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GRIFFINCOAL
THE GRIFFIN COAL MINING COMPANY PTY. LIMITED

Consultative Environmental Review

Ewington Open-Cut Mine

Volume 1

Halpern Glick

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August 1991

Halpern Glick Maunsell

CONSULTATIVE ENVIRONMENTAL REVIEW

PROPOSED EWINGTON OPEN-CUT MINE

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal.

The Consultative Environmental Review (CER) for the proposed Ewington open-cut mine has been prepared by The Griffin Coal Mining Company Pty Limited (Griffin) in accordance with the Government of Western Australia (Government) procedures. The report will be available for comment for 4 weeks, beginning on 2nd September 1991 and finishing on 30th September 1991.

Comments from Government agencies and from the public will assist the EPA to prepare an Assessment Report in which it will make a recommendation to Government.

Following receipt of comments from Government agencies and the public, the EPA will discuss these comments with Griffin and may ask for further information. The EPA will then prepare an assessment report with recommendations to Government, taking into account issues raised in the public submissions.

WHY WRITE A SUBMISSION?

A submission is a way to provide information, express your opinion and put forward your suggested course of action including any alternative approach. It is helpful if you indicate any suggestions you may have to improve the proposal.

All submissions received will be acknowledged.

DEVELOPING A SUBMISSION

You may agree or disagree, or comment on, the general issues discussed in the CER or with specific proposals. It helps if you give reasons for your conclusions, supported by relevant data.

You may make an important contribution by suggesting ways to make the proposal environmentally more acceptable.

When making comments on specific proposals in the CER:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable; and
- suggest recommendations, safeguards or alternatives.

POINTS TO KEEP IN MIND

By keeping the following points in mind, you will make it easier for your submission to be analysed.

Attempt to list points so that the issues raised are clear. A summary of your submission is helpful. Refer each point to the appropriate section, chapter or recommendation in the CER. If you discuss sections of the CER keep them distinct and separate, so there is no confusion as to which section you are considering.

Attach any factual information you wish to provide and give details of the source. Make sure your information is correct.

Please indicate whether your submission can be quoted, in part or in full, by the EPA and its Assessment Report.

REMEMBER TO INCLUDE YOUR NAME, ADDRESS AND THE DATE

THE CLOSING DATE FOR SUBMISSIONS IS: 30TH SEPTEMBER 1991

SUBMISSION SHOULD BE ADDRESSED TO:

The Chairman
Environmental Protection Authority
1 Mount Street
PERTH WA 6000

Attention: Mr Jim Treloar

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SUMMARY

1. INTRODUCTION

The Proponent, The Griffin Coal Mining Company Pty Limited (Griffin) proposes to develop an open-cut coal mine on an area of confirmed coal reserves within the Collie Coal Basin. The site of the mine is known as Ewington and it will be located east of the Collie townsite.

A key aspect of Griffin's plan to proceed with development of the Ewington mine was the preparation of an Environmental Impact Assessment (EIA) for evaluation by the Environmental Protection Authority (EPA). Upon referral of the proposal to the EPA it was decided that a formal assessment would be undertaken at the level of a Consultative Environmental Review (CER).

Griffin commenced preparation of this CER at a time when decisions to proceed with a coal-fired power station in Collie and the source of coal for such a station were still being considered.

However, in preparing this CER, Griffin's intention has been to ensure and maintain its ability to supply coal to the proposed Collie coal-fired power station. Such coal supplies may be required either in the short term or in the longer term. Alternatively, Griffin wishes to maintain the option of developing the Ewington mine to supply potential industrial customers.

This CER has been prepared on the basis that the Ewington mine will be developed to meet coal supply contracts with the new Collie power station. However, the details presented are also generally consistent with mine development to supply coal to potential industrial customers should this become the principal reason for opening the mine.

The proposed Ewington minesite is located approximately 1.5km east of the Collie township. It will cover an area of 10km^2, 60% of which is currently forested. It is proposed to develop the mine as an open-cut, strip mining operation with continuous dewatering in advance of mining. Coal production targets will range between 1.6Mtpa and 2.3Mtpa.

2. NEED FOR THE PROPOSAL

2.1 Justification

Modern society depends upon the availability of reliable supplies of electrical energy. Not only must power supplies be reliable, they must also be competitively priced to attract wealth generating industries.

Increasing living standards, strong population growth and the development of a range of major mineral processing industries have all contributed to a rapid increase in demand for electrical energy. This demand growth has dictated a need to plan for the installation of further baseload power

generating facilities within the next 5 to 10 years. As a consequence, the Western Australian Government (Government) has decided to proceed with the construction of a coal-fired, baseload power station at Collie.

The proposed power station site is located on the northern edge of the Collie Basin. The Ewington coal reserves controlled by Griffin and that form the subject of this CER are located immediately south-west of and adjacent to the power station site.

The Ewington deposits would provide an attractive source of coal for the new Collie Power Station because:

(a) The mine is located in close proximity to the power station site thereby minimising coal transportation costs from the mine.

(b) There are sufficient reserves of coal to meet the anticipated demands of the power station over its planned life.

(c) The quality of the coal in the Ewington deposits is ideally suited as a fuel for a baseload power station.

(d) Use of the Ewington deposits will necessitate the development of a new mine thereby allowing for the introduction of state-of-the-art mining techniques and equipment to ensure minimum coal costs combined with responsible environmental management.

Although early development of the new Ewington coal mine would be related to coal supply contracts for the new coal-fired, baseload power station in Collie it should be recognised that the Ewington deposits are a viable source of coal for generating purposes and as a process raw material.

It is therefore apparent that development of the Ewington deposits by Griffin will occur in response to demand, whether such demand is created by a baseload power station, an industry specific power station or by an industry requiring coal as a raw material.

2.2 Benefits of the Proposed Development

There is clear evidence to show that the key to the future economic wellbeing of Australia lies in the development of further downstream processing of its rich mineral and other natural resources and increases in the range and efficiency of its manufacturing industries. Reliance solely on the mining of natural resources and on the production of basic agricultural commodities can only sustain a certain level of community wealth and standard of living.

Some of the benefits that are predicted to accrue to the State and the nation from the joint development of a power station and a new coal mine include:

- significantly increased direct and indirect employment opportunities (with subsequent financial flow-on effects) during the construction and operation phases of the development,

- increased revenue to the State and the nation from government taxes, levies and royalties from the mining of coal and taxation of employee income and Griffin's profits,

- an increased contribution towards the nation's annual export income through the incentives offered for additional resource processing and commodity production at internationally competitive prices due to the availability of cheaper power.

The construction and operation of the Ewington mine would provide a significant and long-lasting stimulus to the local communities, both socially and economically.

These would include:

- employment opportunities for about 300 people during the operation phase of the new Ewington mine (Griffin's current total workforce at Muja and Chicken Creek is approximately 570 people),

- increased demand for goods and services from local industries and businesses,

- increased incentive for more specialised services to locate in the South-West Region with related spin-off benefits to the community,

- increased population in local centres near the Ewington mine, ie Collie and Allanson, thereby assisting State policies of decentralisation and increasing the revenue base for local authorities,

- improved training of the local workforce through on-the-job training and employer operated or sponsored training programmes.

Benefits to Griffin from development of the Ewington coal mine include:

- the opportunity to develop a state-of-the-art open-cut mining operation with equipment and techniques suited to the nature of the deposit,

- the ability to capitalise on the economies of scale in mining operations,

- the opportunity and security of being able to maintain a sustainable operation to extend the life of current mining activities for a further 20 years beyond currently committed mining activities,

- the ability to maximise efficiencies and cost effectiveness in administration of current and planned mining activities in Collie.

3. LEGISLATIVE AND POLICY REQUIREMENTS

In preparing the CER account has been taken of the Government's policies in regard to conservation, mining and energy with respect to the Collie Basin and the greenhouse effect. Policies specifically addressed include:

- **Energy Policy** - there are considerable incentives for the Government to develop the Collie Basin to its full extent to fulfil its policy of maximising the utilisation of the State's energy resources.

- **Greenhouse Policy** - a key element in this policy is the identification and implementation of initiatives designed to minimise greenhouse gas emissions. Griffin has acted in line with these policies by undertaking its own Greenhouse Audit (Griffin, 1989). Several practical initiatives relating to minesite operations were developed as a result of this exercise.

- **Coal Mines Rehabilitation Committee** - Griffin actively works with and complies with the recommendations of this Committee and pursuant to Clause 11 of the Collie Coal (Griffin) Agreement Act submits environmental reports to the Minister for State Development for consideration by the Committee.

- **Collie Development Structure Plan** - Griffin, as a member of the Collie Basin Management and Planning Group, has been an active participant of this planning process and the Ewington mine development is consistent with the Draft Plan.

- **Collie Coal Basin Water Resources Management Strategy** - the Government has recognised the value of regional water resources and have developed a policy to improve the quality of any discharges into the Wellington Dam catchment. The details of this proposal are consistent with those requirements.

4. EVALUATION OF ALTERNATIVES

Alternatives to the development of the Ewington mine include:

- The pursuit of an alternative baseload electricity generating strategy by the Government using alternative fuel sources such oil, renewable energy sources, nuclear power and natural gas. The major advantages in using coal as an energy source are:

  - availability of large quantities of proven reserves well in excess of those needed by a single baseload power station over a 30 year operating life,

  - price stability because of the unique situation in the Collie Basin where export opportunities do not currently exist,

  - security of supply due to coal deposits being located in close proximity to the proposed power station site and the ability to stockpile reserves to avoid short term fuel supply shortfalls,

- large scale cost effective mining techniques ensure minimum coal costs.

The use of alternative sources of coal for the proposed Collie Power Station thereby obviating the immediate need to develop the Ewington deposits.

The use of Ewington as a source of coal for the proposed Collie Power Station has a number of advantages related to coal production and delivery costs that do not exist at other potential sources of coal supply. This is of prime importance to the achievement of the most competitive coal prices and, as a consequence, to the most effective means of supplying electrical power to SECWA.

The scope for expansion of existing Griffin mining operations instead of developing the Ewington deposits.

Assessment of the Muja and Chicken Creek operations as supply alternatives for the Power Station were based upon a comprehensive study of different transport methods, routes and associated costs. The Muja and Chicken Creek operations were considered together with the Ewington and Premier alternatives in order to investigate the overall effect on costs which would result from economies of scale that could be achieved in the expanded mining operations. However, it was determined that the coal supply schedule to the Power Station could be most economically sourced primarily from either the Ewington or Premier deposits.

The scope for Griffin to develop coal deposits other than Ewington to supply the proposed Collie Power Station.

Griffin has evaluated a number of alternative strategies to supply coal to the proposed Collie Power Station. The possible sources considered were those reserves which Griffin has identified as being capable of producing coal at lowest costs, ie from the Muja, Chicken Creek and Griffin's Premier and Ewington deposits, which are illustrated in Figure 1.2. Whilst production of coal from a property close to the point of delivery appeared to be the most logical strategy for supply, other alternatives were also evaluated. It was determined, however, that the anticipated coal requirements of the new power station could be most economically sourced primarily from either the Ewington or Premier deposits.

Factors leading to the choice of Ewington included:

- both deposits offered low cost coal of a quality suitable as a power station fuel;

- more information was available on the Ewington deposits, including more boreholes and more coal quality information. In addition, portions of the deposit had been mined previously;

- Premier consisted of a greater number of generally thinner seams, a situation having the potential to make mining more complex, more expensive, and to give rise to greater losses of coal and dilution of coal by waste materials.

. The use of mining techniques and technologies other than the proposed open-cut methods outlined in this CER.

A substantial part of the Ewington deposits are suitable to be economically mined by open-cut methods.

Both underground and surface mining methods have been examined for use in developing the comparatively shallow coal reserves for the proposed Ewington mine. Open-cut mining is preferred for economic and safety reasons and also because it provides the most effective means of recovering as much coal as possible.

5. SITE DESCRIPTION

The proposed Ewington mine will be located in the Collie Coal Basin, approximately 1.5km east of the Collie township. Characteristics of the site include the presence of:

. old, abandoned coal mines,

. electrical power transmission line corridors,

. water supply pipeline,

. a nearby airstrip capable of being used for 24 hour light aircraft operations,

. a nearby railway,

. the nearby Coalfields Highway,

. three minor roads.

Land use in the area consists of:

. coal mining,
. electricity generation,
. water supply,
. urban development,
. recreation and conservation,
. forestry, and
. agriculture.

Private land on which the Ewington minesite will be located is owned freehold by Griffin but over 60% of the land is Crown Land vested in CALM as State Forest. The land is zoned rural or for forestry purposes. The Ewington minesite is defined by a number of Coal Mining Leases (CML) held by Griffin.

6. EXISTING ENVIRONMENT

The proposed Ewington minesite is located within the Darling Plateau, a physiographic unit on the Yilgarn Block of Archean age. Specifically, it lies within the Collie Basin, one of a number of small sedimentary basins within the Darling Plateau. Climatically, the area experiences warm, dry summers and cool, wet winters.

The Ewington minesite area can be characterised by two landform units, namely:

- The Collie landform unit consisting of gently undulating lateritic uplands over the western and eastern margins of the minesite, and

- The Cardiff landform unit expressed by broad, shallow swampy depressions covering the central and southern areas of the minesite.

The sediments of the Collie Basin are comprised of two formations, the basal Stockton Formation and the overlying Collie Coal Measures both unconformably overlain by the Nakina Formation. The coal seams in the Ewington minesite all occur in the Ewington Member of the Collie Coal Measures. The coal seams of economic importance occur towards the base of the Member and are the Moira, Stockton and Wallsend seams.

The proposed Ewington minesite is located within the drainage basin of the Collie River East and South Branches. The whole area is part of the Wellington Dam catchment. River flows are highly seasonal with little or no flows in autumn. Extensive areas of the southern part of the minesite are subjected to annual inundation. Outflows from the minesite are generally via these seasonal swamplands to the south into the abandoned Stockton open-cut or north through similar swamplands into the Collie River East Branch.

Water flowing in the Collie River East and South Branches is generally saline (flow weighted TDS of approximately 900-1,000mg/l) but of neutral pH (pH = 7).

The proposed Ewington minesite lies adjacent to the edge of the Collie Basin which forms the boundary between areas of different geology and stratigraphy and therefore hydrogeological characteristics. Within the Collie Basin the highly permeable sandstones of the Collie Coal Measures form a multi-layered aquifer system with aquifers separated by shales, siltstones and coal seams of low permeability. Groundwater quality is generally good (TDS = 388mg/l, pH = 5.4) although this quality can be expected to deteriorate as mining proceeds.

Air quality at the proposed Ewington minesite is good and not expected to be adversely affected by any current activities within the Collie Basin (eg coal mines, power station). Similarly the Ewington area is not subject to any significant and continuing sources of noise or vibration. Minor noise sources include the pistol range, speedway and airstrip (occasional sources) and the sawmill.

The minesite is located on lateritic uplands which are approximately 20m higher than the Collie townsite. Vegetation and flora surveys have shown the presence of three vegetation complexes, these being the Collie, Cardiff and Muja complexes. It consists primarily of open forest of *Eucalyptus marginata - Eucalyptus calophylla* on the drier areas with *Melaleuca preissiana* on the seasonally wet swamps.

No gazetted rare species were recorded on the Ewington minesite and only two potentially restricted species were identified, these being *Restio ustulatus* and *Hibbertia silvestris*. Both species are known to occur at several locations in the South-West and require further survey to determine their status.

The vegetation survey indicated an overlap in distribution of some plant species with adjacent regions and also reflected the significance of the local soils and site conditions on distribution of plant species. Physiological stress within the vegetation was noted and considered to be related to recent fire damage, insect infestation and the presence of dieback. Also, there are a number of areas that have been logged, most at least twice.

