and have a low nutrient status.

(v) The climate at the site is moderate with warm summers and cold winters. Most rain falls in winter and rainfall invariably exceeds evaporation during winter months. Frosts are common from late autumn to early spring.

(vi) Stream water quality of the immediate area is good but tends to be hard.

(vii) In the immediate vicinity of the mine, Cowriga Creek waters recharge solution channels in the Cowriga Limestone Unit. The mine operates pumps continuously to dewater the open cut.

(viii) Eight bores are located within 5 km of the mine site, but not intersecting Cowriga Limestones.

(ix) The existing noise climate reflects the rural nature of the area. Higher levels are recorded on occasions at the closest residence, "Bonnie Doon" reflecting the existing component of the Browns Creek Mine to the local noise climate.

(x) Five vegetation communities are present on site. These communities have been alienated by past grazing and mining practice over many years. A small isolated stand of Eucalyptus stellulata is worthy of conservation.

(xi) Three non-mine related residences are located within 2 km of the mine site. The closest non-mine related residence is less than 1 km from mine-related activity.

ENVIRONMENTAL IMPACTS

(i) The local topography will differ at the completion of site operations as:

(a) Four process residue storage areas (three of which exist currently on site) will form flat terraced areas.

(b) The open cut will deepen to 90 m and have approximate surface dimensions of 200 m wide by 500 m. On completion of mining activities the open cut will fill with water to approximately 790 m AHD creating a water feature.

(c) A contoured overburden storage area will not exceed the general height of local topographic features, however, the nearby flat open plant site will be in contrast to existing slopes and valleys.

(ii) Locally the water quality will remain good. Downstream users have and will continue to benefit from modulated creek flows due to mine dewatering and recharge downstream. After rehabilitation of the project is complete only areas directing runoff to the open cut and overburden emplacement pondage will be contained. Water levels in the open cut and pondage will stabilise to an equilibrium with groundwater and drainage levels. The rediversion of Cowriga Creek will have minimal hydrological impact.

(iii) The site area will be rehabilitated to a grazing land use capability.

(iv) Air quality on the site will not be adversely affected due to a range of dust control measures.

(v) The existing noise levels of site operations at surrounding residents will be reduced due to the effect of acoustical shielding and an efficient relocated plant.

(vi) The economic benefits of existing employment at the Browns Creek Mine will be maintained. Additional economic stimulus will result from temporary employment during a 6 month period of construction works.

(vii) Visual amenity of the site will be improved. Visual bunds along Platform Road, completed over the 6 month period of its rediversion will be supplemented by progressive rehabilitation and landscaping. The clay stockpile, an existing visual impact on site, will be levelled back to a gentle slope and rehabilitated.

TABLE (i)
PROPOSED WORKING HOURS AT BROWNS CREEK MINE

Activity	Time	Days	Status
Construction	7.00am - 10.00pm	Mon-Sat	Temporary
Crushing	7.00am - 7.00pm	Mon-Sat	Normal
	7.00am - 10.00pm	Mon-Sat	Contingency
	8.00am - 5.30pm	Sun	Contingency
Treatment Plants	24 hrs per day	7 days	Normal
Rock Breaker	7.00am - 5.30pm	Mon-Sat	Normal
Mining	7.00am - 5.30pm	Mon-Sat	Normal
	5.30pm - 7.00am	Mon-Sat	Contingency
Blasting	3.00pm - 6.00pm	Mon-Fri	Normal
	Other daylight hrs		Contingency

SECTION 1

INTRODUCTION

1.1 SCOPE

This Environmental Impact Statement has been prepared by R.W. Corkery & Co. Pty. Limited and BHP Gold Mines Limited to support a Development Application by BHP Gold Mines Limited to Blayney Shire Council. This statement primarily addresses the proposed changes to the overall mining and treatment operation expected throughout the remaining economic life of the Browns Creek Mine.

In order to mine and process the known ore reserves at Browns Creek, the treatment facilities and Cowriga Creek need to be relocated and approximately 2.5 million m^3 of overburden material removed.

The Browns Creek Mine is located approximately 13 km west of Blayney immediately adjacent to Cowriga Creek to the east and Platform Road to the west. Figure 1.1 shows its proximity to the main centres of Bathurst, Orange and Blayney. In order to continue and improve the mining and treatment operations at Browns Creek, the Company has lodged a Development Application with Blayney Shire Council. This Environmental Impact Statement has been prepared to support this Development Application in accordance with Section 77 of the Environmental Planning and Assessment Act, 1979.

The Company's proposed operations are located on private land in the Parishes of Beaufort, Errol and Calvert, in the County of Bathurst.

The Statement will also serve as a basis for application to the State Pollution Control Commission for approval and licences required to continue the operation of the mine and the treatment plant.

The continued operation of the open cut at Browns Creek Mine requires the rediversion of a prescribed stream, Cowriga Creek. The expansion of the overburden storage

area requires infilling over a small tributary of Cowriga Creek to the south of the mine. This Statement addresses in detail the need for and the design of these diversions in support of applications to the Department of Water Resources, required in accordance with Part II of the Water Act, 1912.

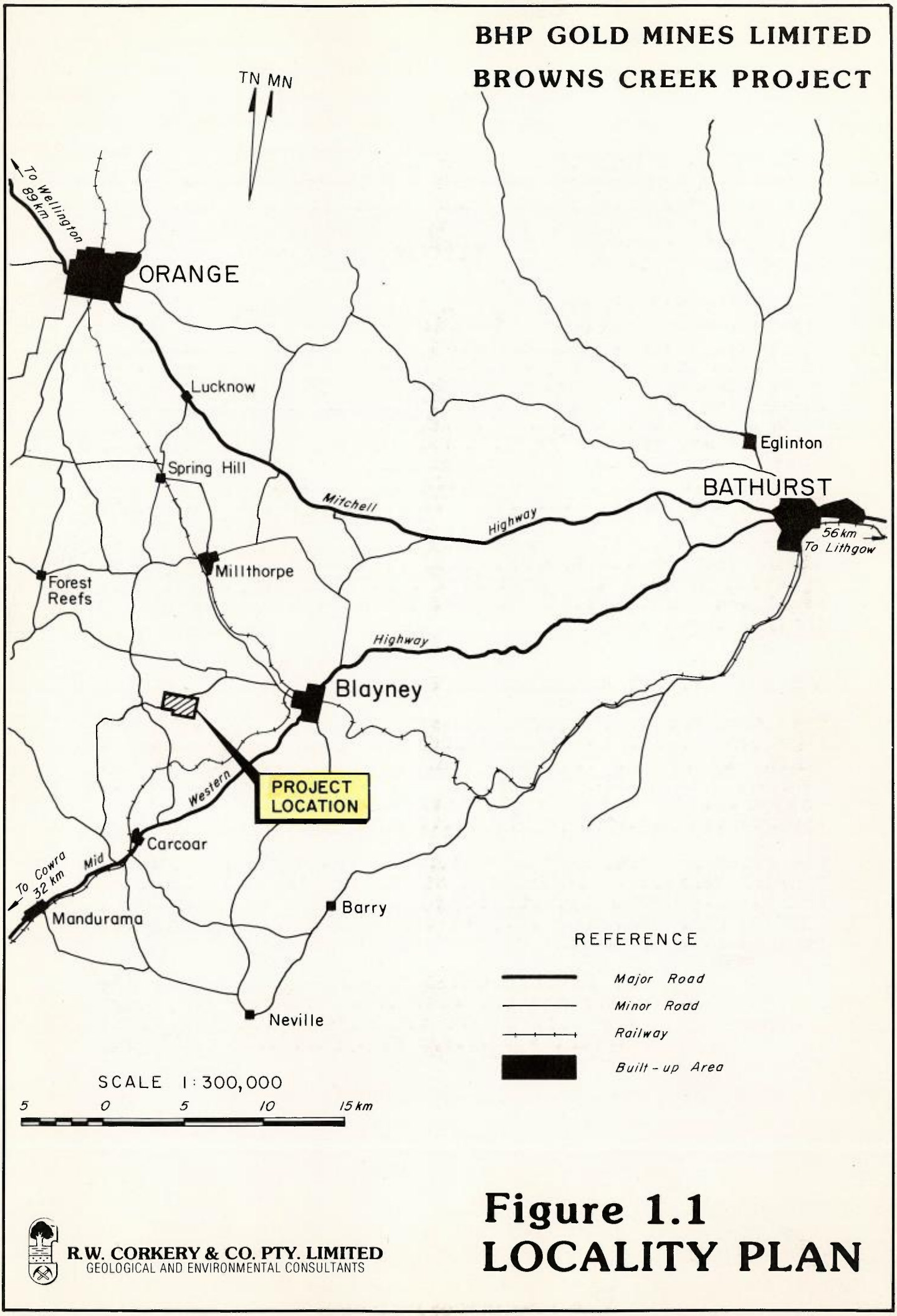
The Statement incorporates a Mining, Rehabilitation and Environmental Management Plan for both the existing operation and proposed continuation of mining and treatment activities at the Browns Creek Mine. Sections 2 and 4 of this document present all details appropriate to the Management Plan. Such a Management Plan is a requirement of the conditions of the existing mining leases, which were reviewed and updated by the Department of Mineral Resources when these leases were transferred to BHP Gold Mines Limited in 1987. The Mining, Rehabilitation and Environmental Management Plan which this Statement addresses, is for the approval of the Minister for Mineral Resources. The consideration of the Mining, Rehabilitation and Environmental Management Plan will be undertaken once the Company's Development Application is finalised and approvals granted from the State Pollution Control Commission.

1.2 FORMAT OF THE IMPACT STATEMENT

This Environmental Impact Statement has been written in six sections with a set of appendices. The requirements of Clause 34 of the Environmental Planning and Assessment Regulations, 1980 and the Director's requirements (Appendix 1) have been incorporated into the most appropriate sections of the Statement.

The document's format was discussed with the Department of Mineral Resources, Department of Environment and Planning, and Blayney Shire Council representatives in September, 1987. This format would, in one comprehensive document, facilitate presentation of:

(i) An Environmental Impact Statement for the environmental assessment of the long term development of the Browns Creek Mine to support a development application to Blayney Shire Council;



R.W. CORKERY & CO. PTY. LIMITED
GEOLOGICAL AND ENVIRONMENTAL CONSULTANTS

Figure 1.1
LOCALITY PLAN

(ii) A Mining, Rehabilitation and Environmental Management Plan for both existing and proposed mining activity in satisfaction of requirements of the mining leases transferred to the Company.

The format is as follows:

Section 1: Introduces the proposal for the overall mine, outlines the history of mining at Browns Creek and provides details of the existing leases and approvals under which the mine is currently operating.

Section 2: Outlines the Company's objectives, the existing operations and their proposed plans for the extension of the existing open cut, diversion of Cowriga Creek and construction of overburden storage areas and process residue storage areas. The safeguards to be incorporated throughout the planning and construction of these components of the project are detailed.

Section 3: Describes the existing environment around the mine site and potential constraints are identified.

Section 4: Presents detailed rehabilitation and environmental management procedures for the remaining mine life.

Section 5: Analyses the impact the continuation of mining and treatment operations will have on the environment around the site and surrounding district.

Section 6: Justifies the project in terms of environmental, economic and social considerations and examines the consequences of not continuing with the mining operation.

Appendices: Present correspondence from the Department of Environment and Planning and the National Parks & Wildlife Service. Baseline environmental data, details of the noise assessment, the Energy Statement and a glossary of terms are also included in the Appendices.

1.3 THE PROPONENT

The Browns Creek Mine is 100 per cent owned by BHP Gold Mines Limited (hereinafter referred to as the "Company"), a listed public company incorporated in the State of Western Australia on the 3rd March, 1987.

BHP-Utah-Minerals International (BHP-Utah) Limited, a wholly owned subsidiary of the Broken Hill Proprietary Company Limited, is the manager for the mining, exploration and marketing activities of BHP Gold Mines Limited and its subsidiaries. BHP-Utah-Minerals has established a world class expertise in all aspects of gold exploration, mine development and ore treatment. Through its other mines, the BHP-Utah-Minerals International group has extensive experience in metalliferous mine operation.

The Company holds 79.7 ha of granted mining leases and a 216.7 ha prospecting licence at Browns Creek.

In addition, the Company is in joint venture on several exploration tenements adjacent to granted leases at Browns Creek to fully determine the extent of the mineralisation and locate further prospective regional ore bodies. BHP Minerals holds a number of additional tenements in the central west of New South Wales over which exploration is in progress either in joint venture or wholly undertaken by the Company.

1.4 HISTORY OF MINING AT BROWNS CREEK

The first recorded gold production at Browns Creek was in 1876. Estimates of gold production over the next 11 years vary with an estimated 55,744 ounces of gold at a recovered grade of 0.13 oz/ton (4.0 g/tonne Au). The recovered grade improved to 0.22 oz/ton (6.7 g/tonne Au) from 1887 to 1892. Tonnages of ore were not always stated and an estimate of 290,000 tonnes of ore was produced assuming average grade and recovery factors.

By 1887 the mine had been worked to the then water table, and increasing water problems occurred with depth. The shortage of capital resulted in mining activity ceasing during 1888 despite indications of a richer lode at depth.

In 1890 a new company, Johnson and Woodhouse commenced working the lode which was reported to be 50 ft wide. Five hundred tonnes was subsequently crushed to yield 0.5 oz/ton of gold (15.3 g/tonne Au).

In 1895 the Compagnie des Mine D'or invested 20,000 pounds sterling to re-open the mine but due to insufficient funds the company did not start production.

The next production from the mine occurred between 1904 and 1910 primarily from a small open cut extracting oxidised ore. Records indicate 35,000 tonnes of ore for 4,500 oz of gold (0.13 oz/ton or 4.0 g/tonne Au).

In 1913 the Mines Inspector reported bulk sampling along a 150 ft development driven in a large body of ore averaging 15.3 g/tonne Au, however, no further extraction took place.

Late in 1913 the Golden Springs Mining Company NL attempted to commence mining operations with no success due to the outbreak of World War I. The area then reverted to grazing with intermittent small producers working the mine up to 1940. Further exploration was undertaken in the Browns Creek area by both companies and individuals up to 1974.

In summary, the records indicate the mine produced approximately 60,000 ounces of gold from 330,000 tons of clay lode at an average grade of 5.5 g/tonne Au.

During 1979, M.J. Hickey acquired the mining leases covering the Browns Creek Mine. At that time there were no mining activities on the leases. Since 1980, mining activities have included:

(i) The sinking of a new shaft to the 61 metre level at the eastern edge of the current open cut;

(ii) Horizontal development from the 30 m and 61 m levels with stoping of ore zones between these levels;

(iii) The construction of a treatment plant consisting of crushing, milling, gravity concentration and froth flotation facilities to recover gold, silver and copper from the skarn ore.

Subsequent shallow drilling west of the treatment plant indicated a rich clay lode. The mining of this clay lode by open cut methods commenced in 1984. The treatment plant was expanded to handle and scrub the oxidised ore and a carbon-in-pulp plant was commissioned for gold recovery. Until operations were suspended in June, 1986, this plant has treated 70,000 tonnes per annum of oxidised ore averaging 2.5 g/tonne.

On the 1st September, 1986 BHP Minerals Limited acquired the mining tenements and mine plant and equipment and in November, 1986 resumed mining and milling operations and initiated a mine rehabilitation programme. Intensive mine planning and metallurgical and geological studies were undertaken to provide a basis for planning of future mine development. In 1987, BHP Minerals Limited transferred all its gold mining interests to BHP Gold Mines Limited.

1.5 SUMMARY OF EXISTING OPERATIONS AND APPROVALS

1.5.1 Summary of Existing Operations

The Browns Creek Mine currently employs approximately 72 persons on site with the number varying slightly depending on the level of contractor activity. The mine also generates additional employment in service industries in the local community.

The Company has initiated procedures to ensure the long term rehabilitation of the site is not compromised. Topsoil is removed from areas affected by the operations and stockpiled for later use. The Company has consulted with officers from the Soil Conservation Service and has commissioned investigations on soil profiles and characteristics with recommendations on rehabilitation procedures will be assessed on an ongoing basis throughout mine life and progress reviewed during annual reports on the Management Plan to the Department of Mineral Resources.

Two types of ore are currently being mined by open cut methods and treated in the treatment facilities on the eastern edge of the current open cut:

(i) **Oxidised or Clay Ore**

The soft oxidised clay ore is screened and scrubbed prior to being ground in a ball mill to liberate the gold. A carbon-in-pulp circuit is utilised to recover the gold.

(ii) Skarn Ore

The hard skarn ore is crushed in three stages prior to ball mill grinding. A gravity and flotation circuit recovers the gold and copper minerals in concentrates which are further treated off-site.

Highly selective mining is practiced in conjunction with intensive grade control to mine relatively small pockets of ore associated with the complex geological structures around the mine.

The current installed capacity of the treatment plant consists of 220,000 tonnes per year of oxide ore on the C.I.P. circuit and 66,000 tonnes per year on the flotation curcuit for a combined total treatment capacity of 286,000 tonnes per year. The treatment rate reduces to 120,000 tonnes per year if both circuits treat skarn ore.

Process residues are pumped to process residue storage areas where water is reclaimed for re-use in the treatment plant.

1.5.2 Summary of Approvals

The history of consents and approvals from Blayney Shire Council dates back to 1979 for various existing operations at Browns Creek Mine. Table 1.1 summarises these consents and approvals.

Since May, 1980, the mine has been operating with a licence from the State Pollution Control Commission under the provision of the State Pollution Control Commission Act, 1970. This licence (No. 01249) was transferred to BHP Minerals Limited on the 4th November, 1986.

1.6 MANAGEMENT OF THE INVESTIGATIONS

The investigations and report writing for this Statement have been undertaken jointly by Mr R. Corkery and Mr G. Summerhayes of R.W. Corkery & Co. Pty Limited, and BHP Gold Mines Limited. Fieldwork for the project commenced in December, 1986 when baseline environmental studies were first instituted. Additional background data and discussions with a number of Government Authorities and Blayney Shire Council was undertaken between December, 1986

TABLE 1.1
BROWNS CREEK MINE
CONSENTS AND APPROVALS FROM BLAYNEY SHIRE COUNCIL

Application No.	Applicant	Consent/ Approval Date	Development Description	Act
Application 131/79	M.J. Hickey	13/4/79	Establishment of small scale copper mining and treatment plant on ML 5895	Local Government Act, 1919
Amendment to 131/79	M.J. Hickey	21/12/79	Amendment incorporating extension of area (by 69.7 ha) and hours of operation (7am-11pm)	Local Government Act, 1919
Extension to 131/79	M.J. Hickey	24/12/81	Extension of 12 months	Local Government Act, 1919
Application 43/82	M.J. Hickey	28/6/82	Underground mining within MLA 170 (3.55 ha)	EPA Act, 1979
Amendment to 131/79	M.J. Hickey	27/2/86	Amendment to allow mine to treat gold and silver	EPA Act, 1979
Application 30/86	M.J. Hickey	8/9/86	Construction of a tailings dam	EPA Act, 1979
Application 41/86	BHP Minerals	1/10/86	Relocate office accommodation and extend buildings	EPA Act, 1979
Amendment to 43/82	BHP Minerals	12/3/87	Amendment to mine upper 20 m on ML 1188	EPA Act, 1979
Approval to divert Browns Creek Road	BHP Minerals	15/4/87	Approval for temporary road deviation.	Local Government Act, 1919
Amendments to 131/79 and 43/82	BHP Minerals	17/6/87	Enlargement of waste rock dump, subject to a plan showing erosion control and rehabilitation	EPA Act, 1979
Approval for traffic	BHP Minerals	22/6/87	Delegation for traffic control during road construction and blasting operations (to be reviewed March, 1988)	Local Government Act, 1919

EPA Act, 1979: Environmental Planning and Assessment Act, 1979

and November, 1987. Discussions were held regularly with the Company and their consultants throughout the preparation of the Statement.

Company personnel involved with the preparation of this document, and for planning and design input include:

Mr R. Weston - Principal Mining Engineer and Project Co-ordinator

Mr J. England - Principal Metallurgist

Mr I. Lipton - Senior Mine Geologist

Mr I. Bojanic - Mine Planning Engineer

Assistance with the Statement's preparation and supporting studies was obtained from:

Mr Col Bower - for a flora and fauna study of the project site;

Australasian Mining Title Services Pty Ltd
- for aspects relating to Mining Titles;

Richard Heggie Associates Pty Ltd
- for matters relating to the acoustical and vibration aspects of the project;

Ms Margo Jamieson
- For soil description and investigation.

BHP Engineering
- Cowriga Creek Rediversion Design Study;
- Overburden Storage Area Design Study;
- Pit Geotechnical Study;

Coffey and Partners
- Process Residue Storage Area Design Study;
- Preliminary Dewatering Study.

Australian Fertilizers Limited
- Soil and Plant Analysis Service.

The following authorities were consulted by R.W. Corkery & Co. Pty Limited, the Company and their subconsultants during the preparation of the Environmental Impact Statement. Those marked (*) provided comments on a draft copy of the Statement.

Department of Environment & Planning (Sydney*)
Blayney Shire Council (Blayney*)
Department of Mineral Resources (Sydney* and Orange*)
Crown Lands Office (Sydney* and Orange*)
Soil Conservation Service (Orange*)
Department of Industrial Relations (Orange)
Ophir County Council (Orange)
National Parks & Wildlife Service (Bathurst)
State Pollution Control Commission (Bathurst*)
Telecom (Bathurst)
Department of Water Resources (Sydney and Forbes*).

SECTION 2

DESCRIPTION OF THE PROJECT

2.1 OUTLINE OF PROPOSAL

Figure 2.1 shows the local setting of the Browns Creek Mine. The Company proposes to undertake a range of activities throughout the remaining life of the mine for which approval is being sought. The primary activities are:

(i) The continued open cut mining with an extension of the open cut to the east and to approximately 90 m in depth. Limited underground mining is proposed at the completion of open cut mining.

(ii) Construction of a more efficient crushing and treatment plant in an area located 350 m south west of the existing facilities, and the removal of the existing facilities which are currently located on the ore body.

These activities will necessitate:

(i) Rediversion of Cowriga Creek around the eastern extremity of the main ore body to enable extraction of proven ore and to reduce groundwater inflows from the creek into the pit;

(ii) Extension of the existing overburden storage area to an area on the southern side of the existing overburden storage area;

(iii) Construction of an additional process residue storage area to store the process residue expected over the life of the known ore body;

A result of these activities will be improved mine access and security.

Figure 2.2 presents the existing site layout and Figure 2.3 presents the proposed site layout with the location of the above activities indicated.

2.2 MINING TENEMENTS

Table 2.1 presents details of the mining leases held by the Company over the Browns Creek ore body. Also detailed in the table is Prospecting Licence 1073, which surrounds the mining leases and which encompasses all mining, treatment operations and related activities proposed in this Statement. The boundaries of the mining leases and the prospecting licence are shown on Figure 2.4.

The conditions of these mining leases have been recently reviewed during their transfer from BHP Minerals Limited to the Company, and updated in September, 1987 by the Department of Mineral Resources. The additional conditions placed on the mining leases at the Browns Creek Mine are presented in Appendix 6. Included in these conditions (No. 4 of Schedule B) is a requirement for the preparation of a Mining, Rehabilitation and Environmental Management Plan.

2.3 THE ORE BODY

The Browns Creek ore body is approximately 450 m long and has been delineated to a maximum depth of 85 m below the existing land surface. Figure 2.5 presents a horizontal section through the ore body, in plan at the 790 m A.H.D. level.

Percussion and core drilling have defined a proven and probable in situ reserve of 460,000 tonnes of ore with an average gold content of 6.0 g/t. This reserve consists of 80,000 tonnes of soft, oxidised clay ore and 380,000 tonnes of hard skarn ore. In addition, a possible in situ resource of at least 160,000 tonnes at 6.0 g/t is expected to be located. The probability of delineating an additional tonnage above these proven reserves is considered high.

Approximately 60 per cent of the known skarn ore lies under the plant and Cowriga Creek and in order to mine the existing reserves, the treatment facilities and Cowriga Creek need to be relocated and approximately 2.5 million cubic metres of overburden material removed.

The mineralogy of the principal rock types found on site is detailed in Table 2.2. Sulphide mineralisation in the ore is limited predominantly to chalcopyrite and bornite. Minor arsenopyrite, pyrite and pyrrhotite is associated within the margins of the andesite adjacent to skarn rock.

BHP GOLD MINES LIMITED
BROWNS CREEK PROJECT

REFERENCE

- Major Road
- Minor Road
- Watercourse
- Contour
- Built-up Area
- Boundary of PL 1073
- 15392 Registered Bore
- T Telecom Line
- Boundary of Mining Leases

SCALE 1:50,000

0·5 0 0·5 1·0 1·5 2·0km

TN MN

TALLWOOD

To Forest Reefs Exchange

To Millthorpe 11 km

To Forest Reefs 9km

To Forest Reefs 16km

To Millthorpe 7km

To Bathurst 34km

To Newbridge 11km

To Cowra 55km

To Barry 5km

51918

15207

11629

55799

51651

57414

15392

50385

Alternative 66 kv Power Supply Line to Site

Alternative Power Supply Line to Site

Existing 66 kv Power Supply Line

Existing 11 kv Power Supply Line

SUBSTATION

PL 1073

BROWNS CREEK MINE PROJECT

BLAYNEY

PLATFORM ROAD

GAP ROAD

ABATTOIR CREEK

SUGARLOAF CREEK

McKENZIE FLAT CREEK

DIRT HOLE CREEK

DIRTY CREEK

COWRIGA CREEK

McKENZIES CREEK

WATERHOLES CREEK

COLDWATER CREEK

BELUBULA RIVER

BELUBULA CREEK

MID WESTERN HIGHWAY

CARCOAR LAKE

CHAIN OF PONDS CREEK

Carcoar

Carcoar Dam

900 1000 800 700

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Figure 2.1
LOCAL SETTING

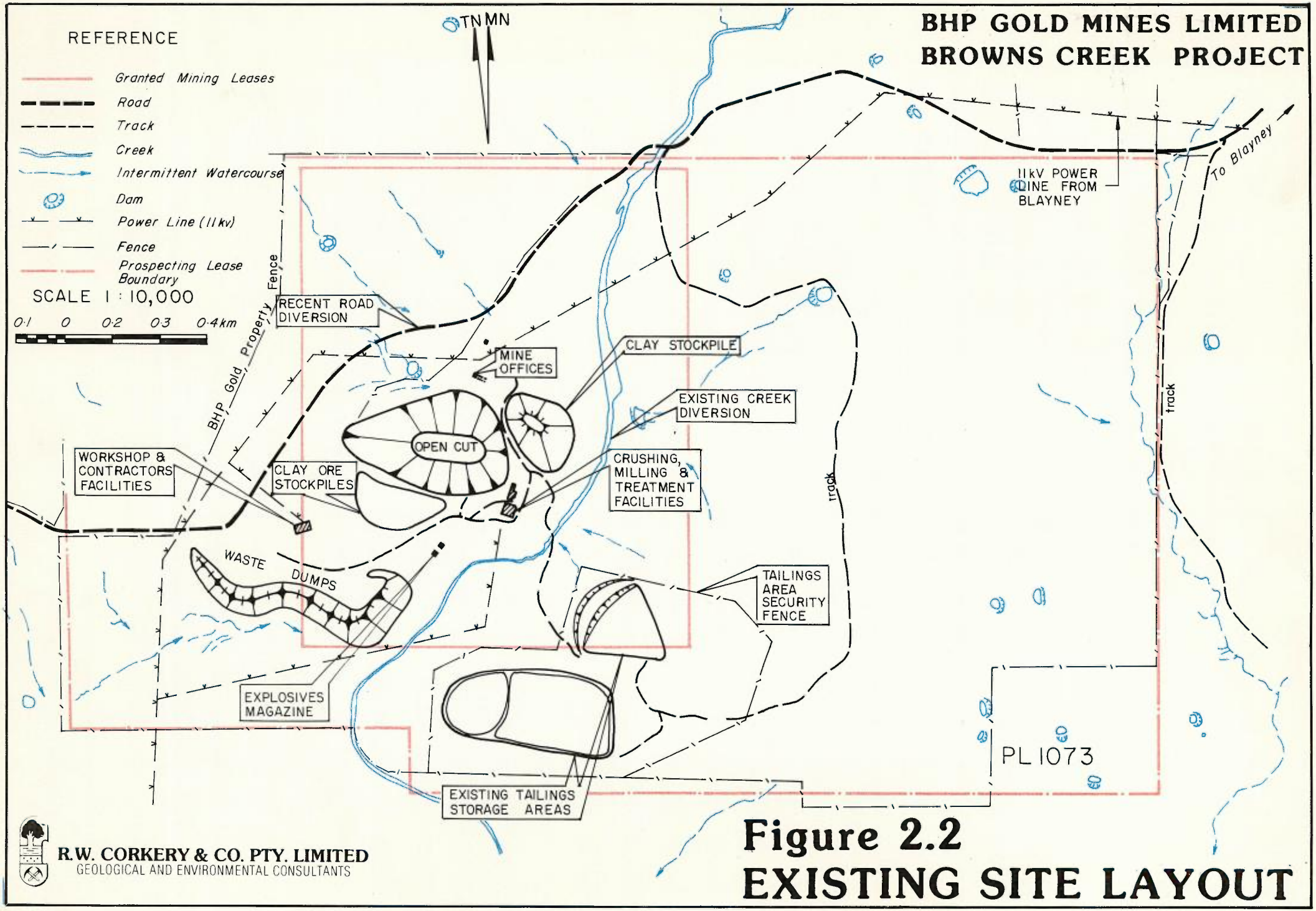
BHP GOLD MINES LIMITED
BROWNS CREEK PROJECT
REFERENCE
Granted Mining Leases
Road
Track
Creek
Intermittent Watercourse
Dam
Power Line (11kv)
Fence
Prospecting Lease Boundary
SCALE 1 : 10,000
0·1 0 0·2 0·3 0·4km
TN MN
11kV POWER LINE FROM BLAYNEY
To Blayney
BHP Gold Property Fence
RECENT ROAD DIVERSION
MINE OFFICES
CLAY STOCKPILE
EXISTING CREEK DIVERSION
OPEN CUT
WORKSHOP & CONTRACTORS FACILITIES
CLAY ORE STOCKPILES
CRUSHING, MILLING & TREATMENT FACILITIES
track
track
WASTE DUMPS
TAILINGS AREA SECURITY FENCE
EXPLOSIVES MAGAZINE
EXISTING TAILINGS STORAGE AREAS
PL 1073
R.W. CORKERY & CO. PTY. LIMITED
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Figure 2.2
EXISTING SITE LAYOUT

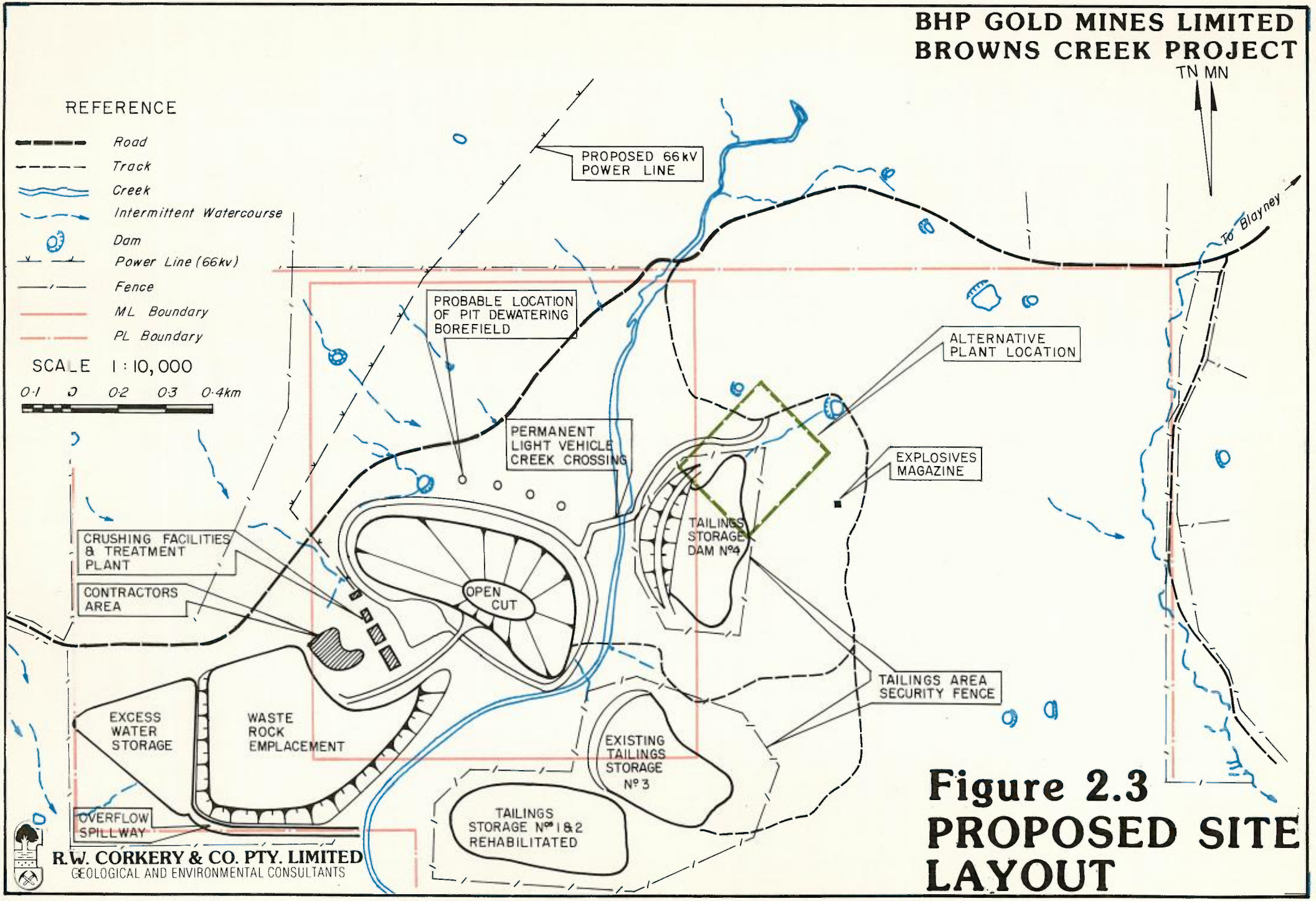
BHP GOLD MINES LIMITED
BROWNS CREEK PROJECT
TN MN
REFERENCE
Road
Track
Creek
Intermittent Watercourse
Dam
Power Line (66kv)
Fence
ML Boundary
PL Boundary
SCALE 1 : 10,000
0·1 0 0·2 0·3 0·4km
PROPOSED 66kV POWER LINE
To Blayney
PROBABLE LOCATION OF PIT DEWATERING BOREFIELD
ALTERNATIVE PLANT LOCATION
PERMANENT LIGHT VEHICLE CREEK CROSSING
EXPLOSIVES MAGAZINE
TAILINGS STORAGE DAM Nº4
CRUSHING FACILITIES & TREATMENT PLANT
CONTRACTORS AREA
OPEN CUT
TAILINGS AREA SECURITY FENCE
EXCESS WATER STORAGE
WASTE ROCK EMPLACEMENT
EXISTING TAILINGS STORAGE Nº3
TAILINGS STORAGE Nºs 1&2 REHABILITATED
OVERFLOW SPILLWAY
R.W. CORKERY & CO. PTY. LIMITED
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Figure 2.3
PROPOSED SITE LAYOUT

TABLE 2.1
MINING AND EXPLORATION TENEMENTS
ON AND AROUND THE BROWNS CREEK MINE

Tenements	Holder	Security	Area (ha)	Date	Term (Yrs)	Minerals	Restrictions
GL 5895*	BHPGM		8.12	27/8/71	20	L, Au, Ag, Ni, Cu, Zn, Pb.	Nil
ML 1015**	BHPGM		3.55	20/10/82	21	L, Au, Cu, Ag, Zn, Pb, M.	20 m surface exemption.
ML 910**	BHPGM	$151,000	22.4	14/1/81	21	L, M, Au, Cu, Ag, Zn, Pb, Ni, Co.	20 m surface exemption.
ML 911**	BHPGM		44.9	14/1/81	21	L, M, Au, Cu, Ag, Zn, Pb, Ni, Co.	20 m surface exemption.
ML 912**	BHPGM		0.15	14/1/81	21	L, M, Au, Cu, Ag, Zn, Pb, Ni, Co.	Nil
ML 1188**	BHP Minerals	$4,000	4.08	29/4/87	6.5	Au, Cu, Ag, Zn, Pb.	20 m depth restriction.
PL 1073**	BHP Minerals	$3,000	216.70	13/10/87	1	L, M, Au, Cu, Ag, Zn, Pb, As, Co.	Nil

Reference: BHP Gold Mines Limited
* Act 1906
** Act 1973
Ag = Silver As = Arsenic Au = Gold Co = Cobalt Cu =Copper L = Limestone M = Marble Ni = Nickel Pb = Lead Zn = Zinc

TABLE 2.2
MINERALOGY OF PRINCIPAL ROCK TYPES

Rock Type	Mineral Constituents*	Chemical Composition
Limestone	Calcite	$CaCO_3$ (lime)
Skarn (Ore)	Wollastonite	$CaSiO_3$
	Garnet	Ca, Fe, Mg, Al, Silicate
	(Diopside)	Ca, Mg, Fe, Silicate
	(Pyroxene)	Ca, Mg, Fe, Al, Silicate
	(Chalcopyrite)**	$CuFeS_2$
	(Bornite)**	Cu_5FeS_4
Andesite	Pyroxene	Ca, Mg, Fe, Al, Silicate
	Feldspar	K, Na, Ca, Al, Silicate
	(Quartz)	SiO_2
	(Arsenopyrite)***	FeAsS
	(Pyrite)	FeS_2
	(Pyrrhotite)	FeS
Granodiorite	Quartz	SiO_2
	Mica	K, Mg, Fe, Al, Silicate

* Minerals in brackets are only found in minor amounts.
** Gold is associated with chalcopyrite and bornite, as microscopic grains.
*** Only andesite in the vicinity of skarn rock sometimes contains arsenopyrite. Chemical analysis has shown that the arsenic content in such rock averages around 200 ppm.

2.4 MINING OPERATIONS

2.4.1 Existing Mining Operations

The Company commenced open cut mining operations during November, 1986. Extensive development was required to provide efficient and safe access to the open cut. The mining method employed is by conventional benching using hydraulic excavators and rear dump trucks as the principal mining equipment.

Highly selective mining is practised in conjunction with intensive grade control to mine relatively small pockets of ore associated with the complex geological structures.