Fauna present on the proposed Ewington minesite is typical of the jarrah forest of the Darling Plateau. The only gazetted rare species present on the site are the Southern Brown Bandicoot and possibly the Tammar Wallaby. The Ewington Bandicoot population is currently undergoing a period of growth and numbers about 100. There is only a small possibility of the Tammar Wallaby being found on the site due to the limited suitable habitat. No examples were found during the field surveys.

The Ewington area encompasses landform and vegetation associations which are widespread throughout the South West Region and the Darling Ranges. Thus these habitats which support the greatest biodiversity, such as the jarrah-marri forest, are of minor ecological significance.

The level of disturbance from dieback, logging and fire has eroded the conservation value of the area by reducing fauna resources such as hollow logs and deep litter beds. The shrub wetland habitats are in relatively good condition and represent pre-disturbance status.

The habitat-vegetation type present in the Ewington area which is least well represented in the Collie Basin is the sedge-shrub wetland.

The Southern Brown Bandicoot and the Tammar Wallaby are fauna of significance which occur within the Ewington minesite. Minimisation of impacts on these species by implementation of specific management measures is recommended.

Three isolated finds of artefact materials were located during an archaeological survey of the minesite. This is consistent with other surveys in the area. Extensive recourse was made to local Aboriginal informants concerning the Ewington area through interviews and telephone conversations. Field visits did not locate any ethnographic sites.

7. THE PROPOSAL

Planning for the proposed Ewington mine is at an early stage but through the experience gained by Griffin over 60 years of coal mining in the Collie Basin it is possible, in this CER, to provide a broad outline of the mining activities and procedures that will take place.

In particular, there are a number of aspects of mine procedures and operations described that reflect current practices as developed by Griffin and as otherwise required of Griffin under the Agreement Act (refer Section 3.2.3). The Agreement Act has provided the statutory framework around which specific procedures, practices and requirements have been progressively developed. It is proposed to largely extend those features of the existing operations to encompass the Ewington mine.

The Ewington deposits will be mined by open-cut strip mining methods commencing in the north-western corner of the deposit. All overburden from the first strip will be dumped out-of-pit along the western edge of the mine pit between the mine pit and the haul roads. Overburden from subsequent strips will be dumped into previously mined-out strips. Replaced overburden will be progressively rehabilitated behind the mining operation.

The mining activities will involve site preparations such as construction of drainage controls and removal of vegetation and topsoil; overburden removal initially by truck and shovel and then by dragline; and mining of the coal seams. Blasting will be required to loosen hard overburden and interburden materials for excavation and also to break-up coal seams for mining.

The Ewington deposits will be dewatered by bores prior to the mining operations. The groundwater abstracted and surface water collected within the mine pit will be discharged to the power station and to natural drainage. There are a number of discharge scenarios and treatment options available with final selection being based on water quality criteria and economic considerations.

Rehabilitation procedures will include initial construction of drainage control works, surface preparations, then revegetation with selected local native species.

It is anticipated that the mine development will involve a construction workforce of up to 100 and a permanent average workforce of 200 to 250 personnel.

8. ENVIRONMENTAL IMPACTS

Potential environmental impacts of the proposed Ewington minesite have been identified in terms of:

- **Aesthetics**

The majority of mining activity will occur within the pit and is therefore not expected to impact on the aesthetics of the area. Special measures will be taken to contour the out-of-pit overburden dumps to limit their aesthetic impact. Many of these dumps, by virtue of their locations, will ameliorate a number of other potential impacts such as containment of dust, noise reduction and protection against airblast overpressures. Haul roads will be constructed around the perimeter of the mine but on alignments and at levels designed to minimise noise impacts.

- **Landform/Geomorphology**

Impacts will be minimised by backfilling of excavations behind the mining activities and shaping of overburden dumps to match surrounding ground contours.

- **Erosion**

Erosion control is of prime concern in achieving satisfactory rehabilitation and methods developed for existing mines will be extended to Ewington. In particular, structures will be installed to protect natural water courses against siltation and excessive turbidity.

- **Hydrology**

Discharge of mine water and runoff from the Ewington minesite will be subject to a water discharge licence issued by WAWA, the condition of which will specify criteria to which the quality and volume of the water discharged must abide. These criteria will be set at a level so that the discharge would not be expected to significantly impact on the biological or social environments and would be according to the Water Resources Management Strategy for the Collie Basin (refer Section 3.1.5).

The effects of discharging mine water would be as follows:

- reduction in pH during summer and autumn,
- marked reduction in Total Dissolved Solids (beneficial),
- maintenance of water levels and oxygen concentrations (beneficial),
- reduction in nutrient levels and therefore production of algae (beneficial),
- reduction in hardness and total alkalinity (beneficial),
- a small amount of mine water would pass some distance downstream of the discharge area but most would rapidly re-enter the water table (beneficial),
- maintenance of downstream flow during long, dry summer and autumn periods (beneficial).

Development of the Ewington minesite and subsequent control of drainage in its vicinity will result in interception of a proportion of the catchment runoff into watercourses which drain the area.

This will result in smaller seasonal flows in the watercourses affected. However, drainage from only a small portion of the Ewington minesite will be intercepted at any one time. This impact will not be permanent because the catchment area affected by mining will be progressively rehabilitated with the original drainage patterns being restored. Discharge of mine water in excess of that taken by the power station will also ameliorate this impact.

. **Hydrogeology**

The proposed mining operations at Ewington will require groundwater levels/heads to be lowered by up to 120m in the pit area. This will be achieved by the planned dewatering scheme. Extraction of groundwater for this purpose will result in some drawdown of the groundwater level around the proposed mine. The extent of drawdowns in the coal measures (Permian sediments) and superficial sediments are estimated to be up to 10m at 2km from the pit and up to 1m at 0.5km to 1km from the pit respectively.

. **Dust**

Dust control measures developed at existing minesites will be implemented at Ewington and are expected to ameliorate the potential effects of any fugitive dust on the Collie townsite.

. **Noise and Vibration**

Acceptable maximum noise levels for residential premises specified by the Environmental Protection Act, 1986 providing no tonal, impulsive or other annoying characteristics exist, are as follows:

Monday to Saturday	daylight hours	7am to 7pm	50dB(A)
Any day	night-time hours	10pm to 7am	40dB(A)
Any other time			45dB(A)

The background noise level at Ewington between the hours of 10pm and 7am is 27dB(A). It is generally accepted that levels up to 5dB(A) above the background level, ie 32dB(A) do not cause annoyance providing tonal or other characteristics do not exist.

From the EPA procedure, 40dB(A) would be the worst case acceptable level for night-time operations. For noise with tonal characteristics an acceptable level would be 35dB(A).

The worst case noise propagation scenarios for both the north-western and a southerly location of the operations were modelled under cool, calm conditions. In terms of the nearest residents in the eastern part of the Collie townsite, the mining operation will result in noise levels up to

34dB(A) when the mining operations are in the north-western corner of the pit. This level is unlikely to cause annoyance under normal atmospheric conditions. When the mining operation is in the south-western part of the mine pit these levels will decrease to 20dB(A) which is well below the night-time noise background level.

The north-western location was also modelled under worse case conditions of dominant propagation towards the Collie townsite, ie a north-easterly light breeze of 2-3m/s. Residents in the eastern part of Collie would experience noise levels of up to 44dB(A) under these conditions. Such wind conditions occur intermittently throughout the year for around 10% of the time at the Collie townsite. Higher wind speeds increase the background levels and hence will not present a problem. The resultant level of 44dB(A) is not expected to be a problem due to its limited occurrence.

Airblast, vibration and associated noise from blasting will require strict management and control at the Ewington minesite as it will be required to operate within limits specified in its Works Approval licence issued by the EPA.

Griffin currently uses the latest technology in drilling and blasting to reduce vibration and airblast levels produced in its existing operations. Sequential delays and non-electric firing methods are used, which ensure that the maximum instantaneous charge is kept to a minimum, thereby lowering the amount of energy fired on any one delay. Griffin has also developed a drill and blast programme to lessen the effect of noise propagation to the surrounding environs.

Griffin intends to use the latest technology in its drill and blast programme for the Ewington minesite to lessen the impact of blasting on the surrounding environs. Better placement of holes and downhole surveying will allow correct burden and spacing of holes, redrilling of unsatisfactory blast holes and reduced noise emission by confinement of explosives.

The eastern portion of the Collie townsite will experience some effects of blasting at the Ewington minesite. These effects will be noise, airblast and vibration.

Since the potential effects are reduced with separation distance from the source of the blasts it is expected that impacts of the blasting operation will be conducted within operational limits specified by the EPA. These criteria are designed to prevent excessive vibration and structural damage in the immediate vicinity of the minesite, therefore impacts to residents in the eastern part of Collie townsite will be minimised. The minesite will operate within acceptable levels set in the licence conditions. There is no reason to expect that these standards cannot be met.

The blasting operations of the Ewington minesite will move southwards and eastwards over time away from the townsite. Additional separation distances to the townsite and residences will increase the attenuation of both vibration and airblast and thus will aid the control of airblast and vibration emission impacts.

. **Vegetation and Flora**

The total area of land to be disturbed during the life of the Ewington mine is approximately 10km^2 (1,003ha). This includes the mine area (583ha), associated mine facilities (22ha) and haul roads. The Ewington minesite will affect 377ha of State Forest, the remainder has already been cleared for rural activities. Apart from a small pocket (approximately 3ha) of sedgeland association A3 which is atypical of the northern Jarrah forest, the minesite will not impact any vegetation associations that are not regionally widespread in the Northern Jarrah Forest region.

The prime management objective will be to minimise vegetation removal. There will be no disturbance of vegetation outside those areas designated for clearing. Vegetation within the Ewington minesite will be cleared progressively as individual strips are prepared for mining. As mining progresses, rehabilitation will follow behind, ameliorating the aesthetic impacts of clearing vegetation by replacing the native vegetative cover and stabilising soil. The overburden dumps would be in various stages of revegetation, and areas in advance of mining would be as yet undisturbed.

Continuous dewatering of the Ewington deposits to enable mining to commence will result in drawdown of groundwater levels in the surficial aquifer in the vicinity of the mine pit. This drawdown will be significant (3m) around the mine pit, but will decrease rapidly further from the mine pit.

The Jarrah forest vegetation in the Ewington area is typically not dependent on direct root contact with the watertable. It is also very well adapted to seasonal groundwater drawdown and therefore restricted water availability. The sedgelands in the vicinity of the minesite are dependent on seasonal inundation through rainfall and a perched watertable due to underlying clay sediments. Thus it is highly unlikely that the slight lowering of groundwater levels in the vicinity of the Ewington minesite will adversely impact the surrounding vegetation. This is consistent with experience at Muja and Chicken Creek.

No species of Gazetted Rare flora are known to occur in, or close to, the areas at the Ewington minesite that are to be disturbed. There are two vulnerable species which do occur. *Hibbertia silvestris* occurs throughout the site and would certainly occur elsewhere in areas surrounding the minesite. *Restio ustulatus* is widespread within sedgelands in the southern part of the minesite. Both species are not under threat and are known from several localities within the northern forest region.

The field survey indicated that dieback infection of the Ewington minesite appears to be widespread, although the swampland areas do not show evidence of infection as susceptible species are not as typical of this habitat. Thus mining in the Ewington area would not be expected to exacerbate the existing infection. In this case management procedures for mining activities will concentrate on preventing the disease from spreading to uninfected areas outside the minesite.

CALM currently burns the Ewington area by aerial drops. However once mining begins, this will not be possible due to the proposed infrastructure facilities, roads and the like. Thus additional firebreaks and access roads will need to be created to enable the fuel reduction

programme to be continued by hand. This means smaller areas will be burnt each time.

Twelve introduced weed species already occur on the Ewington minesite due to past human activities such as logging. Thus protection of the Ewington minesite from weed invasion will concentrate on prevention of further introduction of weed seeds and vegetative matter, and control of weeds which already occur or which may be accidentally introduced.

. **Fauna**

The principal impacts of the proposed Ewington minesite will be the loss of vegetated area, reduction in area of forest and woodland habitat and the impositions on the wetland drainage system. The area of vegetation lost due to the proposal (1,003ha) is insignificant in comparison to the widely distributed ecological habitat-vegetation units represented in the Collie region. The area is already of a degraded nature due to historical forestry practices.

The impact on the fauna is generally expected to be secondary in nature. There will be major local impacts initially with destruction of habitat, loss of sedentary species and relocation of mobile species into adjacent habitats. Impacts will be minimised by staged clearing, limiting clearing to a minimum (refer to Section 8.9.1), fencing off dangerous areas and limiting road and track development.

Increased traffic may cause localised death of larger mobile species, predominantly kangaroos, wallabies and monitor lizards.

The local population of the Southern Brown Bandicoot *Isoodon obesulus* will be adversely affected by the proposed minesite. Removal of a significant proportion of low lying wetland will reduce the area of local habitat available to this population, displacing it into adjacent less optimal habitat or causing its enforced migration to other areas of suitable habitat. Both of the above scenarios will result in increased individual mortality due to increased exposure to predators and territorial fighting if displaced bandicoots migrate into already populated areas.

The eradication of feral predators such as foxes and cats from the Ewington area will significantly enhance the survival of remaining bandicoot populations in the area.

Research has been conducted into the impacts of mine water on fauna in the Collie River. Native fish species which occur in the south and east branches of the Collie River are known to migrate into tributaries and/or floodwaters in winter and early spring to spawn. Thus the sexually maturing, embryonic and early larval stages, which are most likely to be susceptible to environmental changes, are not exposed to the low pH conditions found in the discharge area during summer. Thus it is not expected that mine water discharge would have any adverse impact on fish in the rivers.

. **Other Land Uses**

Apart from the State Forest and rural uses of the land in the actual minesite area, mining at Ewington will impact on few other land uses in the area.

9. ENVIRONMENTAL MANAGEMENT

The following commitments outline the major areas of environmental management identified by Griffin for implementation during development and through the operational life of the Ewington mine. Griffin undertakes to fulfil these commitments in accordance with the applicable State laws and regulations and with standards and procedures agreed with the State.

1. Construction

. Access to the mine construction site will be strictly controlled, and all vehicles will be subject to strict dieback hygiene control. A construction phase dieback management programme will be prepared, in consultation with CALM, prior to the commencement of construction.

. Site clearing during construction will only be undertaken in accordance with prior approvals obtained from WAWA. A generally applicable minimum disturbance policy will be implemented.

. All employees will be instructed on the environmental policy of Griffin before commencing work on-site.

2. Vegetation

. Vegetation clearing ahead of mining will be restricted to the minimum required for safe working practices. No clearing of any bushland will be undertaken without prior approval from WAWA.

. Griffin will conduct a flora study for the location and mapping of rare and vulnerable plant populations. Research into the propagation characteristics of these species will be undertaken to investigate the incorporation of such species into the rehabilitation programme.

. Any rare plants identified within proposed mining areas will only be removed after Ministerial approval.

. Where feasible, rare plants which would be removed as part of the mining operations will be transplanted into rehabilitated areas, used as a source of seed for rehabilitation purposes or used as nursery stock.

3. Dieback

. An operational phase dieback management plan will be developed in consultation with CALM prior to the commencement of mining.

. A detailed dieback hazard map will be produced.

. As part of the management programme the following control measures will be taken:

- A washdown area for dieback hygiene purposes will be established before commencement of works. its location and design will be determined in consultation with CALM.
- All heavy machinery to be introduced for site work will be washed down.
- The work areas will be monitored for dieback disease, and if it is found, assistance and advice on the most appropriate procedures will be obtained from CALM.
- Regular surveys will be undertaken to assess the effectiveness of the control measures.

4. Weeds

. The introduction of weed seeds will be minimised by the rigorous dieback disease hygiene procedures.

. Weeds that become established will be controlled by regular site inspection and, where necessary, eradication programmes.

5. Dust

. Dust will be managed to the satisfaction of the EPA by:

- the use of watersprays on stockpiles,
- the watering of haul roads in dry conditions,
- the early and progressive implementation of rehabilitation.

. A comprehensive dust monitoring programme will be implemented, so that any problems may be readily identified and rectified.

6. Fire

. Fire control will be implemented by:

- the education of all personnel in fire prevention requirements,
- the provision of trained fire-fighting crews at all times,
- the maintenance of firebreaks around and within the minesite area.

. Fire control working arrangements will be developed in conjunction with CALM, the Bush Fires Board and the local Bushfire Brigades.

7. Native Fauna

. Native fauna will be protected by the following actions:

- minimisation of vegetation disturbance,
- prohibition of firearms and pets on the minesite.

8. Feral Animals

. The introduction of potential feral species will be prevented by the banning of all pets from the project area.

. Feral fauna will be monitored on a regular basis and appropriate control programmes implemented where necessary, in consultation with the Agriculture Protection Board Pest Control Division.

9. Landform

. Final pit design will ensure that the highwall is left at a stable angle, as determined in conjunction with the Department of Mines.

. Overburden dumping will be conducted in accordance with the overburden management programme developed prior to the commencement of mining. Overburden will be selectively dumped so that overburden materials likely to inhibit successful rehabilitation are buried at depth.

. The visual impact of mining will be minimised by:

- designing overburden dumps so that wherever possible they are no higher than the natural topographic high points,
- progressive rehabilitation,
- screening from view where appropriate and practical.

10. Water

. A surface water management programme will be developed, prior to the commencement of mining, in consultation with the appropriate authorities.

. Prior to the commencement of mining activities in any area, drainage structures will be constructed to control water movement and divert runoff from undisturbed areas around the proposed mining area.

- Mine water will be managed to meet effluent discharge quality criteria consistent with achieving the water quality objectives defined in the Draft Water Resources Management Strategy for the Collie Coal Basin.

- Monitoring of the various effluent streams will be undertaken in accordance with the programme developed in the management programme and results reported to the appropriate authorities.

- Runoff management and drainage will be undertaken so that uncontaminated runoff from outside mining areas does not impinge on the operations. Contaminated water will be retained within the operational area and only discharged to the natural environment after treatment to a suitable quality.

11. Noise and Vibration

- Blasting noise and vibration will comply with the appropriate standards administered by the Department of Mines and will be controlled by:

  - ensuring that explosion gases are essentially devoid of energy by the time they emerge into the atmosphere,
  - firing blasts when there is a low probability of an atmospheric inversion being present,
  - firing blasts during daylight hours at regular times and wherever possible between the hours of 10.30am and 3.30pm.
  - using firing delays and detailed blast hole loading design.

- Regular monitoring will be undertaken to develop a blast prediction model.

- General mine noise will be managed by specifying noise emission limits on all mining equipment purchased.

- Noise monitoring will be undertaken in accordance with a noise monitoring management programme, and will take place under a range of operational and meteorological conditions. If monitoring identifies any significant adverse impact on nearby residents, remedial action will be taken.

12. Rehabilitation

- A rehabilitation management programme will be prepared prior to the commencement of mining.

- Rehabilitation trials will be undertaken.

- Rehabilitation to local native species with the objective of development of productive forest will be undertaken progressively throughout the life of the mine.

- Species selected for rehabilitation will meet the following criteria:

  - species which occur naturally in the project area,
  - species which are known to be able to readily establish themselves will be favoured,
  - species which have proved suitable for rehabilitation purposes in the Collie Basin will be favoured.

- Rehabilitation monitoring will be undertaken in accordance with the management programme.

- Griffin will liaise with the appropriate authorities to select plant species for rehabilitation and to develop completion criteria.

13. Public Consultation

- Griffin's staff will be available to respond to queries and problems raised by the local community. Every effort will be made to resolve any issues which may arise and records will be kept of all enquiries and complaints to facilitate this.

14. Reporting

- Griffin will report to the appropriate Government authorities regarding environmental management matters in accordance with the requirements of the Collie Coal (Griffin) Agreement Act, 1979.

15. Additional Proposals

- Additional proposals, under Clause 10 of the Agreement Act will be submitted for approval.

1. INTRODUCTION

1. INTRODUCTION

1.1 THE PROPONENT

The Proponent is The Griffin Coal Mining Company Pty Limited (Griffin). Griffin is one of two coal producers currently in Western Australia and operates the Muja and Chicken Creek open-cut coal mines in the Collie Basin about 200km south of Perth and 30km east of Bunbury (Figure 1.1). In Perth, Griffin's offices are located in the Griffin Centre, 28 The Esplanade.

1.2 AN OVERVIEW OF GRIFFIN

Griffin is an experienced coal miner, having operated in the Collie Basin for over 60 years. This is longer than any other past or present operator in the Collie Basin, and positions Griffin amongst the longest established operators in the Australian coal mining business.

The Muja and Chicken Creek open-cut coal mines in the Collie Basin have a combined output of 2.5 million tonnes per annum (Mtpa) and employ about 570 people. Although the mines are operated as two separate entities, administration and management are centralised. Their close proximity, about 5km apart, also allows the interchange of men and equipment as and when required. Figure 1.2 shows the location of these operations, and the Ewington Deposit in relation to the proposed Collie Power Station site and the Collie townsite.

Griffin produces sub-bituminous coal with low ash and low sulphur contents, high moisture content and medium specific energy.

Coal mined by Griffin is ideally suited as a fuel for power stations. The coal from the Premier coal sequence, which is mined at Chicken Creek, has also been proven to perform well as a reductant for the mineral sands industry in the production of synthetic rutile.

Griffin has title to approximately seventy-five Coal Mining Leases (CML) in the Collie Basin, with the principal leases being those associated with the operating Muja and Chicken Creek mines and the as yet undeveloped Ewington/Premier coal deposits.

. Coal Sales

Griffin has long term contracts in place for about 99% of its coal production, with the principal contract being the State Energy Commission of Western Australia (SECWA). This contract provides for the delivery of some 2.1 million tonnes (Mt) of coal annually until 30th June, 2003, and 1.5Mt thereafter to 30th June, 2010 and accounts for approximately 84% of Griffin's output. The remainder of Griffin's production is sold principally to the mineral sands industry and to cement producers, as well as to some other minor private customers.

1.3 PROPOSAL IN BRIEF

The full title of the proposal is "Proposed Ewington Open-Cut Mine to Supply Coal to the New Collie Power Station and/or Other Industrial Customers".

SECWA has, for some time, been considering the options available for providing the most cost effective supply of baseload electrical power to the State. This process culminated in a decision by the Western Australian Government in April 1991 to adopt a two-staged strategy, this being:

- the immediate construction of two 110MW gas turbines at its Pinjar site to ensure power supplies can meet anticipated demand before 1995, and

- the development of a privately built, owned and operated 600MW coal-fired power station at Collie.

In preparing this CER, Griffin's intention has been to ensure and maintain its ability to supply coal to the proposed Collie coal-fired power station. Such coal supplies may be required either in the short term or in the longer term. Alternatively, Griffin wishes to maintain the option of developing the Ewington open-cut coal mine to supply potential industrial customers, albeit at lower annual tonnage rates than currently planned for the Collie Power Station.

This CER has been prepared on the basis that the Ewington mine will be developed to meet coal supply contracts with the new Collie Power Station. However, the details presented are also generally consistent with mine development to supply potential industrial customers should this be the principal reason for opening the mine.

A decision to proceed with mine development is dependent upon the signing of coal supply contracts with the successful bidder to SECWA for the construction, operation and ownership of the new Collie Power Station or commitments by potential industrial customers to purchase large coal tonnages from Griffin.

The proposed Ewington minesite is located approximately 1.5km east of the Collie township, as shown on Figure 1.2. It will cover an area of 10km^2, 60% of which is currently forested. Figure 5.1 shows the location of the proposed Ewington open-cut mine in relation to existing infrastructure and Figures 5.2 and 5.3 indicate land use and tenure. Griffin currently holds title to CMLs in the general area which are free of any encumbrances and coal reserve commitments.

Griffin proposes to develop the Ewington deposits as an open-cut, strip mining operation with continuous dewatering in advance of mining of the coal measures. This is a similar mining method to that currently used at the Chicken Creek operations.

Commencement of mining may occur as early as 1996 on the basis of current planning for the development of the power station. Dewatering operations need to be commenced two years prior to commencement of mining. The mine could supply coal to the Collie Power Station for at least 31 years.

The mine will be capable of supplying coal to the power station at an annual rate generally ranging from 1.6Mt to 2.3Mt. Actual crushed coal production rates will depend entirely upon the amount of power purchased by SECWA from the power station consortium. Allowance will be made in mine planning and development for a maximum annual production level of 2.5Mt to provide adequate flexibility in mine and power station operations.

1.4 PURPOSE OF THIS DOCUMENT

The object of Environmental Impact Assessment (EIA) is to provide for environmental matters to be taken into account during decision-making by all interested parties. It also aims, in the interests of sound environmental management, to ensure that the potential environmental effects of activities are considered in the early stages of development planning and prior to a decision to proceed at each stage of the project.

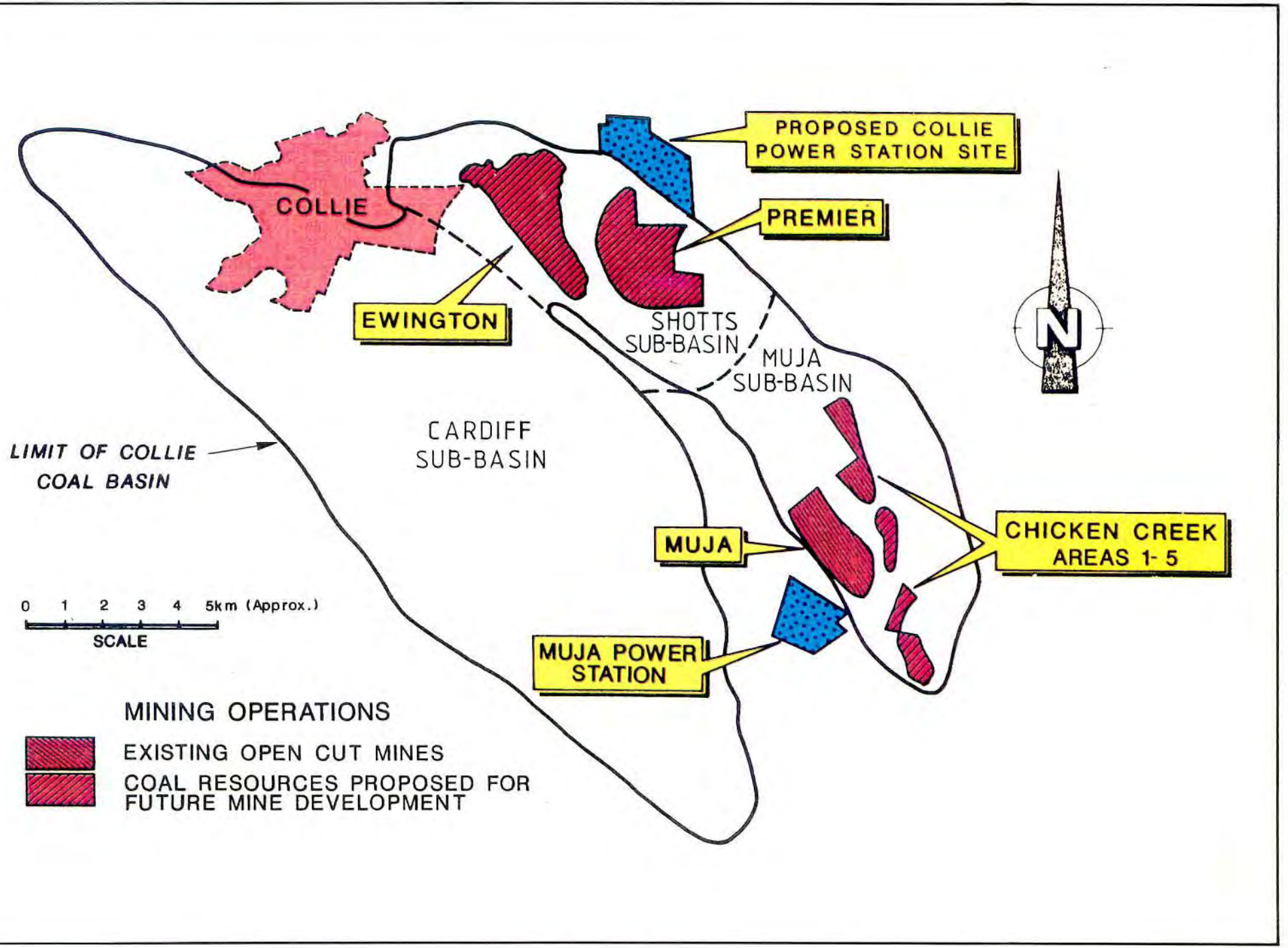
The purpose of this document is to facilitate the assessment of the environmental implications of the proposed Ewington mine operations by the Environmental Protection Authority (EPA) and to allow comment on the proposal by affected and concerned parties.

Following formal notification in July 1990 by Griffin to the EPA of the proposal, as required under the Environmental Protection Act (1986), the EPA has deemed it desirable that the local public be made aware of the environmental impacts of the mining proposal and measures proposed to protect the environment.

The level of assessment for the mining proposal has thus been set by the EPA at Consultative Environmental Review (CER). At this level of assessment Griffin is required to produce a report suitable for restricted public consideration that details the scope of the project, the nature and extent of likely environmental impacts and the management measures that will be implemented to ensure such impacts are either minimised or kept within acceptable levels.

This report will be evaluated by the appropriate authorities both as an aid to Government decision-making and to enable the identification of any environmental conditions which need to be attached to approvals. The CER has been prepared in accordance with guidelines issued by the EPA, contained in Appendix A.

The scope of the CER is limited to the incremental impacts on areas that would be directly or indirectly affected by the operation of the Ewington open-cut mine. The emphasis of the CER is the identification of the potential environmental impacts associated with the proposed mining operation and the presentation of Griffin's proposed environmental management plans and commitments.



EWINGTON OPEN CUT MINE
CONSULTATIVE ENVIRONMENTAL REVIEW
for THE GRIFFIN COAL MINING COMPANY PTY LIMITED

MINING OPERATIONS

FIGURE 1.2

2. NEED FOR THE PROPOSAL

2. NEED FOR THE PROPOSAL

2.1 JUSTIFICATION

Modern society depends upon the availability of reliable supplies of electrical energy to both function efficiently and for the purposes of creating the wealth upon which it relies for the maintenance and improvement of its living standards. Not only must power supplies be reliable, they must also be competitively priced to attract industries and ensure their ability to sell products on national and international markets.

Increasing living standards, strong population growth and the development of a range of major mineral processing industries within the State over the past twenty years and particularly in the last five years have all contributed to a rapid increase in demand for electrical energy. SECWA states that electricity sales within the State have grown by 50% since 1985 with an associated growth in peak demand of almost 40% (SECWA, Jan. 1991).

This demand growth has dictated a need to plan for the installation of further baseload power generating facilities within the next 5 to 10 years. Baseload generating capacity is necessary to ensure the cheapest and most reliable power supplies can be provided.