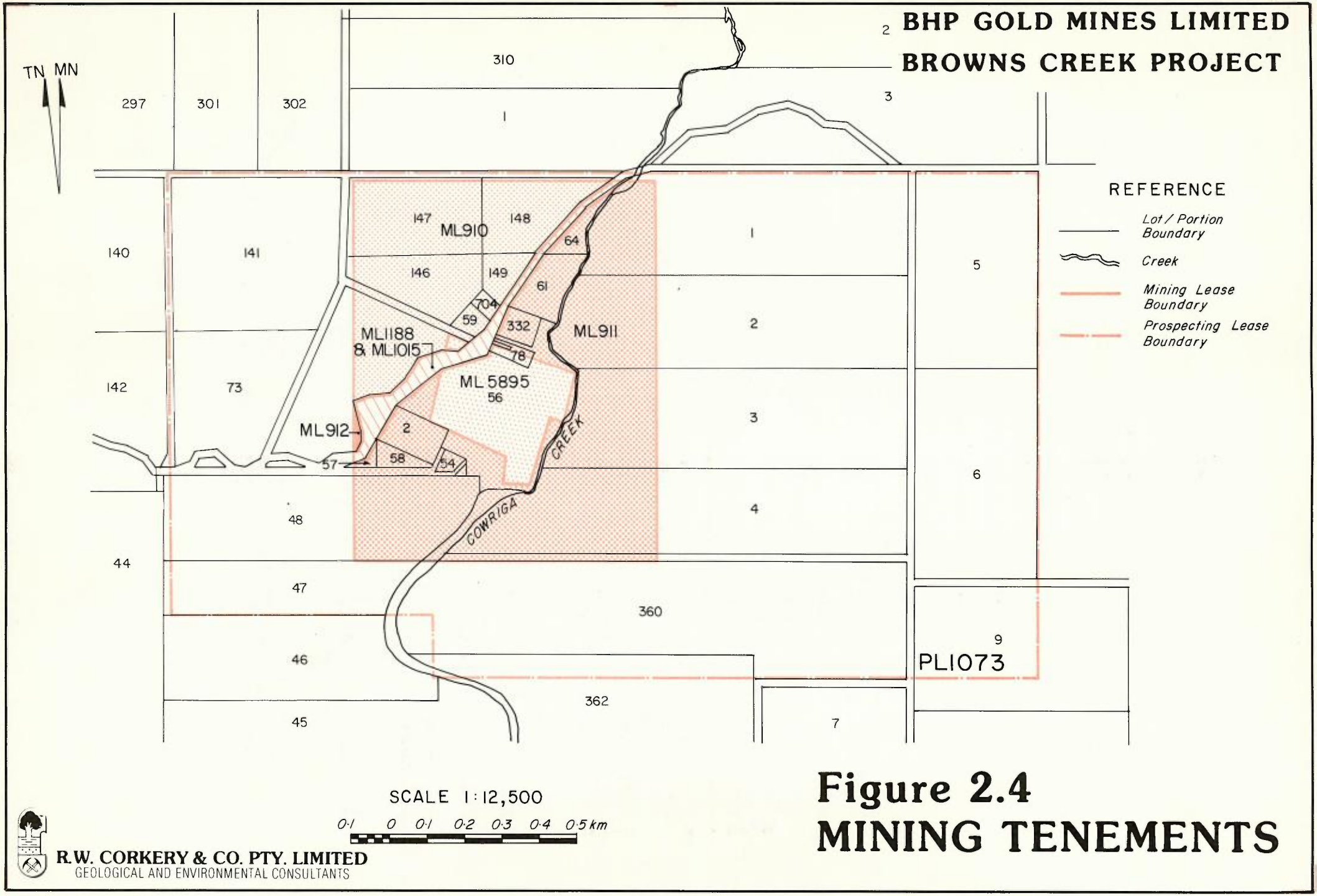
BHP GOLD MINES LIMITED
BROWNS CREEK PROJECT
TN MN
297
301
302
310
1
2
3
140
141
142
73
147
148
ML910
146
149
64
61
704
59
332
ML1188
& ML1015
78
ML911
ML 5895
56
ML912
2
57
58
54
48
44
47
46
45
360
362
7
1
2
3
4
5
6
9
PL1073
CREEK
COWRIGA
REFERENCE
Lot / Portion Boundary
Creek
Mining Lease Boundary
Prospecting Lease Boundary
SCALE 1:12,500
0·1 0 0·1 0·2 0·3 0·4 0·5 km
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Figure 2.4
MINING TENEMENTS

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BROWNS CREEK PROJECT

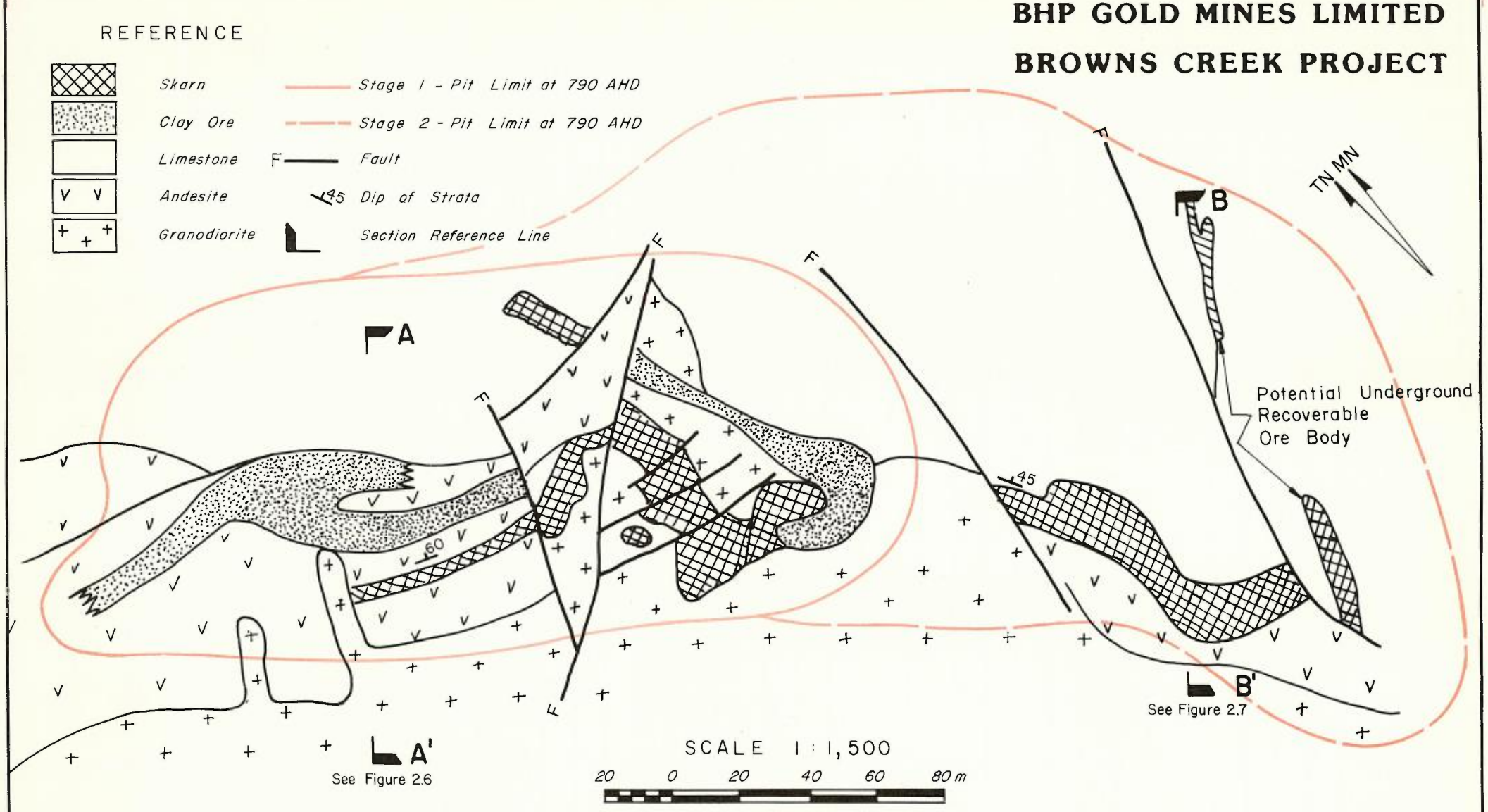

Figure 2.5
HORIZONTAL SECTION OF ORE BODY (AHD 790m)

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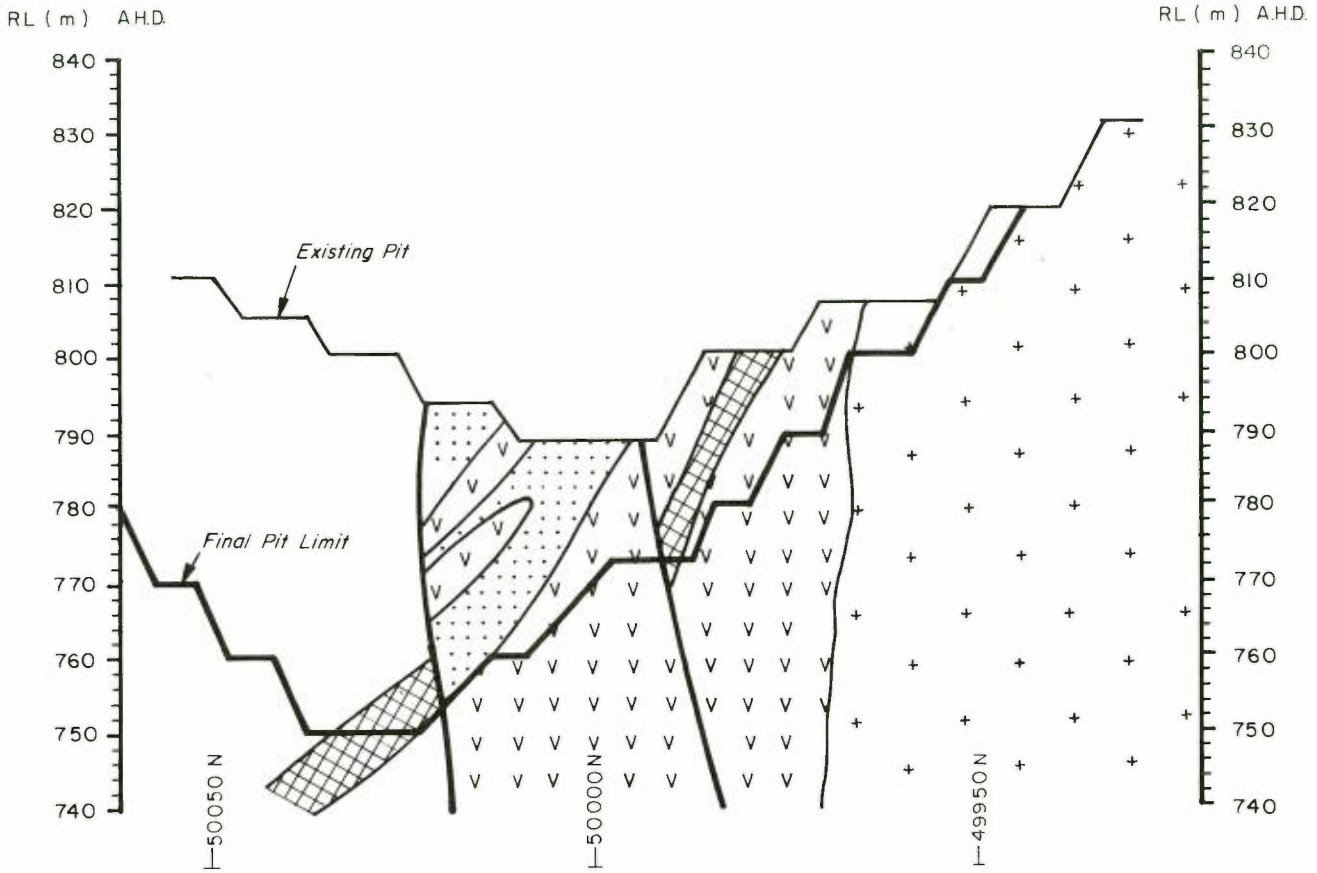
BROWNS CREEK PROJECT

NOTE : See Figure 2·5 for location of Section.



REFERENCE

- *Skarn*
- *Clay Ore*
- *Limestone*
- *Andesite*
- *Granadiorite*
- *Fault*

Figure 2.6
CROSS SECTION AA' INTERPRETED GEOLOGY

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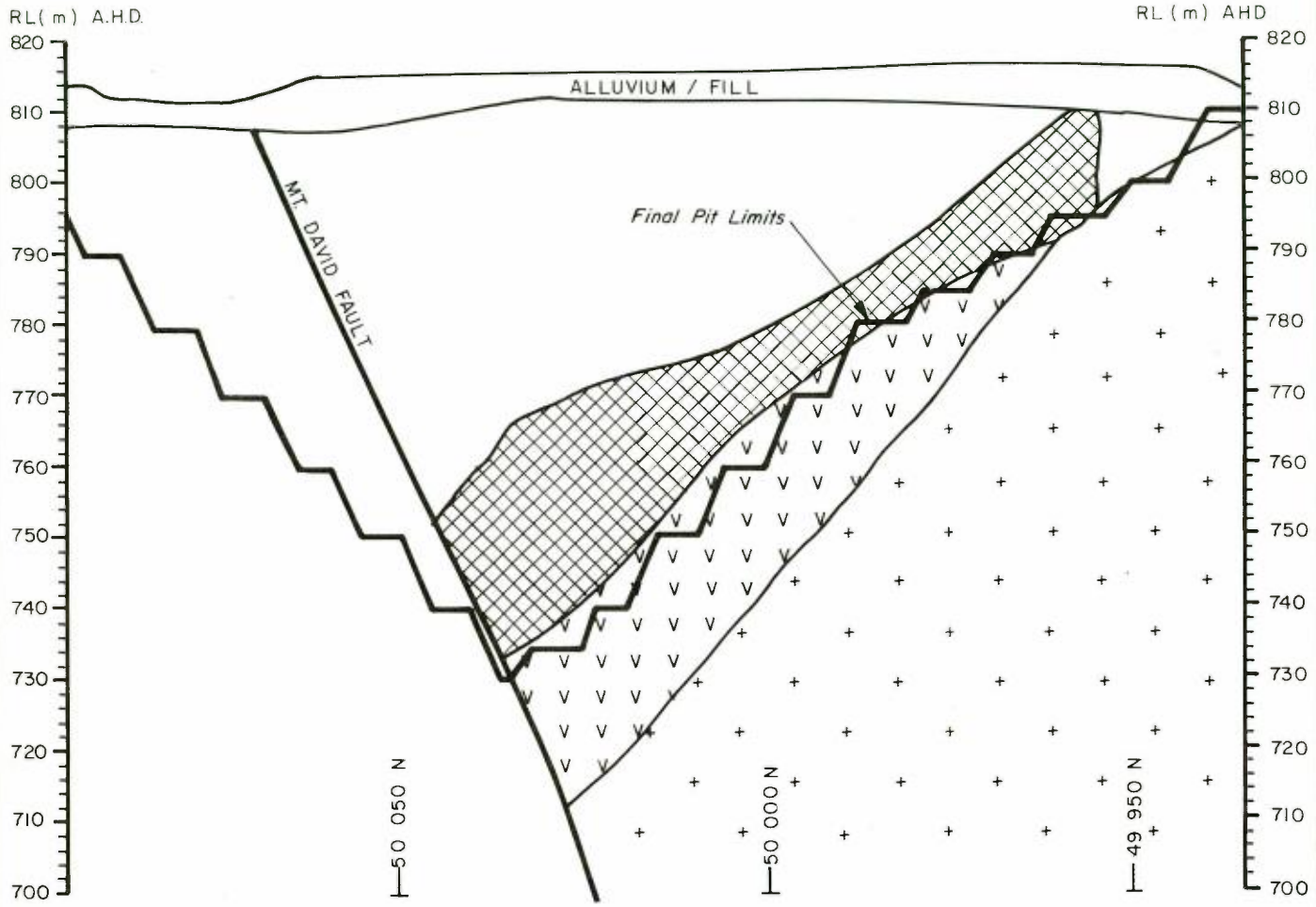
BHP GOLD MINES LIMITED
BROWNS CREEK PROJECT

NOTE : See Figure 2·5 for location of Section.



REFERENCE

- Skarn
- Clay Ore
- Limestone
- Andesite
- Granodiorite
- Fault

Figure 2.7
CROSS SECTION BB'
INTERPRETED GEOLOGY

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The open cut method of benching involves the establishment of level working surfaces around the perimeter of the open cut, forming benches at different levels. These benches provide the working area for drilling and blasting, and actual excavation and removal of the material by the mining equipment. In conjunction with the benches, an open cut access road or haul road is constructed to provide access to all bench levels.

The extent of the open cut is governed by the location of the ore body, the minimal overburden material that has to be removed to recover the ore, and the construction of the haul ramp. The overall open cut slope is governed by the stability of the individual benches and the main factors that influence overall stability are the rock material types, jointing planes, faults, fractures and other weakness planes and the effect that groundwater has on these materials.

The sequence of operation involves the following activities with minor variations depending upon ore types.

Hard Rock Overburden and Skarn Ore

All hard rock contained within the open cut requires drilling and blasting. A drilling rig capable of drilling holes up to 100 mm in diameter holes is used to drill the blast patterns to a depth of approximately 5 m. During the drilling of each hole, the drilling chips are collected for every metre drilled and these chips are then assayed for detailed grade assessment. On completion of the drilling pattern and grade assessment, the holes are charged with explosives and the shot fired. The blasted material is levelled with a bulldozer and an excavator moves onto the material and loads a rear dump truck for hauling to the hard rock ore stockpile or overburden storage areas respectively.

Clay Ore

This type of ore does not require blasting, and is generally freely excavated by the equipment. Prior to any removal of material, a bulldozer is used to level the area and expose the fresh clay, and rips trenches along designated sampling lines. Samples along the trenches are taken for assay. The resultant grade of the material will determine whether the clay is classified as overburden or ore.

Clay overburden is removed and dumped in the overburden storage area. Clay ores are removed and dumped for further grade control prior to screening and treatment. All the clay ore requires screening to remove large oversize rocks and old mine timbers. After screening, the clay ore is moved to the clay ore stockpile prior to treatment and gold recovery. The oversize rocks and mine timbers from the screening plant are moved by truck to the overburden storage area.

Existing mining operations are carried out from Monday to Saturday with hours of operation from 7.00 am to 5.30 pm, however, the mining operations are adversely affected by wet weather, with cessation of activities of several days per month being common. The vulnerability of the project to wet weather is caused by the nature and location of clays within the open cut. Although haul roads are well maintained, clay material accumulates on the roads and creates slippery surfaces when wet.

The Company utilises the services of a mining contractor who owns, operates and maintains all mobile equipment on the site. The current mining fleet and the proposed mining fleet is listed in Table 2.3.

Mine Dewatering

The open cut mine is highly sensitive to groundwater levels. This is due to the nature of the limestone with its inherent cavities and the extensive old underground workings which intersect these cavities. Dewatering of the open cut is carried out from the base of the new main shaft at a depth of 61 m (754 m AHD) as shown on Figure 2.8. A number of electric pumps are operated throughout the year on a 24 hour per day basis. These pumps have a maximum capacity of 14 Ml per day. This high pumping rate is required during winter months and decreases to a low of approximately 5 Ml/day during the drier summer months.

The relationship between hydrogeology and pumping rates is not simple and hydrogeological investigations are ongoing. Any operational problems with these pumps results in a rapid rise in the water table and flooding of the open cut workings. Water from underground is of good quality and is released directly into Cowriga Creek below the mine workings. The dewatering activity is licenced under the State Pollution Control Commission Approval transferred to the Company on 14th November, 1986. Analyses of water released are discussed in Section 3.6.2.

2.4.2 Proposed Open Cut Mining Operations

The continuation of mining operations at Browns Creek will be identical to the methods currently employed, with some minor equipment changes proposed (see Table 2.3).

As the ore body underlies the crushing and treatment facilities, mining of the ore body will be in two stages.

Stage 1 will involve the continued development and deepening of the current open cut prior to the removal of the existing treatment plant. Figure 2.8 shows the extent of Stage 1 open cut development and existing facilities.

Stage 2 will involve the extension of the open cut to the east once the crushing and treatment facilities have been removed. Figure 2.9 shows the extent of the Stage 2 pit development after relocation of these facilities.

Rediversion of Cowriga Creek from its present alignment is required in order to access and mine the ore body as the open cut progresses east in Stage 2. The diversion works will provide upgrading of the existing levees on the watercourse for protection against inundation of the open cut. The rediverted watercourse will be lined to avoid water seepage into sink holes in the limestone. Several diversion alternatives have been examined. These alternatives and design details are presented in Section 4.4.2.

The first stage of pit development will involve deepening the existing open cut. Haulage of overburden and ore will be via a temporary ramp system on the eastern and northern perimeter or via the permanent southern ramp system. This ramp system will be further developed in Stage 2. It is estimated Stage 1 will be completed midway through 1988.

Delays in removal of the treatment plant will necessitate further deepening of the open cut and an increase in operational delays and costs due to the confined work area which will restrict efficient equipment usage.

TABLE 2.3

MINING EQUIPMENT IN USE AND PROPOSED AT THE BROWNS CREEK MINE

Type	Existing No.	Proposed No.	Size	Duties
Hydraulic Excavator	1	2	3.5 m^3	Ore/waste removal
Hydraulic Excavator	1	1	2.3 m^3	Ore/waste removal
Hydraulic Rock Breaker	1	-	150 kW	Breaking rocks
50 t Rear Dump Truck	3	7	485 kW	Ore/waste haulage
35 t Rear Dump Truck	3	-	340 kW	Ore/waste haulage
Front-end Loader	1	1	200 kW	Treatment plant
Front-end Loader	2	1	150 kW	Treatment plant
Universal Front-end Loader	1	1	60 kW	General duties
Grader	1	1	120 kW	Haul road maintenance
Bulldozer	1	1	300 kW	General duties
Water Truck	1	1	40,000 l	Dust reduction
Service Truck	1	1	10 t	Oil/fuel service
Blast Drill	1	1	100 mm	Drill ore/waste

NOTE: SHOWS EXISTING FACILITIES PRIOR TO RELOCATION

BHP GOLD MINES LIMITED
BROWNS CREEK PROJECT

MINE OFFICES

MINE ACCESS ROAD

CLAY STOCKPILE

CREEK

Primary Crusher

ROM Ore Stockpile

Crushed Stockpile

Fine Ore Stockpile

NEW MAIN SHAFT

Underground Pipe

Gravity & Flotation Circuit

CIP Circuit

Clay Plant

Ore Stockpile

Mine Water Discharge Tank From Plant

Discharge Point

OLD CREEK BED

DIVERSION OF CREEK

EXISTING CREEK

CLAY ORE STOCKPILE AREA

HAUL ROAD

To Waste Dump

MN TN

SCALE 1:1500

10 0 50 100m

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Figure 2.8
OPEN CUT LAYOUT STAGE 1

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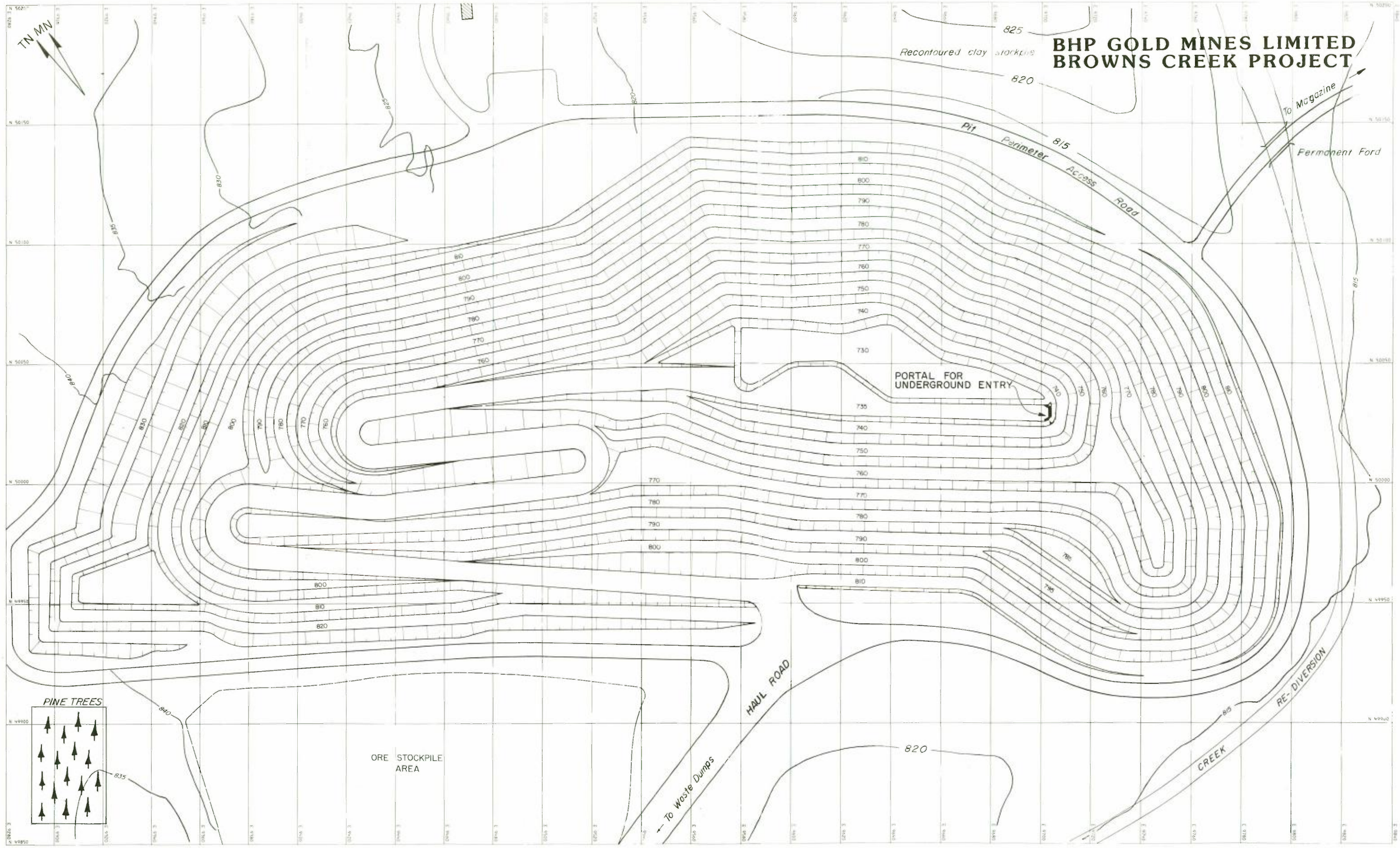
BROWNS CREEK PROJECT



SCALE 1:1500

25 0 25 50 75 100m

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Figure 2.9
OPEN CUT LAYOUT STAGE 2

The mining of Stage 2 will commence as soon as the crushing and treatment facilities have been moved. Mining will commence from the eastern surface perimeter of the Stage 1 open cut and proceed along the southern area where the ore body is located nearer to the surface. It will then follow the ore body down dip to the north. The base of the Stage 2 open cut is expected to be at approximately 730 m A.H.D., however, prevailing economics may warrant a variation in this depth.

Potential ore material in the open cut is sampled and assayed for gold content prior to mining. Based on the assay results, the material is deemed overburden or ore and sent to the overburden storage area or ore stockpile areas respectively. Mining of the material will be undertaken by either hydraulic face shovel or excavators loading into rear dump trucks for haulage. The hard rock material must be drilled and blasted prior to loading while the clay material can be loaded directly from its in situ state.

A proposed life of mine schedule for the open cut based on proven and possible reserves is presented in Table 2.4. The Company is confident of delineating additional ore above the current proven and possible reserve, which will extend the life of the open cut. Extraction of the ore shown in Table 2.4 is a function of the milling capacity and also the capacity of the mining operations to extract the required amounts of ore at minimal overburden to ore ratio.

The clay stockpile north of the open cut will be partly removed and contoured. The old creek watercourse between the block dam and the mine will be filled with some of the clay to reduce seepage into the limestone formations.

Haulroads within the expanded open cut will be constructed to a uniform grade of 8 per cent and a paved width of at least 10 m. In areas where a dual carriageway is not possible, passing bays will be provided to minimise truck delay times. Haul roads outside the open cut will be up to 15 m in width. All haul roads are surfaced with compacted crushed diorite overburden, which is graded and cambered to provide a good travelling surface. Surface runoff above haul roads will be directed through culverts and discharged into the natural drainage system. Runoff from the surface of haul roads and surrounds will be directed to sedimentation dams prior to discharge into the natural drainage system.

TABLE 2.4
OPEN CUT PRODUCTION SCHEDULE
BASED ON PROVEN RECOVERABLE RESERVES

Year Ending May	Skarn Ore*	Clay Ore*	Total Ore*	Over-burden*	Stripping Ratio
1988	110,000	40,000	150,000	1,450,000	9.7
1989	130,000	20,000	150,000	1,750,000	11.7
1990	150,000	-	150,000	1,500,000	10.0
1991	63,000	15,000	78,000	760,000	9.7
	453,000	75,000	528,000	5,460,000	10.3

* tonnes

Note: (i) 1991 includes the mining of the possible resource of 45,000 tonnes (see Table 3.2.

(ii) Total open cut overburden volume approximately 2.5 million m^3.

Open Cut Design Criteria

The open cut design criteria on which the plan shown in Figure 2.9 was based is presented in Table 2.5.

A geotechnical appraisal of the open cut has been carried out by BHP Engineering. It is recommended that double benching (20 m bench height with a 5 m berm) may be possible in the more competent materials expected below 790 m AHD. This will increase the overall lower pit slopes from 50^{o} to 59^{o}.

2.4.3 Proposed Underground Mining Operations

Initial investigation into areas of the mineralisation where underground mining is being considered has shown sub-level stoping to be the most feasible method, with access being achieved through a decline from the open cut. The proposed mining method and access may be revised as information on the area increases development confidence.

TABLE 2.5
PROPOSED OPEN CUT DESIGN CRITERIA

Lowermost level in open cut		730 m AHD
Vertical depth below surface		90 m
Working bench height		5 m
Final bench height (depending on material)		20 m
Berm width		5 m
Final overall open cut slope		
- West in clay above 820 m AHD		35°
- All other walls (depending on material)		50° to 57°
Haulroad - Width		10 m
- Gradient - Straights		8%
- Corners		10%
Specific Gravity - Ore - Skarn		2.7
- Clay		1.8
Overburden - Hard rock		2.6
- Clay		1.8

Note: The final open cut slopes are subject to change depending on geotechnical conditions.

At this stage it is envisaged that the two ore bodies, one to the southeast and one to the northeast of the main ore body, will be mined by underground methods, expected to be by stoping. Based on drilling and interpretations to date, the underground resource is estimated to be 115,000 tonnes at an average grade of 8.0 g/t. There appears to be sufficient tonnages at relatively high grades to warrant a detailed feasibility assessment on underground mining to be carried out. Depending on the results of these ongoing studies, underground operations may proceed as soon as suitable access is available. Access to the ore bodies may be through a decline with its portal for underground entry at the base of the open cut as shown on Figure 2.9.

2.5 ORE HANDLING AND CRUSHING OPERATIONS

2.5.1 Outline of Existing Procedures

Skarn Ore

After blasting, the skarn lode benches are visually grade controlled during the loading operation to separate overburden material from ore. Overburden is removed by truck to the relevant overburden material disposal area. Facilities are available to crush overburden material for mine road maintenance.

Skarn ore is trucked to the crusher stockpiles where a hydraulic rockbreaker reduces any large ore blocks to a size suitable to feed the primary crushing circuit. A primary jaw crusher reduces the ore to minus 200 mm for stockpiling. Where possible, these activities are carried out between 7.00 am and 5.30 pm. There has been the need on occasions to operate the jaw crusher at night to overcome problems associated with equipment availability and weather.

Primary crushed ore is further reduced in two crushing stages to the treatment plant feed size (minus 8 mm) in a closed secondary/tertiary crusher circuit. The crushed product passes to a 150 tonne feed bin which feeds one of the grinding mills. As the crushing circuit is affected by wet weather, a stockpile of crushed ore provides continuous feed for the treatment plant.

Oxidised Ore

Clay lode benches are grid sampled to determine the extent of the economic ore zones. These are subsequently selectively extracted and the ore individually truck dumped for further grade assessment.

Overburden material identified by these procedures is removed by truck to the relevant disposal area.

A screening operation is required to remove the oversize rocks and trash material typically contained within the clay ore. The screened clay ore is then stockpiled prior to feeding the clay treatment plant.

2.5.2 Outline of Proposed Procedures

Skarn Ore

The proposed crushing circuit flowsheet for skarn ore is shown in Figure 2.10. Grade control techniques for skarn ore will remain similar to those already in practice.

The crushing and ore handling facilities will be upgraded on relocation to improve operating efficiencies and reduce costs. It is also proposed to increase crusher throughput and ore storage capacity to reduce the operating time which would otherwise be required with the existing facilities.

Subject to final design, the relocated crushing facilities will comprise the following typical components:

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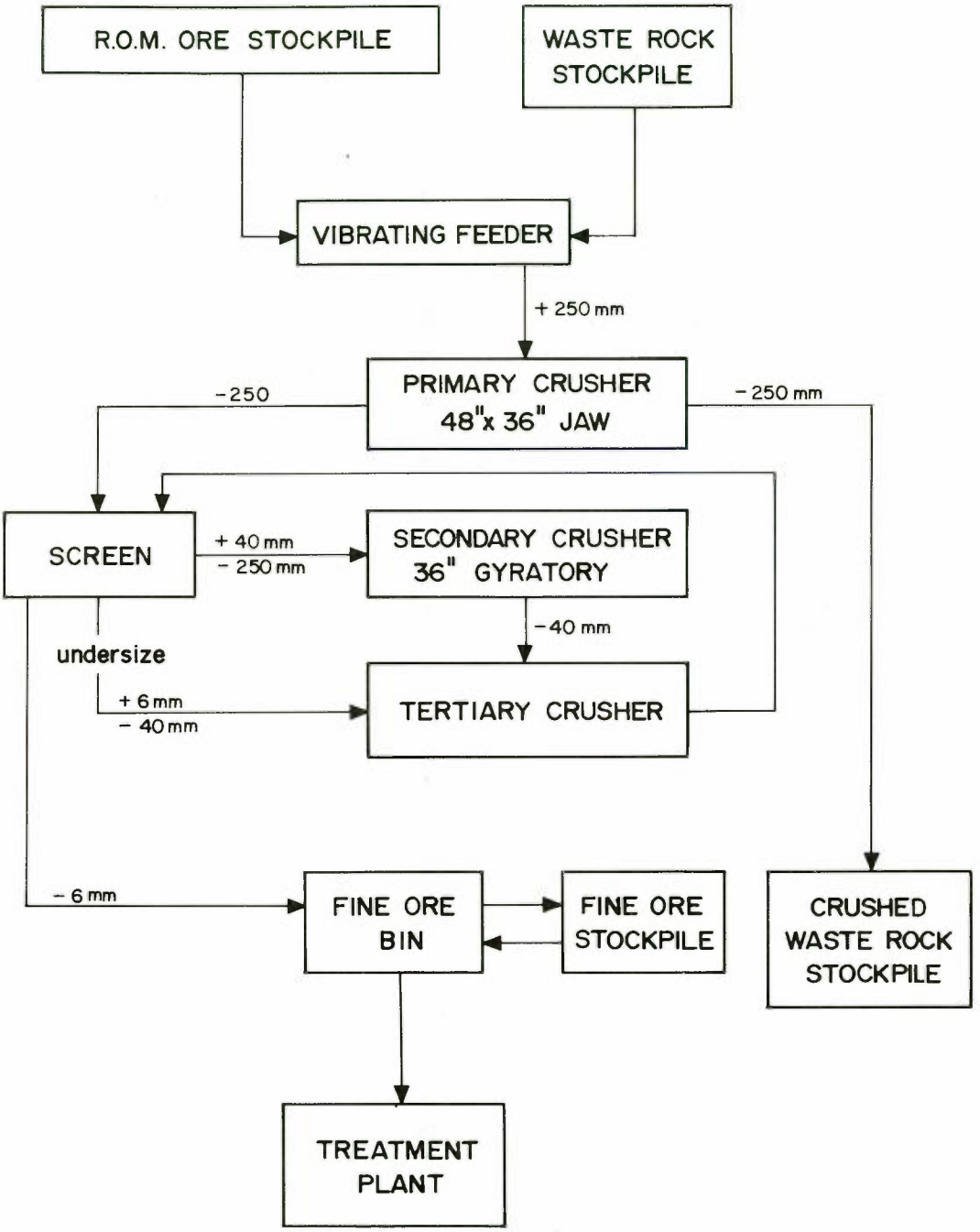

NOTE: Size +40 mm – 250 mm means Particles in Size Range 40 mm – 250 mm

Figure 2.10 PROPOSED CRUSHING CIRCUIT FLOWSHEET

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(i) A truck dump stockpile area located between the open cut and the crusher feed system for the primary jaw crusher. This will be located on presently disturbed land.

(ii) A three stage crushing plant incorporating a primary grizzly, a primary jaw crusher, a secondary gyratory crusher and a tertiary autogenous (or cone crusher) in closed circuit with a vibrating screen.

(iii) Provision will be made to stockpile crushed overburden material for road base material.

The elevations and design of the relocated crushing circuit is shown in Figure 2.11.

Oxidised Ore

It is expected that most of the remaining Browns Creek clay ore will be treated through the existing facilities, and therefore current practices of grade control and handling will remain unchanged.

If further oxidised reserves are located as a result of current and future exploration activities, and providing it is economically justifiable, then the ore handling circuit may be modified to treat these ores.

2.6 TREATMENT PLANT OPERATIONS

2.6.1 Outline of Existing Treatment Processes

The treatment plant currently has two separate processing circuits to recover metal values from the two different ore types forming the ore reserve. Both circuits operate in parallel on a 7 day per week, 24 hour per day basis throughout the year. The combined gold production is 20,000 oz per annum.

Skarn Ore Treatment

This circuit treats crushed skarn ore at a rate of 66,000 tonnes per annum in a conventional grinding, gravity, flotation circuit. The crushed skarn ore is ground in a ball mill to a size less than 90 um to liberate the gold/copper minerals. The mineralised particles are then separated from the non-mineralised particles by a gravity circuit for coarse particles and flotation cells for finer particles.

The mineral concentrates are subsequently dewatered by settling and filtration. On completion of treatment, the concentrates contain approximately 8 per cent moisture. They are stored in a concrete bunker within the mill building, awaiting truck despatch from the site for refining and smelting.

The remaining material is pumped to the residue or process residue storage dams. Water is reclaimed from these dams for re-use in the treatment of fresh ore.

Oxidised Ore Treatment

This circuit treats oxidised ores at an annual rate of 220,000 tonnes per annum in a scrubbing, grinding and Carbon-in-Pulp treatment plant for gold recovery.

Clay ores are autogenously scrubbed to break up the clays and liberate gold containing particles. Particles greater than 90 um in size are ground in a ball mill to further liberate gold minerals.

A Carbon-in-Pulp plant (C.I.P.) recovers gold by leaching and adsorption onto carbon which is subsequently treated to produce gold as dore bullion.

After gold extraction, the finely ground material from the C.I.P. plant is pumped to process residue dams for storage and the water is recycled to the treatment plant for re-use.

2.6.2 Need for Treatment Plant Relocation

The present treatment facilities were built in the present location (see Figure 2.2) on the basis that skarn ore extraction would be by underground methods. Skarn ore reserves, economically mineable by open cut methods, have since been identified beneath the present site of the treatment facilities.

To maximise the recovery of the mineral resources and reduce the amount of ores sterilised it is therefore necessary to relocate and upgrade the treatment facilities for the following reasons:

(i) The facilities in their present location sterilises the economic extraction of 270,000 tonnes of proven ore. This additional ore effectively extends mine life by at least 2 years.

NOTE : FOR VIEW DIRECTIONS SEE PLANT LAYOUT - FIGURE 2.13

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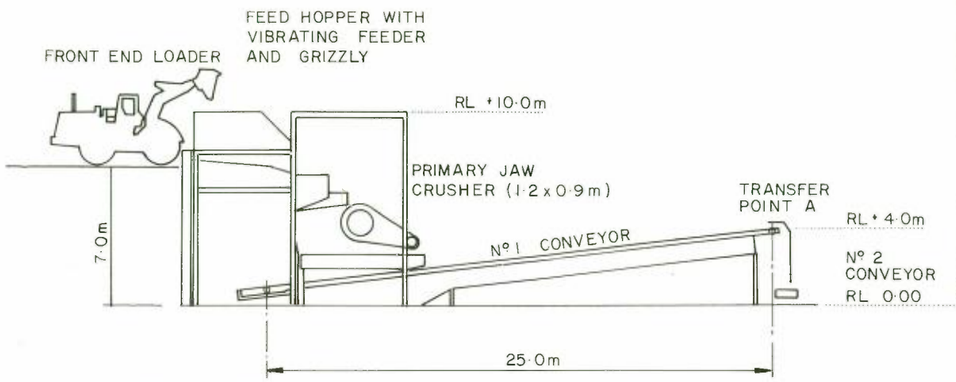
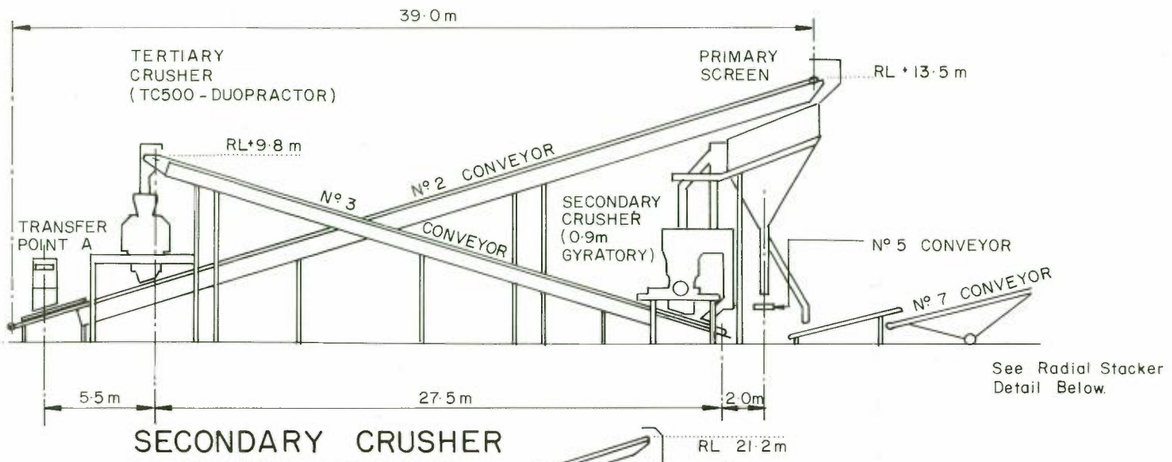
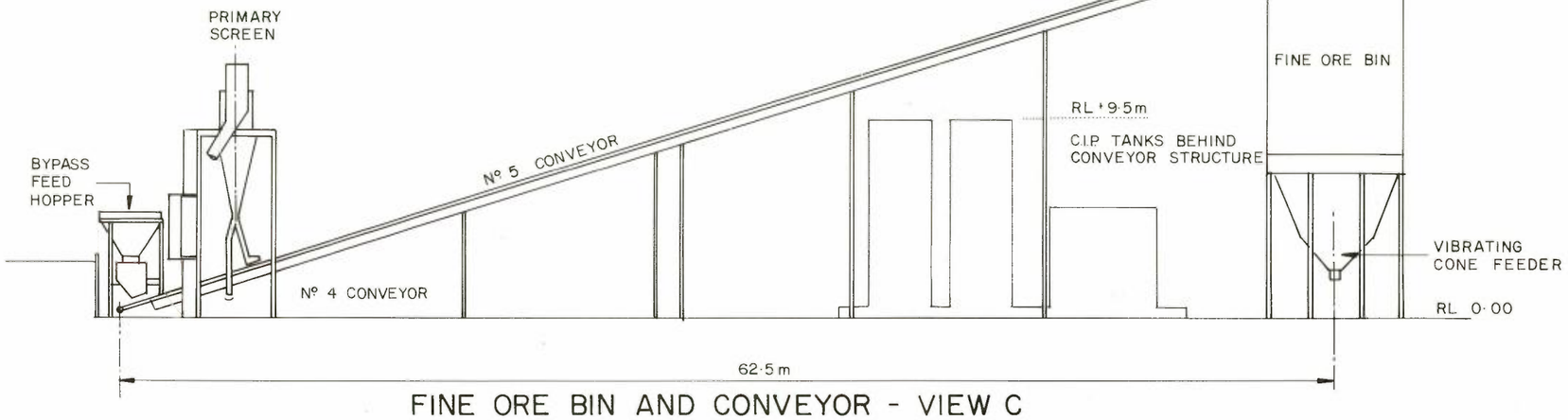


PRIMARY CRUSHER ELEVATION - VIEW A

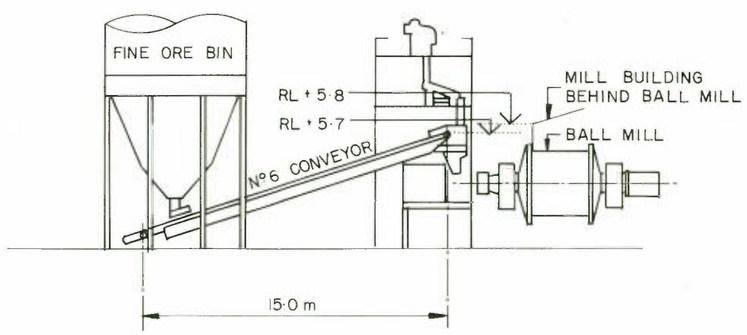


SECONDARY CRUSHER
ELEVATION VIEW B

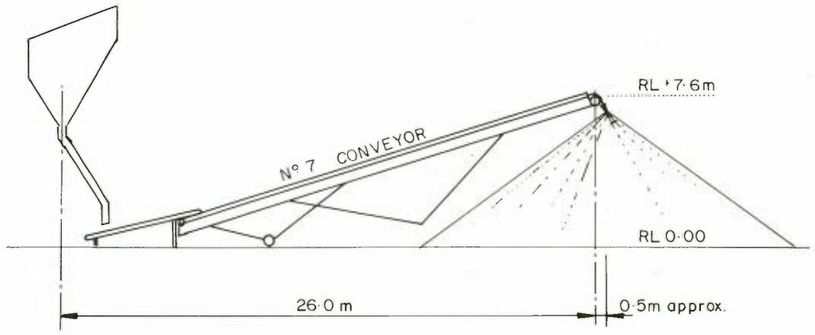


FINE ORE BIN AND CONVEYOR - VIEW C

Note : RL 0·00 = AHD 830 ± 2·0m



TREATMENT PLANT GRINDING CIRCUIT
VIEW D



RADIAL STACKER STOCKPILE DETAIL - VIEW E

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Figure 2.11
CRUSHING CIRCUIT ELEVATIONS

(ii) To upgrade and rationalise treatment equipment to improve cost effectiveness and mineral recoveries.