SECWA has undertaken extensive investigations to determine the most suitable means of providing additional baseload generating capacity at the most competitive prices. As a result of this work the Government has decided to:

- install two 110MW, gas-fired generators at its Pinjar site north of Perth, and
- endorse the construction of a privately built, owned and operated coal-fired, baseload power station of 600MW nominal capacity in Collie subject to the meeting of a number of requirements designed to ensure effective reduction in power generating costs.

The SECWA analysis shows that, provided all requirements are met, a coal-fired, baseload power station in Collie will provide the best and most cost-effective option for development of Western Australian power supplies.

The proposed Collie Power Station site is located on the northern edge of the Collie Basin. This siting has been chosen to ensure the power station is located as close as possible to readily available coal reserves. The reserves in the southern part of the Collie Basin are fully committed to the existing Muja Power Station and other customers.

The Ewington reserves controlled by Griffin and that form the subject of this CER are located immediately south-west of and adjacent to the proposed Collie Power Station site. Griffin proposes to develop its Ewington coal mine subject to:

- a final commitment to construction of a baseload, coal-fired power station at Collie, and

- a decision by the successful private consortium to purchase coal from Griffin for its power station or alternatively for other industrial customers to purchase large tonnages of coal from Griffin.

The Ewington deposits would provide an attractive source of coal for the new Collie Power Station because:

(a) The mine is located in close proximity to the power station site thereby minimising coal transportation costs from the mine.

(b) There are sufficient reserves of coal to meet the anticipated demands of the power station over its planned life.

(c) The quality of the coal in the Ewington deposits is ideally suited as a fuel for a baseload power station.

(d) Use of the Ewington deposits will necessitate the development of a new mine thereby allowing for the introduction of state-of-the-art mining techniques and equipment to ensure minimum coal costs combined with responsible environmental management.

Although early development of the new Ewington coal mine is related to new coal supply contracts with a coal-fired, baseload power station in Collie it should be recognised that the Ewington deposits are a viable source of coal for generating purposes and as a process raw material. Indeed, plans have been in place to develop a Ewington open-cut mine since the late 1970s when the deposits were examined as a fuel source for the supply of power to an aluminium smelter.

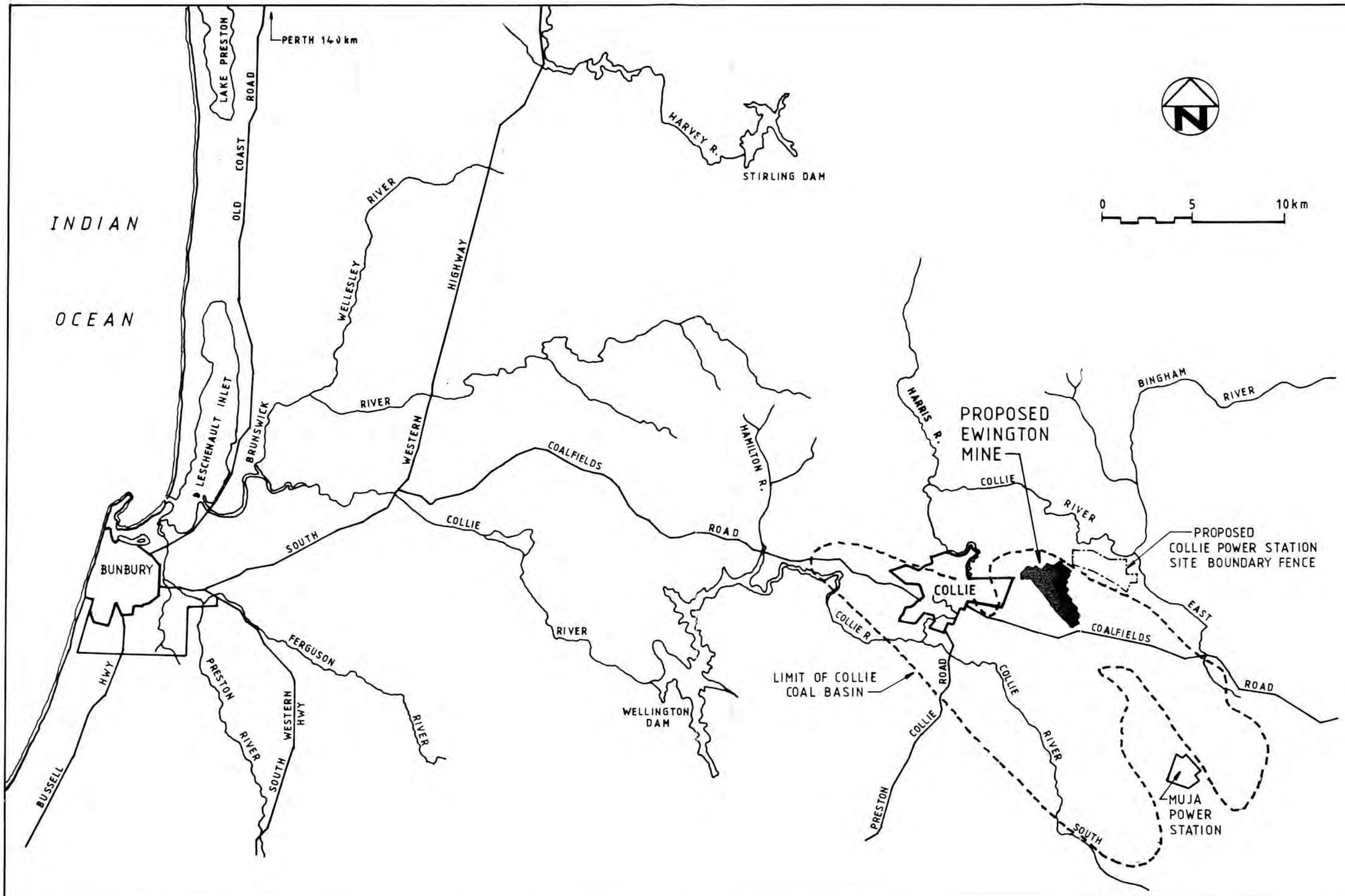
The Government is currently undertaking planning studies related to heavy industry development in Collie. It is possible that industries will be attracted to Collie because of the ready availability of coal for use as a source of power or as a raw material (eg as a reductant in the synthetic rutile process).

It is therefore apparent that development of the Ewington deposits by Griffin will occur in response to demand, whether such demand is created by a baseload power station, an industry specific power station or by an industry requiring coal as a raw material.

2.2 BENEFITS OF THE PROPOSED DEVELOPMENT

2.2.1 State and National Economies

As detailed in Section 2.1, early development of the Ewington coal mine is dependent upon a decision by the Government to develop a coal-fired, baseload power station in Collie and a further decision by the successful private power station consortium to source coal through Griffin. Under



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EWINGTON OPEN CUT MINE
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PROJECT LOCATION

FIGURE 1.1

this development scenario it is appropriate to identify the flow-on benefits to State and national economies from the linked development of a power station and an associated coal mine at Ewington.

There is clear evidence to show that the key to the future economic wellbeing of Australia lies in the development of further downstream processing of its rich mineral and other natural resources and increases in the range and efficiency of its manufacturing industries. Reliance solely on the mining of natural resources and on the production of basic agricultural commodities can only sustain a certain level of community wealth and standard of living.

A key element of the nation's ability to attract and develop new industries and to improve the international competitiveness of its products is the availability of reliable and cheap electrical power. As outlined in Section 1.3 detailed analyses by SECWA have shown that, under certain conditions, the development of a coal-fired, baseload power station in Collie offers the best opportunity to generate cheap electrical power within Western Australia in the near future.

Some of the benefits that are predicted to accrue to the State and the nation from the joint development of a power station and a new coal mine include:

- significantly increased direct and indirect employment opportunities (with subsequent financial flow-on effects) during the construction and operation phases of the development,

- increased revenue to the State and the nation from government taxes, levies and royalties from the mining of coal and taxation of employee income and Griffin's profits,

- an increased contribution towards the nation's annual export income through the incentives offered for additional resource processing and commodity production at internationally competitive prices due to the availability of cheaper power.

A recent study by the National Institute of Economic and Industry Research (NIEIR, Nov. 1990) has shown the following benefits accruing from the joint development of a power station and an associated coal mine. The analysis confined itself to the construction phase only.

- **Western Australian Economy**

  - The cumulative increase in Gross State Product within Western Australia is estimated to be $440 million.

  - Employment opportunities (direct and indirect) during the construction phase will represent in excess of 6,900 positions.

  - Total increase in State revenues over the construction phase would be approximately $36 million.

- **The National Economy**

  - The cumulative increase in Gross Domestic Product for the nation is $1,060 million during the construction phase.

The development of the new coal mine will involve considerable capital investment. Under The Collie Coal (Griffin) Agreement Act (Agreement Act) (refer Section 3.2.3) Griffin is committed to maximising the use of firstly Western Australian and secondly Australian goods and services. This commitment is reflected in Griffin's policy contingent upon there being the necessary skills and experience available at competitive prices.

Similarly, Griffin will pursue this policy of preference for locally available goods and services during the operational phase of the development.

2.2.2 Local Community

Collie has a historically close association with primary industry. The mining, electricity and water sectors are currently estimated to provide approximately 90% of the town's direct and indirect employment base.

The Shire of Collie and local residents appear to view properly managed industrial developments as greatly beneficial to the town and its residents. General discussions with the Shire of Collie and various sectors of the community indicate that the development has community support.

The construction and operation of the Ewington mine would provide a significant and long-lasting stimulus to the local communities, both socially and economically.

These would include:

- employment opportunities for about 300 people during the operation phase (Griffin's current total workforce at Muja and Chicken Creek is approximately 570 people),

- increased demand for goods and services from local industries and businesses,

- increased incentive for more specialised services to locate in the South-West Region with related spin-off benefits to the community,

- increased population in local centres near the Ewington mine, ie Collie and Allanson, thereby assisting State policies of decentralisation and increasing the revenue base for local authorities,

- improved training of the local workforce through on-the-job training and employer operated or sponsored training programmes.

The majority of the workforce for the mining operations at Muja and Chicken Creek was initially recruited from local communities and the broader South-West Region of Western Australia. Wherever practical, a similar recruitment policy would be used to engage the additional workforce required for the Ewington open-cut mine. Recruitment of the workforce would continue to be non-discriminatory with the objective of employing the most suited applicants available. In addition, Griffin would undertake relocation of existing employees from the Muja and Chicken Creek operations into the Ewington operation as opportunities arise and would also maximise the opportunities for worker retraining as the new operation develops.

2.2.3 The Proponent

Benefits to Griffin from development of the Ewington coal mine include:

- the opportunity to develop a state-of-the-art open-cut mining operation with equipment and techniques suited to the nature of the deposit,
- the ability to capitalise on the economies of scale in mining operations,
- the opportunity and security of being able to maintain a sustainable operation to extend the life of current mining activities for a further 20 years beyond currently committed mining activities,
- the ability to maximise efficiencies and cost effectiveness in administration of current and planned mining activities in Collie.

These benefits to Griffin can all, in turn, be translated into a lower overall cost structure for the mining of coal. This not only assists in maintaining the competitive position of Griffin and its operations in Collie but also has the potential of a flow-on effect to the State by ensuring the long-term availability of low cost coal for power generation and for other industrial users.

3. LEGISLATIVE AND POLICY REQUIREMENTS

3. LEGISLATIVE AND POLICY REQUIREMENTS

3.1 GOVERNMENT POLICIES

In preparing the CER, account has been taken of the Government's policies in regard to conservation, mining and energy with respect to the Collie Basin, and the greenhouse effect.

3.1.1 Government Energy Policy

A major objective of Government energy policy is the utilisation of the State's energy resources to promote economic development. It is only by promoting and encouraging such development that the economic wellbeing of the State and the living standards of its population can be maintained and enhanced.

Recent Government policy with respect to coal has centred on the Collie Basin and the management and future use of its considerable reserves. Principal considerations with respect to Collie coal include:

- the availability of large quantities of economically mineable coal in the Collie Basin,
- the improvements in coal extraction technology and mine operating efficiencies largely through taking advantage of the economies of scale in those operations,
- the location, characteristics and costs of Collie coal make it unsuitable for supply to export markets.

From this it is clear that there is a considerable energy resource available within the Collie Basin (in excess of 500 million tonnes of coal) that is essentially available only for the domestic market. Further, the price of Collie coal is not tied to international markets and will, in the longer term, be less likely to suffer the major price variations that apply to internationally traded fuels such as oil and gas.

There are therefore considerable incentives for the Government to develop the Collie Basin to its full extent in order to fulfil its policy of maximising the utilisation of the State's energy resources. There is also the incentive to develop a new, state-of-the-art coal mine to take advantage of:

- the economies of scale in reducing coal production costs,
- the procurement and operation of new, more efficient mining equipment,
- the negotiation of new coal purchasing contracts that provide incentives to increase efficiency of operation and thereby cut energy costs to the State.

Development of a baseload power station and associated coal mine in Collie will also fulfil the Government's commitments to the further development of the Collie Basin.

This, in turn, will provide a positive boost to the decentralisation policy from the flow-on effects of infrastructure and service developments in the Collie area and the South-West Region generally.

3.1.2 Government Greenhouse Policy

In December 1988 the Government issued a policy statement entitled "Greenhouse, Meeting the Challenge" (Govt. of WA, Dec. 1988). The Government has also formed the Western Australian Greenhouse Co-ordination Council to develop a co-ordinated strategy for the Greenhouse Effect. This Council has published a report entitled "Addressing the Greenhouse Effect" (The Greenhouse Co-ordination Council, Nov. 1990) aimed at providing a basis for public discussion on the issue.

The objectives of the Government's greenhouse policy are to:

- reduce contributions of greenhouse gas emissions,
- minimise the effects of climatic change.

Both the Government's policy and the discussion paper issued by The Greenhouse Co-ordination Council indicate that it is essential that greenhouse strategies must be economically defensible and responsible and that strategies must provide for further economic development. A key element in the policy is the identification and implementation of initiatives designed to minimise greenhouse gas emissions.

Griffin has acted in line with these policies by undertaking its own Greenhouse Audit (Griffin, 1989). The aims of this audit were to identify areas where the company could reduce its greenhouse gas emissions and its energy consumption by changing its operating practices. Initiatives arising from the audit include:

- introduction of a mobile unit to recycle refrigerant gases in air-conditioning equipment,
- critical examination of electrical energy usage with the introduction of equipment and practices designed to minimise energy usage,
- implementation of consumable goods recycling schemes both at the mine areas and within the Perth office,
- closer scrutiny of land clearing practices to better utilise cleared timber,
- examination of techniques designed to minimise fuel consumption by mobile equipment.

Griffin is committed to ongoing management of its operations to ensure its contribution to the Greenhouse Effect is minimised within the overall economic constraints of its operations.

3.1.3 Collie Coal Mines Rehabilitation Committee

The Collie Coal Mines Rehabilitation Committee was convened in 1980 with representation from the Departments of Mines, Resource Development (now State Development), Forests (now Conservation and Land Management), Public Works, Agriculture, Conservation and Environment (now EPA), and State Energy Commission in order to guide rehabilitation and land use matters.