(iii) To undertake improvements so that the impact of treatment facilities on the environment may be reduced.

(iv) In the long term, remove the plant from the proximity of the Cowriga Creek watercourse.

2.6.3 Outline of Proposed Treatment Processes

A simplified process flowsheet for skarn and oxidised ore treatment is shown in Figure 2.12. The new plant will have a capacity to treat the ores at a rate of up to 150,000 tonnes per annum (skarn ore) or 300,000 tonnes per annum (oxidised ore).

Skarn Ore Treatment

Initially the relocated treatment plant will consist of a treatment circuit to treat skarn ores which forms the bulk of the known Browns Creek reserves. The upgrading process adopted will continue to be froth flotation, a process which is currently used at Browns Creek Mine, and many operating mines in Australia including Broken Hill, Woodlawn and Mt. Isa.

Subject to final design, the relocated treatment plant will comprise the following typical components (see Figure 2.13):

(i) An enclosed fine ore bin will provide surge capacity between the discontinuous crushing circuit and continuous milling process.

(ii) A wet grinding plant comprising a single stage ball mill with closed circuit cyclone classifiers.

(iii) A wet gravity circuit which recovers coarse free gold, copper minerals and grinding iron. A gravity concentrate for further treatment or smelting will be produced.

(iv) A froth flotation plant consisting of a set of mechanically agitated flotation cells.

(v) A thickening and filtering plant to dewater concentrates for storage in a concrete bunker within the treatment plant building.

Oxidised Ore Treatment

As oxidised clay ore reserves at Browns Creek appear limited, it is planned that most of this ore will be treated through the existing treatment circuit until mining operations to recover skarn ore require these facilities be removed.

Depending on results of further extensive exploration activity in the Browns Creek area, a second treatment circuit for oxidised ores may be incorporated into the relocated ore treatment complex. The construction of this circuit will depend on project economics prevailing at that time.

The ore will be either crushed or scrubbed then crushed to a size for grinding to enable gold to be dissolved and absorbed onto carbon paricles. This process is currently in use at Browns Creek and is widely used in Australia. Local examples of this type of plant are the Sheahan-Grants Gold Project at Junction Reefs and the Paragon Gold operations at Temora.

The C.I.P. circuit (like the present) will consist of:

(i) A set of mechanically agitated leach tanks.

(ii) An adsorption circuit consisting of mechanically agitated tanks, each providing one hour retention time. Carbon will be circulated counter current to the flow of the slurry by either air lifts or recessed impellor pumps. Carbon loaded with gold is recovered and washed on a vibrating screen.

(iii) A gold recovery area will incorporate an acid wash column, an elution system, a carbon regeneration kiln and associated carbon storage bins, screens and feeders.

The exact flowsheet and equipment schedule will depend on the metallurgical and handling characteristics of the ore to be treated, however, a typical simplified flowsheet is shown in Figure 2.12.

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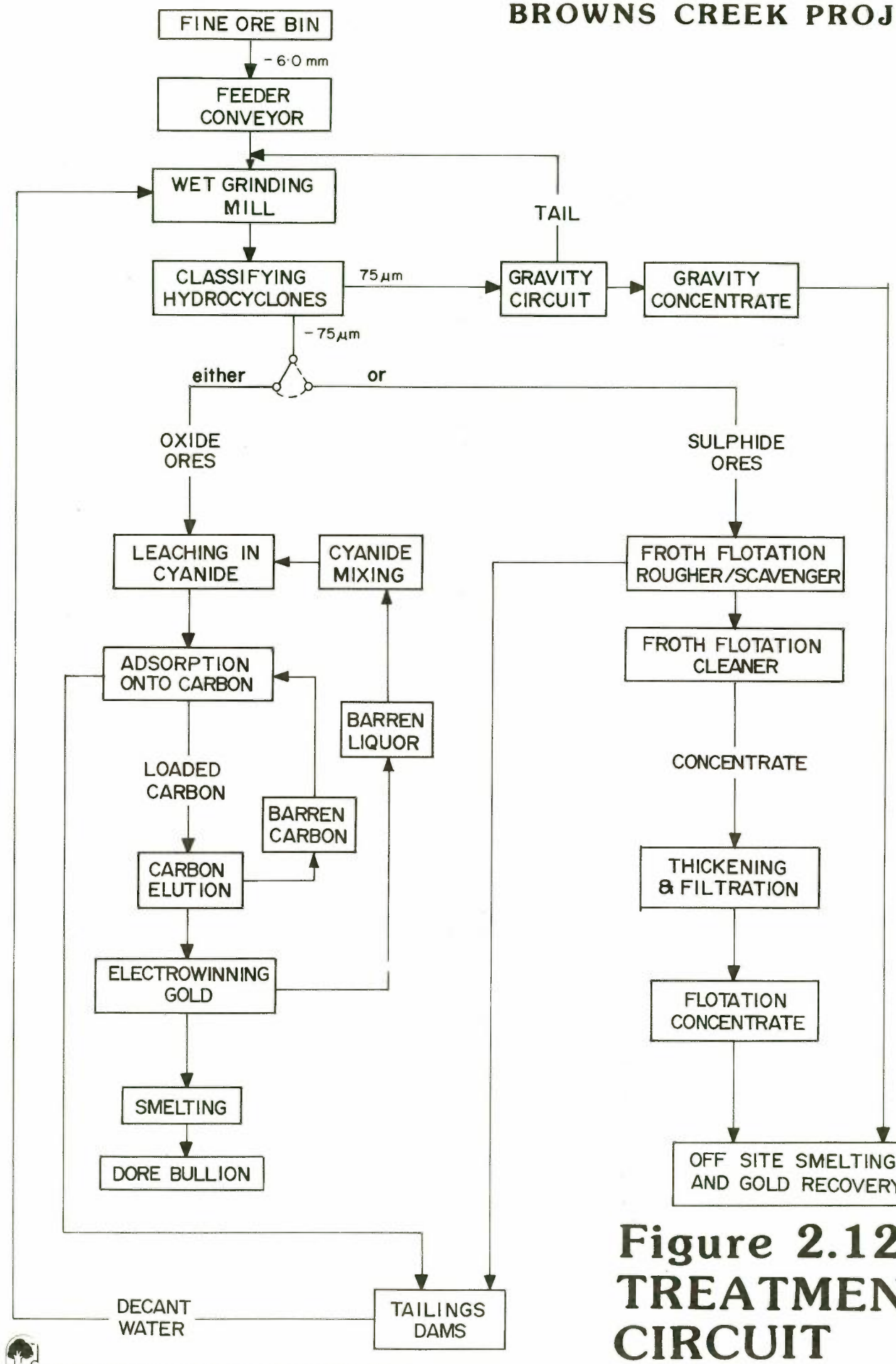

Figure 2.12 TREATMENT CIRCUIT FLOW SHEET

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REFERENCE

Batter Slope

Spoon Drain

Gravelled Access Road

SCALE 1 : 500

5 0 5 10 15 20 m

TN MN

Screened Clay Stockpile

Existing Clay Screen Plant

Dirty Water Settlement Dam

spoon drain

Treatment Plant Workshop

Haul Road to Pit

To Waste Dumps

culvert

CIP PLANT

Gold Room

Elution Regeneration

Adsorption Tanks (6)

Bleach Tanks (3)

Reagent Bund Wall

Electrical Switchgear

FLOTATION PLANT

GRAVITY CIRCUIT

TREATMENT PLANT

FLOTATION CIRCUIT

Concentrate Storage

Mill Office / Crib Room

LIGHT VEHICLE PARKING

Ablutions / First Aid

Crushed Ore Waste Stockpile

VIEW "E"

VIEW "A"

Primary Crusher

VEHICLE ACCESS

Reagent Storage Area

Water Tank

Fine Ore Bin

Ball Mill

Tertiary Crusher

Secondary Crusher

Screening Plant

LIGHT VEHICLE ACCESS

VIEW "B"

VIEW "C"

VIEW "D"

spoon drain

FOOT ACCESS

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Figure 2.13
TREATMENT PLANT LAYOUT

2.6.4 Alternatives

Two alternative sites were examined for the relocation of the treatment plant. The preferred site (southwest of the open cut) and an alternative site on the eastern side of Cowriga Creek are shown on Figure 2.3.

The preferred site was chosen as the following factors were recognised in reducing environmental impacts:

(i) The bulk of the plant will not be visible from the Platform Road. It is possible that the tip of the fine ore bin will be visible from part of the roadway.

(ii) The site is close to the open cut exit which minimises transport distance to the plant.

(iii) It is close to the overburden material disposal area which can serve as a stockpile area during the life of the plant.

(iv) The site is more distant from Cowriga Creek.

(v) The site is largely already disturbed by previous operations.

(vi) The site has a superior basement for construction of the plant.

(vii) The plant would be in a constructed enclave which would minimise noise propogation to nearby dwellings and allow easier management of water runoff within the treatment facilities.

(viii) The plant would not sterilise any ore reserves.

The alternative site is located 500 m northeast of the open cut, to the east of Cowriga Creek. The following disadvantages were prominent in the rejection of this site:

(i) It would be highly visible from the Platform Road and therefore would have a significant visual impact;

(ii) It would result in an overall increase in local disturbance as compared to the first option;

(iii) Few natural barriers exist to attenuate any noise;

(iv) It would be necessary to cross Cowriga Creek with a haulage road whilst ore is extracted from the open cut.

(v) The area is suitable and is proposed as a process residue storage area (see Figure 2.3).

The treatment plant site and service areas will be enclosed within the overall mine lease security fence. Figure 2.13 shows the detailed layout of the proposed treatment plant together with runoff management for the plant area.

2.7 DISPOSAL OF PROCESS RESIDUES

2.7.1 Materials Characterisation

Process resiude from the two treatment circuits are different in nature reflecting the difference in ore types and the treatment processes adopted in each case.

For metallurgical reasons the disposal systems for each circuit must be kept separate. This is necessary to prevent flotation reagents contaminating the C.I.P. circuit water and the C.I.P. reagent interfering with the flotation process.

Flotation Residues

These residues are in slurry form comprising an aqueous and a finely ground solids component. To liberate gold in the treatment process the solids have been ground to a size with 80 per cent by mass passing a 70-90 micron sieve.

The solids component consists of wollastonite skarn, diorite, andesite, limestone, quartz and amphibole. Residual levels of sulphide may exist but the dominance of limestone indicates that there will be no acid problem with the residual process residues.

The aqueous component is expected to contain some soluble metal cations, organic flotation reagents and be slightly alkaline.

Table 2.6 shows a characterisation of present process residues. It is anticipated that future flotation residues will be similar in nature.

TABLE 2.6
CHARACTERISATION OF FLOTATION PLANT PROCESS RESIDUES

	Solids (mg/kg)	Solutions* (mg/l) (i)	(ii)
Au	0.3	<0.3	-
Ag	1	<0.10	-
Cu	148	110	115
Ni	17	1	-
Fe	10,000	<1	<1
Hg	-	<0.001	-
As	12	0.005	-
Pb	<5	0.006	-
Zn	45	<0.01	<0.1
S	1,500	<0.1	-
CN	-	30	3
CN (total)	-	70	104
pH		7-9	9.05

* (i) Company analyses;
(ii) Mineral Resources Development Laboratory-L87/84, sampled 21/8/87.

C.I.P. Process Residues

Like the flotation process residues these comprise an aqueous and a finely ground solids component. To liberate gold in the treatment process the solids are ground to a size with 80 per cent by mass passing a 90 micron sieve.

The solids component consists of fines derived from various clay minerals (illites and smectites) with minor skarn, limestone, diorite, andesite, quartz and residual metal sulphides particles.

The aqueous component contains some soluble metal cations, C.I.P. reagent and is alkaline in nature.

Table 2.7 shows the characterisation of present process residues. It is anticipated that future process residues will be similar in nature. The high copper content of solids and solutions reflects the copper content of the ore. The cyanide content of process residues solutions is indicative of such copper-bearing ores.

TABLE 2.7
CHARACTERISATION OF C.I.P. PLANT PROCESS RESIDUES

	Solids (mg/kg)	Solutions* (mg/l) (i)	(i i)
Au	0.3	<0.03	-
Ag	5	0.1	-
Cu	2,000	777	310
Ni	13	1	-
Fe	10,000	2	8
Hg	-	<0.001	-
As	71	0.51	-
Pb	12	<0.005	-
Zn	45	0.03	<0.1
S	2,000	<0.01	-
CN	-	270	113
pH		8-10.5	9.45

* (i) Company analyses;

(ii) Mineral Resources Development Laboratory analyses - L87/820, sampled 21/8/87.

2.7.2 Process Residues Handling Procedure

The process residues handling procedure remains essentially the same for present and proposed operations.

Process residues slurry from the flotation circuit at 30 per cent solids density by weight and from the C.I.P. circuit at 35-40 per cent solids density by weight are transported by pump and pipeline to the residue process residues dams.

The solids component of the process residues settles in the dam allowing reclamation of the supernatant water for re-use in the appropriate treatment circuit. Figure 2.14 shows the existing process residues disposal procedure and the location of discharge pipes and return lines.

Both water circuits are therefore closed, however, minor amounts of water may be drawn from open cut dewatering activities to supplement evaporation losses or for specific purposes which require a higher quality of water.

Each process residues residue dam will be operated until the settled solids level fills the process residues dam to the design freeboard level. At this time no further process residues will be discharged into the dam and the remaining water allowed to evaporate. When the solids dry sufficiently, the rehabilitation of the dam surface will commence.

The pipeline network to distribute process residues in the dam is installed along the dam wall surface. Spigots or outlet points are attached to the line which discharge process residues into the process residues dam area (see Figure 2.14).

Coarser particles in the process residues settle closest to the dam walls or the dam perimeter thereby improving the embankment stability. Finer particles, particularly the clays, settle away from the dam perimeter and are contained within these coarser particles.

Supernatant water will be recovered by either a floating pump or a decant system depending on relative levels between the dam and the treatment plant.

Standpipe piezometers will be installed in the dam walls to monitor seepage pressures and quality on a regular basis.

2.7.3 Process Residues Disposal Programme

Figure 2.14 identifies the existing process residues management procedures and Figure 2.15 the proposed process residues management procedures. Table 2.8 presents the status, storage capacity and expected life of these process residues dams.

It is proposed that two dams/water systems will be operational concurrently in the short term to allow both C.I.P. and flotation plants to be operated simultaneously.

Flotation Plant Residues

Flotation plant residues are currently being stored in existing dams, however, additional containment will be required for operation of the new flotation plant.

A dam constructed at Site 4 to a wall height of 840 m A.H.D. would contain flotation plant residues for the known mine reserves.

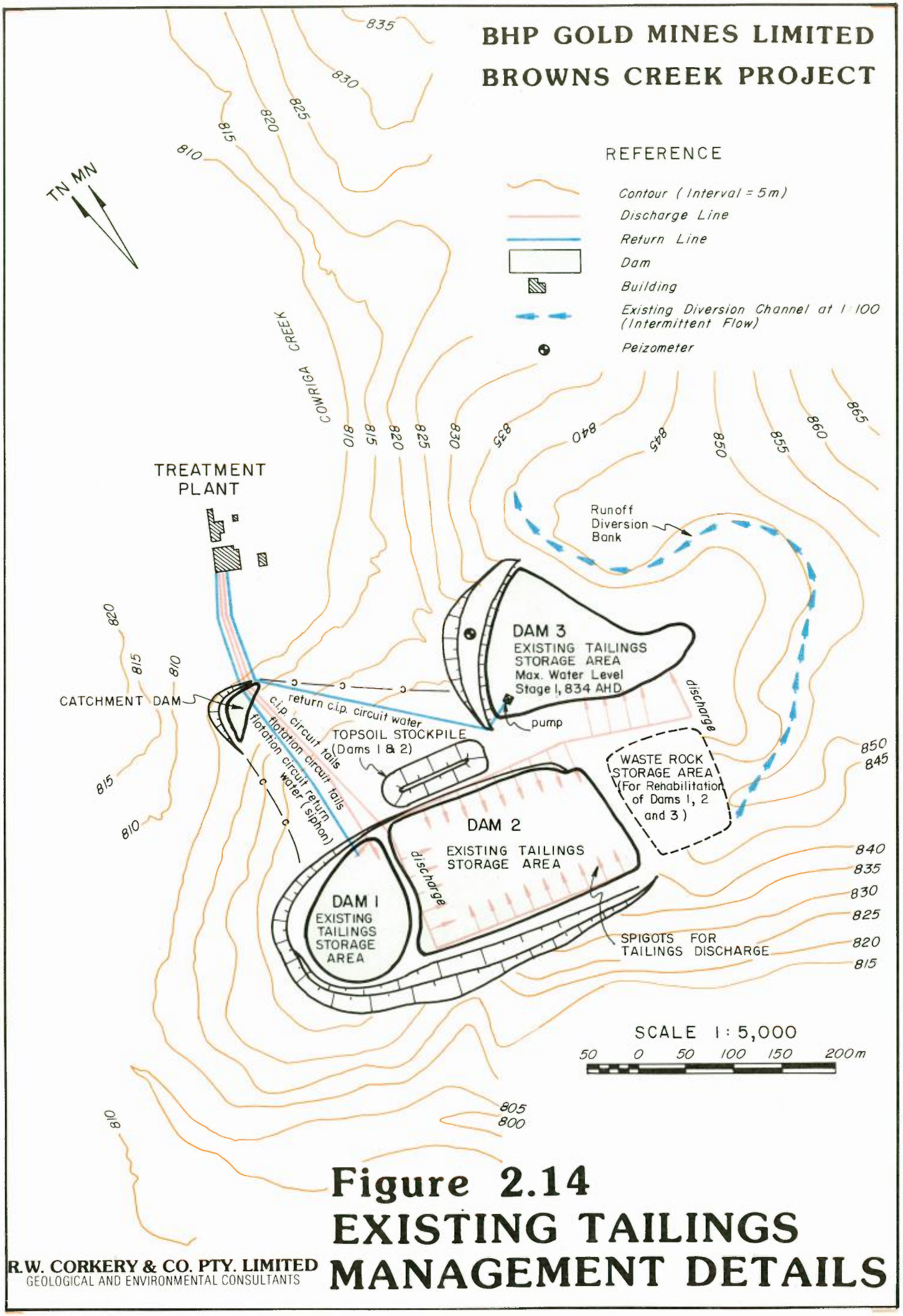

Figure 2.14
EXISTING TAILINGS MANAGEMENT DETAILS

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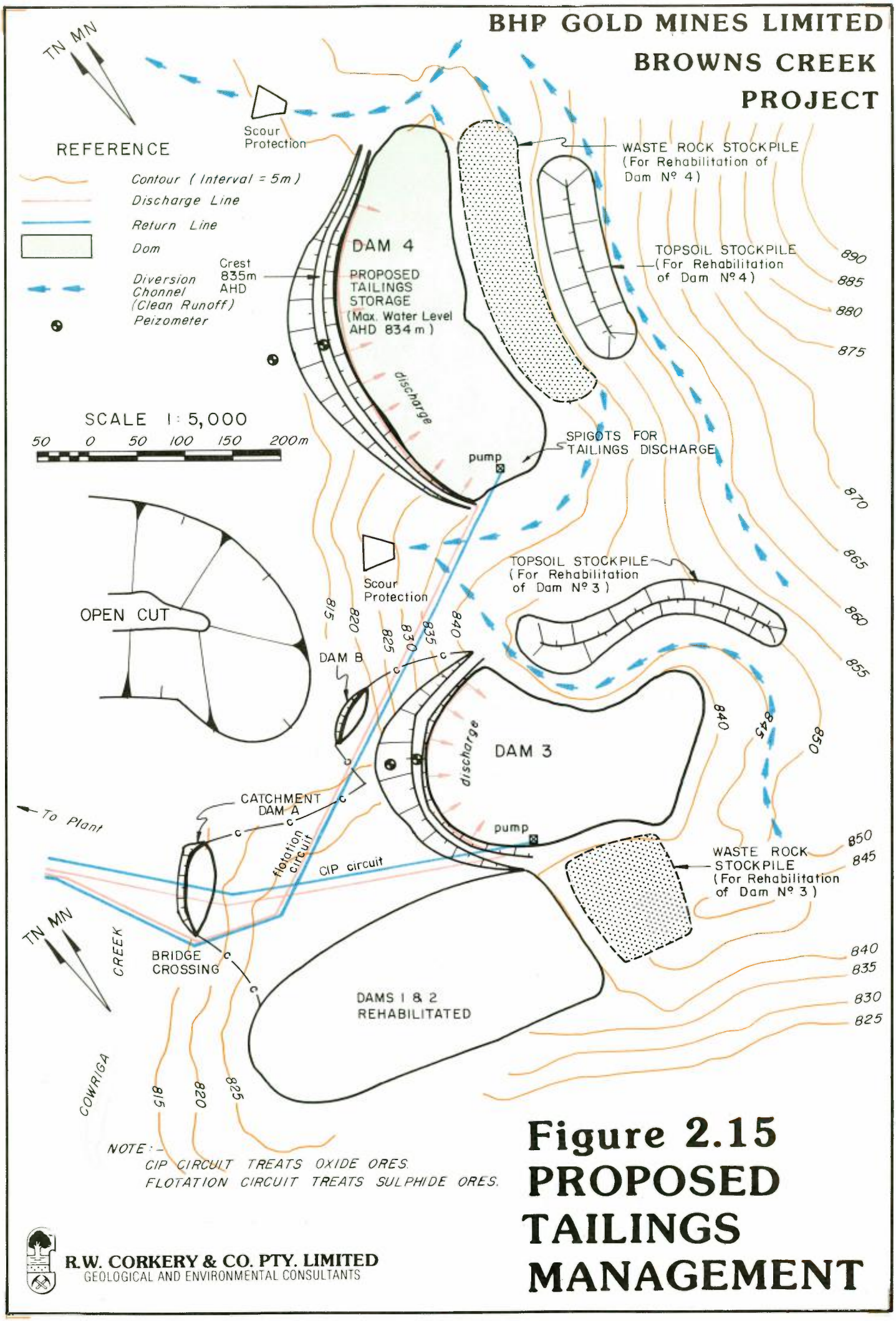

Figure 2.15 PROPOSED TAILINGS MANAGEMENT

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C.I.P. Plant Residues

C.I.P. plant residues will continue to be discharged to the present operating dam. Current known reserves of oxidized ore at Browns Creek will be contained within the current dam (No. 3) and at a wall height of 840 m AHD

Storage of additional oxidised process residues will be achieved by raising this dam wall 5 m to 840 m AHD by the downstream method.

The construction of this process residues dam to its current level (835 m AHD) and the proposed 5 m lift to 840 m AHD has been approved under existing development consents. It is expected that the raising of the embankment will be complete by March, 1988.

2.7.4 Site Selection

A number of sites for storage of process residues for the known life of the ore body have been assessed. The sites selected and the present process residues dams are shown in Figure 2.3. and the status of these dams summarised in Table 2.8.

TABLE 2.8
PROCESS RESIDUE STORAGE AREAS - EXISTING AND PROPOSED

Dam No.	Use	Possible Storage of Process Residues (tonnes)	Estimated Life (years)
Existing			
1 & 2	Oxide/ Skarn	-	Dams Full
3	Oxide	80,000 (oxide)	3.0
		170,000 (skarn)	1.0
Proposed			
4	Skarn	686,000	5.0

Note:
(1) Dam 3 will be used for the known reserves of oxide ore and the estimated life reflects the proposed production schedule. After the oxide ore has been fully exhausted, Dam 3 will be used for skarn storage with an estimated life of 1.0 additional years.
(2) Dam 4 will store only skarn residues.
(3) Assumed storage factors are:
Skarn ore 1.40 tonnes/m^3;
Oxide ore 0.6 tonnes/m^3.

The following factors were considered in the choice of an environmentally acceptable dam location:

(i) Storage areas to be geotechnically sound to ensure maximum stability;

(ii) The storage volume and embankment size be economically efficient in terms of the amount of construction necessary to provide the required storage volumes;

(iii) Materials for the construction of embankments be readily available to the embankment site to reduce construction costs;

(v) The storage area be close as possible to the treatment facilities to reduce process residues transport distances and their associated energy costs.

(vi) The storage area be easily screened from stock and the public and be easily supervised.

Based on the above criteria it is therefore proposed that the dam site closest to the mine (Dam 4) be utilised. If further storage areas are required due to increased ore reserves being found and treated, then any additional storage area will be subject to separate future approval.

2.8 OVERBURDEN DISPOSAL

2.8.1 Materials Characterisation

Overburden material is in the form of hard rock (diorite, andesite and limestone) and clays. The total estimated amount of overburden to be dumped, as calculated from the proposed mine design, is approximately 750,000 tonnes of clay and 5.5 million tonnes of hard rock, of which the quantity of limestone is estimated to be 2.4 million tonnes.

The mineralogy of overburden material (diorite, andesite and limestone) is shown in Table 2.2. The overburden material is predominantly free of sulphide minerals except for limited occurrence within the andesite on the margins of skarn ore.

The high carbonate content of overburden material provides a high neutralisation potential against acid leachate generation.

The overburden material is predominantly angular material varying in size from 1 m to less than 1 mm. The material is hard and competent, and sufficiently well-graded to form a physically stable emplacement. Compaction of the overburden material material is expected by means of normal truck movement and dumping as the emplacement level advances. Experience at other mines indicates that such truck movements on the emplacement will achieve 95 per cent compaction of the top 1.5 m of each level. This enables shedding of water off the emplacement, thereby reducing infiltration.

The clay overburden and weathered diorite has similar physical characteristics to the clay ore. It is predominantly clay material with weathered rock fragments. The material can be tightly compacted and may be of use in selective overburden storage area management.

2.8.2 Existing Disposal Procedure

All overburden material removed from the open cut is taken to the existing overburden storage area located to the south of the mine. The location of the dump is shown in the existing site layout on Figure 2.2. A small amount of hard rock overburden is used for mine development purposes such as road surfacing.

A small non-perennial tributary runs approximately along the southern boundary of this site and currently limits the extent of dumping.

2.8.3 Proposed Disposal Procedure

It is proposed that ongoing overburden disposal will be undertaken by extending the current overburden storage area to the south. Volume calculations of the area have shown that it has the potential to contain all overburden removed from the open cut.

The backfilling of the western side of the open cut with overburden material has been considered, however, this will depend on the geotechnical characteristics of the western face of the open cut at that time.

Overburden material will also continue to be used for mine development work and haul roads when required. Where possible, clay overburden will be selectively emplaced on the final surfaces of the emplacement.

Engineering consultants, BHP Engineering, were commissioned to investigate and assess the feasibility for design of the overburden material emplacement and provision for drainage and diversion.

Design criteria for an environmentally acceptable solution included:

(i) Ponded water will not extend outside the freehold land owned by the Company;

(ii) Flows are fully contained within the diversion;

(iii) Embankment will not be overtopped;

(iv) Ponding will not cause increased flooding of the road located upstream of the embankment;

(v) Construction costs are kept to a minimum;

(vi) The pondage will be used as the overburden storage area sedimentation dam.

(vii) Diversion to convey 100 year Average Recurrence Interval flood flows.

The proposed design, shown on Figures 2.16 and 2.17, and hydrological design details are discussed further in Section 4.4.6.

The proposed construction of the overburden storage area will involve two stages, with the dump being raised basically in two lifts.

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1. Remove topsoil beneath embankment and spillway channel
2. Construct embankment and spillway
3. Construct sedimentation dam and barrier near Cowriga Creek
4. Construct visual barrier adjacent to Platform Road and rehabilitate
5. Remove topsoil progressively from southern side of dump
6. Progressively dump from embankment towards Cowiga Creek

PLATFORM ROAD
860
855
850
pine trees
Visual Barrier 860 AHD
approx. 855 AHD
HAUL ROAD
to pit
Water Storage and Sedimentation Dam
Embankment Level 850 AHD
845
840
835
830
approx 830 AHD
Area A
Remove topsoil and dump waste to 850 AHD
Area B
Remove topsoil and dump waste to 855 AHD
LINE OF PROPOSED CULVERT (ALTERNATIVE B)
Area C
Remove topsoil and dump waste to 830 AHD
Commence initial rehabilitation using topsoil from area B)
Sedimentation Dam
Spillway level 845 AHD
Topsoil Stockpile
from area A, C
855
850
845
840
835
830
825
820
815
810
Sedimentation Barrier
CREEK
COWRIGA
818
818
Rock lined spillway channel
20m barrier
Energy dissapating structure
PROPERTY BOUNDARY
TN MN

SCALE 1:1000

10 0 25 50 75 100 m

Figure 2.16
WASTE ROCK EMPLACEMENT STAGE 1

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1. Dumping of waste progresses in sequence 1 to 5
2. Areas where final contours reached are shaped, topsoiled and vegetated Sequence of rehabilitation from A to I

PLATFORM ROAD
860
855
850
pine trees
Visual Barrier 860 AHD
approx. 855 AHD
HAUL ROAD
to pit
approx 830 AHD
Water Storage Pond
Embankment Level 850 AHD
Spillway level 845 AHD
Sedimentation Dam
Sedimentation Barrier
COWRIGA CREEK
Rock lined spillway channel
20m barrier
Energy dissapating structure
PROPERTY BOUNDARY
TN MN
SCALE 1:1000
10 0 25 50 75 100 m
Final contour attained
Dumping to progress prior to rehabilitation

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Figure 2.17
WASTE ROCK EMPLACEMENT STAGE 2

Stage 1: Figure 2.16

Topsoil beneath the embankment, spillway channel and visual barrier will be removed prior to construction. This embankment will be constructed to a level of 850 m AHD. A visual barrier will be constructed adjacent to Platform Road to minimise the visual impact of the dump areas. In addition an overflow spillway will be constructed to accommodate overflow from the water storage/sedimentation dam. Water in the upstream pondage will be fully contained on the Company's freehold property.

Topsoil will be progressively removed as shown in Figure 2.16, and overburden material dumped to ensure runoff flows west into the catchment pond.

Overburden will be placed firstly in Area A adjacent to the embankment. When the height in Area A is above 850 m the storage area will be constructed progressively in an easterly direction, maintaining wherever possible, drainage back to the sedimentation dam on the western side of the storage area.

Stage 2: Figure 2.17

Involves the dumping of overburden material from the east to the west progressively, to final contours. Overburden is emplaced by back tipping from haul trucks onto an advancing face. The emplacement is built up to finished surface in several lifts. Rehabilitation will commence along the southern edge and then progress on the other areas upon the completion of final contours. Final contours and shaping will be carried out by bulldozer. Topsoil will be placed by elevating scraper or small truck and loader.

2.8.4 Limestone Stockpiling

The limestone currently encountered in the open cut has a high proportion of clay cavities. The cost in separating the clay from the limestone would make it uneconomical for agricultural or construction use. However, it is considered that with greater depth and in the Stage 2 area the purity may greatly improve. It may then be stockpiled separately for future exploitation. The Company is currently undertaking quality analysis studies of the limestone to assess its marketability.

The quantity of limestone available for construction or agricultural use cannot be adequately estimated at this time as the extent of the cavities is not adequately known.

Where possible, limestone will be stockpiled in an area of the overburden storage area which will facilitate later retrieval.

2.9 HOURS OF OPERATION AND MINE LIFE

2.9.1 Construction

The Company expects that once construction of the treatment plant and facilities has begun, it will be completed in approximately 6 months. Construction work hours will be between 7.00 am and 10.00 pm Monday through Saturday inclusive.

2.9.2 Mining Rate and Working Hours

The current mining rate is approximately 150,000 tonnes of total material movement per month and this is significantly affected by the weather conditions. This rate may be increased depending on performance of the new treatment plant.

The proposed hours of operation for the mining operations will be, in general, the working of one shift per day six days per week commencing at 7.00 am and finishing at 5.30 pm. The Company proposes to extend the hours of operation to 24 hours per day Monday through to Saturday inclusive on an intermittent basis when required. This flexibility in operating hours is required to maximise equipment usage and improve productivity without the increases in costs expected with additional equipment numbers. It is proposed that the twenty-four hour per day operation would involve the working of two shifts, one commencing at 7.00 am and finishing at 5.30 pm, and the other commencing at 7.00 pm and finishing at 5.30 am.

The delays between the shifts are required to fuel and check the equipment and carry out maintenance as required. There will be no blasting, rock breaking, or ore removal on night shift and the night shift fleet will generally be restricted to only one excavator, truck fleet and drill. The night shift fleet will only operate as required during the drier summer months and will satisfy noise requirements of the State Pollution Control Commission.

2.9.3 Treatment Plant and Working Hours

The crushing plant has been designed to provide capacity to allow for reduced operating hours based on the expected milling rates of skarn ore encountered deeper in the open cut.

The hours of operation for the crushing plant will normally be from 7.00 am to 7.00 pm six days per week, however, it may be necessary to extend operating hours during wet weather to 10.00 pm Monday to Saturday and 3.30 pm on Sunday. As noted in Section 4.2.2 (Noise Level Controls - Treatment Operations) the requirements of the State Pollution Control Commission will be met.

The treatment plant will operate on a seven day, 24 hour per day basis throughout the year.

2.9.4 Mine Life

The life of the open cut mine is predicted to be approximately five years based on the current definition of the proven ore reserves, possible ore reserve, the boundary constraints and on the current practice of mining.

The Company's exploration programme will fully define resources below 85 m depth as much of the ore body is open at this depth.

Two skarn ore bodies which extend beneath the planned open cut limits have potential for underground mining. Significant gold mineralisation is known to occur to a minimum depth of 390 m below the surface. These zones are not yet fully explored and may extend mine life by several years.

The additional mine life is a function of recoverable ore and treatment capacity, however, it is considered that an underground operation would provide an additional 5 years of mine life.

The only anticipated reason for the project to become intermittent would be a significant downturn in gold prices.

2.9.5 Future Options

The marketing of limestone, wollastonite and clays from the open cut will be assessed by the Company when the quality of these materials improves sufficiently for economic use.

The early development of prospective target areas nearby will be encouraged and treatment of these ores will extend the life of the treatment facilities. These future options will be subject to separate development approvals following completion of exploration and mining feasibility studies.

2.10 SERVICES

Figure 2.18 presents details of the proposed facilities layout, including services, access roads, security fences and location of buildings.

2.10.1 Water Supply

The estimated total water requirements for the site are 1,400 kl per day, with the mill water requirements at approximately 1,200 kl per day. Potable quality water is required for ablutions, drinking water and other minor uses and this requirement will be met principally by collection of rain water supplemented by underground water.

Underground pumping supplies clear water suitable for drinking and ablution purposes.

The water pumped from the underground is also used for the treatment plant makeup water and hosing down.

The current pumping capacity from the underground workings are as follows:

(i) For periods of wet weather and during the months May to October, inclusive, the maximum pumping volume is 14 Ml/day and installed pumping capacity is 240 KW.

(ii) During drier periods, in particular November to April inclusive, the average pumping volume is 5.0 Ml per day.

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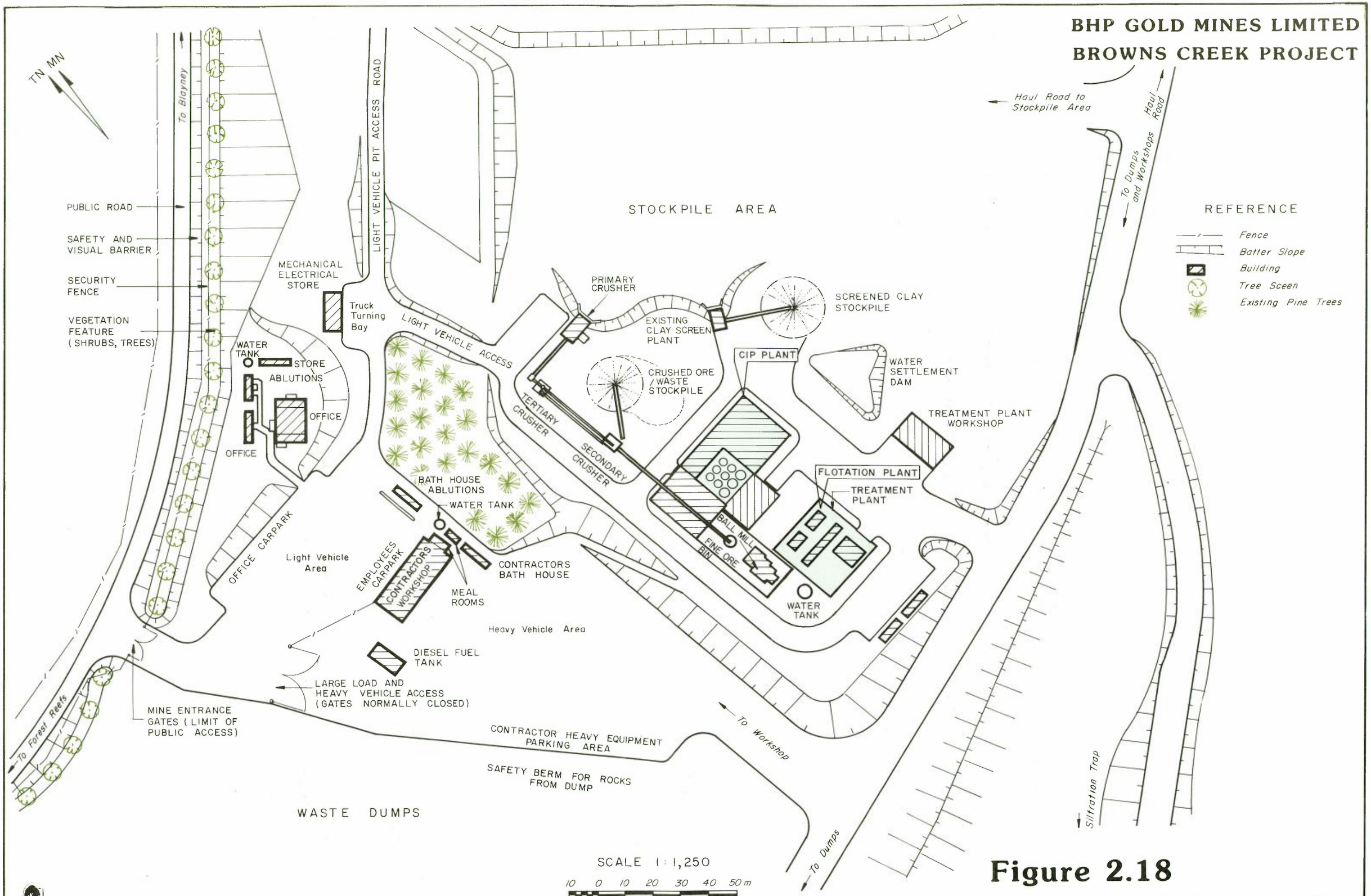

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Figure 2.18
FACILITIES LAYOUT

Other than the amount of water required for the treatment plant, all of the water is released directly into Cowriga Creek.

It should be noted that during periods of dry weather, Cowriga Creek above the mine has ceased to flow, while below the mine the discharged water insures continuation of the flow. Site water management is discussed in detail in Section 4.4.

2.10.2 Electricity

Outline of Existing Supply

The mine power supply is currently from two sources:

(i) The Ophir County Council supplies a maximum of 750 kVa via an 11,000 volt transmission line from Blayney along the Platform Road. The existing transmission line is currently at maximum capacity. Since November, 1986 the Company has installed voltage regulation and power factor connection to this supply system to enable the capacity to be achieved without serious voltage drop to other users along the transmission line.

Grid power is currently used to power the treatment plant and offices, and is distributed via 11 kv/415 V transformers.

(ii) Two semi-mobile diesel generating sets supplies a maximum of 1,000 kVa at 415 Volt. Distribution is via dedicated switchboards and motor control centres.

Generated power is used for the crushing operations and continuous mine dewatering. All major drives within these areas are 415 Volt.

Outline of Proposed Supply Alternatives

The Ophir County Council has advised that they are able to provide an electrical supply with a load of 2,000-2,500 kVa. The increase in supply requirement reflects a number of factors:

(i) In order to reduce the operating hours required, the capacity of the crushing plant will be increased;

(ii) An increase in treatment capacity to improve metallurgical performance;

(iii) An expected increase in mine dewatering capacity and pumping head as the open cut deepens.

This could be achieved by extending a 66,000 Volt (66 kV) spur line to the site from an existing line running between Blayney and Millthorpe. An alternative supply would be an 11,000 Volt (11 kV) line from the Blayney substation along Platform Road reserve to the mine. This option would have high visual impacts and will bring forward plans for the upgrading of the Blayney substation. This option is not preferred as it would preclude any further expansion of the existing operations.

The Ophir County Council and the Company are currently investigating a number of possible routes for the 66 kV line to the mine from the 66 kV Ophir County Council Orange/Blayney feeder. These possible routes will be assessed by the Ophir County Council, who are the determining authority and responsible for the environmental assessment of the line. To minimise the environmental impact, the line will be located on Company owned land where possible.

Negotiations will be held and agreements reached with any affected landowners before the final route is selected and the line constructed.

Figure 2.1 shows the possible alternative routes.

All electrical installations on the mine site will be to the relevant Australian Electrical Standards and comply with electrical requirements for mines of the Department of Industrial Relations Electrical Inspectorate.

Reticulation to the mine dewatering pumps and the process residue storage area water reclamation pumps will be by the overhead supply set on single poles.

2.10.3 Telephone

The mine site will continue to use the existing facilities provided by Telecom.

Current telephone lines from the Forest Reefs Exchange to the mine site total 9. An additional 8 lines are considered desirable for the relocated facilities. Telecom advise that these additional services to the mine site may be provided through one of four alternatives:

(i) Upgrade cable from Forest Reefs Exchange;

(ii) Upgrade cable from Blayney via Forest Reefs Road;

(iii) Provide additional services via proposed new radio system northwest of mine site;

(iv) Provide radio system from Browns Creek.

Any increase in the facilities will be dependent on the cost of upgrading these facilities.

On-site communications will be undertaken using two-way radio, with restricted use during periods of blasting.

2.10.4 Sewerage

Sewerage effluent from the existing facilities are collected in septic tanks and transpiration beds.

The new milling facilites will require relocation of the existing ablutions block and the installation of a suitably sized septic tank and a transpiration trench.

The existing office buildings will be relocated to an area west of the contractors workshop. Ablutions will be provided for office personnel on site.

2.11 TRANSPORTATION

2.11.1 Access

The Company will continue to use Platform Road as the main access road to the site from the surrounding communities. At this stage it is not envisaged that any changes will need to occur to this mode of access.

At present, a gravel-surfaced access road exists from Platform Road to the mine facilities shown on Figure 2.8. The road has suitable drainage controls and is graded when necessary in order to maintain a good surface. A similar type of road exists from the Platform Road to the Contractor's workshop. After treatment plant and office relocation the northern mine acces road will be closed to all traffic at the current mine gate. All vehicles will access the mine through gates located on the existing southern mine entrance and shown on Figure 2.18.

2.11.2 Traffic

The travel pattern to and from the existing mine operations is quite regular. The approximate daily traffic flow by employees and contractors is specified from their place of residence in Table 2.9.

The concentrates from the skarn treatment circuit will be trucked on a regular basis from the mine site to a commercial smelter. On average the trucking rate will be two 20 tonne tippers per week.

The average weekly number of service vehicles travelling to and from the site is 15. Their arrival is mainly between Monday and Friday, 9.00 am to 5.00 pm. It is not expected that the frequency of vehicles will increase with relocation.

2.12 EMPLOYMENT AND HOUSING

The existing mining and treatment operations at Browns Creek Mine employs 72 permanent Company and contractor personnel. A turnover of approximately 5 per cent of this number of permanent employees is anticipated after relocation of the treatment plant.

Temporary contractors involved in the relocation and construction of the treatment plant and in earthworks construction will increase the level of employment for a limited period. Table 2.10 shows graphically the level of temporary employment for the period of 6 months after development approval is granted.

TABLE 2.9
TRAFFIC FREQUENCY

No. of Cars From	Monday to Saturday Day Shift (6.30 am - 5.30 pm)	Night Shift*
Orange	23	3
Blayney	11	2
Barry	1	
Cargo	1	
Millthorpe	7	1
Cowra	1	
Carcoar	2	
Bathurst	2	
Mandurama	1	
Trunkey	1	
Browns Creek	2	
	52	6

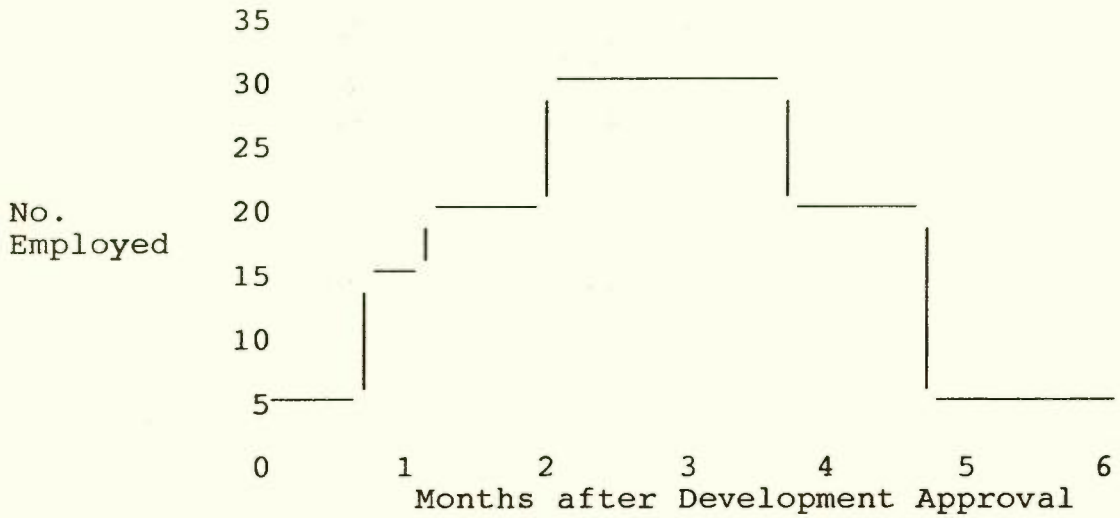
* Includes Sundays day and night shift.

Up to 30 persons will be involved in dismantling the existing treatment plant and construction of the new plant. A further 6 persons in total will be involved in construction earthworks of the Cowriga Creek rediversion, overburden storage area spillway and process residue storage area No. 3 lift.

The construction activities are independent and workforce numbers may overlap for each activity. Table 2.10 estimates the workforce numbers over a six month period.

All personnel employed on a long term basis at the mine reside locally in their own or rented accommodation. Table 2.11 shows the town of residence of employees currently employed at Browns Creek Mine.

TABLE 2.10
GRAPH OF TEMPORARY CONTRACTOR PERSONS



Any contractors of temporary personnel employed by the Company will be accommodated in the motels, hotels and caravan parks in the area, as there is currently limited accommodation available. Table 2.12 presents a list of temporary accommodation available in the Blayney-Millthorpe-Orange area.

TABLE 2.11
EMPLOYEE'S PLACE OF RESIDENCE*

City/Town	Number of Employees
Orange	33
Blayney	18
Barry	1
Cargo	1
Millthorpe	10
Cowra	1
Carcoar	1
Bathurst	2
Mandurama	1
Neville	1
Browns Creek	3
Total	72

* Includes Company and permanent contract personnel.

TABLE 2.12
TEMPORARY ACCOMMODATION
BLAYNEY, MILLTHORPE, ORANGE

Accommodation	Number Available
Guest Houses	2
Hotels	15
Motels	10
Caravan Parks	4

SECTION 3

DESCRIPTION OF THE EXISTING ENVIRONMENT

3.1 TOPOGRAPHY

The Browns Creek Mine site lies in the Central Tablelands of New South Wales in an area dissected by the Cowriga Creek drainage system.

The regional landform is predominantly undulating to rolling hills ranging from 800 to 1050 m in elevation. Local relief ranges from 30-80 m with most in the range 50-60 m. Slope gradients average from 6 to 10 per cent with an average length of 600 m (range 200 to 1500 m). The fixed drainage channels are spaced 800-1000 m apart.

In the local area of the mine site, hills to the northwest and southeast are at elevations from 870 to 890 m. Cowriga Creek flows through the project area approximately north to south through elevations of 830 to 810 m. Local slopes are up to 10^{o}.

3.2 DRAINAGE

3.2.1 Regional Drainage

The regional drainage surrounding the Browns Creek project site is depicted in Figure 3.1. The site is located in the upper eastern catchment of the Lachlan River, near the watershed with the Macquarie River catchment.

The project site straddles the Cowriga Creek which joins the Belubula River approximately 10 km downstream. The Belubula River joins the Lachlan River west of Canowindra.

The main water storage in the region is Carcoar Dam, built in 1968 to provide irrigators downstream with regular riverflows. The dam is located on the Belubula River upstream of the confluence with Cowriga Creek. The dam has a capacity of 36,420 megalitres and provides regular discharges into the Belubula River amounting to approximately 30 megalitres/day.

Cowriga Creek is currently ungauged. There are two gauging stations in the Belubula River. The highest recorded flows at Carcoar (station 412077) and at Mandurama (Station 412079) are 3,570 and 8,110 megalitres/day respectively.

3.2.2 Local Drainage

Hydrological assessment of the Cowriga Creek catchment has been recently carried out in October, 1987 as part of investigations into the rediversion which is proposed in this Statement. Previously a hydrological assessment was undertaken in December, 1986 for the existing diversion of Cowriga Creek. Both hydrological assessments were carried out by BHP Engineering.

The Cowriga Creek catchment covers some 114 km^2 to the north of the Browns Creek project site. Cowriga Creek is a prescribed stream under Section 21B(I)(b) of the Soil Conservation Act, wherein land situated within, or within 20 m of, the bed or bank of a prescribed stream is protected land. No tree (including shrub or scrub) shall be removed or destroyed except in accordance with an authority issued by the Catchment Areas Protection Board.

Catchment boundaries of the local drainage delineated for the purpose of this study are presented in Figure 3.2.

The existing waterway through the project site comprises a low flow channel approximately 3 to 5 m wide bounded by an artificial levee on the right bank and natural valley side slopes to the left.

A computer backwater analysis (HEC, 1982) of this waterway indicated that it presently has a flow capacity of approximately 35 m^3/s, corresponding to less than a 1 year Average Recurrence Interval event.

The hydrological review of the Cowriga Creek catchment was undertaken using the RORB Runoff Routing Computer Programme (Laurenson and Mein, 1985). In summary, use of this programme involves the development of a mathematical catchment model to which calibration parameters are fitted. Given rainfall intensity, duration and distribution, the model will then compute predicted runoff hydrographs. The model developed for the Cowriga Creek catchment was based around the catchment subdivisions shown in Figure 3.2.

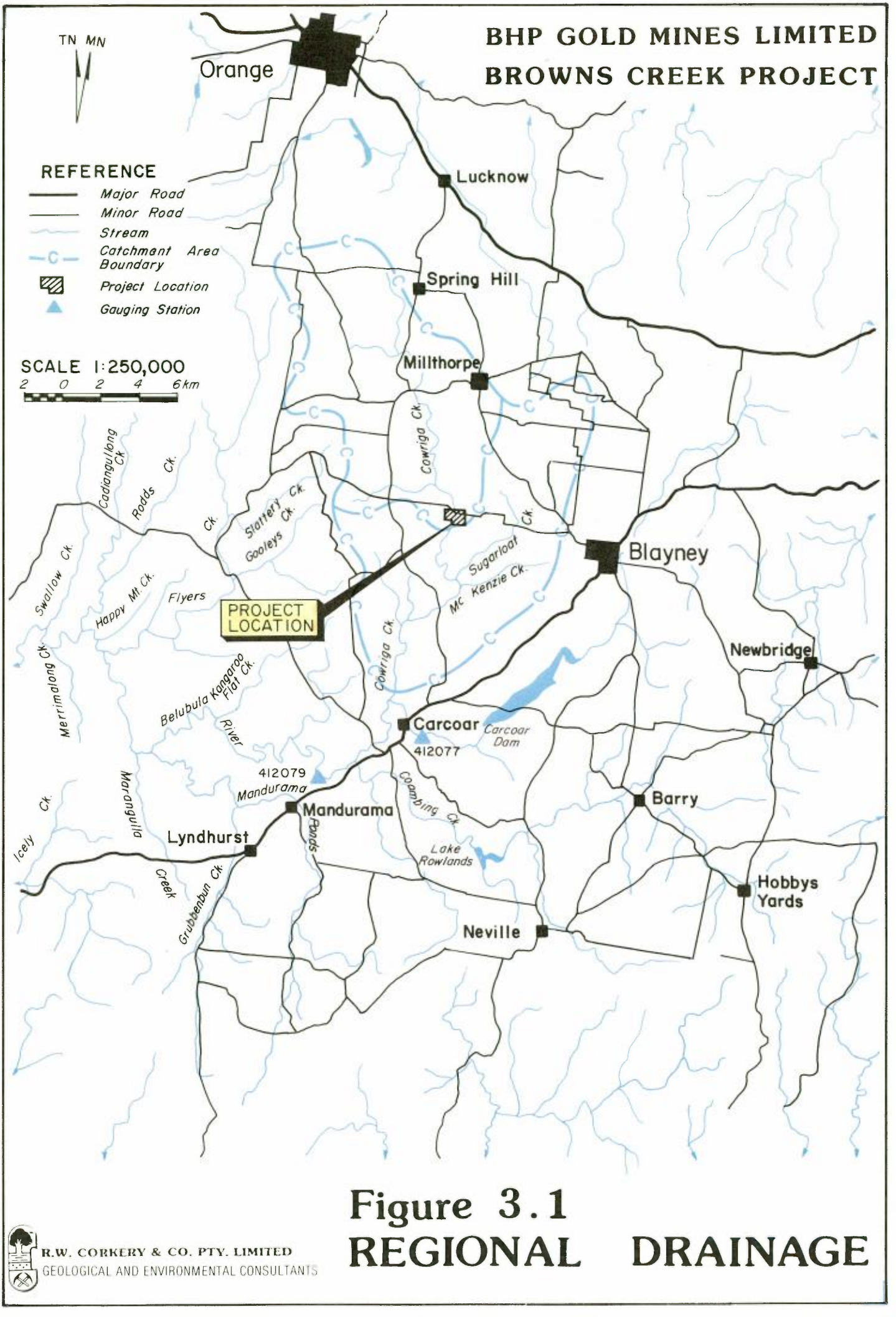


Figure 3.1
REGIONAL DRAINAGE

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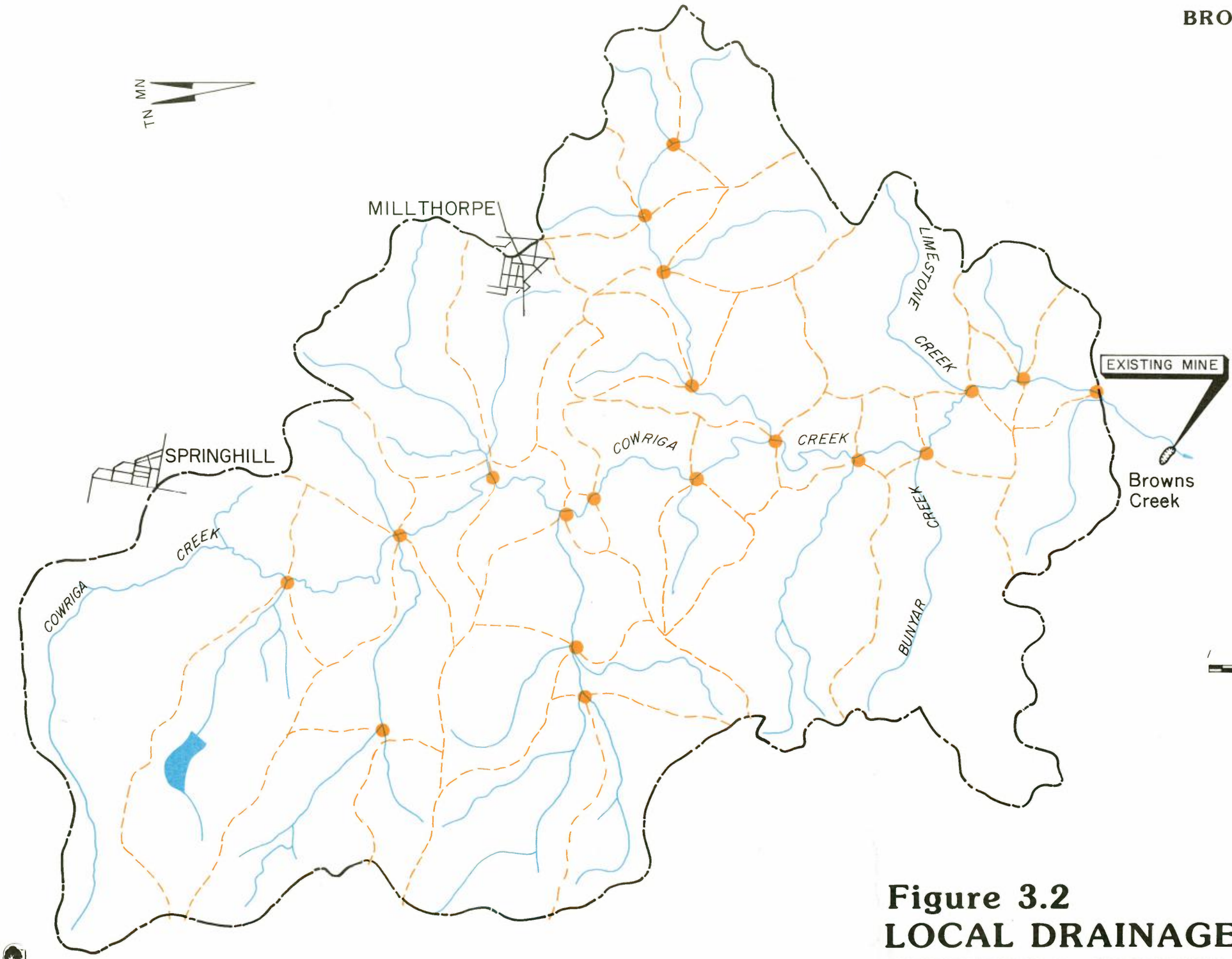
BHP GOLD MINES LIMITED
BROWNS CREEK PROJECT



REFERENCE

- Watercourse
- Catchment Area Boundary
- Sub-Area Boundary
- Model Nodes

SCALE

1 0 1 2 3km

Figure 3.2
LOCAL DRAINAGE
COWRIGA CREEK CATCHMENT

R.W. CORKERY & CO. PTY. LIMITED
GEOLOGICAL AND ENVIRONMENTAL CONSULTANTS

(BASE MAP SUPPLIED BY BHP ENGINEERING
Ref: REPORT Nº BRO/1/1, August 1987)

Calibration parameters for the RORB programme describe both rainfall loss and flood routing modelling characteristics. Their determination is generally most reliably achieved through calibration fo the model to record rainfall and river gauging data.

As Cowriga Creek is ungauged, empirical techniques were used for the estimation of rainfall loss parameters and flood routing parameters. For the purpose of estimation of catchment rainfall loss parameters, land use and soil type have been generalised in accordance with U.S. Soil Conservation Service (U.S. SCS 1956) classifications:

(i) Land use - pasture or range in fair conditions;

(ii) Soil Group C - slow infiltration rates when thoroughly wetted.

Further details of parameter estimation are presented in the B.H.P. Engineering Report No.BR0/1/1, dated October, 1987.

Statistical flood flows were derived from Rainfall Frequency Duration data supplied by the Bureau of Meteorology, and temporal patterns applicable to the "Eastern Interior Zone" as presented in Figure 3.3 of Australian Rainfall and Runoff (Institution of Engineers, 1977).

The RORB model was run for each statical storm event under consideration, for a range of storm duration.

A summary of adopted flood flows, using the RORB model, together with flood flows determined by the Rational method, are presented for comparison in Table 3.1.

Peak flood flows derived using the RORB model have been adopted for purposes of design of the Cowriga Creek rediversion. Design of the rediversion is discussed in further detail in Section 4.4.2.

Analyses undertaken to assess how much the existing waterway levee would need to be raised indicates a general levee raising from approximately 1.3 m to 2.3 m to fully contain a 2 year Average Recurrence Interval design flow.

TABLE 3.11
ESTIMATED PEAK FLOOD FLOWS - COWRIGA CREEK

Recurrence Interval (Years)	Rational Method m^3/s	RORB Model m^3/s	Designation
1	45	-	1 year ARI
2	76	83	2 year ARI
5	103	108	5 year ARI
10	120	123	10 year ARI
20	148	144	20 year ARI
50	176	188	50 year ARI
100	209	211	100 year ARI

ARI: Average Recurrence Interval

3.3 GEOLOGY AND ORE RESERVES

3.3.1 Regional Geology

The Browns Creek deposit lies in the Ordovician Molong Volcanic Rise in a sequence of andesitic volcanic rocks with minor sediments, known collectively as the Angullong Tuff. Alteration and mineralisation occurs near the contact between a unit of porphyritic andesite and the Cowriga Limestone, close to the margin of a granodiorite intrusion known as the Long Hill Diorite. This granodiorite body forms part of the Carcoar Granite and is believed to be of Middle Devonian Age.

3.3.2 Local Geology

The geology of the Browns Creek deposit is complex. The Cowriga Limestone forms a triangular inlier in the hinge zone of a broad, open anticlinal structure which plunges gently north-northeast. The limbs of the anticline dip at approximately 45^{o} to the north and northeast and are cut by numerous faults. The skarns which host the majority of the ore occur mainly at the contact between the limestone and the footwall andesite. Minor skarns also occur lower in the sequence, within the andesite and in sub-vertical, structurally-controlled shoots in the limestone.

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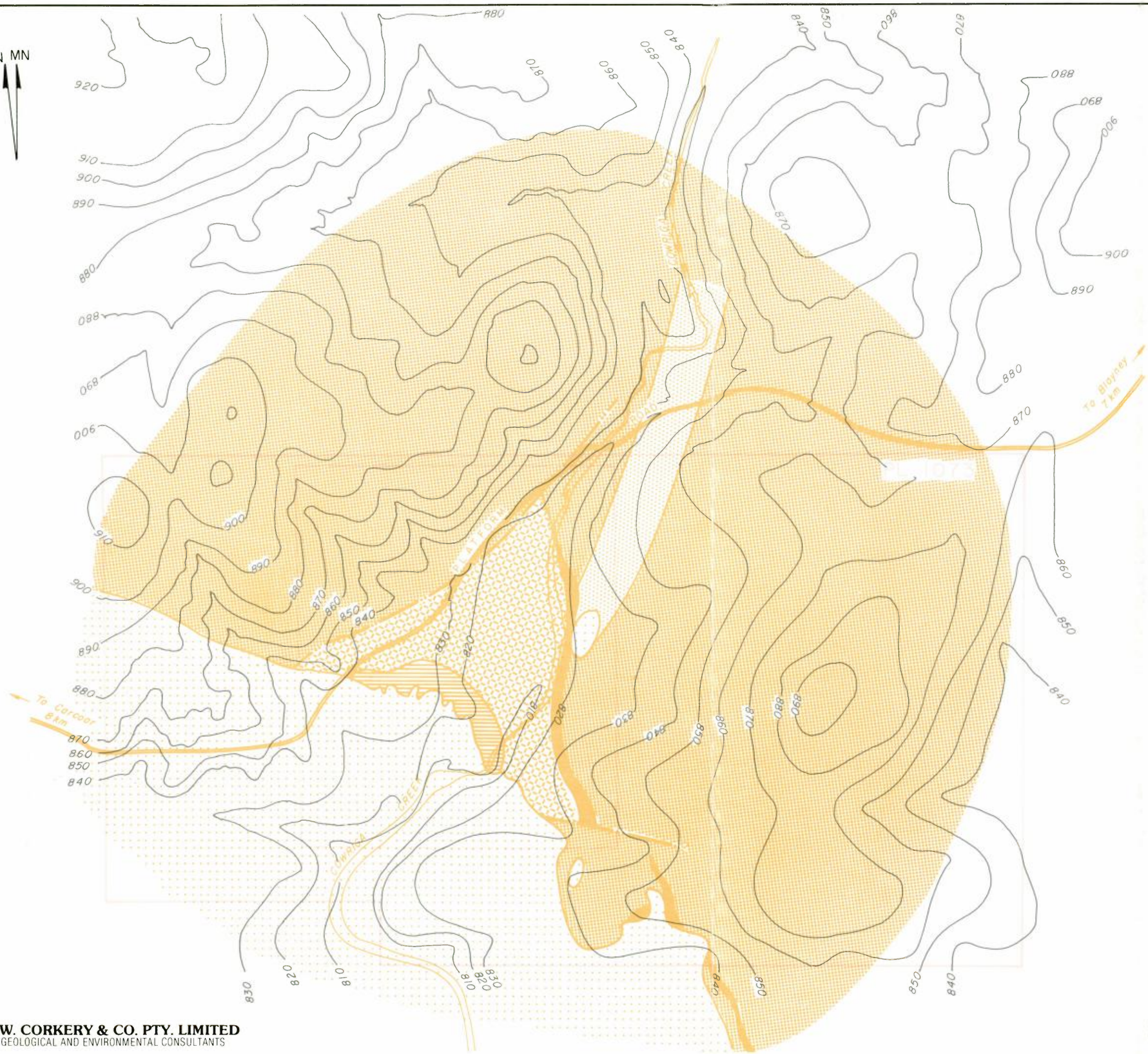
BROWNS CREEK PROJECT



REFERENCE

- Mining Leases Boundary
- Creek
- Road
- Contour (Interval = 10 m)
- Boundary of PL 1073
- Ore Zone
- Granodiorite
- Andesite
- Sheared Andesite
- Jasper - Magnetite Rock
- Limestone
- Fault

SCALE 1:10,000

0·1 0 0·1 0·2 0·3 0·4 0·5 km

Figure 3.3
SITE GEOLOGY

R.W. CORKERY & CO. PTY. LIMITED
GEOLOGICAL AND ENVIRONMENTAL CONSULTANTS

Several phases of skarn development are evident but the dominant skarn minerals are wollastonite, calcite and garnet. Accessory minerals include diopside, hedenbergite and idocrase. Significant mineralisation is generally confined to the wollastonite-rich skarn. Gold occurs as fine disseminated grains and as inclusions within the copper sulphides chalcopyrite and bornite. Average in situ grades are 6.3 g/tonne gold, 0.3 per cent copper and 3 g/tonne silver.

Gold mineralisation also occurs in clay zones of diverse origin. Three styles of clay ore are recognised:

(i) Irregular, high-grade clay-alteration zones within the main skarn;

(ii) Massive clay zones in the upper levels of the deposit, probably formed by weathering of the skarn;

(iii) Clay breccia zones formed by collapse of weathered skarn into cavities within, and adjacent to, the limestone.

The average gold grade of the clay ores is 4.7 g/tonne.

The ore zones are disrupted by thin felsic dykes and faults. Approximately 5 m of alluvial clays and gravelly clays lie over the bedrock at the eastern end of the deposit.

3.3.3 Ore Reserves

The ore body is approximately 450 m long and has been delineated to a maximum depth of 85 m below the existing land surface. Percussion and core drilling have defined a proven in situ reserve of 460,000 t of ore with an average gold content of 6.0 g/tonne, consisting of 80,000 t of soft, oxidised clay ore and 380,000 t of hard, skarn ore. The clay ore can be mined without relocation of the existing crushing and milling plant, however, approximately 60 per cent of all the skarn lies under the plant. In order to mine all of the ore, approximately 2.2 million m^3 of overburden material will need to be removed. On mining of the in situ ore, moisture, ore dilution and ore loss factors are incorporated to represent actual values recovered, and this accounts for the variation between in situ and recoverable quantities.

TABLE 3.2 (i)
OPEN CUT RECOVERABLE, DRY, PROVEN RESERVES
AS AT 30TH JUNE,1987

Pit Stage	Skarn Ore (tonnes)	Clay Ore (tonnes)	Total (tonnes)
1	162,000 @ 5.5g/t	48,000 @ 4.0g/t	210,000 @ 5.2g/t
2	261,000 @ 4.7g/t	9,000 @ 5.5g/t	270,000 @ 4.7g/t
Total	423,000 @ 5.0g/t	57,000 @ 4.2g/t	480,000 @ 4.9g/t

An additional in situ possible resource within and beneath the proposed final pit, as indicated by drilling to 30th June, 1987, is presented under.

TABLE 3.2 (ii)
IN SITU POSSIBLE RESOURCE

	Skarn Ore (tonnes)	Clay Ore (tonnes)	Total (tonnes)
Open Cut	30,000	15,000	45,000
Under-ground	115,000	-	115,000
			160,000*

*Weighted average grade on total tonnes of 5.7g/t.

3.4 LAND CAPABILITY AND SOILS

3.4.1 Land Capability

The land capability classification of the Soil Conservation Service provides a basis for assessment of optimum use of the land surrounding the Browns Creek Mine. The classification is based on an assessment of the biophysical characteristics of the land, the extent to which these will limit a particular type of land use, and the current technology that is available for the management of land. The classification also incorporates an assessment of the soil erosion hazards, with emphasis on a 'safe' level of land use, thus avoiding environmental problems caused by soil erosion and sedimentation. The capability classes categorise the land in terms of its general limitations.

The land falls within classes III, IV and VI of the rural land capability classification prepared by the Soil Conservation Service of New South Wales (Sheet 8730). As outlined in this classification, Class III land is suitable for cultivation but requires intensive soil conservation measures to ensure the protection of the soil resources. These measures include practices such as good soil management, contour cultivation, graded banks, waterways and diversion banks. Class III land is not commonly found in the area. Land in Class IV and VI is suitable for grazing but not for cultivation. On Class IV land simple erosion control measures - such as pasture improvement, livestock control, application of fertiliser and contour chisel ploughing - are necessary to protect the land. Class VI land is generall too steep or rocky for structural soil conservation measures and good management practices are necessary. These may include limitation of livestock, broadcasting of seed and fertiliser, prevention of fire and destruction of vermin, together with retention of green timber on slopes above 33 per cent.

3.4.2 Soil Description and Distribution

There are two major soil types with additional minor soil units found in the undulating to rolling hill country around Browns Creek. The soils change downslope from red earths and yellow podzolics occurring on less well drained sideslopes and footslopes, to yellow solodic soils found in poorly drained depressions. Red earths are predominant with yellow earths being common, and the yellow podzolics and yellow solodics being less common. Soil sampling results and soil management procedures are detailed in Section 4.5.2.

Red Earths

These highly weathered soils form under freely drained conditions and become more clayey with depth. The topsoils are brown to dull reddish brown in colour and 10-25 cm in depth. They are weakly pedal, have a pH of 6-7, and vary in texture from a fine sandy loam to a loam. The soil changes with depth to a weakly pedal, red to reddish brown loam or fine sandy loam.

Red earths are found on freely drained crests, upper and midslopes and are the main soil type found in this area. These soils are highly permeable and have a high water-holding capacity. The chemical fertility of red earths is low and they are generally deficient in nitrogen and phosphorous. Both the topsoil and subsoils are moderately erodible.

Yellow Earths

Yellow earths are characterised by a weakly pedal, fine sandy loam or silty loam topsoil, dark to dull brown or a bleached yellow orange in colour, with a pH of 5-5.5. The topsoil is approximately 25-30 cm in depth. The change to the yellowish brown subsoil may be gradual or clear as the clay content increases with depth. The subsoil has a fine sandy or clay loam texture and is approximately 90 cm deep. The subsoil is weakly pedal and has a similar pH to the topsoil.

Yellow earths are common in the landscape but less common than red earths. They are found on moderately to imperfectly drained midslopes and footslopes. The surface of these soils is hardsetting and the soils are moderately erodible. The chemical fertility status is low, and, as are the red earths, deficient in nitrogen and phosphorus.

Yellow Podzolics

The topsoil is a brown to dark brown fine sandy loam or loam, with weak pedality and a pH of 6-7. Where A2 horizons occur, they are bleached, greyish yellow brown, fine sandy loam with a massive texture. Topsoil varies in depth from 20 to 40 cm. A sharp change takes place to the yellowish-brown subsoil. The subsoil is far higher in clay, being a light to medium clay and may be mottled in colour.

Yellow podzolics occur on moderately well-drained lower slopes, although they are not very common within the landscape. The soils are moderately permeable and have a moderate water-holding capacity. Chemically, their fertility is low and they are deficient in nitrogen and phosphorus. The hard-setting surface is more erodible than the subsoils and the soils are classified as having moderate erodibility.

Yellow Sodolics

Topsoils are a weakly pedal, brown or dull brown fine sandy loam with a pH of 5-6. The change to the subsoil may be clear or gradual. pH varies from 5-5.5 and the texture becomes more clayey with depth to a fine sandy loam or medium clay. With an increase in clay content, the pedality of the subsoil also increases.

Yellow solodics are found in imperfectly to porrly-drained drainage depressions within the landscape. They have a high waterholding capacity but are chemically low in fertility with nutrient deficiencies in nitrogen, phosphorus, calcium and molybdenum. The surface of these soils is hard-setting and highly erodible, while the subsoil is moderately erodible. Severe gullying may occur in yellow solodic soils.

3.4.3 Erosion Potential

Soil erosion mapping categories for the local area, determined by the Soil Conservation Service district office, indicate minor sheet erosion with 1 to 10 per cent bare ground (Category 21p) predominates. A pocket of Category 24m with 40 per cent bare ground and classified as severe sheet erosion has been defined for the existing mine open cut area. This reflects cumulative degradation remnant from a history of mining activities dating back to the early 1900's. This bare ground will be encompassed within the open cut mine limits and subject to rehabilitation.

Both the red earths and the yellow earths are moderately erodible. Once the vegetative cover and hard setting surface has been disturbed, the subsoil may also erode, resulting in minor to moderate gullying.

The yellow podzolic and yellow solodic topsoils are more readily eroded than their subsoils. Yellow podzolics are susceptible to minor sheet erosion, while severe gullying is possible in the yellow solodics.

It is important that all soils be adequately protected to ensure soil erosion is minimised. When topsoil is to be stored for a considerable time (6 months or longer) vegetation should be established on them to protect against erosion.

3.4.4 Value for Rehabilitation

All soils in the Browns Creek area have value for rehabilitation.

The topsoils provide the best source of nutrients for rehabilitation because they are more fertile and better structured than the subsoils and should therefore be removed prior to development and stockpiled for subsequent re-spreading in the rehabilitation programme.

Experience has shown that the usefulness of topsoil is reduced if it is contaminated with the less fertile subsoil. Thus, topsoil and subsoil should be removed separately, stockpiled separately, and replaced separately. Topsoil structure will be damaged if it is respread while very wet or very dry, which will increase the risk of erosion. Application of fertiliser to establishing vegetation is necessary to provide an adequate supply of soil nutrients for plant growth.

The subsoil is also useful for rehabilitation although with its lower nutrient status, it is unlikely to support vegetation without heavy applications of fertiliser.

Its higher clay content makes it a valuable sealing layer when placed in between the overburden material and the topsoil. When used in this manner, moisture retention in the topsoil is improved, making more moisture available to the establishing vegetation.

It is recommended that tests will be carried out to determine the suitability of overburden material to determine its nutrient status as a topdressing material.

3.5 METEOROLOGY

3.5.1 Source of Data

The closest comprehensive meteorological station lies approximately 16 km north-northwest of the project site at Orange airport. Data from this station includes fog and frost frequencies and wind speed and direction.

The closest recorded temperature and rainfall records are from Blayney Post Office. Evaporation data has been drawn from the Bathurst Agricultural Research Station.

3.5.2 Temperature

Table 3.3 lists average daily maximum and minimum temperatures at Blayney, 8 km east of the project site. January is the warmest month and July the coldest month. Frosts are common throughout the winter months.

TABLE 3.3
MEAN DAILY TEMPERATURES - BLAYNEY POST OFFICE - ^{o}C

Month	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	26	25	23	19	14	12	10	11	15	19	21	24
Minimum	11	11	8	3	1	-1	-1	0	1	4	5	8

3.5.3 Rainfall

Table 3.4 lists the mean monthly rainfall and number of raindays per month at the Blayney Post Office. The total average annual rainfall is 768 mm. Most rain falls on average in winter and least in autumn. June, July and August have the highest monthly average rainfall of 75 mm. Least rain falls on average in April.

A review of the monthly rainfall and the average number of rain days per month supports the observations that most winter and spring rain is associated with frontal activity and hence it is of lesser intensity than the summer rains often generated by convection storms.

TABLE 3.4
MEAN MONTHLY RAINFALL - BLAYNEY POST OFFICE - mm

Month	J	F	M	A	M	J	J	A	S	O	N	D	Year
Mean	67	55	52	50	56	75	75	75	62	72	62	67	768
Raindays per Month	6	7	6	7	9	11	12	12	9	10	8	7	104

3.5.4 Evaporation

Table 3.5 shows the recorded mean monthly evaporation. Least evaporation occurs in June and the highest in December. Rainfall invariably exceeds evaporation during the winter months.

TABLE 3.5
MEAN MONTHLY EVAPORATION
BATHURST AGRICULTURAL RESEARCH STATION - mm

Month	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	277	233	209	132	111	48	53	94	114	180	272	308
Minimum	159	136	122	86	45	35	43	48	72	75	0*170	
Average	230	196	160	104	67	41	47	65	94	135	162	241

* True total of evaporation may be greater than this.

3.5.5 Temperature Inversions

Radiation inversions are the main type of temperature inversions likely to cause any noise to be enhanced. An indication of radiation inversions is obtained by examining both the fog and frost frequencies. Temperature inversions invariably occur on clear frosty mornings and when fogs are present. Hence, a review of Tables 3.6 and 3.7 shows that temperature inversions could be expected for approximately one quarter to one third of the year.

TABLE 3.6
FROST FREQUENCIES - ORANGE AIRPORT*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Av. No/Month Recorded/Month	0	0	1	6	12	17	20	19	13	6	4	1
Max. No. Recorded/Month	1	0	5	15	20	28	29	26	21	13	8	4
Min. No. Recorded/Month	0	0	0	2	4	8	11	9	6	2	0	0

* 18 years of records

TABLE 3.7
FOG FREQUENCIES - ORANGE AIRPORT*

Month	J	F	M	A	M	J	J	A	S	O	N	D
Av. No/Month	1	1	2	4	5	6	7	4	2	2	2	1
Max. No. Recorded/ Month	3	4	6	9	11	10	13	10	9	6	6	4
Min. No. Recorded/ Month	0	0	0	1	1	3	3	0	0	0	0	0

* 18 years of records

3.5.6 Wind

Figure 3.4 displays the strength and direction of winds recorded at Orange Airport since 1968.

Wind directions are variable in summer and autumn although easterly and northeasterly winds are more frequent at 9.00 am whereas south and southwesterly winds are more frequent of an afternoon. During winter and spring, winds are dominated both morning and afternoon by southwesterly and westerly winds, often of considerable strength. It is noteworthy that the direction which records least winds is from the southeast.

3.6 WATER RESOURCES

3.6.1 Surface Water

An accurate assessment of background water quality of surface runoff from the ore bodies within the project area is not possible as mining and related surface disturbance has been carried out since the turn of the century. It may be anticipated that these ore bodies would have naturally contributed some form of hydrogeochemical anomaly to the local catchment area.

Monitoring of the existing water quality in the vicinity of the mine has provided a basis for assessment of the impact of the current and proposed mining activity. Monitoring has been undertaken on four occasions over an eight month period at five sites, including one site on Cowriga Creek upstream of the area of mining disturbance.

Figure 3.5 shows the location of the five water monitoring sites. Analytical results are presented in Appendix 2 Table A2.1. These results indicate that:

(i) pH of all waters are within the normal neutral range (6.2 to 7.8).

(ii) The electrical conductivity of all waters suggest low to medium salinity levels (Class 1 to 2, see Appendix 2, Table A2.1). The waters off overburden material areas are more saline (up to 950 uS/cm) than Cowriga Creek water (up to 565 uS/cm), but result in an insignificant increase in salinity level downstream.

(iii) The sulphate levels of waters off overburden material areas are higher than Cowriga Creek water. This may indicate some oxidation of sulphides, however the very high bicarbonate levels of these waters provides a strong buffering capacity against acid generation.

(iv) The suspended solids content of water is generally low in normal flow periods. During high flow periods after heavy rain, results (of 3rd August 1987) indicate a high suspended solid load and it is to be noted that the Cowriga Creek water upstream of the mine area carried high suspended solids (145 mg/l) at that time.

(v) Trace metal concentrations of all waters are within accepted normal levels.

(vi) Water quality of all samples taken are within the limits set by Schedule 2 of the Clean Waters Act. Trace metal concentrations are within accepted normal levels. Iron and manganese concentrations are higher than Schedule 2 limits on infrequent occasions. These levels are however within the range expected of natural waters and offer no toxicity hazard.

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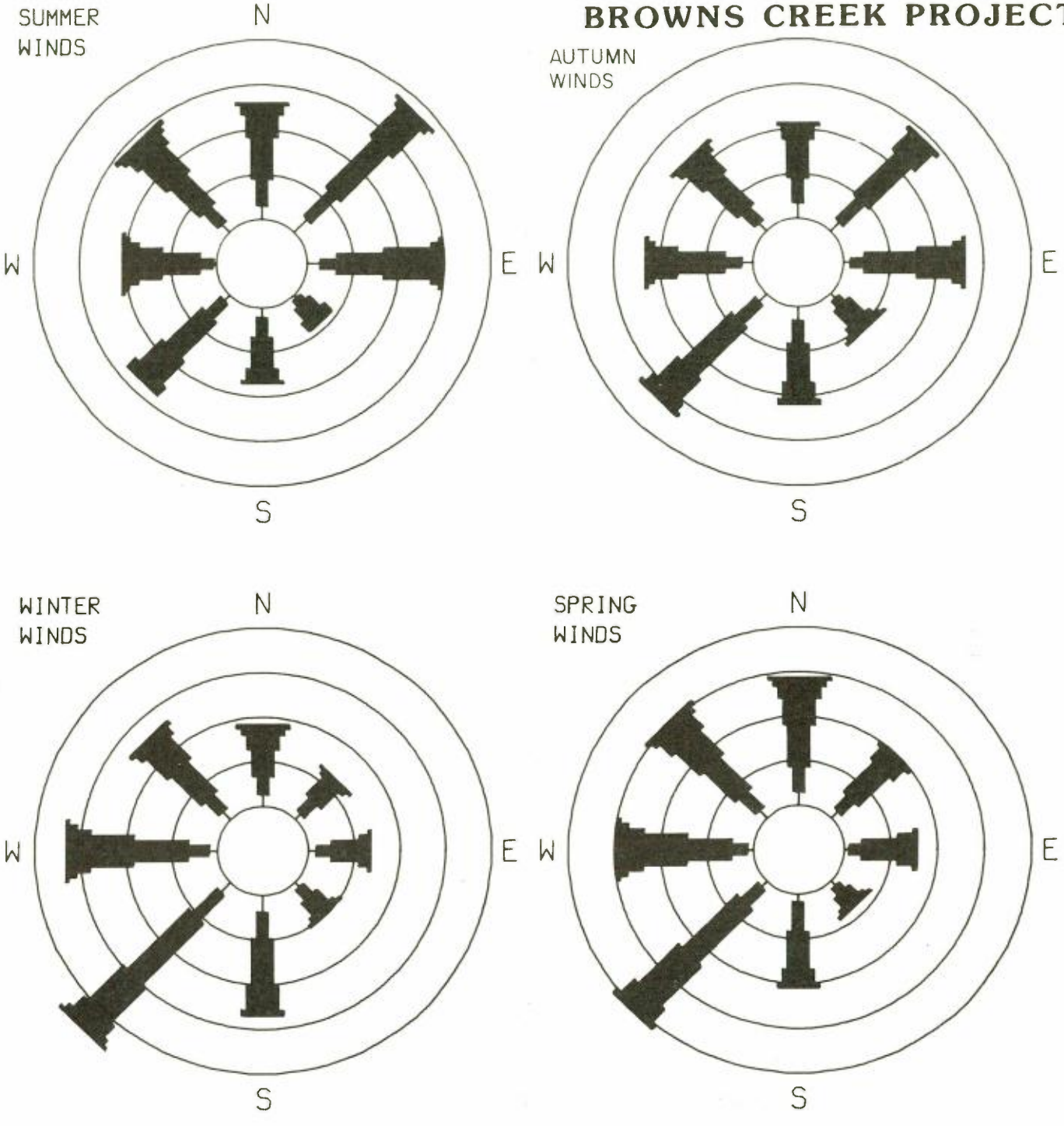

Figure 3.4
WIND SPEED AND DIRECTION

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COMPUTER PLOTTED BY GEOCOM PTY. LTD., SYDNEY

BHP GOLD MINES LIMITED
BROWNS CREEK PROJECT

"Springvale"
BCN-2

TN MN

To Blayney

BCA-1

"Desmond Slopes"
BCN-3

BCW-1

BCA-5

COWRIGA CREEK

BCI-2

BCA-2

BCI-1

BCW-2
BCW-3
BCA-3

BCW-5

BCW-4

BCA-4
BCN-1
"Bonnie Doon"

PL1073

SCALE 1:10,000

100 0 100 200 300 400 500 m

REFERENCE

- BHP Gold Property Fence
- Road
- BCW-2 Existing Water Sampling Site
- BCI-2 Internal Water Sampling Site
- BCA-2 Dust Sampling Site
- BCN-2 Noise and Blast Monitoring Site
- Watercourse
- Prospecting Lease Boundary
- Boundary of Granted Mining Leases
- (P) Proposed Standpipe Piezometers
- Contour (Interval = 20 m)

Figure 3.5
ENVIRONMENTAL MONITORING

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3.6.2 Groundwater

Figure 2.1 shows the location of groundwater bores registered on the Department of Water Resources records in the vicinity of the Browns Creek mine. There are no bores within the mining and exploration tenements of the project. Groundwater data from all bores within a 5 km radius of Browns Creek mine are presented in Table 3.8. None of these bores intersect the Cowriga Limestone.