In 1982, following a report from the Collie Coal Mines Rehabilitation Committee. Cabinet endorsed a number of land use objectives for the Collie Basin, which acknowledged coal mining as the primary land use but provided that full account be taken of the need for mining to be compatible with other land uses. The primary land use objective was stated by Cabinet as:

> *"The Collie Basin contains Western Australia's only currently commercial coal field and for the foreseeable future is expected to retain its position of major importance in providing for the future energy needs of the State. Accordingly, coal mining must be designated to be the primary land use in the area but at the same time full account must be taken of the need for mining to be compatible with other important land uses.*
>
> *The overall management objective for mining and rehabilitation in the Collie Coal Basin is to direct both coal mining and minesite rehabilitation in a manner that optimises coal recovery and the sustained use of the basin's other natural resources, and which is achieved at a reasonable cost."*

3.1.4 Collie Development Structure Plan

The Draft Collie Development Structure Plan is the culmination of work completed by the Collie Basin Management and Planning Group. This Group has operated for the past twelve months under the direction of the Department of Planning & Urban Development (DPUD) in conjunction with the Department of Mines and the Department of State Development (DSD). The draft was circulated to Government agencies for comment and has recently been released for public comment through the Bunbury-Wellington Planning Study, prepared by DPUD.

Griffin was involved in preparation of the structure plan through its membership of the Collie Basin Management and Planning Group. The structure plan defines future coal mining areas within the Collie Basin including the Ewington mine that form the subject of this report. One of the principal aims of the structure planning exercise was to set future directions for development of the Collie townsite, infrastructure and other activities such that none of the known reserves of coal would be sterilised in the future.

3.1.5 Collie Coal Basin Water Resources Management Strategy

The Water Authority of Western Australia (WAWA) released its draft strategy for the Collie Basin in November 1988. The strategy addresses the need to improve the quality of the Wellington Dam which has been steadily degraded over the years.

Groundwater is abstracted from the Collie Basin for the principal purposes of coal mine dewatering and for provision of process and cooling water for power generation. Effluent from mine dewatering and power station cooling blowdown are discharged into branches of the Collie River. Some of these discharges are of a poorer quality than the longer term objectives for Wellington Reservoir and require management to ensure their impact is within acceptable criteria.

The water management strategy has been formulated on a number of policy decisions and commitments. In 1982, Cabinet endorsed the water management objective for the Coal Basin being to *"ensure that coal mining and other activities in the Basin do not significantly diminish the quality and quantity of surface runoff and recharge to the groundwater system and that water resources are developed and utilised in the best interests of the State."*

Under the conditions covering environmental approval for the Harris Dam the Water Authority of Western Australia (WAWA) is committed to the *"....long term objective of returning the Collie River to a salinity level such that the quality of water supplied from Wellington Reservoir is suitable for domestic supplies."*

These objectives and conditions recognise the value of the regional water resources and that this value will increase with time as the resources become scarcer and competition for them increases. The quality of the water in Wellington Reservoir needs to be improved because there are existing end users of the water in the form of irrigators and industry that require available water to be of an appropriate quality for their use.

Action has been initiated by Government to improve the quality of any discharges which are of quality contrary to that requirement. There are a number of possible management options to improve the effluent discharge quality, including pretreatment before disposal and various off-catchment disposal options. Each is to be evaluated in terms of technical and economic feasibility to determine the most acceptable solution. WAWA's preferred strategy for water discharges of adverse quality is off-catchment disposal through a pipeline although this has significant economic implications because of the cost of such an exercise.

These considerations, policies, objectives and commitments provide the basis of the water management strategy for the Collie Coal Basin. It is WAWA's intention that the strategy will be fully implemented by 31st December, 1995.

Work has commenced on preparation of a draft Environmental Protection Policy under the Environmental Protection Act 1986, designed to protect the environment, in particular the quality of surface water flows, and to achieve protection of the beneficial uses of the Collie Coal Basin water resources. The water resources management strategy for the Coal Basin will be incorporated within the Environmental Protection Policy.

The strategy is currently the policy of WAWA. Although it is not yet a legislative Environmental Protection Policy, it has ministerial approval and has been accepted by the EPA in its assessment of proposals involving the Collie Basin.

Parts of the water management strategy for the Collie Coal Basin which are pertinent to the proposed Ewington mine are outlined below:

(i) Allocation of the groundwater resources of the Collie Coal Basin should primarily be for the generation of power in accordance with the stated land use priority of coal mining.

(ii) Groundwater abstractions should be minimised in accordance with good water resources management. Dewatering effluent should be utilised for process and cooling water purposes preferentially to wellfield abstractions.

(iii) Pollution control licences should set effluent discharge quality criteria consistent with achieving the statutory water quality objectives for Wellington Reservoir. These criteria should allow no discharges with salinity in excess of 550mg/L Total Dissolved Solids (TDS) to be discharged into the surface waters of the Coal Basin.

(iv) Individual pollution control licences should be issued to each of the parties discharging effluent and each party should be required to individually meet the above water quality criteria.

(v) Monitoring of performance with respect to the above should be implemented.

3.2 LEGISLATIVE REQUIREMENTS

In addition to obtaining approval from the State's Minister for Environment, the proposal will have to comply with legislation and regulations administered by a number of Government agencies. The legislation includes:

- Environmental Protection Act 1986;
- Wildlife Conservation Act 1950;
- Conservation and Land Management Act 1984;
- Aboriginal Heritage Act 1972;
- Water Authority Act 1984;
- Coal Mines Regulation Act 1946;
- Plant Diseases Act 1914;
- Soil and Land Conservation Act 1945;
- The Collie Coal (Griffin) Agreement Act.

3.2.1 Environmental Approval Process

The environmental approval process is illustrated in Figure 3.1. The CER is intended to provide Government and the public with an understanding of the proposal and its environmental impacts. The CER is made available for public review for a limited period during which submissions from concerned or involved groups and Government agencies are received by the EPA.

Griffin is given an opportunity to respond to the concerns and issues raised in the public submissions. The public submissions and Griffin's responses are then incorporated into the EPA's assessment of the proposal.

3.2.2 Approval to Commence Mining Operations

Only one set of documentation, this Consultative Environmental Review, is needed to satisfy the requirements of all Government agencies.

Licences and Works Approvals cannot be obtained until after the completion of the Consultative Environmental Review and the EPA approval of the development. Most of the licences can be obtained concurrently with EPA Works Approvals/Licences.

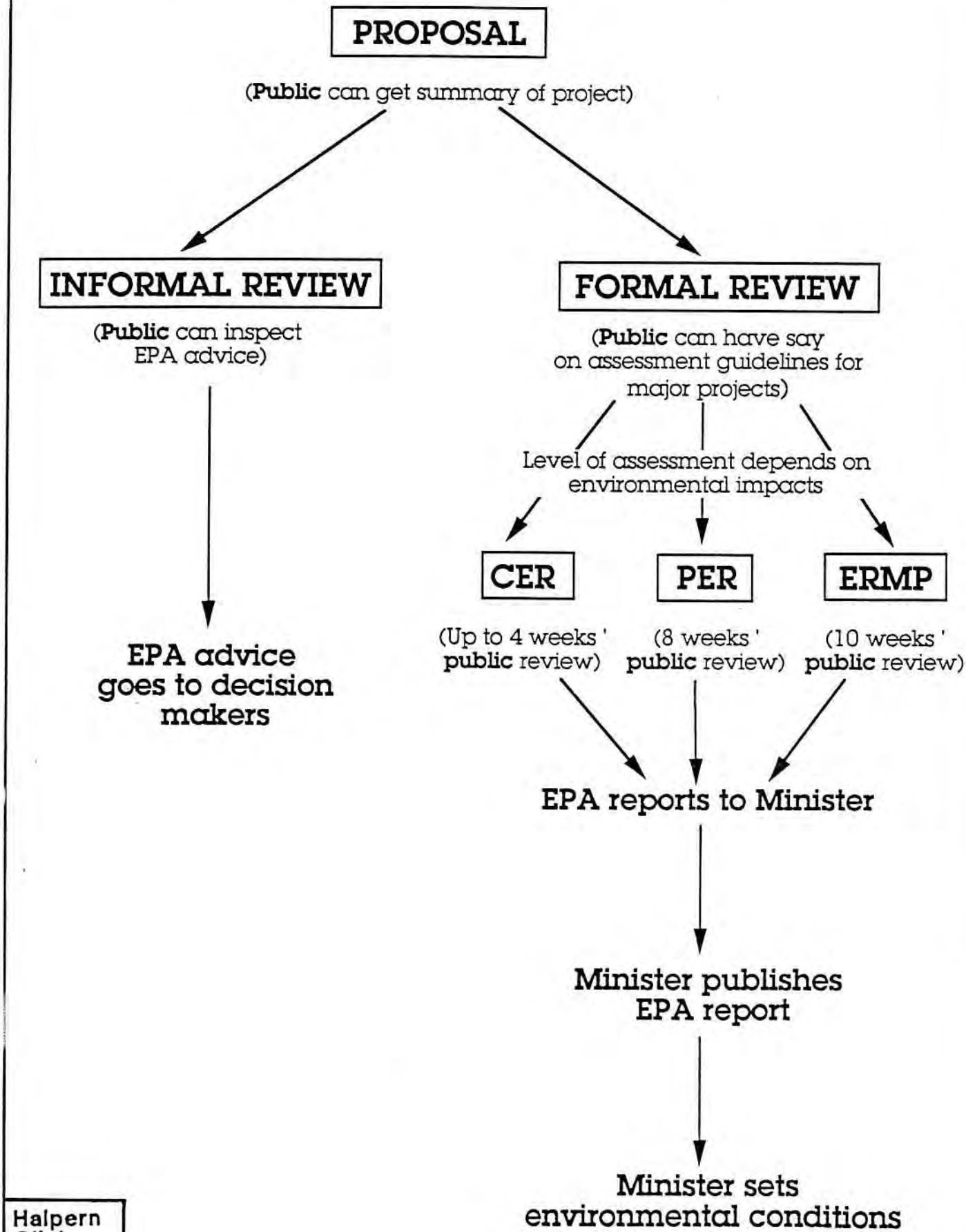
3.2.3 The Collie Coal (Griffin) Agreement Act

The Collie Coal (Griffin) Agreement Act (Agreement Act) was entered into between the State and Griffin in October 1979. The Agreement Act concerns ongoing mining operations as well as applications by Griffin for additional coal mining lease areas and its general plans for coal mining expansion including certain aspects of development on existing leases held by Griffin.

The Agreement Act binds Griffin to observe all the environmental protection requirements made by the State (including its agencies and Statutory authorities) or local government pursuant to any Act in force at any time.

A principal requirement is that Griffin must submit for the approval of the Minister for State Development all development and environmental management proposals. These proposals take the form of 15 year general development plans and more detailed 5 year mining plans. Griffin is also required to monitor the effectiveness of rehabilitation and environmental management and report on these programmes on an annual and triennial basis.

Under Clause 10 of the Agreement Act, Griffin is obliged to give notice to the Minister for State Development of any plans to significantly vary its activities. As part of this approval process Griffin must submit details of its proposed operations consistent with the requirements of the Act and as observed for current operations. Under Clause 11 of the Agreement Act, Griffin must submit environmental reports to the Minister for State Development for consideration by the Coal Mines Rehabilitation Committee.



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EWINGTON OPEN CUT MINE
CONSULTATIVE ENVIRONMENTAL REVIEW
for THE GRIFFIN COAL MINING COMPANY PTY LIMITED

ENVIRONMENTAL APPROVAL PROCESS

FIGURE 3·1

4. EVALUATION OF ALTERNATIVES

4. EVALUATION OF ALTERNATIVES

4.1 INTRODUCTION

The proposal by Griffin to develop an open-cut coal mine at Ewington is directly related to a decision by the Government to proceed with a privately built, owned and operated coal-fired, baseload power station at Collie. The proposal is also dependent upon the reaching of an acceptable contractual arrangement between Griffin and the private power station consortium for supply of coal or on the confirmation of large coal tonnage orders from potential industrial customers.

Alternatives to the development of the Ewington mine can therefore include consideration of:

- The pursuit of an alternative baseload electricity generating strategy by the Government using an alternative fuel source.
- The use of alternative sources of coal for the proposed Collie power station thereby obviating the immediate need to develop the Ewington deposits.
- The scope for Griffin to develop coal deposits other than Ewington to supply the proposed Collie power station.
- The scope for expansion of existing Griffin mining operations instead of developing the Ewington deposits.
- The use of mining techniques and technologies other than the proposed open-cut methods outlined in this CER.

Each of these aspects is discussed below.

4.2 ALTERNATIVE ELECTRICITY GENERATING STRATEGIES

As the Government agency responsible for management of energy within the State, SECWA has an ongoing role in the planning for future supplies of electrical power to the State. SECWA maintains an evaluation of market demands for electrical power and determines, by complex analysis, predicted future demands.

Such forward planning for power demand is essential because of the lengthy time required to initiate, construct and commission a large baseload power station. It is through this predictive work that SECWA has, for some time, realised the need for additional generating capacity within the State.

In giving consideration to the provision of new baseload power generating facilities it has been necessary to focus on the fuel source to be used in generating the power. There are a number of choices of fuel within the State as briefly discussed below:

. **Oil**

Generally oil is no longer favoured as a fuel for power generation because it is relatively expensive and is better suited to use in areas such as transport where its high energy content is beneficial. Also the State, and indeed Australia, is not self-sufficient in oil production and therefore use of large quantities of oil for power generation would tend to raise imports, resulting in a negative impact on the nation's economy.

. **Renewable Energy**

Sources of renewable energy include solar, wind, tidal and biogas. Significant research is under way in Australia and overseas aimed at developing commercially viable power generating capacity from these and other renewable sources of energy. However, there are currently no proven means of using sources of renewable energy on a scale sufficient to meet the immediate needs of the State for baseload power.

. **Nuclear Power**

The use of nuclear energy is not currently considered feasible in the State because:

- the power demands are insufficient to justify the large investment in a nuclear power generating facility,
- there are unresolved concerns about the handling and disposal of radioactive wastes, and
- the cost of power generated from a nuclear facility would be uncompetitive in the State.

. **Natural Gas**

Natural gas is a viable source of fuel for power generation although its availability in close proximity to Perth is limited. Currently natural gas is supplied to the South-West Region from the North West Shelf gasfields with plans to obtain additional supplies from smaller onshore and offshore gasfields near Onslow.

Recent analyses by SECWA (SECWA, Jan. 1991) have demonstrated that, subject to the availability and unit cost of natural gas this source of fuel could be competitive with coal as a fuel source for the next baseload power station in the State.

However, natural gas does have a number of potential disadvantages compared to coal as a fuel for baseload power generation including:

- Natural gas is an internationally traded resource and local supplies can be marketed overseas as an alternative to being used for domestic purposes whereas coal from Collie Basin is unsuited to export and is therefore, to some extent, insulated from world market price variations.

- Natural gas is supplied to the South-West Region via a 1,200km high pressure pipeline. The pipeline is largely fed from the relatively remote North West Shelf gasfield via a 135km offshore pipeline and gas processing plant. Use of current sources of natural gas therefore relies on the continued integrity of this supply link with currently no alternative sources of supply or supply links.

- Recent economic analysis (NIEIR, Nov. 1990) demonstrates a lower economic benefit to the State and to Australia from the development of a natural gas-fired, baseload power station compared to a coal-fired station.

. **Coal**

The use of coal as a fuel for future baseload power generating purposes is discussed in more detail elsewhere in this CER. However, it is relevant to note the major advantages in using coal as an energy source, these being:

- availability of large quantities of proven reserves well in excess of those needed by a single baseload power station over a 30 year operating life,

- price stability because of the unique situation in the Collie Basin where export opportunities do not currently exist,

- security of supply due to coal deposits being located in close proximity to the proposed power station site and the ability to stockpile reserves to avoid short term fuel supply shortfalls,

- large scale cost effective mining techniques ensure minimum coal costs.

4.3 NO DEVELOPMENT OF MINESITE

The option of not developing the Ewington deposit to supply coal to the proposed power station in Collie would obviate the economic and other benefits of this proposal as discussed in Section 2.2. The increased market demand for coal would, however, need to be met by alternative sources of supply either through Griffin or some other supplier.