TABLE 3.8
BORE DATA IN THE VICINITY OF BROWNS CREEK MINE

Reg No	Depth (m)	Yield (l/s)	Water Zones	SWL (m)	Quality	Distance (km)
7414	30	0.3	26	10	-	3.5 NE
1918	75.3	0.03	15.2	-	Good	2.8 N
		0.16	68.6	-	Good	
5799	30.7	0.3	15.2	10	Good	4.0 NE
1651	13.7	0.44	-	3.7	-	2.7 NE
0385	16.8	-	14.6	5.5	-	2.5 S
5392	23.2	0.88	16.8	5.2	Hard	2.3 SW
5207	15.7	0.19	12.2	4.6	Hard	2.2 N
629	18.6	0.3	18.3	6.1	Hard	1.7 NNW

Groundwater in the area is utilised for stock purposes and is reported to be variable in quality from good to hard. The occurrence of hard groundwater is likely to be directly correlated to the Cowriga Limestone geological unit. Similarly the quality of surface waters may be described as hard reflecting the high bicarbonate content.

Groundwater yields of bores in the area average 0.33 litres per second (range 0.03 to 0.88l/s) from generally shallow aquifers (12 to 26 m depth). An isolated bore intersected low yields at 69 m depth. Static water levels ranged from 3 to 10 m.

In the immediate vicinity of Browns Creek mine, Cowriga Creek waters recharge limestone and fractured rock aquifers. The mine operates pumps continuously to dewater the open pit and underground shafts.

The underground mine water is of good quality. Recent sampling and analysis of this water in November, 1987 indicates it to be of potable quality. The broad parameters of this water are:

pH 7.1
Bicarbonate 370 mg/l
Sulphate 4.6 mg/l
Chemical Oxygen Demand <1 mg/l
Total Coliform Organisms 3/100 ml.

The groundwater generally has a salinity of less than 500 mg/l but is slightly hard.

A preliminary pit dewatering study has been commissioned by the Company to address the problems of dewatering of the pit, in particular for Stage 2. The study indicates that the groundwater appears to have concentrated flows in solution channels along major fault structures within Cowriga Limestone. These flows are hydrolaulically connected to Cowriga Creek via sink holes in the original and diverted creek beds. The preliminary hydrogeological study has recommended further investigations which will include test drilling and pumping, and testing within underground workings. The results of these further investigations will be reported to the Department of Mineral Resources and Department of Water Resources.

The maximum pumping capacity is 14 ML/day during the wetter period of May to October. During dryer periods, November to April, the average pumping volume is 5 ML/day. Groundwater inflow into the open cut which is excess to site use is released back to Cowriga Creek downstream of the mine at a rate varying from 5 ML/day to 14 ML/day.

3.7 EXISTING NOISE ENVIRONMENT

Noise surveys conducted under various weather conditions have established the existing noise environment in the areas around the Browns Creek Mine.

The lowest L_{90} noise levels measured at "Bonnie Doon" and "Desmond Slopes" during daytime have been 33 dB(A) and 30 dB(A) respectively. Higher levels were recorded on other occasions and reflected the component of the Browns Creek Mine to the local noise climate. An L_{90} of 30 dB(A) is predicted at "Springvale" based on the minimum levels measured at the two other residences.

When audible above other background noise sources (e.g. local road traffic, wind, animals and insects), the existing daytime noise levels were generally dictated by contributions from the crushing plant and other mine sources.

A number of daytime and night time statistical measurements of the existing noise environment were also conducted at the residence "Bonnie Doon", situated approximately 1350 m southwest of the crushing plant. These results are summarised in Table 3.9.

TABLE 3.9
MEASURED NOISE LEVELS AT "BONNIE DOON"

Noise Sources	Time Of Day	Noise Level L_{10}
Treatment plant, some mobile equipment and trucks	Day	46 dB(A)
Treatment plant, and all mobile plant	Day	49 dB(A)
Treatment plant, front-end loader, primary jaw crusher	Night	50 dB(A)
Treatment plant, front-end loader, secondary crusher	Night	46 dB(A)

The weather conditions during the night time statistical surveys were generally still, whereas during the daytime surveys, there was a steady northwesterly wind of approximately 8 knots. The measured daytime statistical noise levels cannot therefore be directly compared to the night time levels.

Topographical barriers between the mine and residences "Desmond Slopes" and "Springvale" attenuate the noise level contributions from the existing operations. The residence "Bonnie Doon", however, has line of sight to the existing operations and consequently has no additional attenuation due to topographical screening.

3.8 AIR QUALITY

The Browns Creek mine is located within a rural area where the most common air contaminant is dust from agricultural activities and unsealed roads. Other contaminants are seeds, pollen and fire debris.

There is no data on background air quality monitoring prior to mining activities at Browns Creek.

The Company has established a network of five air quality monitoring sites around the existing mine site (see Figure 3.5), principally to determine the impact of existing open cut mining activities on air quality. The stations will provide a useful comparison of dust levels from the existing mining (Stage 1) and future mining (Stage 2).

Airborne deposited matter has been sampled on a monthly basis from February, 1987. Table A2.4 in Appendix 4 lists the recorded levels at the deposit gauges for the period to October, 1987.

This data has been summarised in Table 3.10, averaged to season. The results for site BCA-4, located at "Bonnie Doon" which is the closest residence to the mine, indicate deposited matter levels less than 2 g/m2/month. These levels are relatively low and are comparable to typical dust levels for a residential area. The State Pollution Control Commission has no defined criteria to assess the impact of dust fallout, however in general, levels of 4 to 6 g/m2/month generally attract complaints. It is notable that the predominate winds are south westerly and hence blow from the direction of "Bonnie Doon" to the mine.

Dust levels with the exception of 2 results for the other sites average in the range 0.64 to 2.53 g/m2/month. This indicates that air quality is variable but generally of good quality. Site BCA-5 in May, 1987 recorded a significantly high level of 33.76 g/m2/month. This result is attributed to a period of earthworks for the Platform Road reconstruction. Site BCA-1 in October, 1987 recorded a high level of 20.4 g/m2/month. The monitoring site is located 50 m from a Company owned residence northeast of the mine. Prevailing strong winds in October are from the southwest. During the period of October, rehabilitation and soil handling around exploration consteans were carried out on the Company's prospecting licence. This presumably contributed to the levels of dust recorded at BCA-1. It is noted that both BCA-1 and BCA-5 are positioned on land owned by the Company.

3.9 ECOLOGY

3.9.1 Introduction

The ecological environment around the Browns Creek Mine is typical of the western edge of the Central Tablelands in New South Wales. It reflects the transition between the higher moist tableland areas and the lower, drier western slopes.

A large part of the site has been alienated by past and current mining activities. Much of the remainder has been partially cleared of the original forest cover and is used for grazing sheep. Other areas are completely treeless and have been used for cropping. A small area south of the process residue storage area appears to substantially retain its original tree cover and some of the original understorey grass and herb species. This site does not appear to have been heavily grazed.

Another area of interest is the northern side of Platform Road on the western boundary of PL 1073. This narrow strip between the road and the paddock fence retains a number of native herbs and shrub species that have disappeared from the rest of the area due to grazing, cropping and mining.

A detailed survey of the site was carried out on 15th March, 1987. Figure 3.6 records the vegetation communities observed. Complete lists of all species seen are given in Tables A3-1 to A3-5 of Appendix 3.

3.9.2 Flora

Treecover

The location and tree species composition of remaining woodland remnants are shown on Figure 3.6. The main native tree species are associations of Eucalyptus melliodora (Yellow Box) and E. bridgesiana (Apple Box). The proportion of each species varies on different sites. A large area in the centre of PL 1073 east of the mine consists solely of E. melliodora woodland. An association of E. viminalis and E. bridgesiana dominates on wetter sites, i.e. south facing slopes and along major creeks. Introduced Basket Willow (Salix viminalis) forms dense stands along Cowriga Creek and the tributary gully running west through PL 1073. The stands of native woodland around the process residue storage area are the densest on the site and appear to have had little thinning in the past.

Less common eucalypts on the site are a small stand of Broad-leaved Peppermint (E. dives) southeast of the process residue storage area, and a few specimens of Black Sally (E. stellulata) between the gully and the eastern boundary road. The latter are particularly interesting as they have an unusual bark colour, white instead of the normal greenish-brown. These trees may be of some scientific interest. Both the E. dives and E. stellulata are characteristic tableland species, whereas E. melliodora is more associated with the western slopes, indicating the transitional nature of the vegetation.

Shrubs

The distribution of shrub species reveals much about previous land use. The only shrubs found within the fences of the paddocks were introduced species, or planted ornamentals and fruit trees. No native shrubs occur in grazed or cropped areas. However, six species of native shrubs were found on the northern side of the public road in the western quarter of PL 1073 outside the paddock fence. There is no doubt these species would have originally been widespread over the site along with others that have disappeared. Intensive grazing by sheep would have been mainly responsible for the demise of much of the native flora.

Herbs and Grasses

Apart from four cultivation paddocks in the northeast of PL 1073, the understorey or ground vegetation consists predominantly of a mixture of native and introduced herbs and grasses. Most of the site appears to have been used as native pasture for sheep grazing, which has resulted in a ground flora of mainly grasses and weeds in the most intensively grazed areas. Around the process residue storage area a higher proportion of native herbs appears to have survived, perhaps reflecting the higher tree density (more suitable habitat) and/or lighter grazing.

3.9.3 Fauna

Thirty species of birds were observed on or flying above the site. The majority were associated with the eucalypt woodland remnants, some with the dense vegetation along the creeks and a few with open pasture. Only a few of the species are likely to have populations permanently resident on the site. Most species seen are nomadic, their populations normally ranging over wide areas.

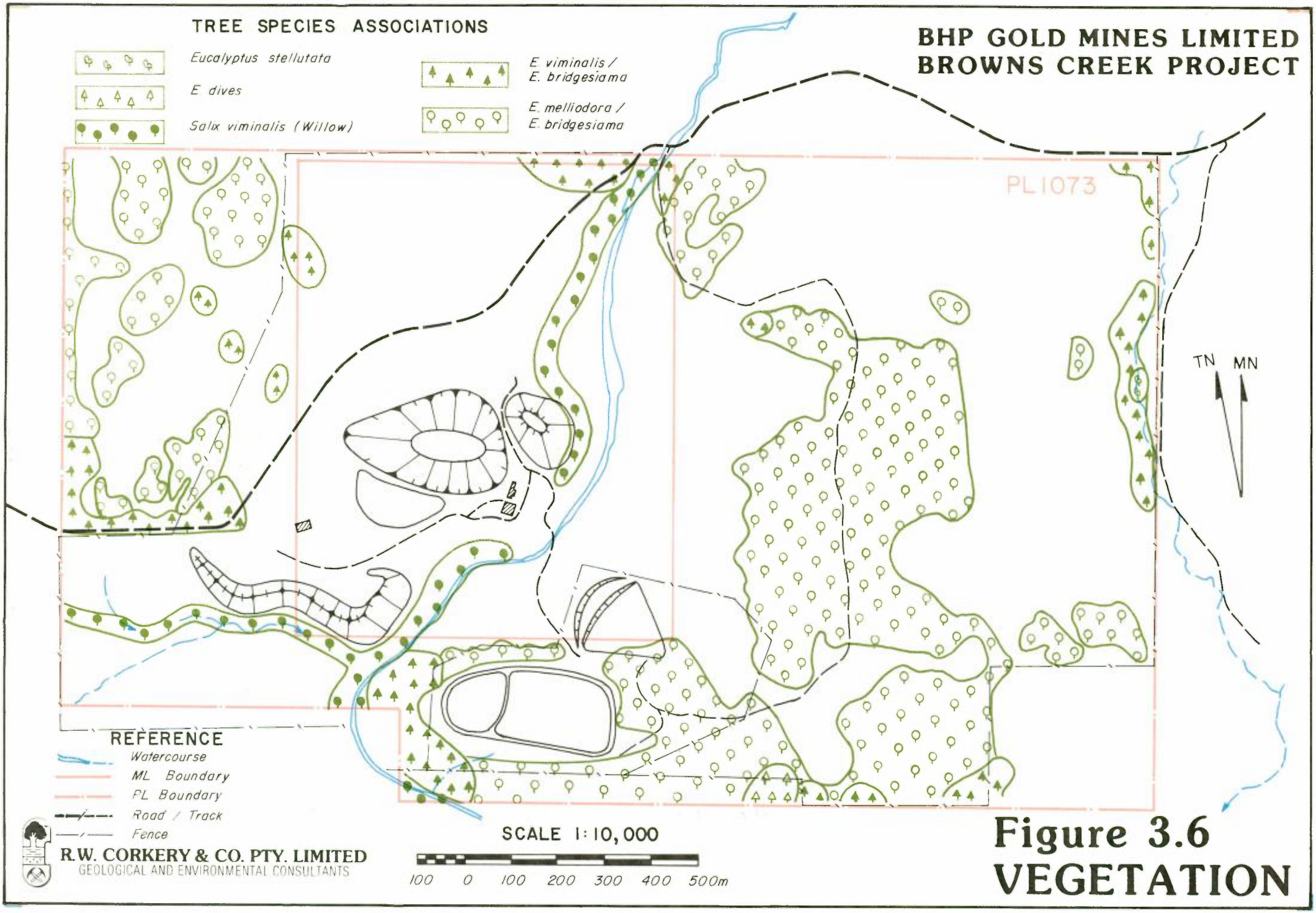
TREE SPECIES ASSOCIATIONS
Eucalyptus stellutata
E. dives
Salix viminalis (Willow)
E. viminalis / E. bridgesiama
E. melliodora / E. bridgesiama
BHP GOLD MINES LIMITED
BROWNS CREEK PROJECT
PL1073
TN
MN
REFERENCE
Watercourse
ML Boundary
PL Boundary
Road / Track
Fence
SCALE 1:10,000
100 0 100 200 300 400 500m
R.W. CORKERY & CO. PTY. LIMITED
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Figure 3.6
VEGETATION

The Browns Creek woodlands are not critical for these birds but are simply one of many areas available for them to exploit. Loss of these woodlands would, however, reduce the overall resource available to the birds. All birds seen were common, widespread species able to utilise semi-cleared woodlands.

Terrestrial Fauna

No evidence of native terrestrial mammals was found anywhere on the site. Agriculture, fencing and grazing appear to have rendered the site unsuitable for macripods and most other fauna. It is likely that Sugar Gliders (Petaurus breviceps) and Brush-tailed Possums (Pseudocheirus peregrinus) survive in the woodland trees, but no spotlighting was carried out to detect them. Due to the considerable habitat alteration it is highly unlikely that any rare or endangered mammals exist on the site. Two common frogs were found in the dams and creeks, and a single Blotched Blue Tongued Lizard (Tiliqua nigrolutea) was found in the remnants of native vegetation beside the public road. The habitat is unsuitable for any rare frog or reptile species.

Aquatic Fauna

The creek systems on the site are small, shallow and carry low volumes of water most of the time and may have no flows for long periods during dry seasons. The creeks are therefore unable to support permanent populations of fish or aquatic mammals. However, when flowing, Cowriga Creek does support fish life above and below the mine.

The Belubula River supports a valuable recreational native fishery, as well as populations of Platypus (Ornithorhynchus anatinus) and Water Rats (Hydromys chrysogaster). Fish species include Brown Trout (Salmo trutta), Murray Cod (Maccullochella macquariensis) and Golden Perch (Plectroplites ambiguus).

3.9.4 Nature Conservation Status

No rare and endangered species were detected on the site. It is considered that the degree of habitat alteration, due particularly to grazing, means that no rare and endangered species are likely to occur there. All species found were common and widespread. One form of possible scientific importance was found during the survey. The white-barked form of Eucalyptus stellulata warrants further investigation to determine its importance as a distinct variety of an otherwise common species. The stand of E. stellulata is worthy of conservation. This stand isolated on the eastern boundary of PL 1073 (see Figure 3.6).

The vegetation communities at Browns Creek are too highly disturbed, and too small in area, to be of significant value for nature conservation. Alternative occurrences of these vegetation communities are present within national parks and nature reserves, although not always well preserved.

The site is infested with several declared noxious species. These include Serrated Tussock (Nassella trichotoma), Blackberry (Rubus fruticosus), St. John's Wort (Hypericum perforatum) and rabbits (Oryctolagus cuniculius). Blackberry in particular is a problem in the south of PL 1073.

3.10 LAND ZONING AND LAND USE

3.10.1 Land Zoning

All land within and surrounding the Browns Creek Project is zoned Non Urban 1 (A) within Interim Development Order No. 1, Shire of Lyndhurst. Consent is required from Blayney Shire Council for mining activities in this zone.

3.10.2 Land Ownership

Figure 3.7 displays the land ownership within and immediately surrounding the Browns Creek Project. All land within the area of the mining leases at Browns Creek Mine is owned by the Company with the following exceptions:

(i) Portions 54 and 55, Parish Beaufort in the name of M.T. Hunter;

BHP GOLD MINES LIMITED
BROWNS CREEK PROJECT

REFERENCE

- Anglican Property Trust Licence BHP Gold
- BHP Gold Mine Limited
- State of N.S.W. Lessee B.H.P. Gold
- B.R. Long
- B.W. & P.A. Adams
- D.J. Ewin
- R.J. Ewin
- J.A. & I.P. Hawker
- R.P. Millner
- M.T. Hunter
- State of N.S.W. - Lesee J.B. & E.B. Baker
- Public Works Department
- Lot / Portion Boundary
- Road
- Residence
- Boundary of Mining Leases

SCALE 1:20,000

0·2 0 0·2 0·4 0·6 0·8 1·0km

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Figure 3.7
LAND OWNERSHIP

(ii) Portions 169 and 170, Parish Beaufort in the name of the Anglican Property Trust (under licence to B.H.P. Minerals);

(iii) Portions 56,61, 64, 330, 331 and 332, Parish Beaufort (Crown Land under lease to B.H.P. Minerals).

Consent has been obtained for the development application relating to Portions 54, 55, 169 and 170 as required in Section 77 (1) of E.P.A. Act. In relation to Portions 61, 64, 71 and 332, the Company is the lessee and lawful occupier of these Crown Lands.

3.10.3 Site Land Use

The immediate area of the Browns Creek mine has been the subject of a mining land use dating back to the first recorded gold production in 1876. Section 1.4 documents the history of mining at Browns Creek. The mining leases over the ore bodies have been worked by both underground and open cut by a number of companies over this period.

In 1979, M.H. Hickey acquired the mining leases covering the Browns Creek Mine and had undertaken mining and treatment activities until 1986 when B.H.P. Minerals Limited acquired the mining tenements and mine plant and equipment. The history of consents and approvals dating back to 1979 from Blayney Shire Council are presented in Table 1.1 of Section 1.5.

The Company owned land within the project site which has not been the subject of mining activity is used primarily for grazing sheep and cattle. This land is fenced and is leased back to surrounding private landowners.

The land is described in the Department of Agriculture Land Classification Map (Shire of Blayney - 1:100,000) as being Class 4 suitability. The Agricultural Suitability classification is defined on the basis of maximum use of the land and is dependent on market demand. Class 4 land is described as suitable for grazing but not cultivation. Production is based on native pastures and/or improved pastures relying on aerial and/or zero establishment techniques. Production may be seasonally high but low overall because of major constraints.

3.10.4 Surrounding Land Use

The land use surrounding the project site consists predominantly of sheep and cattle grazing.

The areas to the south and east comprise Class 4 land of the Department of Agriculture classification described in Section 3.10.3.

The areas to the west and north consist of Class 3 land, which is well suited to grazing and pasture improvement and suited for occasional or limited cropping in a rotation with pasture. The overall level of production is moderate and is not suited to regular cropping or intensive horticulture.

3.11 PRE-EUROPEAN HISTORY

The disturbed nature of the project site, from both past mining and agricultural land uses, precludes the likelihood of signs of aboriginal habitation of the area. The National Parks and Wildlife Service, following an inspection of the site by one of their district officers, have advised the Proponents that no further archaeological assessment is required (see Appendix 4).

3.12 SOCIO-ECONOMIC FACTORS

3.12.1 Introduction

The Browns Creek project site is located within the Blayney district approximately 15 km southwest of the township of Blayney. The village of Millthorpe is 10 km north of the site. Orange is the main regional centre and is approximately 35 km north of the site.

3.12.2 Population

Table 3.11 lists the populations of Orange, Blayney, Millthorpe and four rural areas immediately surrounding Browns Creek. Orange and Blayney have a population of approximately 29,000 and 2,600 respectively. The rural areas surrounding the project site have a population density of approximately 1 person per 0.6 km^2.

Table 3.12 lists the age distribution of the populations referred to above.

TABLE 3.11
POPULATION AND HOUSING
ORANGE, BLAYNEY, MILLTHORPE AREA, JUNE, 1986

Locality (Collector's District)	Average Distance From Mine (km)	POPULATION M	F	T	HOUSING Private Dwellings Occupied	Unoccupied
Orange	25	14041	14894	28935	9310	731
Blayney	8	1269	1324	2593	879	72
Millthorpe	9	341	297	638	212	17
152602	8	70	72	142	49	4
152502	10	100	92	192	57	5
152510*	8	54	54	108	41	10
152504	12	170	162	332	108	13

* The mine is within this district.
Source: 1986 Census

3.12.3 Employment and Services

Statistics from the 1986 Census on employment in Orange and four Blayney collection districts around the Browns Creek Mine are presented in Table 3.13. Approximately 44 per cent of people in Orange and 66 per cent of people in the districts around the mine are employed. Correspondingly, 11 per cent of the workforce in Orange and 7 per cent of the workforce around the mine area unemployed. These differences may be explained by the employment categories for the Blayney district which is dominated by an agricultural labour force. More recent unemployment data from the Commonwealth Employment Service for the local areas of Blayney, Millthorpe and Orange are presented in Table 3.14.

Table 3.15 lists the 1986 Census percentage of persons employed in each industry. The rural areas are naturally dominated by workers involved in agriculture whereas the larger towns of Orange and Blayney have a higher percentage of sales workers, administrators, tradesmen and persons from the service industries.

TABLE 3.12
AGE BY POPULATION
ORANGE AND BLAYNEY DISTRICTS, JUNE, 1986

Age (Yrs)	Orange M	Orange F	152602 M	152602 F	152502 M	152502 F	152510* M	152510* F	152504 M	152504 F
0-4	1357	1303	4	13	4	0	3	6	20	11
5-9	1318	1290	4	8	12	3	8	8	15	12
10-14	1491	1496	4	6	8	4	4	6	17	16
15-19	1426	1472	8	4	14	16	2	0	10	16
20-24	1244	1305	6	2	8	8	2	4	10	13
25-29	1210	1262	10	9	4	5	6	4	10	14
30-39	2266	2366	9	9	14	16	17	15	28	7
40-49	1783	1740	8	13	15	16	4	4	25	25
50-54	750	695	6	4	7	3	4	4	12	5
55-59	656	660	8	6	4	4	6	4	8	2
60-64	637	706	2	3	2	6	4	2	6	8
65-69	477	565	4	0	4	2	2	0	2	6
70-74	378	523	2	2	4	0	2	4	4	2
75+	473	861	0	0	0	4	0	2	2	3
Tot.	15466	16244	75	79	102	93	64	63	169	161

* The site is within this district.
Source: 1986 Census.

TABLE 3.13
EMPLOYMENT - ORANGE AND BLAYNEY DISTRICTS, JUNE, 1986

	Orange	152602	152502	152510	152504
Employed - male	7344	51	50	33	92
- female	4915	22	39	19	63
Unemployed - male	827	6	4	0	5
- female	709	0	2	0	7
Total employed	12259	73	89	52	155
Employment Category (% of total labour force)					
Agriculture/Forestry	4	55	31	40	42
Mining	<1	3	0	8	1
Manufacturing	17	10	9	21	10
Electricity/Gas/Water	2	0	2	0	0
Construction	7	0	9	8	4
Wholesale/Retail	20	0	8	13	10
Transport	5	0	2	0	3
Communication	2	0	0	0	0
Finance/Services	7	3	7	4	4
Public Administration	5	5	0	0	3
Community Services	21	12	27	12	16
Recreational/Personal	8	0	0	0	3
Not Known	1	12	5	0	4

TABLE 3.14
UNEMPLOYMENT FIGURES ORANGE, BLAYNEY, MILLTHORPE

Locality	Postcode	Male	Female	Total
Orange	2800	1,011	371	1,382
Blayney	2799	88	39	127
Millthorpe	2798	51	11	62

Source: Commonwealth Employment Service, May, 1987.

3.12.4 Housing

Table 3.13 shows that there is a considerable quantity of unoccupied housing throughout the surrounding district. However, these statistics do not necessarily indicate if the dwellings are habitable.

Although the availability of homes for rental is limited in Blayney and Millthorpe, a greater rental market exists in the larger centres of Orange and Bathurst. At present the availability of rental accommodation is very low.

There exists ample accommodation for temporary personnel in hotels and motels at Blayney and Orange. Both Blayney and Orange also have caravan parks.

The distribution of residences of personnel currently employed at Browns Creek Mine (see Table 2.7) provides a good indication of the distribution of accommodation of future personnel in the area.

3.13 VISUAL ASPECTS

The Browns Creek mine is currently visible from Platform Road (Shire Road 98) along a 1.3 km section of the road immediately adjacent to the site. Much of these vantages are screened by bunds on the eastern side of the realigned Platform Road. Placement of these bunds was completed in November, 1987.

Distant views of the open cut pit, overburden storage area and existing process residue storage area are possible along approximately 2 km of the Carcoar-Millthorpe Road (Shire Road 99), west of the mine site. Views along this road section are interrupted with vegetation and topography.

The mine site and associated facilities are visible from the homesteads "Bonnie Doon" and "Taralee" which are located southwest of the mine.

3.14 TRANSPORTATION NETWORK

3.14.1 Roads

The roads in the immediate vicinity of the Browns Creek mine are Shire Roads servicing the rural properties and connecting the small rural villages of Millthorpe and Forest Reefs with the larger regional centres of Blayney and Orange.

Shire Road 98 (Platform Road) is a sealed road 4.2 to 4.6 m wide of average to poor condition. The crossing over Cowriga Creek consists of a one lane timber bridge. A traffic count carried out by Blayney Shire Council in January, 1987, at the bridge crossing on Platform Road indicated average daily traffic movement of 265 vehicles. January, 1987 traffic count data for Shire Road 98 before the intersection with Shire Road 99 indicated an average daily traffic movement of 195 vehicles.

Shire Road 99 (Carcoar-Millthorpe Road) is an unsealed gravel road of average condition. This road extends north-south from Millthorpe to Carcoar and intersects Shire Road 98 2 km west of the mine site.

Access from the mine site to Blayney is via Platform Road, thence Main Road 245. Main Road 245 joins Blayney and Orange and is a sealed road in good to average condition.

The main highway (State Highway No. 6) runs from Bathurst through Blayney to Cowra.

3.14.2 Railway

The Main Western Railway runs from Bathurst through Blayney and on to Orange and Dubbo. There exists at Blayney a main station for passenger service and a siding for goods loading.
The Blayney-Demondville Railway is a spurline which branches from the Main Western Railway at Blayney.

3.15 SERVICES

3.15.1 Water

There is no reticulated water supply in the immediate vicinity of the mine site. Local homesteads use rainfall collection tanks and bore water for domestic supply.

The existing mine site uses a combination of rainfall collection tanks and groundwater pumped from the underground mine shaft.

3.15.2 Telephone

There are currently nine working cable pairs available at the mine site, all of which are in use (8 telephone lines and one for facsimile facilities). The mine is serviced from the Forest Reefs Exchange, which is a small rural exchange.

3.15.3 Power

The treatment plant is currently supplied by an existing 11 kv rural power supply line. The route of the power supply line, which runs approximately along the route of Platform Road to Blayney.

An existing 66 kv power supply line runs north from the Blayney substation to Millthorpe along Main Road 245.

The existing 11 kv and 66 kv power supply lines are shown on Figure 2.1.

SECTION 4

REHABILITATION AND ENVIRONMENTAL MANAGEMENT

4.1 AIR POLLUTION CONTROLS

4.1.1 Introduction

Air pollution control procedures are currently adopted for the existing mining and treatment operations at the Browns Creek Mine to ensure minimal local environmental effect. An assessment of dust deposition data at 5 monitoring sites around the mine, indicate that existing operations have limited impact on overall ambient air quality. The levels of total insoluble solids are predominantly within the range 0.39 to 2.53 $g/m^2/month$, with the exception of two high levels in September, 1987 at BCA 1 northeast of the mine and in June, 1987 at BCA 5, 300 m north of the mine (Section 3.8 reviews the results in detail).

The establishment of a more efficient treatment plant and progressive rehabilitation measures proposed for the continued operations at Browns Creek mine will further reduce the impacts on air quality.

4.1.2 Mining Operations

A water truck fitted with a wide fan pressure spray operates to suppress dust generated by vehicular movements on the haul roads and access roads. The frequency of watering depends on the atmospheric conditions prevailing at the time. The spray has a capacity to water the roads at a rate of 1.5 m^2 per application. Sufficient water is applied to suppress dust and not cause slippery conditions.

Dust generated by blast hole drilling is contained by the dust collection system which is fitted on the drill, this unit receives maintenance to ensure performance. Standard industry blasting practices are utilised to minimise dust generation.

All internal combustion engines on site confirm with manufacturers' design specifications for vehicle emissions. Regular maintenance ensures the level of emission is kept low.

Blasting fumes are minimised by the proper and complete mixing of explosive components. The minor amount of fumes generated are readily dispersed into the local atmosphere and do not present any hazard.

4.1.3 Treatment Operations

Potential air contaminants from the treatment plant operations are dust and fumes from reagents.

Dust

Current practice at the existing plant illustrates that appropriately located water sprays significantly reduce the quantity of dust generated by the crushing and handling of ores. The use of a fine ore bin will eliminate dust generation from the stockpiling of finely crushed ore.

The improved crushing facilities will incorporate dust control measures to ensure dust emissions from the plant are minimised.

These may be:

(i) Water sprays fitted and operated when necessary to reduce dust;

(ii) The stockpiling conveyor designed to reduce the amount of free fall for crushed ores;

(iii) Screens enclosed with a fabric hood;

(iv) Rubber skirts used to enclose transfer points where appropriate.

Details of dust control measures are to be confirmed with the State Pollution Control Commission as part of standard procedures which require application for approval to operate the plant.

After entering the ball mill the ore will remain as a slurry throughout the flotation or C.I.P. process, and consequently dust is not generated.

Reagents

Odours from flotation reagents such as Xanthates may be detected at close proximity to the plant. These odours are readily dissipated by adequate ventilation as outlined in the manufacturer's Safety Data Sheets.

Odours from the C.I.P. reagents such as sodium cyanide (NaCN) and sodium hydroxide (NaOH) may be detectable from to time in close proximity to the plant.

Sodium cyanide is odourless, however, on contact with water of low pH, hydrogen cyanide gas (HCN) is formed. The principal safeguard proposed by the Company to eliminate the formation of HCN gas is to ensure that stores of sodium cyanide are kept dry in secured areas, and that the pH of the circuit water is kept at a sufficiently high level to prevent the liberation of HCN. The pH of the circuit water is frequently monitored to ensure high pH levels are maintained.

During the gold stripping operation, minute quantities of ammonia are evolved which readily dissipate.

4.1.4 Waste Disposal Operations

Process Residues

The operational process resude storage area will not generate dust as the supernatant solutions keep the surface moist. After the dams are full to thier design capacity they are allowed to dry out as a prerequisite to rehabilitation.

Rehabilitation of completed storage areas will commence as soon as practicable, thus minimising the exposure of process residues. The period required for full rehabilitation will depend on the surface having dried to form a crust which is sufficiently stable to allow the passage of low ground pressure vehicles.

Overburden

All access roads to the overburden storage area will be regularly watered by a water tanker to minimise dust generation by haul trucks. The access roads are maintained by a grader and fresh waste rock is applied to the haul road surface as required.

The surface of the waste rock emplacement is compacted by haul trucks. During hot and windy periods, the active haul roads on the overburden storage area will be regularly watered by a water truck.

Dumping of overburden onto the advancing face of the storage area during normal weather conditions generates limited amounts of dust, as indicated in the assessment of dust deposition rates at monitoring sites BCA-3 and BCA-4.

4.2 NOISE AND BLAST LEVEL CONTROLS

4.2.1 Major Noise Sources

The main sources of noise during mining is drilling equipment and the loading and transporting of overburden and ore.

Other noise sources are the rock breaking hammer which is used for secondary rock breaking and reversing alarms. The reversing alarms on the heavy equipment are essential to the safety of all employees working around the equipment. The use of such alarms is standard on major mining equipment. The dominant noise source in the present treatment facilities is the primary crusher. On relocation, its hours of operation will be reduced to minimise this impact.

Where possible, the Company has endeavoured to reduce the sound levels emitted from the site's activities. A major consideration of the treatment plant relocation has been to reduce noise levels below those heard at surrounding residences.

A comprehensive survey and review of file data was conducted to compile the noise emission levels for the items of ore processing and mobile equipment proposed for the new Browns Creek Project. Table 4.1 lists the equipment used in the mining and treatment operation, the proposed safeguards and measured spectator noise levels.

TABLE 4.1
SOUND PRESSURE LEVELS FOR PLANT AND EQUIPMENT
CURRENTLY OPERATING AT THE BROWNS CREEK MINE

Item	Distance	Noise Level
Primary Crusher	18 m	86 dB(A)
Primary Screen	28 m	75 dB(A)
Secondary Crusher	28 m	75 dB(A)
Tertiary Crusher	10 m	75 dB(A)
Ball Mill	20 m	80 dB(A)
Vibratory Cone (Fine Ore Bin)	40 m	64 dB(A)
Clay Screen	20 m	84-89 dB(A)
Rockbreaker	18 m	93 dB(A)
Drill	17 m	85 dB(A)
Haul Trucks	7 m	89 dB(A)
Reversing Alarms	20 m	66-84 dB(A) (adjustable)

Where possible, existing plant items at Browns Creek similar to or the same as that proposed for the new project were used to determine these source noise levels.

4.2.2 Noise Control Measures

As the Company engages a contractor to undertake mining, the contract stipulates that all equipment be fitted with appropriate noise and pollution safeguards to satisfy the requirements of the State Pollution Control Commission.

Diesel operated equipment such as the generating sets, front-end loaders and compressors are used 24 hours/day and are fitted with mufflers and engine cowlings.

Following relocation, the crushing operations will normally be between 7.00 am and 7.00 pm with contingency to operate to 10.00 pm to limit noise impact. An application to operate at these hours will be made to the State Pollution Control Commission and the appropriate safeguards will be maintained to ensure the prescribed requirements are met.

It is expected that much of the diesel operated equipment associated with the treatment plant will be eliminated following relocation, that is, generating sets and compressors. If required they would be appropriately located to provide sound shielding and the appropriate

safeguards maintained to ensure the requirements of the State Pollution Control Commission are satisfied. Plant noise between the hours of 10.00 pm and 7.00 am will be mainly from the ball mill which is contained within the bunded treatment plant area (see Figure 2.10). Table 4.2 summarises the proposed safeguards for noise generated by the crushing and treatment facilities.

Specific noise control measures incorporated into the continuation of mining and treatment operations include:

Reduced Hours of Operation

Unlike the existing operation, the crushing and screening operations will normally operate in the daytime between 7.00 am and 7.00 pm Monday to Saturday. Any extension beyond 7.00 pm would only be for 3 hours for short periods to enable production catchup due to bad weather, etc.

The noisiest item of plant, the rockbreaker, will operate as required during the daytime, and where possible these operations will be carried out within the pit.

TABLE 4.2
CRUSHING AND TREATMENT FACILITIES
PROPOSED NOISE SAFEGUARDS

Noise Source	Proposed Safeguards
Primary Crusher	Reduce ore/metal contact by choke feeding and suitable chute design. The crusher's location maximises topographic shielding.
Secondary Crusher Circuit	Rubber screen decks, rubber lined hopper where feasible.
Flotation Plant	Partially enclosed. Use rubber where practicable.

Acoustic Barriers

Waste rock barriers will be constructed along the southern side of Platform Road and southwest of the crushing, screening and treatment plant to acoustically screen the majority of the surface plant operations from the residences "Springvale" and "Bonnie Doon" respectively.

Existing topographical barriers will effectively screen the residences "Desmond Slopes" and "Springvale" from the proposed operations. The effect of the latter barrier combines with that of the man made barrier to further attenuate the noise level contribution at "Springvale".

Optimise Plant Location

The orientation and position of the crushing/treatment plant and the pit design have been optimised to provide the maximum degree of noise attenuation from natural and man made acoustical barriers.

The haul truck routes to the clay screen and primary crusher have also been designed to obtain maximum benefit from the topographical and man made barriers in terms of acoustical screening. As well, the gradients of the pit and surface haul roads within the lease area have been minimised to avoid excessive noise due to trucks labouring.

Scheduling of Major Noise Sources

As well as restricting the noisiest operations to daytime only, the operating positions of some mobile plant may be changed. The blasthole drill, for example, may operate on lower benches during the night time and during adverse weather in order to maximise the noise attenuation produced by the pit walls. There is also scope to vary the position of the drill on a particular bench around the perimeter of the pit in order to maximise shielding benefits.

Controlling Vehicle Reversing Alarms

Reversing alarms are currently fitted to all mobile equipment, however, reversing alarms which have a variable power level (92 dB(A) to 110 dB(A)) will be investigated and if effective may be fitted to major items of mobile equipment. The power level can therefore be adjusted so that the alarms are audible above the ambient noise level but have a sufficiently low source power level that they are not offensive at nearby residences.

The reversing alarms will be located behind a panel of the mobile plant at the lowest practical height above the ground and should be directed towards the ground. The power level can then be adjusted so that the maximum radiated sound pressure level does not exceed the vehicle's engine noise (including exhaust) by more than 10 db(A).

As the sound power level of the alarm is most likely dictated by the 500 Hz and 1 kHz octave bands, the distance and barrier attenuations between the closest residences not associated with the mine and the positions where the majority of reversing will take place will reduce the source power level of 110 dB(A) to an inaudible level (approximately 20 dB(A) at "Bonnie Doon"). Other nearby residents will notice the reduced noise levels from the mobile equipment should the new alarms are fitted.

4.2.3 Site Preparation and Construction Noise

Site preparation will require the use of a range of earthmoving equipment most of which currently operates on site.

Other vehicles periodically used on site will include cranes, low loaders, concrete trucks, mobile welders, mobile compressors and mobile generating sets. This equipment will be fitted with standard exhaust mufflers.

Normal construction noises such as hammering will occur primarily between the hours of 7.00 am and 10.00 pm daily, until construction is completed. The construction programme for the crushing and treatment facilities will be completed within a period of 6 months.

The construction of the overburden storage area diversion channel, Cowriga Creek rediversion and Dam No. 4 will also be completed in 6 months.

4.2.4 Blasting Operations

All blasting on site is carried out in such a manner to minimise the environmental effects of the operations.

The frequency of blasting operations for Stage 1 pit development is expected to average twice per week. This is a function of drilling rates, available drilling locations for the drill, the prevailing weather and the requirements for ore.

To date the blast size has averaged 2,000 m^3 per blast with an average maximum instantaneous charge (MIC) of 250 kg per delay. In the Stage 2 development it is expected that the frequency of blasting will average 3 blasts per week. The maximum expected MIC is 300 kg with the average MIC in the range 200 to 250 kg.

An MIC value of less than 200 kg may be achievable with the development of numerous working faces on the benches, however, the volume of material blasted in any particular shot is expected to increase to 3,000 m^3 for Stage 2. The mine requires the flexibility of maintaining an MIC of up to 300 kg to account for variations in working space and direction and amount of throw.

The majority of the blasting operations for Stage 2 will commence approximately 10-15 m below surface after the softer weathered material has been removed by excavator.

Conditions of the mining leases at Browns Creek mine with respect to blast require:

(i) Ground vibration peak particle velocity is less than 10 mm per second and does not exceed 5 mm per second in more than 5 per cent of blasts at any dwelling or occupied premise outside the lease area.

(ii) Blast overpressure noise level is less than 120 dB (linear) and does not exceed 115 dB (linear) in more than 5 per cent of blasts at any dwellings or occupied premises.

Any departure from these requirements must be approved by the Regional Mining Engineer of the Department of Mineral Resources or satisfy the provisions of the State Pollution Control Commission Act, 1970.

4.3 SAFETY MANAGEMENT

4.3.1 Public Safety

Access to the mining lease area is restricted to employees and authorised personnel and vehicles. Fences and gates are positioned around the site to restrict public access. The mining lease process residue storage areas and other restricted areas will be signposted with warnings. The location of fences are shown on Figures 2.3 and 2.18.

Public safety in the vicinity of the mine during blasting operations is of specific importance and control procedures are detailed in Section 4.3.5.

4.3.2 Mine Safety

All safety requirements within the mining leases are governed by the Mines Inspection Act, 1901 and administered by the Department of Industrial Relations.

The Mines Inspection Act, 1901 stipulates the requirements for the occupational safety of employees and the general working conditions in and around the mine. The mine is regularly inspected by the Department of Industrial Relations (Mechanical, Mine and Electrical Inspectorate). The Act requires that a competent person, acting as manager, is responsible for the control and management of the mine.

The mining contractor and all contractors on site are required to observe the requirements of the Mines Inspection Act and all directions from the manager as required. Company supervisory personnel regularly brief employees on any safety hazards and adequately train employees to avoid accidents.

Personnel safety equipment such as safety boots, safety hats, eye and hearing protection is readily available. The use of safety hats and safety boots is mandatory on the site. Eye and hearing protection is required in risk areas and their use actively policed.

4.3.3 Cyanide Compounds

The Company has adopted strict safety standards to ensure that the health and safety of employees is not endangered through the use of cyanide and other reagents used on site.

The following measures are undertaken at present in the handling and use of cyanide compounds, in accordance with the requirements set by the Department of Industrial Relations:

(i) Protective measures to avoid ingestion or inhalation of cyanide such as:

(a) Mixing of cyanides in alkali solution especially constructed mixing tanks which are well ventilated;

(b) Strict use of protective clothing and breathing protection in the mixing area;

(ii) Instructions on the safe use of cyanide;

(iii) Good personal hygiene such as the washing of hands before eating and the prohibition of any food, drink, eating and smoking in the cyanide area;

(iv) Blayney District Hospital has been advised that cyanide compounds are being used at the mine and have appropriate emergency equipment;

(v) Emergency procedures have been established and specific cyanide first aid kits are held on site;

(vi) Cyanide compounds are stored in a secure area;

The following specific regulations relate to the storage of concentrated liquid cyanide, in particular in the leach and adsorption tanks.

(a) Where concentrated liquid cyanide is stored in a tank or tanks in an amount which exceeds 1,000 litres, a bund shall be constructed around the tank or tanks;

(b) The bund shall be constructed so that it is:

(i) Away from the tank or tanks at a distance of at least half of the height of the tallest tank;

(ii) Capable of containing at least 120 per cent of the capacity of the largest tank.

(vii) Tailings disposal dams containing cyanide compounds are fenced off.

4.3.4 Flotation Reagents

Although not as toxic as cyanide some flotation reagents are harmful or irritant when inhaled or ingested. Strict use of protective clothing and dust maskes are adopted when handling or mixing Xanthates or other reagents in line with recommendations from the manufacturer's Safety Data Sheets.

Employees who handle such reagents are made aware of any hazards and the necessary safety procedures.

Bunding will also be provided to contain 120 per cent of the volume of the largest flotation reagent vessel.

4.3.5 Blasting Operations

The proximity of Platform Road and the existing treatment plant to the pit has necessitated specific safety measures to be adopted during periods of blasting. The manager decides on the safety requirements during blasting and the appointed shotfirer executes these requirements.

Platform Road is closed for a short period (approximately 15 minutes), either side of the actual ignition of the blast. This amount of time provides the necessary margins to block the road, to ensure no personnel, either public or employees, remain within the blast zone, and to ensure an all clear from the shotfirer after the shot has been fired. In general, a full day is required to charge the blast holes, and this restricts earlier firing times.

Firing times and road closure are between the hours of 3.00 pm and 5.00 pm during April to September due to failing light, and between 4.00 pm and 6.00 pm during October to March. Firing times outside of these nominated hours will be infrequent and generally only for safety reasons or misfires.

The Company proposes to install blast notification signs at both ends of the mine of Platform Road to advise regular motorists of the proposed nominated firing and road closure times. The signs will indicate the day and time of firing.

There are currently 3 magazines on site for the storage of explosives. It is proposed to relocate the magazine facility and upgrade storage capacity. The new location to the east of Cowriga Creek satisfies the Australian Standard requirements (AS 2187.1-1984) on distance to workplaces and public places and the requirements of the Department of Industrial Relations. The magazines will be bunded and security fenced.

4.4 WATER MANAGEMENT

4.4.1 Water Pollution Control Objectives

The principal potential sources of water pollution are:

(i) Sediment suspended in surface runoff after rainfall from previously disturbed areas;

(ii) Spillages of reagents from the treatment plant area;

(iii) Spillage of fuel and lubrication oils from the facilities area;

(iv) Spillage and/or leachate from circuit return water lines and process residue storage areas.

The objective in sound site water management and pollution control is to classify areas of specific operations according to anticipated water quality. Three water quality classifications have been adopted for water management purposes. These are:

(i) "Clean" for runoff from undisturbed areas within the project site which can be diverted and released to natural drainage lines;

(ii) "Dirty" for runoff containing suspended sediments from disturbed areas of the pit, waste rock emplacement or facilities area which can be collected and diverted to settlement ponds prior to discharge to natural drainage lines;

(iii) "Contaminated" for process waters and runoff which comes into contact with tailings or treatment plant process areas and must be contained on site and not released.

The objective of site water management is to maximise "clean" runoff while controlling "dirty" runoff and minimising "contaminated" site water to containable quantities. All water discharged off site will satisfy water quality criteria of Schedule 2 of the Clean Waters Act. Figure 4.1 displays the layout of the site's water management. Reference is made on this figure to other figures where water management is presented as part of layours.

As the majority of water controlled on-site is classified as "dirty", extensive use is made of settling dams. Supernatant water in these dams may either be allowed to overflow through a flume decant or used for dust suppression. Most surface runoff to the north of the open cut flows into the original creek bed and then into the cavernous limestone and old workings where it is naturally clarified.

4.4.2 Mine Area Runoff Control

The dewatering of the existing open cut operation is achieved by pumping water from the existing underground workings and shaft beside the pit. The water is of good quality and released directly into Cowriga Creek at a point south of the existing treatment plant (see Figure 2.8). Investigations are under way to establish the most effective pit dewatering system for the remaining life of

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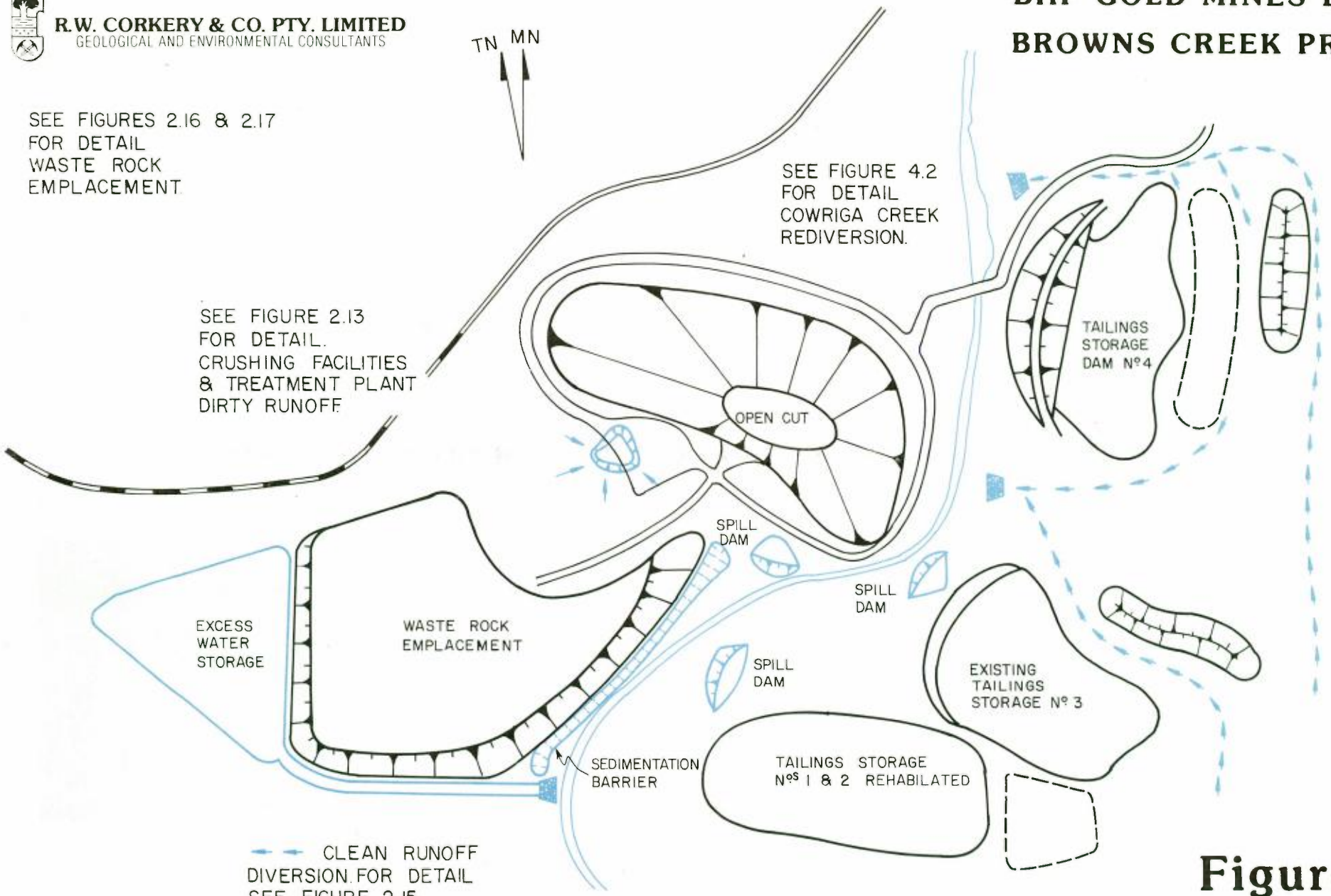

Figure 4.1

WATER MANAGEMENT LAYOUT

the mine.

The following runoff management plan will be adopted to minimise impacts on the drainage system:

(i) Runoff to the north and northwest of the mine will collect in containment areas along the old creek bed to the north of the current pit. Sedimentation will take place and supernatant water allowed to overflow to the Cowriga Creek rediversion.

(ii) In-pit runoff will drain to the mine dewatering system. Sedimentation will occur underground. A sedimentation dam to the southeast of the current pit will be constructed and mine water passed through this system to remove any remaining solids.

(iii) Surface runoff along the south wall of the pit will also drain to the aforementioned sedimentation structure.

4.4.3 Treatment Plant Area Runoff Control

Runoff from around the treatment plant, crusher and stockpiles is classified as "dirty". A containment dam will be constructed to the east of the new plant (see Figure 2.10). Such runoff will be collected and diverted to this dam by a series of spoon drains. The water contained in this dam will be recycled back into the treatment process or be collected by the water truck for dust suppression on the mine haul roads.

Specific controls will be adopted to contain and control possible spills of "contaminated" plant reagents. This will include the following features:

(i) The plant area where reagents are used will be bunded to contain 120 per cent of the volume of the largest containment. The bunds will drain to a sump. The water from this sump will either be recycled in the plant or pumped to a process residue storage area.

(ii) Areas where reagents are stored on site will drain to the plant sump.

(iii) A system of catch drains along pipelines draining to catchment dams constructed to contain any possible leakages from tailings lines;

(iv) Where tailings and return water lines cross Cowriga Creek the use of extra heavy duty/high pressure pipelines will be installed to minimise the risk of failure.

(v) An automatic monitoring system will be investigated, however, the regular inspection of all tailings lines is currently in practice and will continue. Manual inspection of the lines and dams has proven to be reliable.

4.4.4 Cowriga Creek Rediversion

Design Criteria

Hydrological consultants (B.H.P. Engineering) were commissioned to undertake an investigation into the hydrological characteristics of Cowriga Creek and to assess the suitability of several alternatives for the rediversion of the creek.

Physical features that impose restrictions on the proposed rediversion include the limits of the open cut extensions, the proximity of the tailings dams and the upstream bridge crossing.

Design criterion applied to assessment of the various diversion alternatives was based around satisfying the following requirements:

(i) Diverting the existing Cowriga Creek watercourse around the limits of proposed open cut extensions;

(ii) Protection against open cut inundation from diversion overflow;

(iii) Protection of open cut inundation from the formation of "sink holes" within the diversion waterway;

(iv) Diversion works will not effect the stability of either the existing tailings dam (after the proposed raising) or the wall of the proposed pit extensions;

(v) Diversion works will not induce excessive flood level increases (aflux) upstream of the site.

Several schemes were investigated. The first three were used to establish both the most appropriate type of diversion and a qualitative assessment of tradeoffs between design standard and relative construction cost. The fourth diversion alternative represents the selected diversion type and includes three variations to suit possible alternative proposed mine development plans.

The Cowriga Creek catchment covers some 114 km^2 to the north of the Browns Creek project site. Catchment boundaries delineated are presented in Figure 3.2.

The hydrological review of the Cowriga Creek catchment was undertaken using the RORB Runoff Routing Computer Programme (Laurenson and Mein, 1985). In summary, use of this programme involves the development of a mathematical catchment model to which calibration parameters are fitted. Given rainfall intensity, duration and distribution, the model will then compute predicted runoff hydrographs. The model developed for the Cowriga Creek catchment was based around the catchment subdivision and flow path designations shown in Figure 3.2.

Existing Waterway

The existing waterway comprises a low flow channel approximately 3 to 5 m wide bounded by an aritificial levee on the western bank and natural valley side slopes to the east. A computer backwater analysis (HEC, 1982) of this waterway indicated that it presently has a flow capacity of approximately 35 m^3/s. Once the capacity of the levied waterway is exceeded, flows spread out over the full width of the Cowriga Creek floodway.

Analyses were undertaken to assess how much the existing waterway levee would need to be raised so as to fully contain a range of statistical flood flows. Results indicate general levee raising from approximately 1.3 m for a 2 year average recurrence interval design flow, to approximately 2.3 m for a 100 year ARI design flow.

Once the capacity of the levied waterway is exceeded, flows spread out over the full width of the Cowriga Creek floodway.

Design Alternatives

Two basic rediversion approaches were considered:

(i) A raised diversion formed by excavation into the eastern side of the Cowriga Creek valley in conjunction with the construction of a right bank levee.

(ii) A realigned diversion comprising refurbishment of the existing waterway levee (western bank), upstream of the proposed pit extension, in conjunction with the excavation of a new channel into the eastern side of the Cowriga Creek valley.

Rediversion Work Proposed

In summary, the rediversion works will comprise:

(i) Refurbishing and raising the existing waterway levee by an average of 1.5 m;

(ii) Construction of lined trapezoidal diversion channel: 5 m base width with 1 vertical to 1.7 horizontal side slopes:

(iii) Inlet and outlet transitions between diversion channel and the existing waterway.

Figure 4.2 shows the design and alignment of the waterway rediversion.

In view of past problems associated with pit flooding due to the development of sink holes in Cowriga Creek, it is considered desirable that seepage from the creek be minimised. Low permeability channel lining in the vicinity of pit workings is therefore considered an essential component of diversion works.

The proposed lining has therefore been designed to satisfy both low permeability and scour resistance requirements. The lining proposed consists of an impermeable membrane and rock mattress. Typical sections of the rediversion lining are shown on Figure 4.3.

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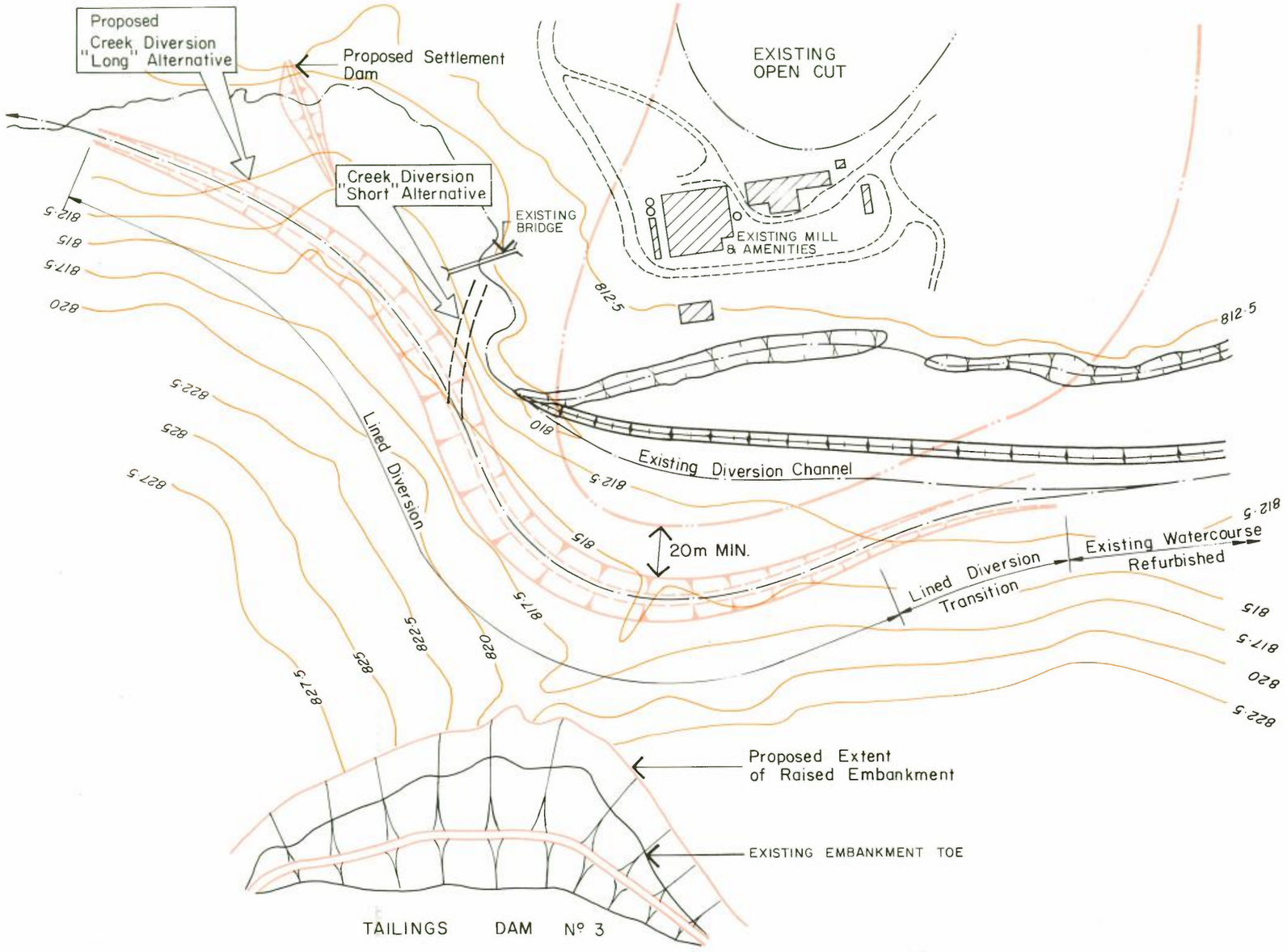

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REFERENCE

- Existing Creek Diversion Levee
- Original Creek
- Proposed Creek Diversion
- Limit of Existing Open Cut
- Limit of Proposed Pit
- Existing Contour (Interval = 2·5m)
- Existing Access Road

SCALE 1 : 2,000

20 0 20 40 60 80 100 m

Figure 4.2
COWRIGA CREEK REDIVERSION WATERWAY ALIGNMENT

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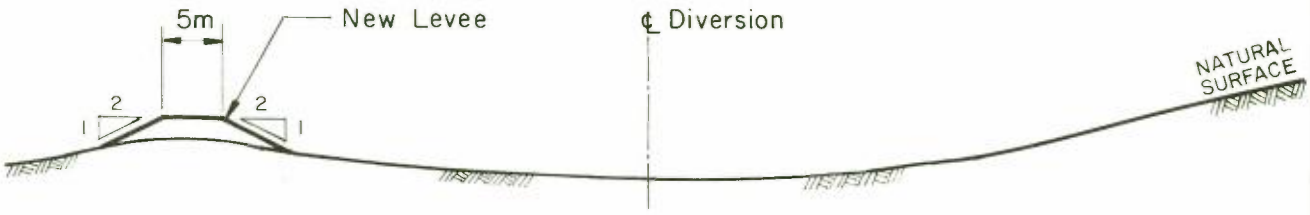
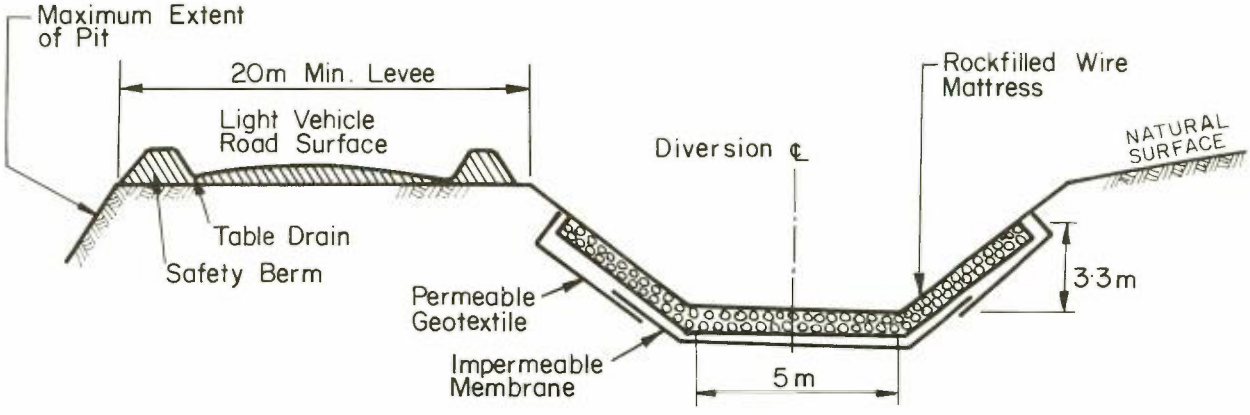


TYPICAL SECTION FOR RAISED LEVEE

LOOKING UPSTREAM

Not to Scale



TYPICAL SECTION FOR LINED CHANNEL (proposed)

LOOKING UPSTREAM

Not to Scale

Figure 4.3
COWRIGA CREEK REDIVERSION
TYPICAL SECTIONS

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4.4.5 Process Residue Storage Area Design

The design objectives for the process residue storage areas or tailings dams are:

(i) To provide a safe and efficient storage area;

(ii) To provide sufficient capacity for process residues for the mine life;

(iii) To contain process water and provide decanting for recycling;

(iv) To allow rehabilitation within an acceptable period.

Runoff diversion drains have been incorporated in the design of the process residue storage areas in order to minimise the quantity of contaminated water contained in the storage area and to ensure sufficient capacity for the process residues. Figure 2.14 details the water management of the existing process residue storage areas on site and Figure 2.15 details the water management of the process residue storage areas proposed for continued mine life.

A sampling investigation carried out by the Department of Mineral Resources' Development Laboratory in October, 1986 indicated no sign of leakage from the existing tailings dams. Sediment below the dam wall contained less than 0.02 ug/g total cyanide.

Sampling of waters in these dams at that time showed the predominant species to be very stable complex $Cu(CN)_2^-$. No free cyanide nor free copper was detected. However it was noted that this stable complex could dissociate if leakage occurred into streams resulting in a toxicity hazard.

The process residue storage areas proposed will therefore be constructed to specifications as recommended by the Company's geotechnical consultants.

(i) All topsoil contained within the storage area and embankment area will be removed and stockpiled on the northern side of the dam and sown with grass for later rehabilitation of the dam at the end of its active storage life;

(ii) Excavation for the general dam foundation consists of the removal of topsoil as per (i) and any other materials which might interfere with a proper bonding of the dam embankment with the foundation or the proper compaction of the dam embankment. The cutoff trench shall be excavated into the clay soils and below the level of any gravel layers.

(iii) The embankment will be constructed with an impermeable upstream barrier.

(iv) Standpipe piezometers will be installed in each dam and seepage pressures and water quality monitored on a regular basis. A typical standpipe piezometer configuration is shown in Figure 4.4.

Figure 4.4 also shows the design proposed for the dam embankments.

4.4.6 Overburden Storage Area Drainage Controls

An assessment of a number of alternative designs of the waste rock empoundment and diversion structure was undertaken by B.H.P. Engineering. These were discussed previously in Section 2.8.3. A hydrological assessment of the waste dump catchment, upon which the design is based, was undertaken using the RORB Runoff Pointing Computer Programme (Version 3, Monash University 1985). The catchment subdivision used for modelling covers some 19,000 ha. A summary of derived flood flows at the waste dump empoundment are listed in Table 4.3.

TABLE 4.3
ESTIMATED PEAK FLOOD FLOWS

ARI* (years)	Discharge (m^3/s)
5	5
20	6
100	9

* ARI - Average Recurrence Interval

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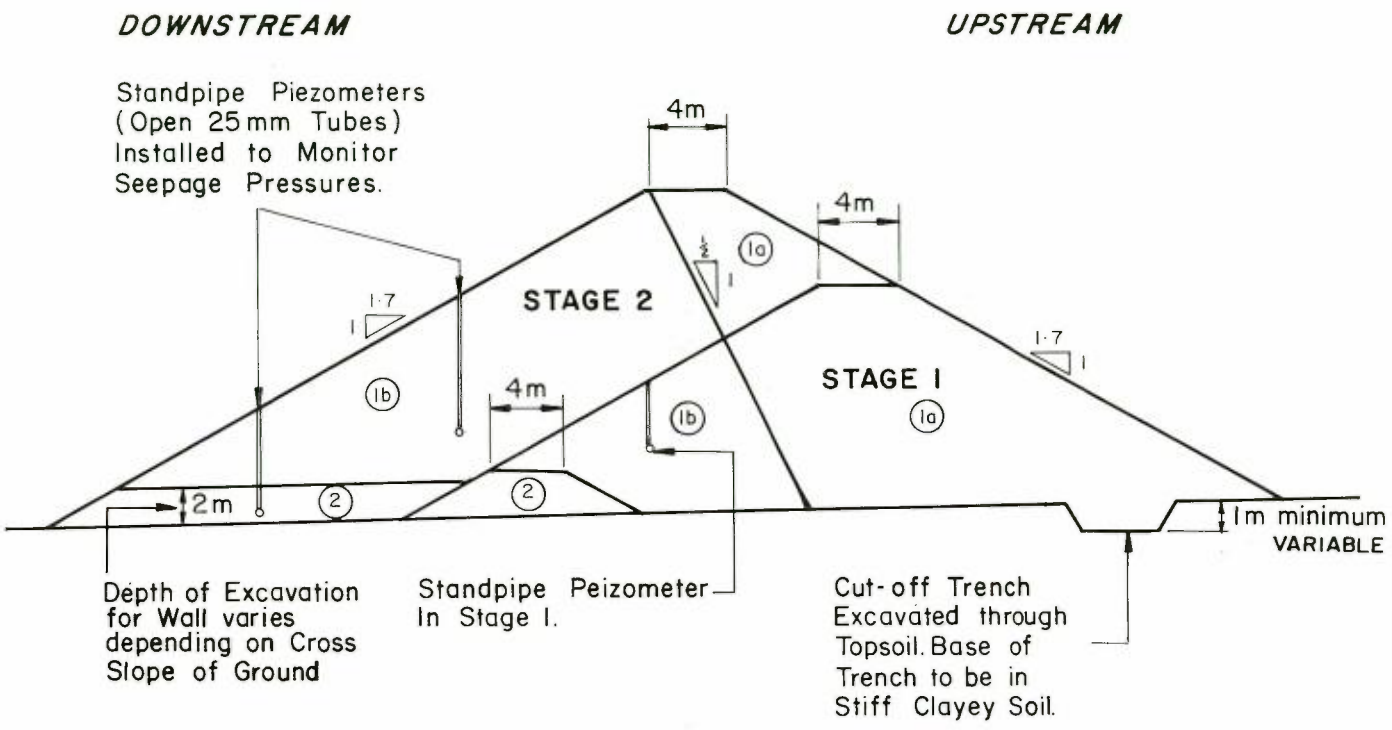

TAILINGS DAM CROSS SECTION

Not to Scale

EMBANKMENT MATERIAL ZONES

(1a) IMPERVIOUS FILL MATERIAL.
SILTY CLAY & EXTREMELY WEATHERED GRANITE.

(1b) IMPERVIOUS & SEMI-IMPERVIOUS MATERIAL.
GRAVELLY CLAY & EXTREMELY WEATHERED GRANITE.

(2) WEATHERED ROCK FILL. SLIGHTLY TO HIGHLY WEATHERED DIORITE FROM OPEN PIT OPERATIONS.

Figure 4.4 PROPOSED TAILINGS DAM CROSS SECTION

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The Company's preferred design comprises an engineered embankment, constructed of waste rock materials, and a diversion spillway to convey the 100 year ARI flood flows. The embankment and spillway will be constructed prior to the first stage of the proposed waste rock disposal. The layout is shown on Figure 2.16.

Figure 4.5 shows detailed cross sections of the spillway, diversion channel and energy dissipating structure.

Runoff from the surface of the overburden storage area will be directed to sedimentation dams on the eastern and western sides of the storage area. Water quality monitoring on four occasions over an eight month period at site BCW 2, which receives runoff and drainage from the existing waste rock, shows no evidence of acid leachate generation or heavy metal contamination. The waters are slightly higher in electrical conductivity.

For control purposes, water off the waste emplacement is classified as "dirty" requiring settlement of suspended solids.

An additional sedimentation structure will be constructed below the waste rock dump to collect runoff from this dump until rehabilitation of the surface is completed. Clean water will be allowed to decant off by a spillway. When necessary, sediment buildup from this dam will be removed to restore its capacity.

Most runoff will be directed to the dam constructed on the western side of the overburden storage area. Suspended solids will settle and clarified water will overflow along the diversion channel to Cowriga Creek after heavy rainfall events.

4.5 SOIL MANAGEMENT AND EROSION CONTROLS

4.5.1 Introduction

Conservation of soil is implicit in successful rehabilitation of disturbed areas at the site. Site inspections and sampling of all existing soil stockpiles and areas proposed for topsoil stripping were undertaken in October, 1987 and a soil management strategy established.

The objectives of this strategy are:

(i) Predetermined topsoil stripping of disturbed areas;

(ii) Predetermined topsoil stockpiling sites which would neither be subsequently disturbed or contaminated;

(iii) Sequential topsoil stripping to be undertaken in phase with the mine development programme. This ensures that large areas are not disturbed at any time nor left denuded for a long period of time;

(iv) The integrity of the stripped topsoil is to be protected by stockpiling to a desired maximum height of 1 m, and thence seeded with grass for stabilisation;

(v) Erosion control measures, diversion drains and sedimentation ponds to be emplaced prior to major earthworks.

The Company and its consultants have and will continue to work closely with officers from the Soil Conservation Service throughout the life of the project on matters of erosion control and rehabilitation.

4.5.2 Soil Management

Soils around the Browns Creek site are described generally in Section 3.4. There are predominantly two major soil types, red and yellow earths on sideslopes and yellow solodics in the poorly drained depressions. Land classifications within the area are predominantly Class III and Class IV.

All soils found in the area have value for rehabilitation. It is therefore proposed that soil from all areas of future disturbance be pre-stripped and selectively stockpiled for use in respreading for rehabilitation.

Soil stockpile areas for proposed process residue storage areas (No's 1, 2, 3 and 4) are shown on Figure 2.14 and 2.15. Soil stockpile areas for the overburden storage areas are shown on Figure 2.16.

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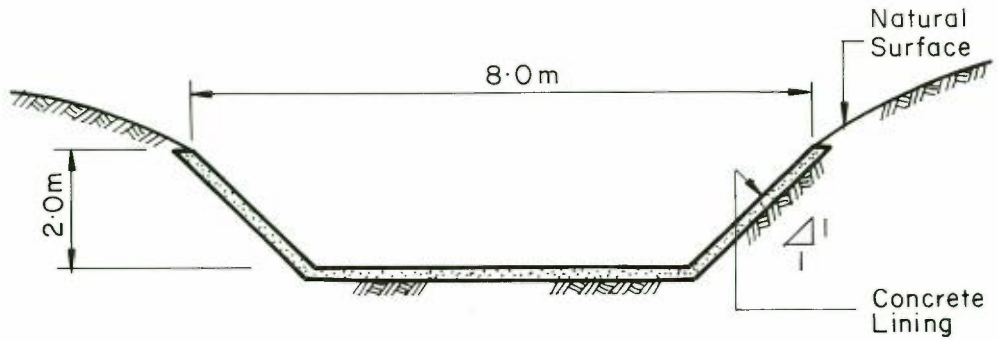
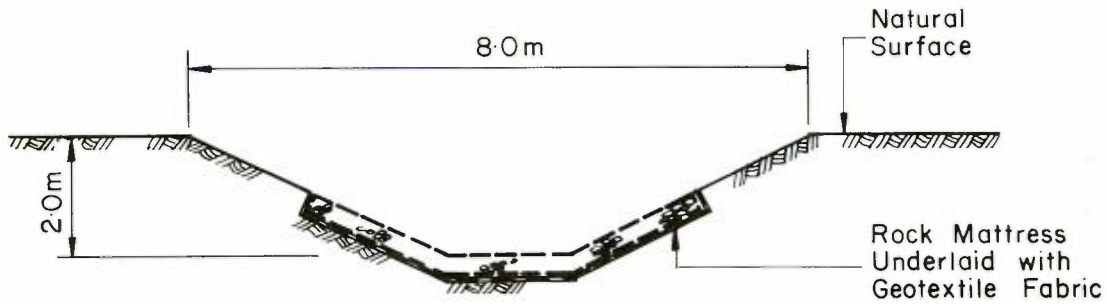
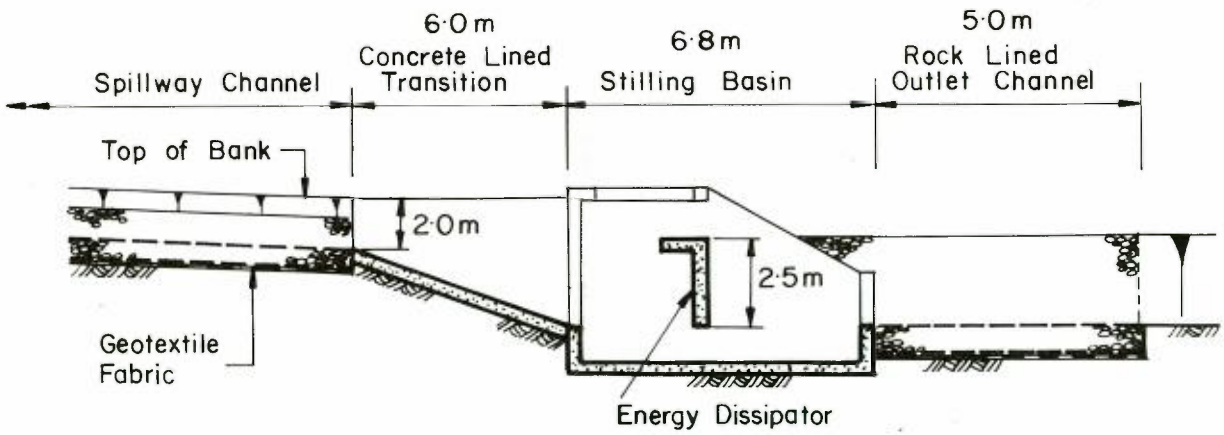
NOTE : DESIGN BY BHP ENGINEERING PTY. LTD.



1. CROSS SECTION THROUGH SPILLWAY STRUCTURE



2. TYPICAL CROSS SECTION THROUGH CHANNEL



3. LONGITUDINAL SECTION THROUGH ENERGY DISSIPATING STRUCTURE

Figure 4.5 WASTE ROCK MANAGEMENT

SECTIONS THROUGH SPILLWAY, CHANNEL AND ENERGY DISSIPATING STRUCTURE

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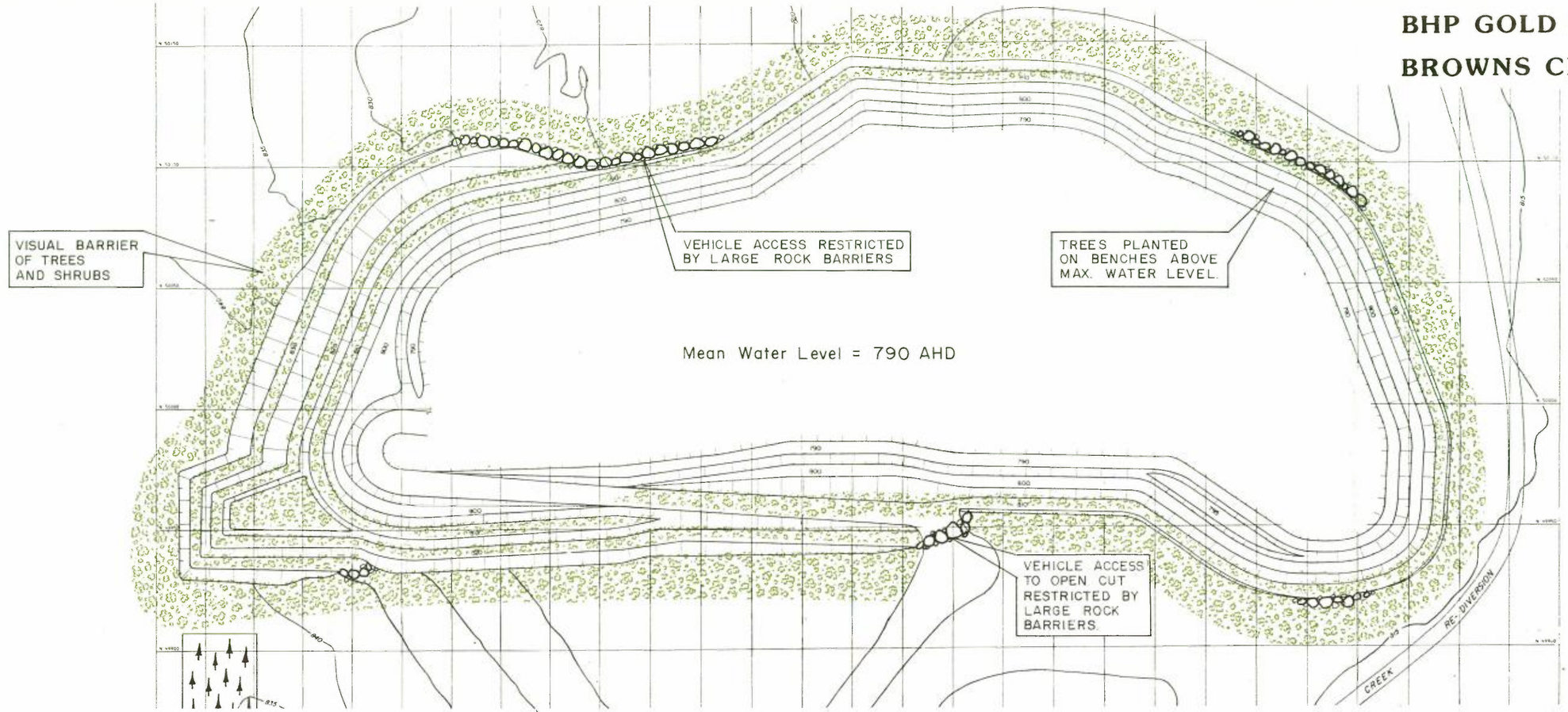
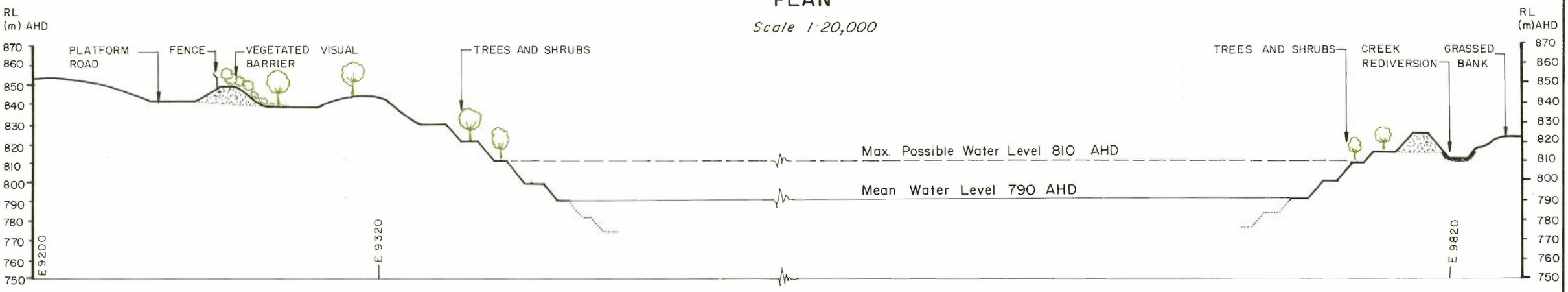


PLAN

Scale 1:20,000



SECTION AA'

Horizontal Scale 1:10,000
Vertical Scale 1:2,000
Vertical Exaggeration = 5

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Figure 4.6
OPEN CUT FINAL LANDFORM-PLAN AND SECTION

A sampling programme was undertaken of soils from areas proposed for tailings dams. Both topsoil and subsoil were sampled. Samples were also taken from existing stockpiles of soils stripped from the waste rock emplacement area. The soils were comprehensively analysed by Australian Fertilizers Limited for nutrient status. Fertiliser application rates were recommended by an A.F.L. agronomist. Results are shown in Table 4.4.

The results are generally applicable, in respect of nutrient status, for all soils to be utilised at the project site for rehabiliation.

The analytical results indicate:

(i) Nitrate and Phosphorous are generally low in all soils. The subsoils are more deficient than topsoils, but may be corrected for rehabiliation purposes by fertiliser application. The following applications of "Starter 15" fertiliser are recommended:

Topsoil - 190 kg/ha;
Subsoil - 230 kg/ha.

(ii) Potassium levels in the soils sampled are moderately low requiring generally an application of 60 to 80 kg/ha of muriated potash. Soils sampled from existing stockpiles showed no deficiency of potassium.

(iii) There appears to be generally no significant imbalance of exchangeable cations. However, where the calcium/magnesium ratio falls below 2, problems of hard setting may appear.

(iv) Soil pH is slightly acid to neutral, indicating no real soil acidity. There is no indication of aluminium toxicity.

(v) Lime requirement of the soils is low, however, to correct the calcium/magnesium ratio an application of 1 tonne per hectare of agricultural lime is recommended. Fine crushed limestone from the waste rock at the Browns Creek Mine would be an ideal supplement to the soils for rehabilitation.

TABLE 4.4
SOILS NUTRIENT STATUS

*Site	Site 1		Site 2		Site 3		Site 4		Topsoil Stockpiles	
Site Depth (cm)	0-10	25-40	0-20	45-60	0-20	40-60	0-20	25-45		
Nitrate ppm	12	7	4	2	3	2	4	2	40	2
Phosphorus ppm	14	2	13	7	12	12	15	8	16	10
Potassium ppm	80	126	58	71	50	49	51	49	272	178
pH in Water	5.2	6.0	6.3	7.3	5.9	6.3	5.5	5.9	5.4	6.1
pH in $CaCl_2$	4.7	5.4	5.7	6.6	5	5.4	4.7	4.9	5	5.3
Sodium meq%	0.1	0.1	0.05	0.2	0.2	0.15	0.1	0.05	0.05	0.05
Potassium meq%	0.15	0.3	0.15	0.15	0.1	0.1	0.1	0.1	0.5	0.2
Calcium meq%	5.6	11	11	16	11	16	7.9	7.5	6	6.2
Magnesium meq%	3.3	11	7.7	18	. 7	16	3.2	4.2	2	3
Aluminium meq%	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
CEC meq%	9.15	22.4	18.9	34.35	18.3	32.25	11.3	11.85	8.55	9.45
Ca/Mg Ratio	1.69	1.00	1.42	0.88	1.57	1.00	2.46	1.78	3.00	2.06
Exch Sodium %	1.09	0.44	0.26	0.58	1.09	0.46	0.88	0.42	0.58	0.52
Organic Matter %	2.8	1	3.3	2.4	2.6	1.8	4.7	1.5	2.4	1.2
TSS %	0.012	0.019	0.018	0.009	0.009	0.015	0.015	0.004	0.031	0.006
Copper ppm	2	1.6	3.5	1.8	1.8	2.4	2.8	2.4	0.5	1.2
Zinc ppm	4.6	0.5	1	0.5	0.8	4.7	1.1	1.1	0.8	1.1
Iron ppm	60	27	83	26	76	43	113	39	34	22
Manganese ppm	57	38	50	15	27	7.3	51	18	12	15
Boron ppm	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.2
Lime Requirement pH in $CaCl_2$ To pH 6.0 t/ha	1.75	0.94	0.5		1.41	0.8	2.44	1.11	1.01	0.66

* See Figures 2.14, 2.15 and 2.16 for site locations

(vi) The status of all trace metals in the soils was adequate for successful rehabilitation. Copper levels were lower than expected and pose no toxicity hazard.