Similarly, the use of Ewington as a source of coal for the proposed Collie Power Station has a number of advantages related to coal production and delivery costs as discussed in Section 4.4 that do not exist at other potential sources of coal supply. This is of prime importance to the achievement of the most competitive coal prices and, as a consequence, to the most effective means of supplying electrical power to SECWA.

The no development option is therefore not attractive to the State or to Griffin.

4.4 ALTERNATIVE SITES FOR MINE DEVELOPMENT

Griffin has evaluated a number of alternative strategies to supply coal to the proposed Collie Power Station. The possible sources considered were those reserves which Griffin has identified as being capable of producing coal at lowest costs, ie from the Muja, Chicken Creek, Premier and Ewington deposits, which are illustrated in Figure 1.2. Whilst production of coal from a property close to the point of delivery appeared to be the most logical strategy for supply, other alternatives were also evaluated (see Section 4.5). It was determined, however, that the anticipated coal requirements of the new power station could be most economically sourced primarily from either the Ewington or Premier deposits.

Coal reserves within either the Ewington or the Premier deposits would be sufficient to support the supply of coal to the proposed power station over a 31 year supply period and hence either deposit could form the basis for supply. A preliminary mining study performed on these deposits revealed that neither was likely to produce markedly cheaper coal than the other. Therefore, when considering mining costs alone, there was no reason to prefer one deposit more than the other as the coal source.

A subsequent, more detailed study was carried out in January 1990, utilising newly acquired data, to confirm whether this previous conclusion was still valid. The study also incorporated a number of other factors which had influence upon the choice between the Ewington or Premier deposits as the source of coal supply. It was decided, after analysing the results of the study, that:

- both deposits offered low cost coal of a quality suitable as a power station fuel;
- more information was available on the Ewington deposits, including more boreholes and more coal quality information. In addition, portions of the deposit had been mined previously;
- Premier consisted of a greater number of generally thinner seams, a situation having the potential to make mining more complex, more expensive, and to give rise to greater losses of coal and dilution of coal by waste materials.

Ultimately it was decided that Ewington would form the basis of Griffin's proposal to supply coal to the power station.

4.5 EXPANSION OF EXISTING MINES

A number of strategies to supply coal to the proposed Collie Power Station were evaluated by Griffin. Apart from developing the Ewington and Premier deposits, the possibility of transporting coal across the Collie Basin from Griffin's Muja and/or Chicken Creek operations was also examined. As mentioned in earlier sections, Griffin has long term contracts in place for about 99% of its coal production with 84% of current output going to SECWA and the remainder being sold to private customers. Presently, the Muja mine is the dedicated supply source to SECWA for its Muja Power Station. The Chicken Creek operation principally supplies private customers.

The reserves which would be required to supply a baseload power station for an initial period presently exist at Muja and Chicken Creek under CML held by Griffin. However, the economies of scale derived from expanding these existing operations would not offset the increased costs of transporting the coal from the Muja/Chicken Creek areas to the proposed power station.

In addition, the coal available at Muja and Chicken Creek has a low ash content and the Muja Power Station has been designed specifically for this type of coal. Coal reserves in the northern part of the Collie Basin have higher ash content and as a consequence the power station will have to be designed to use this type of coal. It would be uneconomic to design a baseload power station to accept both types of coal with initial supplies being derived from the southern part of the Collie Basin and subsequent supplies having to be obtained from the northern part of the Basin.

Assessment of the Muja and Chicken Creek operations as supply alternatives for the power station were based upon a comprehensive study of different transport methods, routes and associated costs. The Muja and Chicken Creek operations were considered together with the Ewington and Premier alternatives in order to investigate the overall effect on costs which would result from economies of scale that could be achieved in the expanded mining operations. However, it was determined that the coal supply schedule to the power station could be most economically sourced primarily from either the Ewington or Premier deposits.

4.6 ALTERNATIVE MINING METHODS AND TECHNOLOGIES

A substantial part of the Ewington deposit are suitable to be economically mined by open-cut methods.

Both underground and surface mining methods have been examined for use in developing the comparatively shallow coal reserves for the proposed Ewington mine. Open-cut mining is preferred for economic and safety reasons and also because it provides the most effective means of recovering as much coal as possible.

The coal measures at Ewington consist of a number of seams of varying thickness and depth. Several seams are too thin to be economically mined by current underground techniques and by extracting seams that are sufficiently thick to sustain underground operations access to overlying, thinner seams will not be economically viable.

Open-cut mining methods ensure maximum recovery of coal reserves consistent with the Cabinet statement on the Collie Basin which reads in part *"... in a manner that optimises coal recovery ..."*. Traditional underground mining methods applied in the Collie Basin recover far less than 40% of seams mined although this may be an economically acceptable solution where seams are extremely deep and therefore economically inaccessible to open-cut mining.

Again, the development of the Ewington deposits using the open-cut mining methods and equipment briefly described in this CER offers the most cost competitive means of supplying coal to a new baseload power station in Collie or alternatively to other industrial customers.

5. SITE DESCRIPTION

5. SITE DESCRIPTION

5.1 LOCATION

The proposed Ewington mine will be located in the Collie Coal Basin within the locality of Ewington in the Shire of Collie. Its location is approximately 1.5km south-east of the Collie township. Figure 5.1 shows the location of the proposed Ewington mine in relation to existing infrastructure.

5.2 ABANDONED COAL MINES

Griffin has previously mined coal in the Ewington area. These now abandoned mines are known as Ewington No. 1 and Ewington No. 2 open-cut mines, and Ewington underground mine. Their locations are shown in Figure 5.1. The old Ewington No. 1 open-cut workings will be incorporated into the proposed Ewington open-cut mine. The Ewington underground mine and the Ewington No. 2 open-cut were rehabilitated by Griffin between December 1987 and February 1988.

The disused collieries, Stockton underground and Stockton open-cut, are located approximately 1.5km and 2km south of the proposed Ewington minesite south of the Coalfields Highway respectively.

5.3 SERVICES

Electrical Power

The major power transmission lines that cross in the vicinity of the proposed Ewington minesite are shown in Figure 5.1.

One of the two major transmission lines (330kV) that lead from Muja Power Station to the Perth metropolitan area extends to the north-west for 6km to the northern edge of the Coal Basin. The northern part of this powerline route intersects the proposed Ewington minesite.

Transmission powerlines (330kV) are situated in 60m wide easements and are carried on steel towers 20m to 30m high.

One of six 132kV transmission powerlines from Muja Power Station heads north-west between the proposed Ewington minesite and the Collie township. This powerline runs along the western margin of the proposed minesite. These 132kV powerlines are carried on wooden poles 20m to 25m high.

There are other low voltage powerlines within the Coal Basin. A 66kV transmission powerline leads from the Muja Power Station and extends north-west along the boundary of the Collie Coal Basin to supply the Collie townsite.

. **Water Supply**

A pipeline connecting Muja Power Station with the Great Southern Towns Water Supply (GSTWS) conduit provides domestic water and an emergency back-up for cooling water to the power station. The GSTWS is supplied from Wellington Dam. This pipeline follows the route of the 132kV transmission powerline leading to Collie townsite from the Muja Power Station and runs along the western margin of the proposed Ewington minesite.

Small residential centres within the Coal Basin such as Shotts are supplied with potable water from Harris River Dam. Private bores in these centres also draw on groundwater.

. **Airstrip**

The Collie airstrip is situated east of the Collie township in the Ewington locality. It runs approximately east-west and the proposed Ewington minesite will be approximately 1.5km east of the airstrip.

The airstrip is located such that flight paths involve low level flying over the proposed Ewington minesite and the central business area of Collie. The airstrip is an unlicensed but authorised landing area for local users such as farmers and the Royal Flying Doctor Service. There are no regular commuter services.

The airstrip has recently been upgraded. The gravel airstrip is now 1,200m in length and is safe to Department of Aviation standards for night time operations. The airstrip can be used at night by using portable lighting. There are no protected surfaces surrounding the airstrip apart from the required minimal gradients for the purposes of takeoff and landing which extend 900m from either end of the airstrip. Alternative sites for the Collie airstrip have been identified in the event that there is future need for a licensed airstrip of greater capacity in the Collie area.

. **Railway**

The Brunswick Junction-Narrogin railway passes through Collie, crossing the north-eastern part of the Coal Basin. It passes approximately 1km south-west of the proposed Ewington minesite. This facility fell into disuse in 1983. However, the section between Collie and the Muja Siding has recently been repaired and is now in use in conjunction with the Chicken Creek rail spur which services the Chicken Creek open-cut mine. A second spur extends from Collie to other coal mining operations in the south-west of the Coal Basin.

. **Roads**

The Coalfields Highway is the main road which services Collie. It passes through the Coal Basin linking Collie to the South Western Highway at Roelands and Darkan to the east. This road was substantially upgraded a number of years ago, to service the alumina industry at Worsley. It is currently being upgraded east of Collie. The proposed main access to the proposed Ewington minesite is from the Coalfields Highway.

The Collie-Williams Road is a secondary road (unsealed in the Shire of Williams) which skirts the Collie Coal Basin to the north-east, some distance from the proposed Ewington minesite. There are no other public roads between this road and the northern boundary of the minesite.

There are three roads in the vicinity of the proposed Ewington minesite which are used to access surrounding areas. Barnes Road, which accesses Griffin's Blue Waters Farm and leads into the Collie township, the airstrip access road and Davis Road.

Barnes Road is sealed to Blue Water Farm and was the original main access to the old Ewington Nos. 1 and 2 open-cut mines. This road passes through part of the area which will be mined.

The majority of the airstrip access road (as it is known) is sealed, although partly unsealed near its junction with Bullfinch Road. It is also the only access to the pistol range.

Davis Road is the direct access to the airstrip from the Collie township and is fully sealed.

5.4 LAND USE

Land use in the vicinity of the proposed Ewington minesite, and the region in general reflects Collie's long-established economic base of coal mining, electricity generation, forestry, grazing and agriculture. Currently envisaged land uses for the area in the vicinity of Collie are provided on Figure 5.2.

The Collie Land Use Working Group identified priorities for land use within the Coal Basin catchment that are considered to be appropriate. Those heading the list are coal mining, electricity generation and water supply. The Collie Basin Management and Planning Group has recently proposed long term land use strategies for the coal basin area and these strategies have been released for public comment as part of the Collie Basin Structure Plan for the Bunbury-Wellington Planning Study.

Coal Mining

Currently there are five open-cut and two underground coal mines operating in the Collie Basin. There are also a number of additional areas containing economically accessible coal reserves within the Basin.

Coal mining is identified as the principal land use within the Collie Coal Basin because of:

- the availability of large quantities of coal,
- the economic importance of coal as a fuel source for baseload power generation (refer Section 4.2) and as a raw material for industrial processing,

- the potential economic advantages to the State and the nation from development of a coal-fired, baseload power station in Collie (refer Section 2.2).

. **Electricity Generation**

The value of the coal reserves within the Collie Basin as a source of energy is recognised as discussed above. However, export opportunities for Collie coal do not presently exist. As such, the value of the resource can best be realised by using it as a fuel source for baseload power generation. The comparative economic value of a coal-fired, baseload power station has been discussed in Section 2.2 and in Section 4 of this CER.

A key aspect in developing the cheapest possible electrical power supplies is the need to locate power station facilities as close as possible to the source of coal. This is the case with Muja Power Station. The Ewington coal deposits are similarly situated in close proximity to the proposed baseload power station as shown on Figure 5.1.

. **Water Supply**

The Collie Coal Basin is a major source of surface water and groundwater; both have been developed for supply purposes and both have potential for further development.

The east and south branches of the Collie River, which ultimately supply the Wellington Dam, pass approximately 5km east and 4.5km south-west of the proposed Ewington minesite respectively. There are a number of supply borefields in the Collie Coal Basin including the townsite's water supplies and Shotts borefield which supplies Muja Power Station.

A key requirement in the successful mining of coal in the Collie Basin is the need to dewater the mine areas. The dewatering process removes large quantities of groundwater from above, between and below the coal seams to ensure mining can be carried out in safe working conditions. Dewatering of a major open-cut mine such as Ewington necessitates the extraction of large quantities of groundwater.

Power generation using conventional coal-fired power station technology requires considerable quantities of good quality water for steam generation and for cooling purposes. It is the stated policy of WAWA to utilise coal mine dewatering water for power station purposes. In this way maximum use is made of the groundwater resources that must necessarily be extracted to supply coal to the power station.

. **Urban**

Collie is the urban focal point for the area, with associated residential, industrial and commercial land uses. Collie owes its existence to the primary land uses and supplies the necessary workforce and support. Collie has adequate infrastructure in place to support and function with the development of a further minesite in the area. This infrastructure already supports a large population and potential exists for support of an even larger population base. Collie had a wide range of community facilities to

cater for the needs of youth, the elderly and education, recreation, retail, housing, medical and support services. The Shire of Collie, from previous experience, understands the potential constraints and demands of such development and is in a good position to react.

The locality of Ewington comprises the eastern portion of the Collie townsite. This area mainly consists of larger lots developed as residential blocks and hobby farms. The proposed Ewington minesite will be 1.5km from the townsite boundary and will be approximately 2km east of the nearest home and 3.5km from the township centre. Other urban areas in the Collie Basin and in close proximity to the Ewington minesite are Shotts townsite which is approximately 3km south-east of the proposed Ewington minesite and Muja, Collie Burn and Cardiff townsites.

The only industrial land use in the vicinity of the proposed Ewington minesite is the Bunnings Sawmill located at the west junction of Bullfinch Road and the airstrip access road.

. **Recreation and Conservation**

The Collie Basin has extensive natural areas which are scenically attractive and considered to be ecologically important.

There are specific recreation and conservation areas recognised in the Collie region. The Westralia Conservation Reserve is a sizeable area situated immediately west of the Collie townsite and abutting the Collie River. Previously a State Forest Management Priority area, it is now a reserve specifically designated for recreation, conservation and study of natural ecosystems.

As an important regional centre Collie has a large number of community recreation facilities, the majority of which are located in the southern portion of the townsite. The only recreation facility in the vicinity of the proposed Ewington minesite is a pistol range located approximately 1km west of the minesite near the airstrip.

. **Forestry**

The Collie Basin has in the past been a significant timber producer, but timber production is not currently a major activity. The forest is valued for recreation and nature conservation. Much of the forest is affected by dieback. The State Forest in the vicinity of the proposed Ewington minesite is not a designated Disease Risk Area.

. **Agriculture**

The generally poor agricultural qualities of the Coal Basin soils have deterred clearing for agriculture except for some low lying alluvial areas in the eastern end of the Basin. Most of these eastern areas are privately owned by Griffin and another coal mining company who operate them as farms. In the vicinity of the proposed Ewington minesite the areas to the north are used for agriculture, being outside the Collie Coal Basin. There are also a few rural properties to the south-east.

5.5 LAND TENURE

There are four main categories of land tenure in the Collie Basin: State Forest, rural land, townsites and reserves for recreation and various other purposes (Figure 5.2).

Land tenure with respect to the proposed Ewington minesite is shown on Figure 5.3. The majority of the land which the intended development would cover is Crown Land vested in the Department of Conservation and Land Management (CALM) as State Forest. All of the private property which will be affected by the Ewington minesite is owned freehold by Griffin and consists of partially cleared woodland which is used for grazing.

SECWA has purchased land abutting the north-eastern corner of the Ewington minesite and a property in close proximity south of the minesite. Others also own land in the Coal Basin.