Soil profiles indicate that subsoils, to an approximate depth of 50 cm, consist of fine sandy clay loam to light clay with moderate pedality. These subsoils may, with the applications of fertiliser and additives recommended above, provide an acceptable topdressing material for rehabilitation should the volumes of available topsoil be limited.

It is recommended that topsoil be generally prestripped to 20 cm and selectively stockpiled. Subsoil to a depth of 50 cm should also be stripped and initially separately stockpiled. The subsoil may be useful as a topdressing material for rehabilitation purposes, or used as a filling layer above tailings for shaping to establish a free draining landform prior to surfacing with topsoil.

4.5.3 Erosion Control

Both the red earths and yellow earths of the area are moderately erodable when disturbed for construction earthworks. Yellow podzolics are susceptible to minor sheet erosion.

It is proposed for all earthworks and construction that areas of disturbance are minimised. Soil erosion protection measures proposed include provision of drainage diversion banks around disturbed areas and scour protection of drainage lines. Drainage diversion and settlement ponds have been indicated on all features of mine related activity (see Figures 2.14 to 2.18).

All soil stockpiles, diversion banks and rehabilitated areas are to be sown with grasses for erosion protection as soon as practicable in early spring and autumn. Grass species and sowing rates for erosion control and rehabilitation are shown in Table 4.5.

TABLE 4.5
REVEGETATION PROGRAMME
GRASS SPECIES AND SOWING RATES*

Species	Sowing Rate kg/ha
Legumes	
Subterranean Clover (Woogenellup)	8
White Clover (Haifa)	0.5
Grasses	
Phalaris (Sirosa)	1
Cocksfoot (Currie)	2

* Sowing rates recommended by the Soil Conservation Service.

Pretreatment

(i) Legumes to be inoculated and lime pelletted prior to sowing (subclover - Group C inoculant, white clover - Group B inoculant);

(ii) Insecticide pretreatment recommended.

Fertiliser

(i) Sow with 250 kg/ha single super Mo and follow up with 125 kg/ha in the second year;

(ii) Seed should not be left mixed with fertiliser for more than 1 day.

Reference: Pastures for the Central Tablelands (Draft) - Soil Conservation Service of New South Wales.

4.6 SITE REHABILITATION

4.6.1 Introduction

The Company proposes to undertake progressive rehabilitation procedures where practical in all aspects of the mine development.

The Mining, Rehabilitation and Environmental Management Plan, which is incorporated into this document, has been prepared in satisfaction of mining lease requirements for the approval of the Minister for Mineral Resources.

The short term objective is to stabilise all earthworks, drainage lines and disturbed areas from erosion by means of a combination of grassing, tree planting and rock armouring. Clean and dirty water runoff is kept separate where possible and controlled to minimise contamination of revegetation areas. Tree planting programmes will be undertaken for visual screening of site operations and aesthetic amenity.

The Company's long term objective is to leave all land disturbed by mining and related activity within the lease area as a safe and stable landform commensurate with a future grazing land use and to minimise areas requiring long term maintenance.

For those areas owned by the Company which are not directly affected by the mining and treatment operations, the pre-existing land use of grazing will remain. The Company has leased back much of this land for grazing. Soil conservation and farm management will be observed in accordance with accepted guidelines of the Soil Conservation Service and Pastures Protection Board for those land areas.

4.6.2 Mining Operations

The Company has considered several possible options for the final configuration of the open cut, however, the nature of the mine plan necessitates the continual operation of the main open cut access ramp, and this restricts the amount of backfilling that can be placed within the open cut.

It is proposed that a proportion of the total overburden will be progressively dumped into the western end of the open cut towards the completion of Stage 2.

At the completion of the entire open cut and underground mining operations the open cut dewatering pumps will be turned off and the groundwater level will rise. It is expected that the water level in the open cut will stabilise at a mean water level in the pit of 790 m (AHD), and may rise to a maximum of 810 m (AHD) during high creek flow levels. The mean water level in the open cut will be approximately 20 m below the level of Cowriga Creek.

In addition, the Company proposes to revegetate the upper levels of the open cut and other areas disturbed by mining with native shrubs and trees. Tree and shrub species selection will be developed from trial planting in consultation with a local nursery specialising in native plants.

It is anticipated that the rehabilitation of the open cut will be reviewed by the Department of Mineral Resources as part of the Management Plan process.

The following is proposed:

(i) All batter slopes above 790 m RL will be made stable and safe;

(ii) Benches above the upper expected open cut water level will be ripped, topsoiled and revegetated with suitable grasses and trees to reduce future erosion and to reduce the visual impact of the benches;

(iii) Areas around the open cut disturbed by mining will be graded to remove any remnants of the mining operation, topsoiled and planted with trees and grasses;

(iv) Steep sections remaining around the open cut above 790 m RL will be fenced to restrict access;

(v) Access roads into the open cut will be blocked with large stones to prevent vehicle access.

It is expected from previous open cut flooding experiences that the water level in the open cut will rise rapidly as soon as pumping cease, and the mean level of 790 m AHD should be reached within a maximum of 2 months.

The final rehabilitated landform of the open cut is shown on Figure 4.6.

The existing clay stockpile on the eastern side of the open cut will need to be moved for Stage 2 development of the open cut. It is proposed that much of the material in the stockpile be placed to the north in and surrounding the old Cowriga Creek channel. The remaining material will be reduced significantly in height to blend in with the existing topography and reduce its current visual impact.

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REFERENCE

- Final Contour (Interval = 10 m)
- Trees and Shrubs
- Creek
- Property Boundary
- Road

PLATFORM ROAD

To Blayney

860

855

850

Water Dam

890

880

870

860

850

840

830

820

810

800

790

780

COWRIGA CREEK

ENERGY DISSIPATING STRUCTURE

ROCK LINED SPILLWAY CHANNEL RETAINED

PROPERTY BOUNDARY

TN MN

SCALE 1:1000

10 0 25 50 75 100m

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Figure 4.7
WASTE ROCK EMPLACEMENT FINAL LANDFORM

The following procedures will be adopted for the placement and rehabilitation of the clay stockpile:

(i) All topsoil will be removed from the area where the clay is to be placed;

(ii) The clay stockpile will be relocated;

(iii) After ripping, topsoil (removed in (i)) will be placed on the surface of the stockpile;

(iv) The area will be seeded with grasses and fertilised;

(v) Suitable trees and shrubs will be planted near the base of the remaining elevated area to provide visual barriers;

(vi) The revegetation will be monitored and maintained when necessary.

4.6.3 Overburden Storage Areas

The design of the final surface of the overburden storage area was undertaken using the following criteria:

(i) The area chosen had to accpet all overburden from the open cut;

(ii) The final surface profile had to blend in unobtrusively with the surrounding countryside;

(iii) Continuity for surface drainage should be provided.

A review of the surrounding countryside resulted in the adoption of a maximum slope at 1 on 3 and fill height to 880 m AHD. Progressive development and rehabilitation of the waste rock emplacement was previously shown on Figures 2.16 and 2.17.

The proposed final rehabilitated landform of the waste rock emplacement is shown on Figure 4.7.

The Company proposes that the surface of the overburden storage area be revegetated by replacing the topsoil back on the final surface and sowing to pasture grasses. This will be preceded by ripping the area concerned to assist in locally improving drainage.

Native trees and shrubs will be planted in fenced tree lots over the surface of the completed overburden storage area to provide long term shade.

Revegetation of the waste rock dump will be regularly monitored to ensure it is proceding suitably.

4.6.4 Process Residue Storage Areas

Figure 2.14 shows there are currently three process residue storage areas on site, referred to as Dams 1, 2 and 3.

Dams 1 and 2 are nearing their capacity and have been surfaced with coarser skarn residues to provide a firmer surface on drying for topsoiling. Due to high clay content of these storage areas it is not expected that full rehabilitation will proceed immediately, however, this will depend on the drying characteristics of the surface layer and its load bearing capacity.

Dam 3 will be used to contain the finer oxide ore residues from the C.I.P. circuit for the life of the mine. It is important for metallurgical reasons that the C.I.P. process water and residues be kept separate from the flotation circuit process water necessitating the operators at two storage areas simultaneously.

Dam 4 will be used to contain the skarn ore residues from the flotation circuit for the life of the known skarn reserves.

Should additional ore be delineated in the future, beyond the ore reserves stated in this document, then an additional process residue storage area will be required. All dams will be rehabilitated as soon as practicable after filling.

The Company proposes to undertake the following procedure for the rehabilitation of the residue dams:

(i) Allow the residue dam to dry out sufficiently to enable earthmoving equipment to travel on its surface. The Company estimates that the drying out period will be approximately 12-18 months after no further tailings are placed in the dam.

(ii) Approximately 0.5 m of waste rock will be placed across the entire surface of the tailings dam. It will be contoured to ensure the final ground surface is convex and self draining. This material is designed to provide a subsoil drainage system.

(iii) Subsoil and topsoil initially removed from the area will be replaced over the entire storage area.

(iv) The soil layer will be fertilised and sown with a range of pasture grasses. The pasture grasses sown will be selected on the basis of investigations undertaken throughout the life of the project. The selection of grasses will be undertaken in conjunction with the Soil Conservation Service who have had considerable experience with revegetating mine tailings (Keane and Craze, 1977).

(v) The Company will monitor the success of the rehabilitation and where necessary undertake specific action where the revegetation has not been up to the standard required. The maintenance of the site will be undertaken until the tailings dam is properly stabilised and the revegetation is well in place.

(vi) Fences will be retained around the revegetating tailings dam to ensure that its surface is not overgrazed and that public access is restricted.

4.6.5 Treatment Plant and Infrastructure Areas

All buildings and plant will be removed at the completion of the project. The access ramp to the crusher will be removed and remaining areas around the site will be ripped, scarified, topsoiled, seeded and fertilised. Slopes around the site will be contoured prior to trees and shrubs being planted to complement the grasses.

On completion of the project, the Company will remove and rehabilitate all roads not required for the maintenance of the grazing property and an access to the open cut.

The haul road to the open cut and its benches will be blocked with large boulders (greater than 1 m) forming a boulder barrier across the roadway. An open cut maintenance road will be retained to the top of the southern open cut boundary.

4.7 ENVIRONMENTAL MONITORING

4.7.1 Objectives

Environmental monitoring is undertaken to quantitatively determine the degree of impact the mining and treatment operations are having on the surrounding environment. Assessment of these results can establish if environmental management systems are being successfully applied in the short term and if these management systems need to be amended or can be scaled down in the medium to long term.

Appropriate environmental monitoring, apart from satisfying necessary statutory requirements, demonstrates to the local community the Company's commitment to protection of the environment.

The Mining, Rehabilitation and Environmental Management Plan, which is incorporated in this document, provides a mechanism for presenting and reviewing the results of environmental monitoring. The level of monitoring can be rationalised or scaled up or down accordingly over the life of the mine. Environmental monitoring can also be cost effective if it leads to more efficient management procedures. Implementation of the Management Plan and progress on stated objectives will be reported on annually.

Figure 3.5 indicates the location of air, water, noise and blast monitoring sites.

4.7.2 Water Quality Monitoring

Surface Waters

Water quality monitoring has been undertaken on four occasions to date over an eight month period at five sites. The sites are:

BCW-1: Upstream of the mine on Cowriga Creek.

BCW-2: On the easterly draining tributary below the waste rock emplacement.

BCW-2: On Cowriga Creek downstream of waste rock emplacement.

BCW-3: On Cowriga Creek downstream of the mining lease boundary.

BCW-4: In a gully draining the southern slope of the process residue storage areas (Dam No's 1 and 2).

These sites provide an appropriate characterisation of any potential impact of the mine on water quality. Analytical results of monitoring to date are discussed in detail in Section 3.6. The results indicate that the existing operation has had no significant impact on water quality of Cowriga Creek.

Monitoring at these five sites will continue throughout the life of the mine. Monitoring will be undertaken at least quarterly. Samples will be taken within 24 hours of rainfall events in summer, autumn, winter and spring.

A further two internal water monitoring sites are proposed for sampling within the project operations. These sites are:

BCI-1: Water quality of process water in tailings dams;

BCI-2: Water quality of groundwater seepage into the open cut.

Parameters of water quality to be measured include:

- Total cyanide, pH, electircal conductivity;
- Bicarbonate and sulphate;
- Copper and a range of other heavy metals.

Groundwater

The Company will periodically test the quality of water being pumped from underground within the cavernous limestone.

4.7.3 Dust Monitoring

Monitoring of deposited matter has been undertaken at five sites surrounding the project on a monthly basis since February, 1987. The results of monitoring to date are discussed in Section 3.8.

Monitoring of the project's impact on air quality will continue at these five sites until February, 1988, when 12 months of data will be assessed and a report prepared for the subsequent Annual Report to the Management Plan.

4.7.4 Noise and Dust Monitoring

Noise surveys conducted under various weather conditions provide estimates of existing noise levels at surrounding residences. These are discussed in detail in Section 3.7. Noise monitoring is also proposed at the three nearest residences, once the plant is relocated and operational. Noise monitoring in the future is aimed at verifying or assessing noise predictions presented in the Environmental Impact Statement to determine the success of noise control procedures. The results of noise monitoring will be presented in the Annual Reports to the Management Plan.

In order to assess the effects of airblast overpressure and ground vibration from blasting, a typical production blast was monitored on the 23rd September, 1987 at the three residences "Bonnie Doon", "Springvale" and "Desmond Slopes". The results of blast monitoring are discussed in detail in Section 5.8.

SECTION 5

THE PROJECT'S IMPACT ON THE ENVIRONMENT

5.1 TOPOGRAPHY

The existing topography at the Browns Creek Mine is distinctive of an area which has undergone a history of mining land use. The existing topography is marked by the open cut, overburden storage area and process residue storage areas (Dams No. 1, 2 and 3) within the existing backdrop of rolling hills of cleared pasture land, dispersed with lightly wooded ridges and gullies.

The main change to the existing topography from continued mining development at Browns Creek Mine will be:

(i) A void up to 90 m deep will be left. The Stage 1 open cut will be deepened by 60 m and widened to the east. The open cut will fill to at least the 790 m level creating a water feature. The mine area is currently visible from Shire Road 99 (Carcoar to Millthorpe Road) which is elevated south of the mine. However, at this distance, the widening of the pit will not be noticeable.

(ii) The rehabilitated slopes of the contoured overburden storage area will be consistent with the existing slopes adjacent to the tributary gully.

(iii) The process residue storage areas will create flat areas on land owned by the Company. Although in contrast to the predominantly undulating land that currently exists on the site, on rehabilitation of the process residue storage areas, the contast will not be as noticeable.

(iv) Local minor changes will occur around the site in areas where roads are constructed and minor earthworks are undertaken.

(v) A pondage will be present behind the waste rock emplacement, with a rock or mound spillway leading to the Cowriga Creek. A number of smaller settlement dams will be evident over the site.

(vi) One of the most obvious changes to the topography will be the removal of the clay stockpile adjacent to Cowriga Creek. The final topography will blend into the final landform.

With the exception of (i) the impact of the above changes will generally be moderate since a range of flat areas is being introduced to the area which is in contrast to the existing topography. The presence of the water-filled void created by the open cut will be the most obvious feature in the local topography. This, however, will be an extension of the existing open cut configuration which is currently visible.

5.2 DRAINAGE

The principal impacts of the project on the local drainage system are:

(i) The collection of runoff from the contaminated water dams and the runoff from around the mine, haul roads and overburden storage areas to sedimentation dams. The impact of the reduction in runoff will be minor. There are no dams within the immediate area that would suffer any reduction of inflow.

(ii) After the rehabilitation of the project is completed, the only areas where runoff will be contained on site will be within the open cut and the pondage behind the waste rock emplacement. The water levels in the open cut and pondage will stabilise to an equilibrium with groundwater and drainage levels.

(iii) The impact of the diversion banks will be negligible throughout the life of the project since their prime intention is simply to minimise soil erosion. Their impact long term will be negligible since the diversions will direct runoff to settlement dams that will be useful for stock watering.

(iv) The effect of the rediversion of Cowriga Creek will have minimal hydrological impact. The rediversion is designed for scour protection against a 1 in 100 year flood. The channel will be lined to prevent loss of stream water to groundwater by essentially sealing stream bed cavities. Limited aflux upstream of the bridge over Platform Road is expected, resulting in local backwater during high flow periods.

5.3 WATER RESOURCES

5.3.1 Surface Water

The project will result in a reduction of runoff from the area throughout the operational life of the project, however, the impact of this runoff reduction will be negligible in the context of the Cowriga Creek system as groundwater pumping and discharge downstream will modulate creek flows.

The water quality of the Cowriga Creek will not be affected by the Company's operation, primarily due to the wide range of safeguards designed to contain all contaminated water on site. The continuing water quality monitoring programme throughout the life of the operation and during the rehabiliation phase has been designed to demonstrate the above statement. All pollution control structures e.g. sedimentation dams and diversion banks, will not be removed until the water quality is demonstrated to be similar to the pre-mining conditions.

The existing water quality is good and shows little impact from the current operations.

5.3.2 Subsurface Water

The effects of dewatering the underground shaft and open cut will lower the water level in the immediate vicinity during mine operations. This will have little impact as the nearest registered bore which is 2 km from the pit. The open cut will fill with groundwater to an equilibrium level completion of mining.

The underground shaft currently is recharged by infiltration through limestone cavities from the Cowriga Creek bed. Dewatering and release to Cowriga Creek downstream currently modulates the flow in the creek, and is seen to provide a positive advantage to downstream users in normally low flow periods.

The project will not affect the quality of any groundwater resource near the project site.

5.4 SOILS

The design and operational safeguards outlined in Section 4.5 will ensure the soil resources on the site are properly removed, stored, and replaced. The Company's desire to maintain all soil on site in good condition throughout the project will result in a negligible impact on the soil resources. The use of fertiliser and soil ameliorants for revegetation purposes will be according to accepted application rates.

5.5 AIR QUALITY

The safeguards outlined in Section 4.1 will ensure the dust levels in the vicinity of the Browns Creek Mine are not increased significantly above the levels typical of a rural area. Dust may be noticeable periodically, especially during soil stripping and construction works, however, its duration and impact is similar to ploughing/scarifying, which is a common activity on Class III land throughout the district. Any dust generated on the on-site haul roads will be extremely limited due to the proposed road watering programme.

Dust monitoring undertaken at the site during current mining activity indicates levels typical of a rural area. Periodical activities of less than one month duration, such

as earthworks and soil stripping result in elevated levels. However, the extend of Company owned land effects an adequate buffer for local dust fall out.

The continued mining operations will improve, not exacerbate the existing dust levels.

The measures outlined in Section 4.1 to control potential air contaminants other than dust should ensure the impact from these sources is negligible.

5.6 ECOLOGICAL IMPACTS

The ecological environment in the vicinity of the Browns Creek Mine and within the area of PL 1063 is described in detail in Section 3.9.

The immediate area of the mine has been alienated by past and current mining activities. Much of the remainder has been partially cleared of the original forest cover and used for grazing sheep. All native species found were common, widespread and of no significant nature conservation value. No rare and endangered species were detected on site.

One form of possible scientific importance, the white-barked form of Eucalyptus stellulata, is worthy of conservation. This stand is isolated on the eastern boundary of PL 1073 (see Figure 3.6) and will not be imposed upon or disturbed in proposed activities.

Flora

Little disturbance of existing native woodland is required of the proposal. The following impacts are anticipated on flora and fauna:

(i) Limited removal of trees (mainly E. melliodora and E. bridgesiana along the immediate rim of the tailings dams (Nos 1, 2 and 3) for the siting of waste rock and soil stockpiles;

(ii) Clearing of the tributary gully of mainly introduced willow (Salix viminalis) to allow for progression of the waste rock emplacement;

(iii) The removal of few, if any, riverbank eucalypts and willows to allow for the rediversion of Cowriga Creek and associated sedimentation structures. An application for removal of any such trees within 20 m of the prescribed stream will be made in accordance with requirements of the Catchment Area Protection Board.

Fauna

The continuation of mine related activities should have a minor impact on the fauna observed and known to occur within and immediately surrounding the project.

Noise generated by the existing mining and treatment operations will not be exacerbated by proposed operations. Some birds will be, as now, deterred from entering the area by the activitiy. The more inquisitive birds may be attracted to certain parts of the project site.

The rediversion of the Cowriga Creek will cause temporary interference to fauna frequenting the river bed.

The underground mine dewatering and subsequent discharge to Cowriga Creek will continue at the current rate. This more regulated flow downstream may have some advantage to aquatic fauna especially in dryer periods.

5.7 NOISE IMPACTS

The impact of noise and blasting has been considered in detail in Appendix 7 by Richard Heggie Associates.

Investigations demonstrate that proposed safeguards to be incorporated in the new treatment plant will result in a quieter noise climate at surrounding residences. The primary crusher and rockbreaker will be the major noise sources,a however, their location on site and revised hours of operation will make a noticeable difference to the existing situation.

The Company's mining operation will be able to satisfy all blasting criteria. Measured and predicted levels from blasting are well within the recommended comfort limits which in turn are lower than levels associated with damage to buildings.

5.8 LAND USE AND SURROUNDING RESIDENTS

5.8.1 Site's Land Use

The site's land use will return to primarily grazing at the completion of the project. The open cut when filled with water will become the centre of the ongoing agricultural activities on the land. The permanent water supply will be of considerable value for stock watering and limited irrigation.

The revegetated overburden storage area and process residue storage areas will, in time, be utilised for grazing purposes. It is noteworthy that many landowners downstream from the project site have enjoyed the benefits of permanent water in Cowriga Creek since 1979, especially during the drought of the early 1980's. The continued pumping throughout the remaining mine life will ensure that landowners downstream continue to have access to permanent water.

5.8.2 Surrounding Land Uses

The existing and proposed activities associated with the Browns Creek Mine are not affecting the use of surrounding land, Uses of land at present are similar to those before mining re-commenced in 1979.

5.8.3 Surrounding Residents

The residents within 2.3 km of the project site will continue to be aware of its existence primarily through visibility, noise, blasting, local traffic and intermittent road closures.

Residents of "Bonnie Doon" and "Taralee" will continue to view the activities on site, the most visible of which will be the construction of the overburdened storage area. The new treatment facilities will be hidden from view which will also assist in reducing noise levels.

Nearby residents will be able to hear various components of the project (subject to meteorological conditionss) but as stated Appendix 7, the levels heard will be within the State Pollution Control Commission guidelines. All blasting will be undertaken within guidelines to ensure no building damage results.

Local residents will continue to be aware of the increased local traffic primarily during early morning and late afternoon. Whilst the increase in levels is noticeable, the overall number of vehicles is still small. The impact of continued intermittent road closures during blasting operations will be minor as local residnets are familiar with closing times. Furthermore, the Company's proposal to erect signs to advise residents and motorists of blasting times will assist in minimising the impact of road closures.

5.9 PRE-EUROPEAN HISTORY

The predicted absence of archaeological sites and artefacts on the project site will result in the project having no impact on the local aboriginal history.

5.10 SOCIO-ECONOMIC FACTORS

5.10.1 Employment

The provision of up to 36 jobs during the construction period will have an immediate impact on local employment. Where possible, the Company will engage local contractors and labourers. Other employment generated locally during the construction period will be for local utilities such as Telecom and the Ophir County Council. Indirect employment will increase locally for the provision of accommodation, food and refreshments.

The project will maintain the existing employment levels of up to 72 persons. The provision of new jobs in the Orange-Blayney district is considered to be of great importance especially when considered in the context of the high local unemployment.

Apart from maintaining direct employment outlined, a number of additional persons are likely to be indirectly employed as a result of the Company's project. This trend is already observed in Orange where a WEstern Australian firm specialising in gold assaying has established a laboratory to serve the increasing number of gold mines in the Orange-Blayney district.

5.10.2 Population

The project could result in a temporary net increase of up to 15 persons living in the district during the construction period. It is expected that the bulk of the workforce for construction will be drawn from the Orange-Blayney-Bathurst district. Employment and population will quickly stabilise to that of the existing situation at Browns Creek Mine.

5.10.3 Housing

The project will result in the availability of local rental housing being reduced during the construction phase of the project. It would appear that there is a shortage of rental housing within the Orange-Blayney district. However, it is expected that construction workforce will be accommodated in temporary situations such as caravan parks, hotels and motels. There is ample capacity of these services in the district.

5.10.4 Local Services

The continued operation of the mine will result in a sustained demand for local services. The generation of additional temporary jobs will place an increased demand on local services throughout the district for a short period. There is sufficient capacity in local schools and other facilities to cater for the minor increase in population expected.

5.11 VISUAL ENVIRONMENT

The existing mining operation is distinctive in the local visual environment. Facets of the continued mining operation at Browns Creek Mine are aimed specifically to reduce visual impacts.

As part of the approved Platform Road realignment (see Table 1.1), a visual barrier has been constructed of waste rock material between the road alignment and mining and treatment operations. This barrier will be vegetated and views to the mining activities from Platform Road will be significantly reduced.

Visibility was a determining factor in selecting the preferred locations of the treatment plant and proposed process residue storage area. The relocated plant and stockpile area will be screened by existing tree lots supplemented by overburden visual barriers and tree planting programmes.

The visibility of the project site from the three closest, non-Company owned residences, is presented in Figure 5.1. These sections were taken from each residence ("Bonnie Doon", "Springvale" and "Desmond Slopes") to the highest structure on site, the fine ore bin. Only from "Bonnie Doon" is there currently a direct line of sight. The provision of an overburden barrier will screen views from "Bonnie Doon" to the proposed treatment plant.

Other measures which will reduce visual impact include:

(i) Selective tree planting to screen areas;

(ii) Progressive rehabilitation measures around the tailings dams, stockpiles and other disturbances;

(iii) The mine site, treatment facilities and open cut will be progressively tidied.

Much of the mining and related activities will remain visible from Shire Road 99 (Carcoar-Millthorpe Road). These views are, however, distant views and intermittent along a 2 km section of this road.

The Company's rehabilitation plans will significantly reduce the height of the clay stockpile adjacent to the open cut will be a significant improvement on the visual impacts of the stockpile.

5.12 TRANSPORTATION

The Company will continue to use Platform Road as the main access road to the site from surrounding communities.

A temporary increase in vehicles accessing the site will occur during the construction and relocation of the treatment plant. The number of such vehicles travelling to and from the site each day is expected to be up to 15 during a six month period.

Transport of concentrates from the mine site to a commercial smelter will have minimal impact with an average trucking rate of two 20 tonne tippers per week.

5.13 SERVICES

5.13.1 Power

The Ophir County Council will be able to supply the power requirements for long term development without any detriment to other consumers. The County Council is responsible for the assessment of the environmental impact of the 66 kv line to the site. However, it is noted that its installation and operation will have little impact on surrounding residents. The line will follow Company owned land as far as possible. In the long term when the mine operations are completed, the line may be of considerable benefit to local landholders.

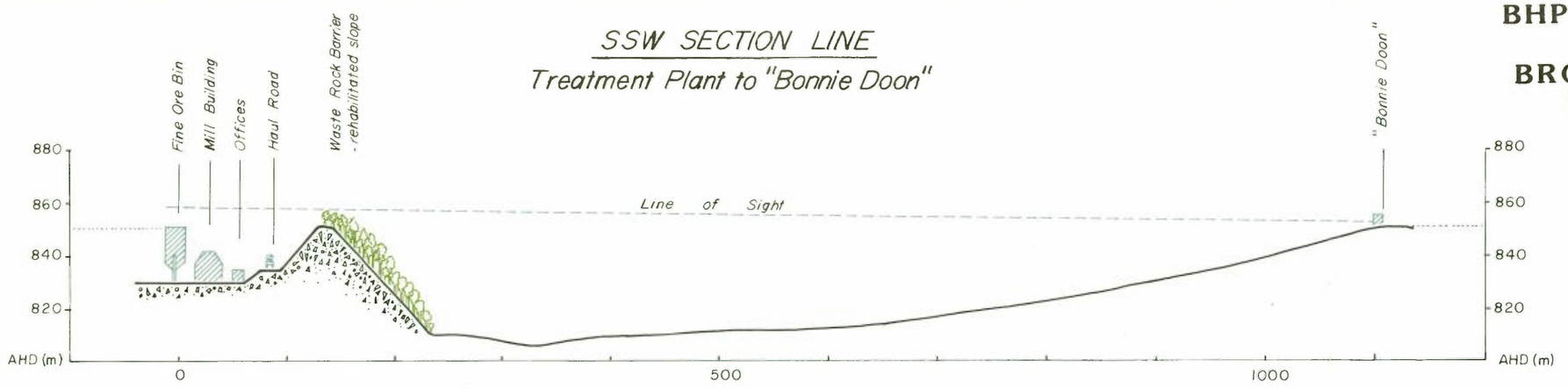
5.13.2 Water

Underground pumping operations supplies good quality water suitable for drinking and ablution purposes.

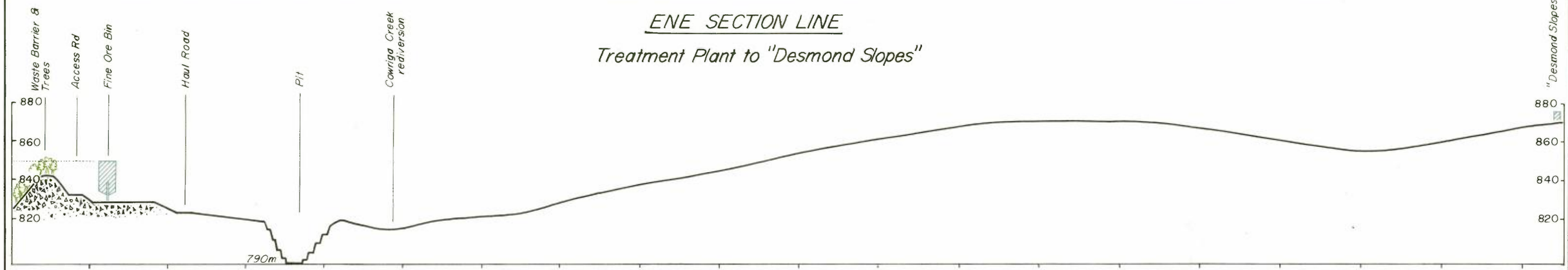
The water demands will not change significantly from the current requirements. It should be noted that during periods of dry weather, Cowriga Creek above the mine has ceased to flow while the release of excess groundwater from mine dewatering insures continuation of flow to the beneift of downstream users.

BHP GOLD MINES LIMITED
BROWNS CREEK PROJECT

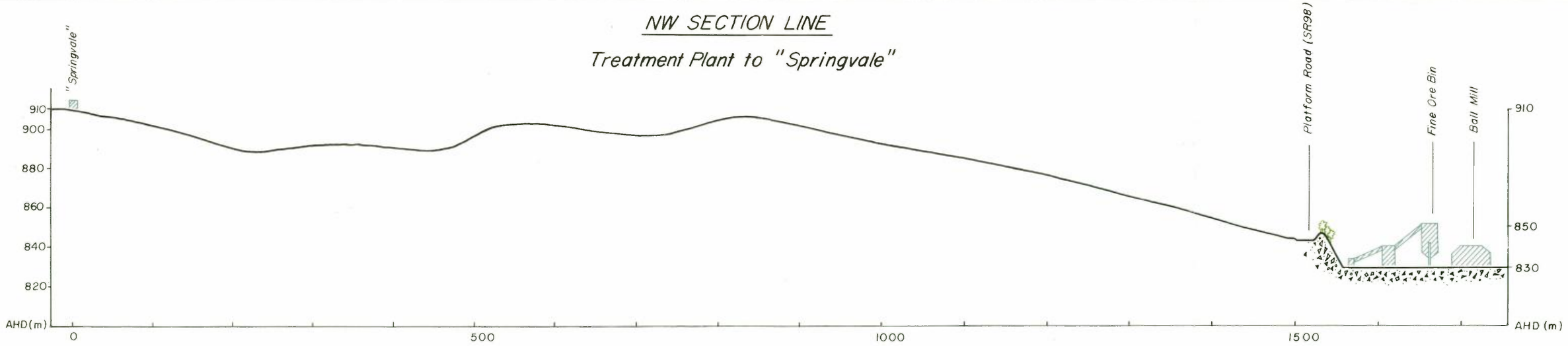
SSW SECTION LINE
Treatment Plant to "Bonnie Doon"



ENE SECTION LINE
Treatment Plant to "Desmond Slopes"



NW SECTION LINE
Treatment Plant to "Springvale"



HORIZONTAL SCALE 1:5000
VERTICAL SCALE 1:2000
VERTICAL EXAGERATION 2.5:1

R.W. CORKERY & CO. PTY. LIMITED
GEOLOGICAL AND ENVIRONMENTAL CONSULTANTS

FIGURE 5.1
VISIBILITY-SECTION LINES TO NEARBY RESIDENCES

SECTION 6

EVALUATION OF THE PROJECT

6.1 JUSTIFICATION OF THE PROJECT

Clause 45(f) of the Environmental Planning and Assessment Regulation, 1980 requires this Statement to justify the proposed development in terms of environmental, economic and social considerations.

6.1.1 Environmental Considerations

The Company's project will be adequately safeguarded during its construction and continued operation to ensure the environment around Browns Creek will not be adversely affected. The principal impacts the project will have on the local environment will be:

(i) Noise levels from the construction phase of the plant relocation and continued mining and treatment operations will be apparent but not excessive. Noise impacts currently experienced from the existing sources will be reduced by acoustic screening and safeguards proposed for continuation of the operations.

(ii) There will be limited removal of trees to enable overburden placement and construction of the earthworks for the project. The impact of tree removal will be reduced in the long term as the Company's rehabilitation programme takes effect.

(iii) The project, whilst in its construction phase will generate significant employment, and in the continuation of operational phases will maintain existing employment levels. The injection of considerable funds into the local economy will result from this employment.

(iv) The local road network will carry a temporary incrase in traffic during the construction phase. Traffic will stabilise to existing levels during operational phases. The road network has the capacity to handle traffic levels. The Platform Road has been diverted and upgraded as part of prior approval.

(v) During regular blasting times (currently at 5.30 pm on average three times per week) traffic on Platform Road will be delayed for safety reasons. This impact is currently recognised during existing operations. Local road users are aware of the times of blasting, and often avoid the site by travelling via Mathews Lane.

(vi) The post mining landform will be modified. The open cut will be extended in dimension and will form a water feature. A number of relatively flat areas will be formed in comparison with the existing rolling topography. The overburden storage area will infill a tributary gully but will be shaped consistent with surrounding slopes and topography.

(vii) Cowriga Creek will be rediverted from its current drainage line. The impact of this will be primarily visibility. Minor local changes to the hydrology of Cowriga Creek will result.

The Company is keen to maintain a good relationship with all adjacent landowners and residents of the Blayney/Browns Creek area. This will naturally involve the Company maintaining acceptable environmental standards throughout the remaining life of the project.

6.1.2 Economic Considerations

Apart from the profits to the Company and its shareholders, there will be considerable benefits earned both directly and indirectly by the local community and State and Federal Governments.

Blayney/Browns Creek District

The existing mine generates considerable employment for local persons and contractors and if approved, will continue to do so for at least a further 5 years. At least $2.3 million per annum is issued in wages, which is spent locally, primarily on food, accommodation and other services. In addition, the Company spending on fuel, other consumables and services also benefits the district.

New South Wales

The New South Wales Government benefits from the employment generated at the mine with its associated payroll tax and other flow-ons as well as $400,000 in royalties annually.

Australia

The Commonwealth will also benefit from the continued employment primarily from taxes paid, as well as export income earned from the production of gold and copper.

6.1.3 Social Considerations

The principal social considerations that will result from the project will be:

(i) The continued permanent employment of approximately 72 persons;

(ii) The short term employment of up to 36 persons during the construction of the treatment plant and associated works;

(iii) The indirect employment already evident in the local community will be sustained;

(iv) The local services that have been boosted by the mine's presence will continue to receive the flow-on benefits from the mine's operation.

(v) The Company is hopeful that regional and local exploration activities will be successful in delineating additional mineable reserves. These additional reserves depending on location may extend the life of the mine or treatment facilities at Browns Creek past the stated life of 5 years. This will maintain employment opportunities for personnel in the region.

6.2 CONSEQUENCES OF NOT PROCEEDING WITH THE PROJECT

(i) An economic deposit of gold, silver and copper ores and other minerals would not be utilised;

(ii) The existing workforce at the mine would need to be retrenched;

(iii) The economic and social benefits outlined in Section 6.1 would not result;

(iv) The Company's plans for the final rehabilitation of the Browns Creek mine site would not eventuate and the best final landform not achieved;

(v) The Company's shareholders would not benefit from a profitable mining operation.

REFERENCES

Department of Mineral Resources, MINFO number 11, 1986, pp15-16

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Geotechnical Investigation for Cowriga Creek Rediversion and Waste Management Schemes, September, 1987 Report No. 100/5

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BHP Brown's Creek Gold Mine, Preliminary Dewatering Study, November, 1987 Report G56/1-AA.

Murphy, B.W. (1985) Regional Institution, Soil Formation and Instability. Problems of Soils in the Bathurst-Orange Region. (Thesis: M.Sc. Agric. - Sydney University).

APPENDICES

APPENDIX 1

CORRESPONDENCE FROM

THE DEPARTMENT OF ENVIRONMENT & PLANNING

A2 New South Wales Government

Department of Environment and Planning

R.W. Corkery & Co. Pty. Ltd.,
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ORANGE NSW 2800 58

Remington Centre
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Box 3927 G.P.O. Sydney 2001
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Telephone (02) 266 7111 Ext 7490
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Contact M. Vincent

Our reference 86/2425

Your reference L:1/86

Dear Sir,

Continued operation of the Browns Creek Gold Mine

I refer to your advice of March 27, 1987, concerning the proposed development at Browns Creek Gold Mine.

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

3. In early discussions with the Department it is understood many of the potential issues were discussed. They included issues associated with the diversion of Browns Creek and possible relocation of the Trunk Road. It would be appropriate, therefore, for these matters to be detailed in the EIS.

4. I have also attached a guide to the type of information most likely to be relevant to the development you propose; not all the matters raised therein may be appropriate for consideration in the EIS for your proposal; equally the guide is not exhaustive.

5. In preparing your EIS you should approach Blayney Shire Council and take into account any comments Council considers may apply to its determination of the proposal.

6. The delay in responding to your letter is sincerely regretted. Please do not hesitate to contact me if I can be of any further assistance in this matter.

Yours sincerely,

23/6/87

COLIN WRIGHT
Executive Assistant
Environment Protection Division

DEPARTMENT OF ENVIRONMENT AND PLANNING
ATTACHMENT No.1

STATUTORY REQUIREMENTS FOR ENVIRONMENTAL IMPACT STATEMENTS.

In accordance with Part 1V of the Environmental Planning and Assessment Act,1979, an environmental impact statement (EIS) must meet the following requirements:

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

(a) full description of the designated development proposed by the development application;
(b) a statement of the objectives of the proposed designated development;
(c) a full description of the existing environment likely to be affected by the proposed designated development, if carried out;
(d) identification and analysis of the likely environmental interactions between the proposed designated development and the environment;
(e) analysis of the likely environmental impacts or consequences of carrying out the proposed designated development (including implications for use and conservation of energy);
(f) justification of the proposed designated development in terms of environmental, economic and social considerations,
(g) measures to be taken in conjunction with the proposed designated development to protect the environment and an assessment of the likely effectiveness of those measures;
(g1) details of energy requirements of the proposed development and measures to be taken to conserve energy;
(h) any feasible alternatives to the carrying out of the proposed designated development and reasons for choosing the latter; and
(i) consequences of not carrying out the proposed development.

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

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

APPENDIX 2

ENVIRONMENTAL MONITORING DATA

TABLE A2-1
BASELINE WATER ANALYSES RESULTS - BROWNS CREEK

Date Sampled	DISCHARGE	pH	E.C.	HCO_3	Cl	SO_4	Ca	Mg	K	Na	S.S.	F	CO_4	Cyanide	UNFILTERED As	Cu	Pb	Zn	Mn	Cd	Fe	FILTERED As	Cu	Pb	Zn	Mn	Cd	Fe
Units	Megalitres /day	uS/cm	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l
BCW-1 23.01.87		7.1	565	340	24	1.7	44	40	2.3	22	8	0.17	Nil	<0.01	3.0	10	9.5	10	300	0.50	0.24	1.5	5.0	6.0	4.0	5.0	0.25	0.02
10.03.87		7.2	425	140	67	12	25	22	2.4	28	22	<0.05	Nil	0.02	<0.05	10	8.0	15	72	0.50	0.45	<0.05	6.0	5.5	12	2.5	0.30	<0.01
02.06.87		7.6	450	255	32	7	31	27	2.1	22	3	Levels Not Determined			<0.05	7.5	5.0	6.5	3.0	0.45	0.10	<0.05	10.0	13.0	12	39	0.80	0.34
03.08.87		6.6	265	110	15	15	12	16	2.6	14	145	Levles Not Determined			1.0	11	9.0	16	335	0.45	1.96	<0.5	7.5	6.5	9.5	10	0.25	0.26
BCW-2 23.01.87		Dry													Dry													
10.03.87		7.8	950	370	64	125	80	46	1.5	60	5	<0.05	Nil	<0.01	5.0	38	27	36	750	1.2	0.50	1.5	7.5	18	12	4.5	0.30	0.02
02.06.87		7.3	740	405	39	25	55	39	0.7	46	4	Levels Not Determined			<0.5	7.5	3.5	7	230	0.75	0.13	<0.5	10	19	14	610	1.30	0.70
03.08.87		7.1	440	175	20	35	24	19	1.3	27	100	Levels Not Determined			5.5	32	18	13	320	0.50	1.32	3.0	10	8.0	5.0	10	0.30	0.16
BCW-3 23.01.87		7.5	610	375	21	2.7	73	29	1.2	15	7	0.14	Nil	<0.01	14	27	14	16	155	1.4	0.20	13	15	7.5	6.0	6.5	0.40	0.01
10.03.87		7.6	420	210	32	9	29	23	2.3	28	30	<0.05	Nil	0.02	<0.5	20	14	16	110	0.35	0.67	<0.5	10	8.0	10	2.5	0.15	0.02
02.06.87		7.3	550	320	25	10	51	27	1.6	19	12	Levels Not Determined			2.0	27	6.0	7.5	45	0.75	0.18	5.0	75	12	12	240	1.0	0.49
03.08.87		6.8	290	120	20	20	15	16	2.7	15	565	Levels Not Determined			6.5	88	14	26	740	0.90	3.30	5.5	23	12	10	12	0.45	0.22
BCW-4 23.01.87		7.5	610	375	24	2.9	72	29	1.2	15	6	0.15	Nil	<0.01	17	18	14	11	119	8.0	0.31	12	10	6.0	4.5	7.0	0.45	0.03
10.03.87		7.5	420	210	35	49	51	23	2.3	27	20	<0.05	Nil	0.01	<0.5	21	12	19	115	0.75	0.64	<0.5	13	8.0	13	5.0	0.40	0.03
02.06.87		7.4	545	310	28	11	50	27	1.6	19	22	Levels Not Determined			5.0	21	7.0	7.5	55	0.65	0.17	7.0	80	12	11	360	0.95	0.68
03.08.87		6.8	295	125	15	15	16	15	2.8	15	640	Levels Not Determined			5.5	110	23	34	860	1.0	2.37	4.0	26	17	18	15	0.55	0.14
BCW-5 23.01.87		Dry													Dry													
10.03.87		6.4	180	50	35	14	8	11	4.3	18	240	<0.05	Nil	<0.01	<0.5	15	8.5	18	156	0.25	2.80	<0.5	8.5	6.0	14	10	0.20	0.12
02.06.87		Dry													Dry													
03.08.87		6.2	140	45	7	30	6.4	8	4.8	8.4	220	Levels Not Determined			5.0	75	14	26	145	0.50	2.41	3.5	22	9.0	11	26	0.35	0.17

TABLE A2-2

SCHEDULE 2 - CLEAN WATERS ACT, 1970

RESTRICTED SUBSTANCES (INORGANIC ONLY)

Substance	Not in Excess of (mg/l)
Arsenic	0.05
Barium	1.0
Boron*	1.0
Cadmium	0.01
Chloride*	250
Chromium (hexavalent)	0.05
Copper	1.0
Cyanide	0.05
Fluoride*	1.5
Iron (filtrable)	0.3
Lead	0.05
Manganese (filtrable)	0.05
Mercury	0.001
Methylene blue active substances	0.5
Nitrogen (ammonia)	0.5
Nitrogen (nitrate plus nitrite)	10.0
Selenium	0.01
Silver	0.05
Sulphate*	250
Uranyl ion	5.0
Zinc	5.0

* Limits indicated do not apply to these substances in regard to tidal waters.

TABLE A2-3
GENERAL CRITERIA FOR THE SALINITY OF IRRIGATION WATER

Class	Description	EC uS/cm	TSS mg/L
1	Low salinity water can be used with most crops on all soils, with all methods of water application, with little likelihood that a silinity problem will develop.	0-280	0-175
2	Medium salinity water can be used if a moderate amount of leaching occurs. Plants with medium salt tolerance can be grown, usually without special practices for salinity control.	280-800	175-500
3	High salinity water cannot be used on soils with restricted drainage.	800-2300	500-1500
4	Very high salinity water is not suitable for irrigation under ordinary conditions.	2300-5500	1500-3500
5	Extremely high salinity water may be used only on permeable, well-drained soils under good management.	Above 5500	Above 3500

EC: Electrical Conductivity
TSS: Total Soluble Salts

Reference: Hart, B.T., 1974
A compilation of Australian Water Quality Criteria. Australia Water Resources Council, Technical Paper 7.

TABLE A2-4
DEPOSIT GAUGE ANALYSES - BROWNS CREEK GOLD MINE

Site No.	BCA-1			BCA-2			BCA-3			BCA-4			BCA-5		
	Insoluble Solids	Loss on Combustion	Rainfall (mm)	Insoluble Solids	Loss on Combustion	Rainfall (mm)	Insoluble Solids	Loss on Combustion	Rainfall (mm)	Insoluble Solids	Loss on Combustion	Rainfall (mm)	Insoluble Solids	Loss on Combustion	Rainfall (mm)
PERIOD															
02.02.87 - 05.03.87	2.11	0.49	117	1.28	0.40	116	2.27	0.44	114	1.91	0.59	114	1.69	0.41	120
05.03.87 - 03.04.87	3.61	1.50	67	1.08	0.34	75	2.43	0.38	78	1.68	0.46	53	2.21	0.47	80
03.04.87 - 01.05.87	1.60	0.39	23	0.59	0.16	18	2.43	1.20	19	1.39	0.27	16	2.26	0.37	22
01.05.87 - 02.06.87	1.64	0.83	108	1.12	0.55	80	2.74	0.81	99	1.88	0.57	97	33.78	16.98	98
02.06.87 - 02.07.87	2.12	1.04	98	1.38	0.70	59	2.68	0.65	101	1.68	0.49	105	1.30	0.41	87
02.07.87 - 03.08.87	0.62	0.13	83	0.34	0.16	66	0.76	0.10	59	0.90	0.21	92	0.81	0.06	72
03.08.87 - 01.09.87	0.02	0.01	93	0.20	0.10	79	0.92	0.07	87	0.25	0.10	91	0.67	0.11	83
01.09.87 - 02.10.87	20.09	4.34	43	0.69	0.22	36	1.33	0.24	45	1.31	0.47	51	2.81	0.79	38

Units $g/m^2/month$

APPENDIX 3

LIST OF FLORA & FAUNA SPECIES

TABLE A3-1
TREE SPECIES

Scientific Name	Common Name	Comments
Family Fabaceae		
Robinia pseudoacacia*	Black Locust Tree	Paddocks, Yards
Family Mimosaceae		
Acacia dealbata	Silver Wattle	Common
Family Myrtaceae		
Eucalyptus bridgesiana	Apple Box	Common
E. dives	Broad-leaved Peppermint	One Small Patch
E. melliodora	Yellow Box	Very Common
E. stellulata	Black Sally	Four Trees Only
E. viminalis	Ribbon Gum	Common
Family Pinaceae		
Pinus radiata*	Monterey Pine	Plantation
Family Salicaceae		
Populus alba*	Poplar	Few
Salix babylonica*	Weeping Willow	Common on Creeks
Salix viminalis*	Basket Willow	Few

* Denotes introduced species

TABLE A3-2
SHRUB SPECIES

Scientific Name	Common Name	Comments
Family Asteraceae		
Cassinia arcuata	Chinese Shrub	Roadside
Family Caprifoliaceae		
Sambucus nigra*	Common Elder	Paddocks
Family Dilleniaceae		
Hibbertia sp. (aff. calycina)	Guinea Flower	Roadside
Family Epacridaceae		
Acrotriche serrulata	Ground-berry	Roadside
Family Fabaceae		
Pultenaea subternata	Pea Flower	Roadside
Dillwynia retorta var. phylicoides	Pea Flower	Roadside
Family Loranthaceae		
Amyema pendulum	Drooping Mistletoe	On Eucalyptus bridgesiana
Muellerina eucalyptoides	Mistletoe	On Eucalyptus melliodora
Family Rosaceae		
Crataegus monogyna*	Hawthorn	Common, Creeks
Prunus sp.*	Ornamental Plum	Two, Yards
Rosa rubiginosa*	Sweetbriar	Common, Woodland, Pasture
Rubus fruticosus*	Blackberry	Common, Woodland
	Quince	Two, Gully
Family Epacridaceae		
Pimelea linifolia	Rice Flower	Roadside

* Denotes introduced species.

TABLE A3-3
GRASSES AND HERBS

Scientific Name	Common Name	Comments
PTERIDOPHYTA		
Family Dennstaedtiaceae		
Pteridium esculentum	Bracken Fern	Near Creek in woodland
ANGIOSPERMAE		
Monocotyledonae		
Family Cyperaceae		
Carex inversa	Knob Sedge	Creek
Family Juncaceae		
Juncus sp.	Rush	Paddock
Family Liliaceae		
Dianella revoluta	Flax Lily	Roadside
Family Poaceae (Graminiae)		
Agropyron scabrum	Common Wheat Grass	Pasture
Agrostis sp.	Bent	Pasture
Briza maxima*	Blowfly Grass	Disturbed Sites
Echinopogon ovatus	Forest Hedgehog Grass	Pasture
Nassella trichotoma*	Serrated Tussock	Pasture
Paspalum dilatatum*	Paspalum	Roadside
Phalaris aquatica*	Toowoomba Canary Grass	Pasture
Poa labillardieri	Tussock Grass	Pasture
Poa spp.	Tussock Grasses	Roadside
Themeda australis	Kangaroo Grass	Pasture
Family Xanthorrhoeaceae		
Lomandra filiformis spp. coriacea		Roadside, Woodland
Lomandra multiflora	Matrush	Roadside, Woodland
DICOTYLEDONAE		
Family Apiaceae		
Daucus glochidiatus	Australian Carrot	Woodland
Hydrocotyle laxiflora	Stinking Pennywort	Woodland
Family Asteraceae		
Carthamus lanatus*	Saffron Thistle	Pasture
Cirsium vulgare*	Spear Thistle	Disturbed
Gnaphalium luteo-album	Jersey Cudweed	Pasture
Hypochoeris radiata*	Flatweed	Pasture
Lactuca serriola*	Prickly Lettuce	Pasture
Onopordum acanthium*	Scotch Thistle	Roadside
Senecio quadridentatus	Cotton Firewood	Pasture
Silybum marianum*	Variegated Thistle	Pasture
Sonchus oleraceus*	Common Sow-thistle	Disturbed

TABLE A3-3 (Continued)

Scientific Name	Common Name	Comments
Family Campanulaceae		
Wahlenbergia gracilis	Native Bluebell	Woodland
W. communis	Native Bluebell	Disturbed
W. stricta	Native Bluebell	Woodland
Family Caryophyllaceae		
Petrorhagia nanteuilii*	Proliferous Pink	Disturbed Pasture
Family Chenopodiaceae		
Chenopodium pumilio	Small Crumbweed	Disturbed
Family Fabaceae		
Medicago arabica*	Spotted Medic	Pasture
Trifolium arvense*	Hare's Foot Clover	Pasture
Trifolium subterraneum*	Subterranean Clover	Pasture
Family Convulvulaceae		
Convulvulus erubescens	Australian Bindweed	Woodland
Family Gentianaceae		
Centaurium erythraea*	Centaury	Pasture, Woodland
Family Geraniacea		
Geranium molle	Cranesbill Geranium	Pasture
Family Guttiferae		
Hypericum perforatum*	St. John's Wort	Roadside
H. gramineum	Small St. John's Wort	Woodland
Family Haloragaceae		
Gonocarpus tetragynus	Raspweed	Roadside
Family Labiatae		
Marrubium vulgare*	Horehound	Disturbed
Scutelaria humilis	Australian Skullcap	Woodland
Family Linaceae		
Linum marginale	Wild Flax	Woodland
Family Malvaceae		
Malva parviflora*	Small Flower Mallow	Pasture
Family Onagraceae		
Epilobium billardierianum spp. cinereum	Willow Herb	Woodland
Family Orobanchaceae		
Orobanche minor	Lesser Broomrape	Pasture
Family Oxalidaceae		
Oxalis corniculata*	Yellow Wood Sorrel	Woodland, Pasture
Family Plantaginaceae		
Plantago varia	Plantain	Woodland

TABLE A3-3 (Continued)

Scientific Name	Common Name	Comments
Family Polygonaceae		
Acetosella vulgaris*	Sorrel	Pasture
Polygonum aviculare*	Wireweed	Disturbed
Rumex brownii	Swamp Dock	Pasture, Creek
Rumex crispus*	Curled Dock	Pasture, Creek
Family Primulaceae		
Anagallis arvensis*	Scarlet Pimpernel	Woodland
Family Rosaceae		
Acaena anserinifolia	Biddy Biddy	Woodland
Acaena ovina	Sheep's Burr	Woodland, Creek
Family Scrophulariaceae		
Verbascum virgatum*	Twiggy Mullein	Disturbed
Solanaceae		
Solanum nigrum*	Blackberry Nightshade	Disturbed
Family Urticaceae		
Urtica urens*	Dwarf Nettle	Yards

* Denotes introduced species.

TABLE A3-4
BIRD SPECIES OBSERVED ON 15TH MARCH, 1987

Scientific Name	Common Name	Comments
Family Acanthizidae		
Smicrornis brevirostris	Weebill	Common
Gerygone olivacea	White-throated Warbler	One Only
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	Common
Family Accipitridae		
Aquila audax	Wedge-tailed Eagle	Overhead
Hieraaetus morphnoides	Little Eagle	Overhead
Family Alcedinidae		
Dacelo gigas	Laughing Kookaburra	Few
Merops ornatus	Rainbow Bee-eater	Overhead
Family Cacatuidae		
Cacatua roseicapilla	Galah	Common
Family Campephagidae		
Coracina novaehollandiae	Black-faced Cuckoo-shrike	Few
Family Climacteridae		
Climacteris leucophaea		
Climacteris leucophaea	White-throated Treecreeper	Common
Family Corvidae		
Corvus coronoides	Australian Raven	Common
Family Cractidae		
Cracticus torquatus	Grey Butcherbird	One Only
Gymnorhina tibicen	Australian Magpie	Common
Family Grallinidae		
Grallina cyanoleuca	Magpie Lark	Common
Family Maluridae		
Malurus cyaneus	Superb Blue Wren	Creeks
Family Meliphagidae		
Philemon corniculatus	Noisy Friarbird	Common
Lichenostomus chrysops	Yellow-faced Honeyeater	Common
L. penicillatus	White-plumed Honeyeater	Common
Melithreptus lunatus	White-naped Honeyeater	Few
Family Muscicapidae		
Turdus merula*	Common Blackbird	Creeks
Pachycephala rufiventris	Rufous Whistler	One Only
Myiagra inquieta	Restless Flycatcher	One Only
Rhipidura fuliginosa	Grey Fantail	Few
Rhipidura leucophrys	Willi Wagtail	Few

TABLE A3-4 (Continued)

Scientific Name	Common Name	Comments
Family Pardalotidae		
Pardalotus punctatus	Spotted pardalote	Common
P. striatus	Striated pardalote	Common
Family Ploceidae		
Emblema temporalis	Red-browed Firetail	Few
Family Platycercidae		
Platycercas elegans	Crimson Rosella	Few
Psephotus haematonotus	Red-rumped Parrot	Few
Family Sturnidae		
Sturnus vulgaris*	Common Starling	Introduced, Common

* Denotes introduced species.

TABLE A3-5
AMPHIBIAN, REPTILE AND MAMMAL SPECIES
SEEN ON 15TH MARCH, 1987

Scientific Name	Common Name	Comments
Family Leptodactylidae		
Crinea signifera	Common Eastern Froglet	Creek, Dam
Limnodynastes tasmaniensis	Spotted Grass Frog	Dam
Family Scincidae		
Tiliqua nigrolutea	Blotched Blue-tongued Lizard	One by Roadside
Family Leporidae		
Oryctolagus cuniculius	Rabbit	Common

* Denotes introduced species.

APPENDIX 4

CORRESPONDENCE FROM

THE NATIONAL PARKS & WILDLIFE SERVICE

A19

New South Wales Government

National Parks and Wildlife Service

BATHURST DISTRICT

N.S.W. Government Offices
140 William Street
Bathurst, N.S.W. 2795

R.W. Corkery & Co. Pty. Ltd.,
P.O. Box 80,
ORANGE. N.S.W. 2800

Our reference: kdG : Ac.

Your reference:

Telephone: 33 4236
STD: 063

Attention: Mr. G.J. Summerhayes

Dear Sir,

I refer to your letter dated 14 September 1987 concerning the need for an archaeological assessment at Browns Creek.

An officer has inspected the site and has recommended that no further archaeological assessment is required.

Yours faithfully,

G.J. PLUMMER,
for Director.

26 October, 1987

APPENDIX 5

ENERGY STATEMENT

APPENDIX 5

ENERGY STATEMENT

The format of this Energy Statement follows the guidelines set out by the Energy Authority of New South Wales.

1. BACKGROUND INFORMATION

The Company proposes to develop an open cut mine to extract a possible 640,000 tonnes of gold-bearing ore. The ore will be crushed and treated in a carbon-in-pulp treatment plant and/or froth flotation treatment plant with a capacity of approximately 160,000 tonnes/year of hard sulphide ore.

The open cut mine will be developed to a depth of approximately 90 m below the existing surface. For every tonne of ore mined there will be approximately 10 tonnes of waste rock which will be placed in an area south of the open cut mine. All ground material from which the gold is extracted will be placed in tailings dams to the east of the proposed treatment plant.

2. OPERATIONAL ENERGY REQUIREMENTS

2.1 Construction Period

During the erection and construction of the treatment plant, the Company will utilise existing available electrical power and fuel-driven vehicles. The power requirement for welding, erection, etc. during this period is estimated at 50 kw.

The following fuel-driven vehicles will be used on site:

- Cranes
- Bulldozers
- Front-end Loaders
- Concrete Mixers
- 4-Wheen Drive Vehicles
- Small Trucks.

The Company expects that the above vehicles will use approximately 85,000 litres of fuel during the construction period.

2.2 Open Cut Mining

It is estimated that the contractor who will undertake the mining will utilise approxximately 1.2 million litres of diesel fuel annually for drilling, loading and transportation of the ore and waste rock.

2.3 Treatment Plant

The treatment plant will be operated primarily by electrical power supplied by the Ophir County Council with an estimated power requirement of 1.75 megawatts. The annual electrical power usage is estimated to be approximately 12,000 megawatt hours.

The only other energy source within the treatment plant will be L.P.G. which is required to operate the kiln in the gold room.

2.4 Total Fuel Usage

The annual liquid fuel usage for the project will be approximately 1.44 million litres.

3. JUSTIFICATION OF LIQUID FUEL USAGE

3.1 Open Cut Mining

There is no alternative economic method to remove the gold-bearing ore and waste rock.

3.2 Treatment Plant

The Company is optimising the use of electrical power supplied from the main grid.

APPENDIX 6

SCHEDULE B

ADDITIONAL CONDITIONS OF
MINING LEASES AT BROWNS CREEK

(Pursuant to the Transfer of Leases to
BHP Gold Mines Limited as Approved by the
Minister for Mineral Resources)

SCHEDULE 'B'
ADDITIONAL CONDITIONS OF MINING LEASES AT BROWNS CREEK

1. (a) Any topsoil which may be disturbed shall be removed separately for replacement as far as may be practicable.

   (b) The registered holder shall plant or sow such grasses, shrubs or trees in the replaced topsoil as may be considered necessary by the Minister to control erosion.

2. (i) The registered holder shall not open up any "new mine" in any part of the subject area, without the prior approval of the Minister first had and obtained and subject to such conditions as he may stipulate.

   (ii) The registered holder shall supply such information as is required to be lodged in respect of any such approval and shall comply with the conditions in any approval by the Minister, including any conditions requiring the lodgement of an additional security.

   For the purpose of this clause, "new mine" shall mean:

   (a) An open cut or underground operation that is not an extension to the currently operating mine;

   (b) Any variation to the mining operation that will significantly increase the production rate of the existing open cut or underground mine;

   (c) Any change to the mining method employed in the subject area.

3. The registered holder shall provide, within a period of 28 days after the 30th June of each year or at such other date as the Secretary may stipulate, a progress report(s) to the satisfaction of the Secretary containing the following:

   (i) Full pariculars, including results, interpretation and conclusions, of all exploration conducted during the twelve months period;

   (ii) Details of expenditure incurred in conducting that exploration;

(iii) A summary of all geological finding acquired through mining or development evaluation activities;

(iv) Particulars of exploration proposed to be conducted in the next twelve month period;

(v) All plans, maps, sections and other data necessary to satisfactorily interpret the report(s);

(vi) The Minister may, by notice in writing served on the registered holder, direct the registered holder to do any one or more of the following things:

(a) To preserve for the period specified in the notice any drilling core or sample recovered as a result of prospecting operations;

(b) To label or otherwise identify those cores or samples in the manner specified in the notice and to keep such other records in relation to those cores or samples as may be so specified;

(c) To make those cores or samples available for inspection by officers of the Department of Mineral Resources at the times and in the manner specified in the notice;

(d) To deliver up to the Secretary any such core or sample specified in the notice.

4. (a) The registered holder shall within 28 days of each anniversary of the transfer of this lease or within such other times as the Minister may allow or direct in writing, submit for the Minister's approval a mining, rehabilitation and environmental management plan (hereinafter referred to as "the plan") which shall describe the methods to be used to protect the environment by controlling disposal of mine wastes, by minimising by best practicable means air, noise and water pollution, by minimising by best practicable means erosion and by rehabilitating the land surface which is disturbed by mining operations.

Plans and appropriate written documents where necessary, prepared to the satisfaction of the Secretary, shall show:

(i) The approximate depth and nature of the topsoil in the subject area.

(ii) The type of vegetation on the subject area.

(iii) The contours of the premined area indicating drainage lines and any water empoundments.

(iv) Plans and sections illustrating mineralisation in the subject area.

(v) An overall site plan showing the surface location of the mine processing plant, mine workings and ancilliary facilities.

(vi) The methods and order in which the land is to be mined and rehabilitated.

(vii) Plans and sections showing the extent to which the mineral resource is utilised and the nature of the remaining mineralisation that is not included in the plan. Mine development and slope layout or pit plans shall be included.

(viii) The methods proposed to be adopted, to prevent effluent or contaminated waters discharging from works or operations in the subject area onto surrounding areas or into creeks, streams or watercourses; toxic waste must be identified and provision for its control both before and after mining be addresed in the plan.

(ix) The methods to be employed to dispose of mine wastes, refuse, tailings, effluent or like substances.

(x) Steps to be taken to minimise adverse impacts caused by dust and the vibration and noise effects of blasting.

(xi) The approximate contours to which the surface shall be rehabilitated indicating drainage lines and any water empoundments.

(xii) A description of the method of minimising erosion.

(xiii) The manner in which it is proposed to remove, store and replace the topsoil, and

(xiv) The grasses, plants, shrubs and/or trees and the planting techniques proposed for the subject area following the mining operations to obtain a self sustaining vegetative cover or such other methods of rehabilitation that shall make the landform stable.

(b) The Minister may in respect to a plan or an amendment to a plan submitted to him under this condition direct the registered holder to amend or vary the plan (or amendment thereto) as may be specified in a notice served on the registered holder and to resubmit the plan or amendment to him for approval within a period specified in the notice.

(c) The registered holder shall on or before each anniversary of the grant of this lease or as directed by the Regional Mining Engineer review the plan to ensure that the plan adequately deals with the matters referred to in paragraph (a). Where the registered holder is of the opinion that the plan should be amended he shall submit the amendment or new plan to the Minister for approval.

(d) The Minister when approving any plan or amendment thereto submitted to him pursuant to this condition may approve the plan or amendment subject to conditions.

(e) Where the Minister is of the view that the plan should be amended he may by notice served on the registered holder direct that the plan be varied in the manner set forth in the notice.

(f) The Minister or his nominee shall consult with the registered holder before:

(i) Any condition is included under paragraph (d) which would have the effect of amending the plan or any amendment thereto submitted pursuant to this condition; or

(ii) Makes a direction under paragraph (e).

(g) The registered holder shall comply with and conduct all operations within the mining area in accordance with the provisions of any plan or amendment thereto approved by the Minister or any variation made pursuant to paragraph (e) or any conditions imposed pursuant to paragraph (d).

(h) On each anniversary of the transfer of the lease, the registered holder shall submit a report to the Minister which describes the environmental management measures used to protect the environment; a summary of the results of the environmental monitoring together with a description of the environmental management measures to be carried out in the succeeding twelve months. The report shall include a plan showing the progress made towards rehabilitation in the preceding twelve months and the rehabilitation proposed for the succeeding twelve months.

(i) Notwithstanding the provisions of paragraph (g) the registered holder may bring to the attention of the Minister at any time, circumstances which have arisen which make partial compliance with the plan untenable.

(j) The registered holder shall when required by the Regional Mining Engineer to do so furnish such information relating to the responsible utilisation of the mineral resources of the mining area as the Regional Mining Engineer may specify.

(k) Where the Minister is satisfied on a report of the Regional Mining Engineer that the method or system or working or processing employed in the development of or in any subsequent operations in any mine is such as to result in failure to recover minerals that would otherwise be economically recoverable at the time he may give notice in writing to the registered holder:

(i) Stating the particulars in which it is considered the method or system of working or processing tends to such failure to recover minerals; and

(ii) Requiring that such methods or system of working or processing be abandoned or so modified as to remedy such failure to recover minerals; provided that:

(a) No such report shall be submitted to the Minister until it has been thoroughly discussed with and has incorporated the views of the registered holder; and

(b) The notice shall not specify the modification of the mining or processing method to be adopted by the registered holder.

(l) The registered holder may object to any notice issued under this condition and on receipt of such an objection the Minister shall refer the objection to a Warden for inquiry and report under Section 178 of the Mining Act, 1973.

(m) On receipt of the Warden's report the Minister shall determine the objection in accordance with findings of such report and the registered holder shall comply with the determination so made.

5. Upon cancellation (in part or in total) or upon expiry, full details of the following shall be lodged with the Secretary:

(i) Plans and sections showing the extent of working on the area cancelled or subject to expiry.

(ii) Records of tonnage and grades mined and treated.

(iii) Records of concentrate and/or finished products produced.

(iv) Geological information including details of any remaining mineralisation.

6. The registered holder shall ensure that the ground vibration peak particle velocity generated by any blasting within the subject area does not exceed 10 mm per second and does not exceed 5 mm per second in more than 5% of the blasts at any dwelling or occupied premises outside the subject area, unless approval has been granted by the Regional Mining Engineer to exceed the said particle velocity or as otherwise determined under the provisions of the State Pollution Control Commission Act, 1970.

7. The registered holder shall ensure that the blast overpressure noise level generated by any blasting within the subject area does not exceed 120 dB (linear) and does not exceed 115 dB (linear) in more than 5 per cent of blasts, outside the said area, at any dwelling or occupied premises, as the case may be unless approval has been granted to exceed such levels by the Regional Mining Engineer or as otherwise determined under the provisions of the State Pollution Control Commission Act, 1970.

8. Only the minimum number of access tracks will be constructed to permit satisfactory operations. Temporary access tracks shall be ripped, topsoiled and revegetated as soon as possible after they cease to be required for mining operations. The design and construction of access tracks shall be in accordance with specifications fixed by the Soil Conservation Service of New South Wales.

9. All precautions will be taken to divert runoff from the surrounding catchment area away from excavations, spoil dumps, access tracks and tailings ponds. All such diversions shall lead runoff to safe disposal areas and be constructed in accordance with designs and specifications provided by the Soil Conservation Service of New South Wales.

10. (a) The registered holder shall prior to the cessation of open-cut operations, submit for the Minister's approval, a plan, describing the ultimate post mining use of the remaining void and the methods to be adopted to render it safe and stabilise the sides of the excavation.

    (b) Upon the Minister's approval and upon cessation of such operations the registered holder shall carry out the works so approved.

11. Unless otherwise directed by the Minister the registered holder shall batter the sides of all waste disposal dumps and stockpiles to an angle no greater than 1:3.

12. (a) Where a Regional Mining Engineer is of the opinion that any condition of this authority relating to the working of the subject area or any provisions of the Mining Act, 1973 relating to the working of the subject area is not being complied with by the registered holder, he may, in writing, direct the registered holder:

(i) To cease working the subject area in contravention of that condition or Act; and

(ii) To carry out within a specified time works at the expense of the registered holder necessary to rectify or remedy the situation.

(b) Where the Engineer issues any direction to the registered holder pursuant to paragraph (a) of this condition the registered holder shall compy with the direction.

APPENDIX 7

ASSESSMENT OF NOISE IMPACT AND IMPACTS OF BLASTING

Prepared in conjunction with
Richard Heggie Associates

A.7.1 General Objectives

In implementing its environmental noise control policy, the State Pollution Control Commission has two broad objectives:

(i) That noise from any single source does not intrude greatly above the prevailing background noise level;

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

In order to limit the potential offensiveness of noise from a specific source, any increase in the background noise level should generally not exceed 5 dB(A). For this purpose, the increase can be determined by the difference between the L_{10} value at the receptor with the potentially intrusive noise occurring and the L_{90} value determined in its absence.

A.7.2 Design Goals for Rural Areas

In relatively undeveloped rural areas, the existing background levels can be quite low. When development is permitted to proceed in such areas (e.g. in view of its social worth or as a result of government decisions on resource use and infrastructure development), the land use designation may change, and there will often be a change in the noise climate.

To assist in balancing the individual and community effects and benefits arising from such situations, the State Pollution Control Commission has drafted a schedule of recommended background noise levels for various land use categories. An extract from the schedule relating to the two most stringent classifications is shown on Table A.7.1.

TABLE A.7.1
RECOMMENDED OUTDOOR BACKGROUND LEVELS AT RESIDENCES

Zoning Description	Time Period*	Recommended Limit L_{90} Acceptable	Maximum
Residences in Rural Areas	Day	45 dB(A)	50 dB(A)
	Night	35 dB(A)	40 dB(A)
Residences Near Industrial Areas	Day	50 dB(A)	55 dB(A)
	Night	40 dB(A)	45 dB(A)

*For Monday to Saturday, "day" is defined as 7.00 am to 10.00 pm.

Due to the existing operations it was not possible to obtain the average minimum (L_{90}) background noise levels normally required for noise impact assessment purposes. The minimum L_{90} noise levels of 33 dB(A) and 30 dB(A) discussed in Section 3.7 were measured under still weather conditions during existing mining operations at residences "Bonnie Doon" and "Desmond Slopes", with the corresponding predicted level at "Springvale" of 30 dB(A).

However, the "acceptable limits" recommended by the State Pollution Control Commission for residences in rural areas for daytime operation is 45 dB(A) (Maximum Limit of 50 dB(A), and 35 dB(A) for night time operation (Maximum Limit of 40 dB(A)).

It is therefore proposed that the background noise level to be used for assessment purposes at residences "Bonnie Doon", "Desmond Slopes" and "Springvale" are 38 dB(A), 35 dB(A) and 35 dB(A) respectively for daytime operations and 35 dB(A) at all these residences for night time operations.

The State Pollution Control Commission's overall objective is for background noise levels not to exceed the specified acceptable limit. Where the recommended acceptable level is not achievable (for technical or economic reasons), then the lowest level achievable may be permitted, provided the resultant noise levels at the receptors do not exceed the maximum noise level limit.

A.7.3 Predicted Noise Levels

Predicted noise level contributions from the major noise sources were calculated at the residences "Bonnie Doon" and "Springvale". These are the closest residences to the proposed operation not associated with the mine. The predicted noise levels are presented in Table A.7.2.

The predicted noise levels include attenuation effects due to the man made and topographical barriers at residences "Bonnie Doon" and "Springvale" and the topographical barrier screening "Desmond Slopes". Also included in the calculations is the attenuation due to distance (hemispherical divergence) and excess attenuation (molecular absorption).

These effects of attenuation (topographic barriers, distance and molecular absorption) at each of the three residences have been determined for the major noise sources and are presented in Table A.7.3

TABLE A.7.2
PREDICTED NOISE LEVELS FROM EQUIPMENT

Source	Noise Level "Bonnie Doon" dB(A)	"Desmond Slopes" dB(A)	"Springvale" dB(A)
Primary Crusher	29	26	14
Primary Screen	20	14	7
Secondary Crusher	19	15	5
Tertiary Crusher	14	11	0
Vibrating Cone (Fine Ore Bin)	14	11	4
Ball Mill	19	16	10
Clay Screen	29	24	14
Rockbreaker	30	24	15
Drill	14	10	4
Haul Trucks	9	6	0
Reversing Alarm	9	6	0

In terms of the location of mobile plant for noise prediction purposes, the "worst" case has been used. This approach has also been applied to the rockbreaker, drill and haul trucks. The rockbreaker will spend the majority of its operating time within the pit. Some of the time (daytime only) will be spent operating on the surface near the existing clay screen plant. The latter location was used for noise prediction calculations.

Similarly, the positions of the blasthole drill and haul trucks used for noise predictions were at the centre of the existing milling facilities and at the top of the haul road out of the pit respectively, both positions are on the surface.

A.7.4 Assessment of Noise Impact

During daytime operations the received levels of noise at the three closest residences (not associated with the mine) are largely controlled by the rockbreaker (operating on the surface), the clay screen and the primary crusher.

The overall noise level contribution from all the major sources are 35 dB(A) at residence "Bonnie Doon", 30 dB(A) at "Desmond Slopes" and 20 dB(A) at "Springvale".

The crushing and screening plant, the clay screen and the rockbreaker will not operate between 7.00 pm and 7.00 am. Also, the blasthole drill will be scheduled to operate on lower pit benches during night time operations.

The treatment plant will operate 24 hours per day, 7 days per

TABLE A.7.3
NOISE ATTENUATIONS

	ATTENUATIONS dB(A)								
	"Bonnie Doon"			"Desmond Slopes"			"Springvale"		
SOURCE	Barrier	Dist	Excess	Barrier	Dist	Excess	Barrier	Dist	Excess
Primary Crusher	16	69	6	13	73	9	24	72	11
Primary Screen	16	69	6	14	73	10	22	72	10
Secondary Crusher	18	69	6	13	73	10	23	72	12
Tertiary Crusher	15	69	5	12	73	7	22	72	9
Vibrating Cone	18	69	4	14	73	6	20	72	7
Ball Mill	20	69	6	15	73	10	22	72	10
Clay Screen	18	69	6	16	73	11	27	72	10
Rockbreaker	17	69	9	15	73	14	24	72	16
Drill	22	69	11	21	73	15	23	72	18
Haul Trucks	24	69	11	21	73	15	24	72	18
Reversing Alarm	24	69	11	21	73	15	24	72	18

week. However, the proposed plant will be rubber lined, where practicable, giving a reduction in noise level.

The predicted night time noise level contributions from the project are prone to enhancement by temperature inversions. Normally, temperature inversions occur at night and disperse an hour or two after sunrise. Strong winds also occasionally occur in the area, more ofter during the daytime rather than the night.

The specific effects of temperature inversions and strong winds at a particular site are extremely difficult to predict. In general however, noise focussing and noise level enhancement effects can be significant.

Under temperature inversion conditions (temperature increasing with height), optimum propogation conditions generally exist, and zero excess attenuation due to molecular absorption should be assumed. In the presence of wind gradients, similar effects occur. Broad noise shadow zones are created upwind and there is little excess attenuation downwind. Under some conditions, some magnification of sound may occur.

When these adverse conditions occur, the predicted noise levels could increase by up to 7 dB(A), 11 dB(A) and 13 dB(A) at the residences "Bonnie Doon", "Desmond Slopes" and "Springvale" (during full operation).

A summary of daytime and night time predicted noise level contributions with the suggested noise level design goal is presented in Table A.7.4.

TABLE A.7.4
PREDICTED NOISE LEVEL CONTRIBUTIONS

Residence	Design Goal		Noise Level Contribution	
	Day	Night	Day	Night
"Bonnie Doon"	38	35	35	26
"Desmond Slopes"	35	35	30	15
"Springvale"	35	35	20	10

All measurements are given in dB(A).

During all normal operating conditions the predicted noise levels are less than the suggested design goals. Under adverse weather conditions, noise from full daytime operations could exceed the design goals. However, during such conditions scheduling of major noise sources can be introduced to reduce noise emission levels.

A.7.5 IMPACTS FROM BLASTING

In order to assess the effect of airblast overpressure and ground vibration from blasting, a typical production blast was monitored at the residences "Bonnie Doon", "Desmond Slopes" and "Springvale".

The blast consisted of 38 blastholes, 100 mm in diameter, in a square pattern of 3 m spacing and 3 m burden, each 6.5 m deep on a 6.5 m column charge of AMEX (packaged ANFO). The initiation system was an electric detonator onto "Trunkline" detonating cord with Nonel 9 ms delay connectors on the surface providing the inter-row delays and Nonel 200 ms delays down the blastholes to the primer.

The maximum instantaneous charge (MIC) was dictated by one row of 9 holes fired on one delay, with 25 kg AMEX per hole, the total ANFO corrected MIC was 225 kg.

The blast was fired at 5.30 pm on 23rd September, 1987. The weather was fine and warm with a clear sky and no wind. Dry temperature 16°C, wet temperature 12°C and relative humidity 62 per cent.

The monitoring results are given in Table A.7.5 with the predicted results (based on the ICI formula).

TABLE A.7.5

TABLE

A7.4 PREDICTED AND MEASURED AIRBLAST OVER PRESSURE AND GROUND VIBRATION - 23RD SEPTEMBER, 1987

Residence	Airblast Overpresssure		Ground Vibration	
	Predicted	Measured	Predicted	Measured
"Bonnie Doon"	109 dB LIN	112dB LIN	1.0 mm/s	0.2 mm/s
"Desmond Slopes"	106 dB LIN	113 dB LIN	0.6 mm/s	0.1 mm/s
"Springvale"	105 dB LIN	107 dB LIN	0.5 mm/s	0.3 mm/s

As mentioned in Section 4.2.4, the maximum expected MIC for the proposed operation is 300 kg. The predicted levels of airblast overpressure resulting from this MIC are only 1 dB higher than those predictions for a MIC of 225 kg in the above table. The corresponding predicted levels of ground vibration are 1.3 mm/s, 0.7 mm/s at "Bonnie Doon", "Desmond Slopes" and "Springvale" respectively.

It is therefore predicted that the levels of airblast overpressure and ground vibration resulting from blasting within the proposed operation will clearly comply with the mining lease conditions of 115 dB (Linear) (allowable exceedance to a maximum of 120 dB (Linear) on 5 per cent of blasts) respectively, at all nearby residences not associated with the mine. It is noted that the above limits relate to comfort criteria and not damage criteria. Hence, if comfort criterias are satisfied, no damage could be expected.

Guidelines from the State Pollution Control Commission on comfort criteria for residential premises are marginally lower than the damage criteria adopted by the Department of Mineral Resources and Department of Industrial Relations.

The State Pollution Control Commission's blasting criteria are presented in Table A.7.6.

TABLE A.7.6
STATE POLLUTION CONTROL COMMISSION CRITERIA

Time of Blasting	Blast Overpressure level (dB(linear))	Ground Vibration, peak particle velocity (mm/sec)
Monday - Saturday, 9 am - 3 pm	115	5
Monday - Saturday, 6 am - 9 am and 3 pm - 8 pm Sunday, Public Holiday, 6 am - 8 pm	105	2
Any day, 8 pm - 6 am	95	1

The State Pollution Control Commission recommends that blasting operations should in most cases be confined to the periods Monday to Saturdays, 9.00 am to 3.00 pm. Blasting outside of those times is approved only where blasting during the preferred times is clearly impracticable, and should then be limited in number.

The Company will be negotiating blasting criteria and blasting times applicable to the Browns Creek Mine with the Commission as part of procedures for application of approvals under the State Pollution Control Act.

APPENDIX 8

GLOSSARY OF TECHNICAL TERMS

GLOSSARY OF TECHNICAL TERMS

Technical nomenclature used throughout the text of this document is in accordance with BHP Gold Mines Limited policy and practice. Reference should be made to this glossary when reading the document.

average recurrence interval
Statistical period in years for a design storm event.

bornite
A copper iron sulphide mineral.

carbon-in-pulp (CIP) treatment
A method of gold extraction from cyanide solutions using carbon as a precipitating agent.

chalcopyrite
A copper iron sulphide mineral.

cut-off grade
The lowest grade of mineralised material considered in the calculation of grade in a given deposit.

dB(A)
Unit of measurement of human appreciation of noise level.

Devonian
A period of geological time from 408 to 360 million years ago.

dip
The angle that rock strata make with a horizontal surface measured at right angles to the strike.

drill core
The cylindrical sample of rock recovered by means of diamond drilling.

dore bullion
Unrefined bullion.

fault
A break in the subsurface strata; strata on opposite sides of the fault have been displaced vertically and/or laterally relative to their original position.

flotation
A common commercial technique for the concentration of economic minerals from crushed and ground ore.

formation
A (named) succession of sedimentary beds having some common characteristic.

geological reserves
The measured total quantity of in-situ minerallisation in a deposit, prior to consideration of mining parameters.

geotechnical
Descriptive of studies of the engineering properties (strength, stability, etc.) of rocks and soils.

g/t
Grammes per tonne, same as parts per million (ppm).

limestone
Sedimentary rock consisting of carbonates.

M.I.C.
Maximum instantaneous charge.

mineralisation
The process by which minerals are introduced and concentrated within a host rock, and the product of this process.

M.L.
Mining Lease.

Ordovician
A period of geological time from 500 to 435 million years ago.

Overburden (or waste rock)
Rock and weathered material without mineralisation or below cut off grade.

oxide (ore) zone
The portion of a mineral deposit which has been affected by surface waters causing, for instance, the alteration of sulphides to oxides and carbonates.

P.L.
Prospecting Licence

process residues (or tailings)
Material rejected from an ore-processing mill once most of the valuable constituent has been removed.

reserve
A resource on which investigational work has established a basis for decisions as to the economic feasibility of extraction.

skarn
A thermally metamorphosed impure limestone with predominant minerals wollastonite, calcite, garnet, contains sulphide minerals and gold.

shaft
A vertical or steeply-inclined excavation used for access to a mine.

sulphide
A mineral compound characterised by the linkage of sulphur with metal.

waste rock
Rock without mineralisation or below cut-off grade.

weathering
The group of processes (e.g. action of air, rain, water, etc.) whereby rocks exposed to the weather change in character, decay, and eventually crumble to soil.

wollastonite
Calcium silicate mineral formed by thermal metamorphism of impure limestone.

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Browns Creek mine, Blayney

Borrower's name	Date	Ext

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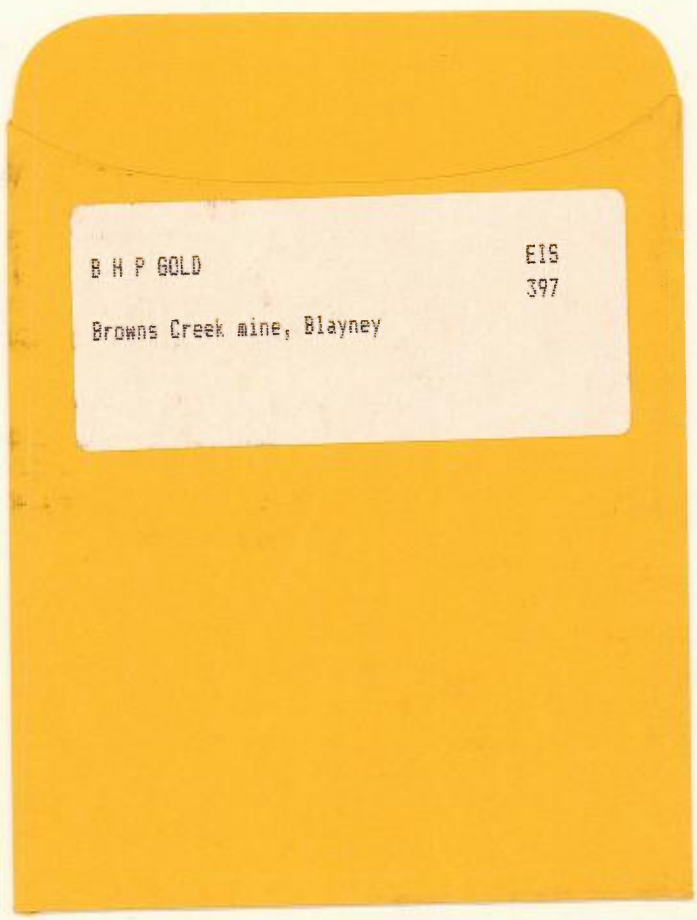
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