5.6 ZONING

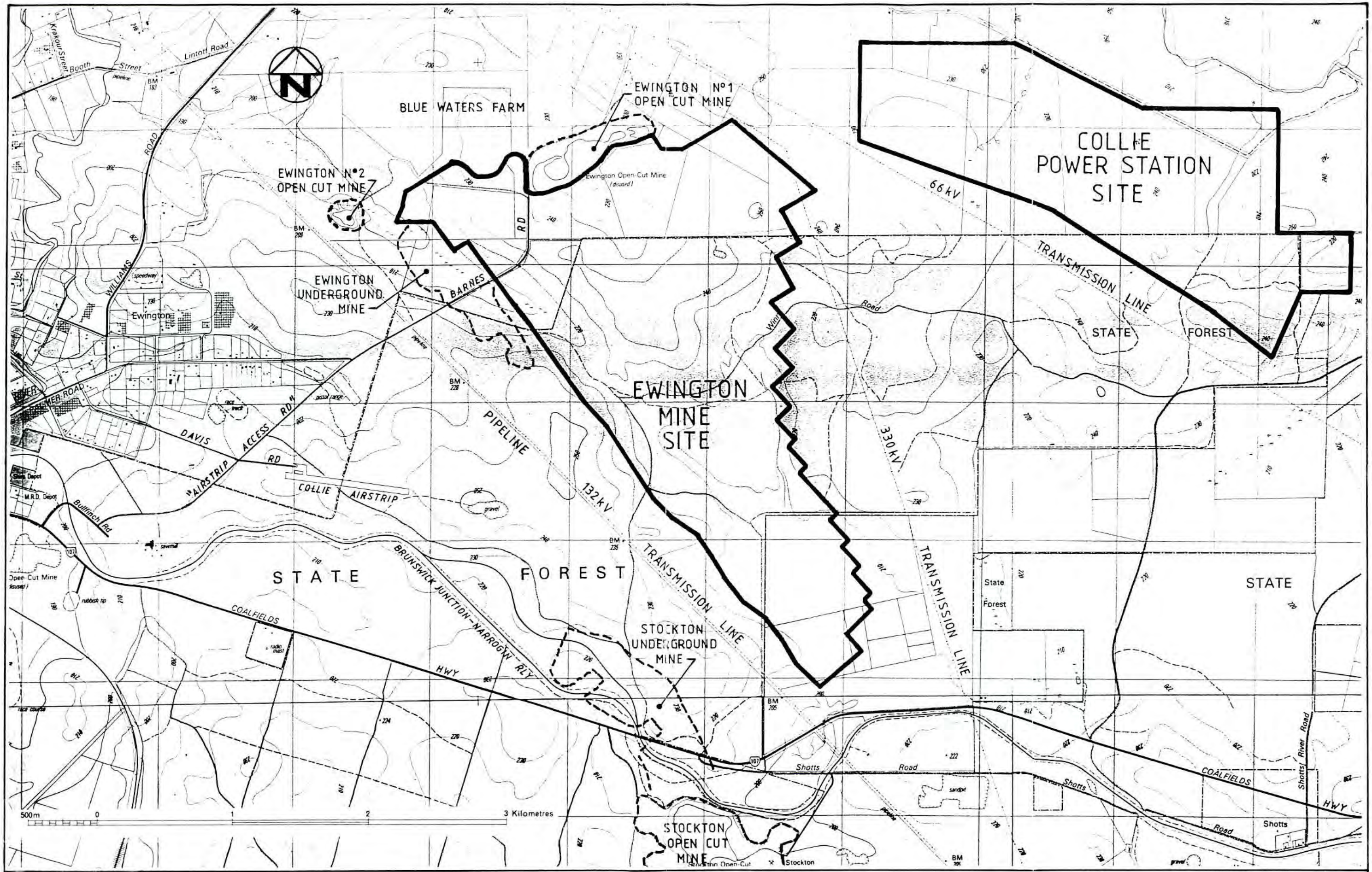
Rural land in private ownership, townsites and urban areas are all subject to provisions contained in the district zoning scheme. In the vicinity of the proposed Ewington minesite the eastern part of the Collie townsite is zoned special residential. The agricultural land to the north and east is zoned rural. The majority of the Ewington minesite area is zoned for forestry with the remaining freehold blocks zoned as rural. Shotts is a gazetted townsite.

5.7 COAL MINING LEASES

As mentioned previously, Griffin has 92 approved CML and 4 tailings leases of which it has title to approximately 75 CML in the Collie Basin under the Agreement Act, with the principal leases being those associated with the Muja and Chicken Creek mines and the Ewington/Premier coal deposits.

The coal resources within Griffin's Ewington and Premier deposits occur within 37 CML to which Griffin currently holds title and 5 CML for which Griffin has applied for title. The 42 tenements cover an area of 38.5km^2 and are currently free of encumbrances and coal reserve commitments. The CML are shown on Figure 5.4.

Under the terms of the Collie Coal (Griffin) Agreement Act, 1979, the various Griffin CML are valid for a period of 21 years with facility for an extension of the currency of those leases for a further 21 year period. Further extensions to the term of the Collie Coal (Griffin) Agreement Act are under negotiation.



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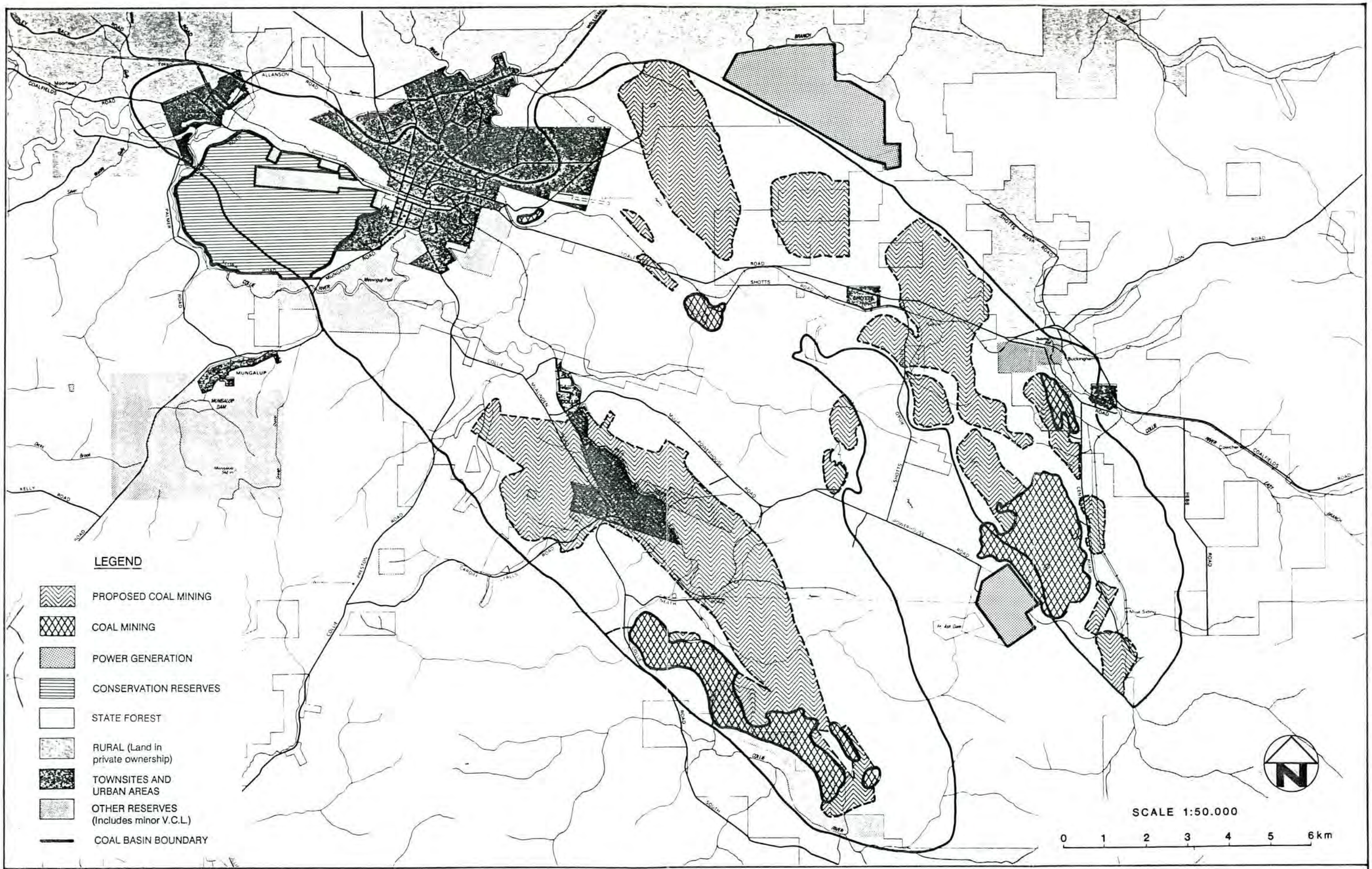
SERVICES

FIGURE 5.1



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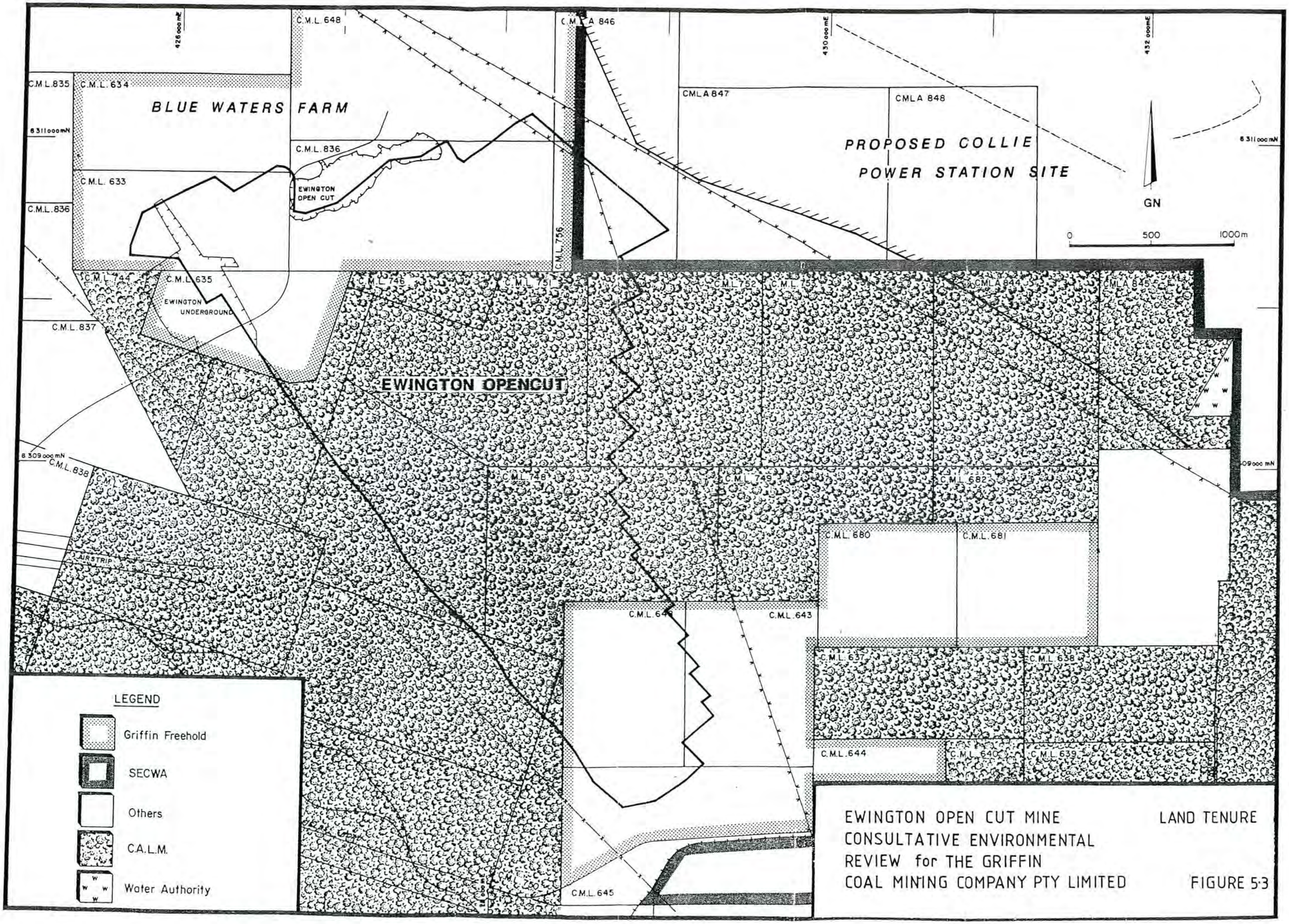
LAND USE AND TENURE

FIGURE 5·2



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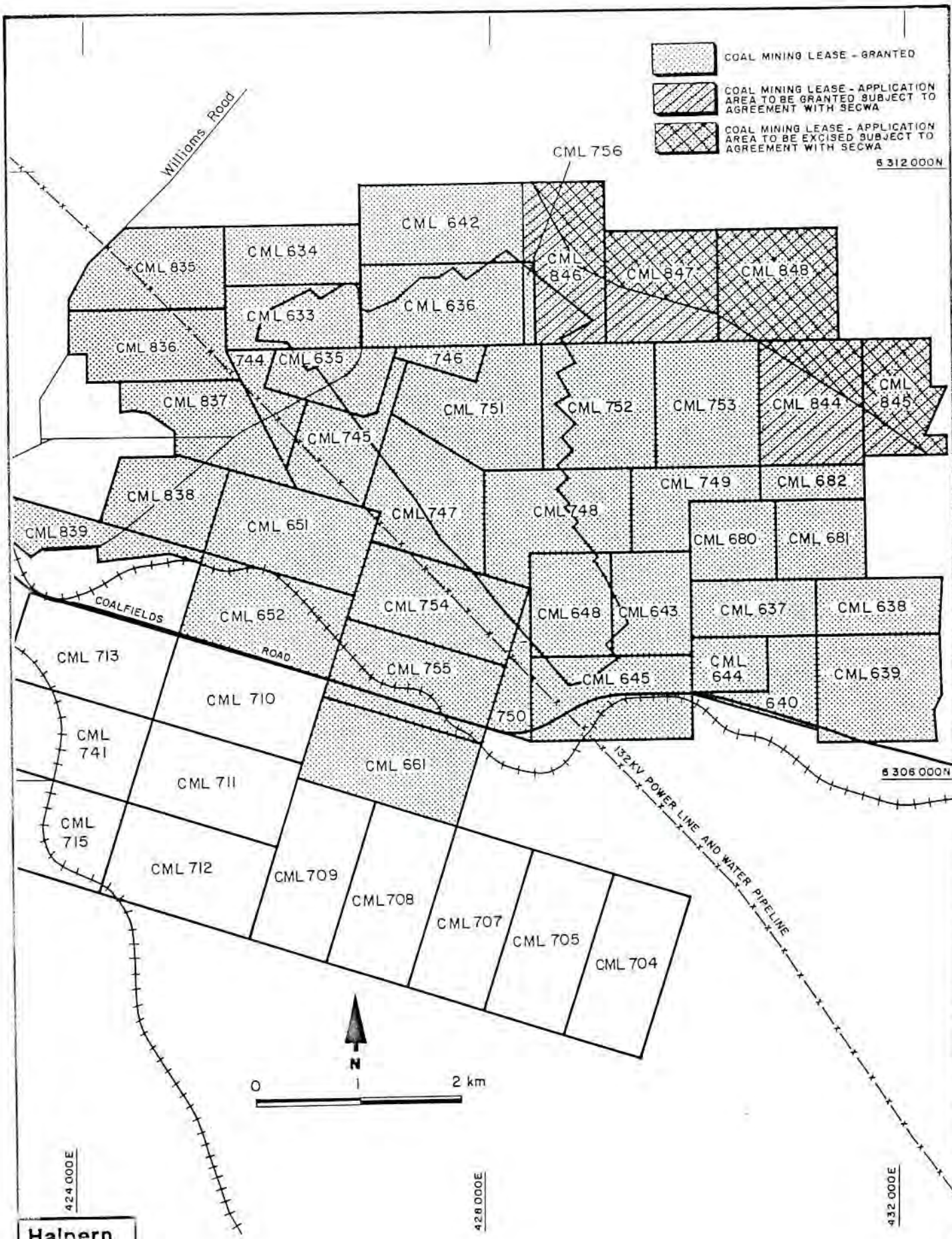
REVIEW for THE GRIFFIN
COAL MINING COMPANY PTY LIMITED

LAND TENURE

FIGURE 5·3


COAL MINING LEASE - GRANTED
COAL MINING LEASE - APPLICATION AREA TO BE GRANTED SUBJECT TO AGREEMENT WITH SECWA
COAL MINING LEASE - APPLICATION AREA TO BE EXCISED SUBJECT TO AGREEMENT WITH SECWA
6 312 000N
Williams Road
CML 756
CML 642
CML 634
CML 835
CML 846
CML 847
CML 848
CML 636
CML 633
CML 836
744
CML 635
746
CML 837
CML 751
CML 752
CML 753
CML 844
CML 845
CML 745
CML 838
CML 749
CML 682
CML 747
CML 748
CML 839
CML 651
CML 680
CML 681
COALFIELDS
CML 652
CML 754
CML 648
CML 643
CML 637
CML 638
ROAD
CML 713
CML 755
CML 645
CML 644
CML 639
CML 710
640
CML 741
750
CML 661
6 306 000N
132KV POWER LINE AND WATER PIPELINE
CML 711
CML 715
CML 712
CML 709
CML 708
CML 707
CML 705
CML 704
N
0
1
2 km
424 000E
428 000E
432 000E
Halpern Glick Maunsell
EWINGTON OPEN CUT MINE
CONSULTATIVE ENVIRONMENTAL REVIEW
for THE GRIFFIN COAL MINING COMPANY PTY LIMITED
COAL MINING LEASES
FIGURE 5·4

6. EXISTING ENVIRONMENT

6. EXISTING ENVIRONMENT

6.1 REGIONAL PERSPECTIVE

The proposed Ewington minesite is located within the Darling Plateau, a physiographic unit on the Yilgarn Block of Archean age, consisting of extensive dissected uplands. Geologically, the Darling Plateau consists mainly of ancient crystalline and metamorphic rocks. Several small sedimentary basins, including the Collie Coal Basin, lie within the plateau.

The Darling Plateau is vegetated by an array of vegetation complexes with Jarrah *(Eucalyptus marginata)* as the dominant species. Collectively known as the Northern Jarrah Forest, these complexes cover an area extending from Perth to Collie and bounded by the coastal plain to the west and by the wheatbelt to the east. It is largely uncleared State Forest.

The region experiences cool to mild, wet winters and hot dry summers. The marked seasonality of rainfall is reflected in the surface hydrology, in that surface water flow and wetlands are largely ephemeral.

6.2 CLIMATE AND METEOROLOGY

This section summarises the available climatic data for the Collie area. The data shows that the Collie area experiences a climate characterised by warm, dry summers and cool, wet winters.

Temperature

Mean summer maximum and minimum temperatures are 31°C and 12°C respectively. Mean winter maximum and minimum temperatures are 16.5°C and 4.7°C respectively. The monthly variation in mean temperatures is illustrated in Figure 6.1.

Rainfall

Collie has an average annual rainfall of 988mm. The proposed Ewington minesite is expected to have a similar average annual rainfall.

Rainfall in the area is seasonal. Winter rainfall (April to October) totals 880mm, whereas summer rainfall (November to March) totals 100mm. Collie is situated between the 1000mm and 800mm rainfall isohyets. Evaporation exceeds rainfall for seven months of the year and totals 1,500mm per annum. East of the Collie area, rainfall decreases markedly.

Rainfall intensities for Collie from the Bureau of Meteorology are 74mm/hr and 82mm/hr for 10 year and 100 year events respectively. Rainfall and evaporation data are shown graphically on Figure 6.1.

- **Wind**

Seasonal wind roses based on data recorded at Collie post office are shown on Figure 6.2. The most common winds are south-easterlies which occur most frequently on summer mornings. West to north-west sea breezes occur on summer afternoons and stronger west to south-west winds occur during the passage of cold fronts during winter periods.

Local topography will not significantly affect wind direction thus this data is representative of winds at the proposed Ewington minesite.

- **Flood Risk**

Records indicate that flood events are rare due to relatively consistent winter rainfall. However, exceptionally wet winters may cause isolated flooding. Collie experienced severe flooding in 1926 and 1964, following above average rainfall throughout the State.

The minor susceptibility of the Collie township to flooding arises from its location close to the Collie River. In comparison, the proposed Ewington minesite is located 20m higher in elevation and for this reason has low flood risk.

6.3 LANDFORM AND SOILS

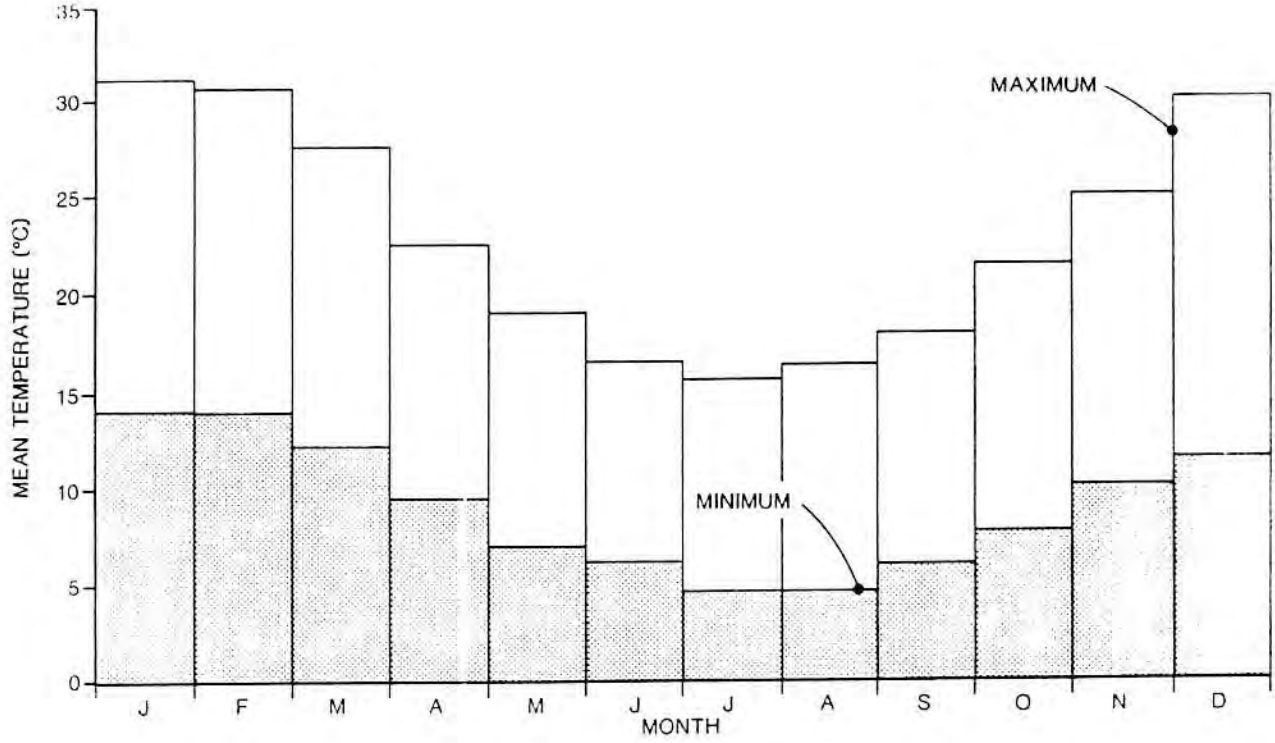
The low-relief laterite ridge and hill landscapes in the Ewington area are a product of weathering of the Permian Coal Measures and the younger Nakina Formation. Erosional modifications to this laterite blanket have created two landform units. They are:

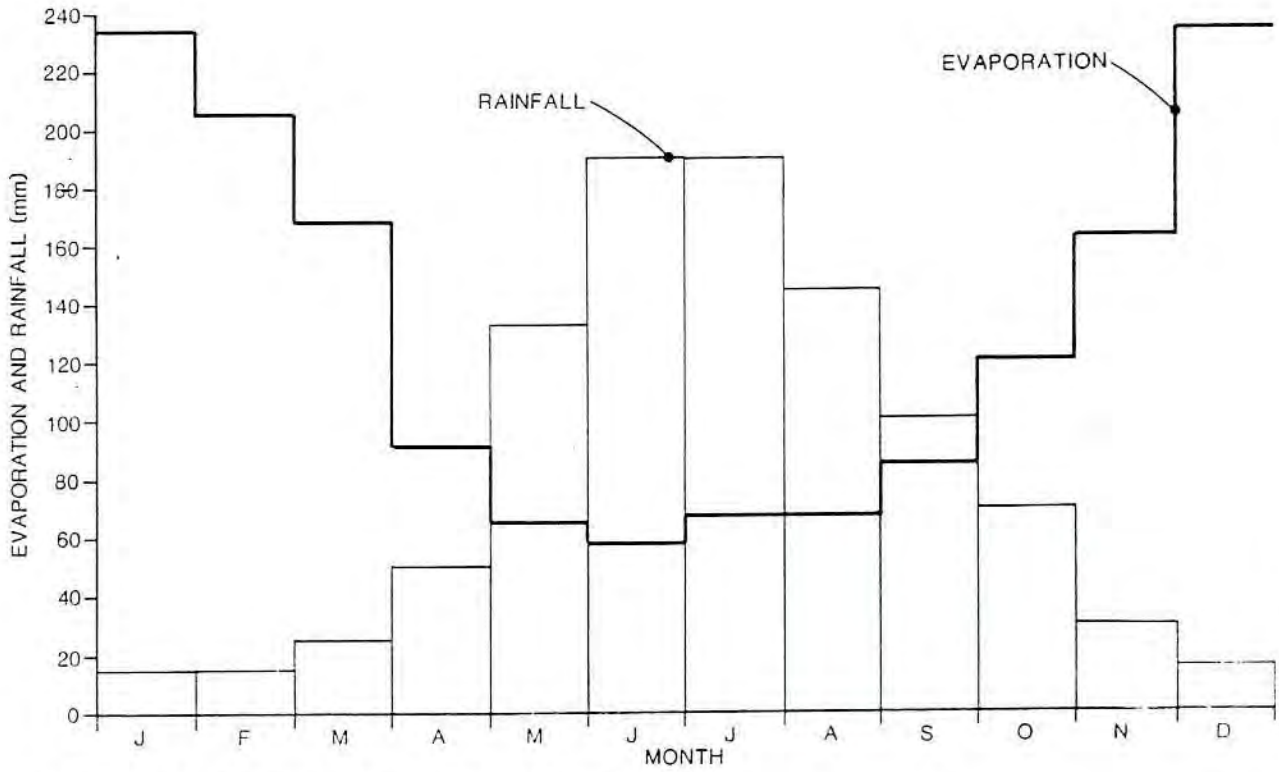
- The Collie landform unit which consists of gently undulating lateritic uplands dominated by duricrust, gravels and grey sands, and

- The Cardiff landform unit which is expressed by broad, shallow swampy depressions dominated by grey sands.

The western and eastern margins of the Ewington minesite are dominated by the Collie landform unit which occupies broad flat interfluves (between streamlines). Undulations are between 220m to 240m AHD on the ridges and slopes are between 5 to 15^{o}.

The Cardiff landform unit occurs over the central strip and southern part of the minesite. This unit is associated topographically with the laterite and is a gently undulating landscape dominated by sands in broad valley floors. Swamps may occur in lower topographic positions.





NOTE: Rainfall and Temperature quantities from Collie Post Office.
Average Evaporation figures from Dwellingup Post Office.

SOURCE: Bureau of Meteorology

EWINGTON OPEN CUT MINE
CONSULTATIVE ENVIRONMENTAL REVIEW
for THE GRIFFIN COAL MINING COMPANY PTY LIMITED

MONTHLY TEMPERATURE, RAINFALL AND EVAPORATION

FIGURE 6.1

The Collie Environmental Geology Sheet (Gozzard and Jordan, 1986) gives detailed boundaries of the surficial lithological units on these landforms. The main units are laterite, sand and gravel. The surface soils within the development area are shown on Figure 6.3 and described below.

. **Laterite**

Massive, hardened but non-cemented, with fine to medium angular quartz, occasionally well rounded quartzite pebbles. Extensive deposits occur on ridge crests.

. **Gravel**

Yellow-brown to dark reddish-brown, pea and irregularly shaped, poorly sorted with sand and silt in the matrix. Widely distributed gravity deposits found on gentle slopes.

. **Sand**

- Fawn to strong brown, fine to medium, sub-angular quartz, some fines, typically leached at surface, poorly sorted. Largely gravity deposited.
- White to pale grey, fine to coarse, angular to sub-angular quartz, little fines, poorly to moderately sorted. Occasionally some pebbles of rounded quartz. Typically found in broad, shallow valleys which are well drained with a high water table.
- Grey to strong brown, fine, sub-angular quartz, well sorted, leached at surface.

The mainly sandy and gravelly soils in the Ewington area are physically poor, chemically infertile and have poor water and nutrient holding capacities.

6.4 GEOLOGY

6.4.1 Collie Basin Setting and Structure

Collie coal occurs in a structural body termed the Collie Basin. The Basin occurs within crystalline basement (including gneiss, granite) of the Yilgarn Block. It is a graben, fault-bounded on the north/ north-east and south/south-west sides, in which the central portions were depressed and infilled with sediment during the Permian period.

The Collie Basin is elongated north-west to south-east, is 26km long and 15km wide with a total area of 230km^2. It consists of three sub-basins Shotts, Muja and Cardiff. The Ewington Deposit occurs on the western flank of the northern Shotts Sub-basin (refer to Figure 1.2 in Section 1).

The Sub-basins are broadly basin-shaped. Normal faults are generally north/north-west striking. They commonly have vertical displacements ranging from minor to 150m. Separation of faults with vertical movement ranges from 0.5 to 1.2km. The dip of the bedding is low, 2^{o}-10^{o} but does increase to about 50^{o} near some faults.

In the Ewington area, the fault displacements increase in magnitude from the Basin margin toward the Basin centre. It is probable that the major portion of the proposed mine area is within fault blocks of greater than 100m width.

The only significant fold axis in the Ewington area is the syncline which forms the Sub-basin axis and plunges gently east/south-east. In the area of the Ewington deposits, the axis plunges at 3^{o} and beds dip towards this at 4.5^{o} from the north/north-west and at 3.6^{o} from the west/south-west.

6.4.2 Collie Basin Stratigraphy

The sediments of the Collie Basin are comprised of two formations, the basal Stockton Formation and the overlying Collie Coal Measures. They are unconformably overlain by the Nakina Formation (Figure 6.4).

The Stockton Formation is of Lower Permian age and contains siltstone, sandstone and claystone. In the Ewington area it is approximately 50m thick.

The Collie Coal Measures conformably overlie the Stockton Formation and date back to late Lower to late Upper Permian. Three component Members are recognised, the Ewington Member covers the whole Collie Basin; the other two members are the Premier Member and the Muja Member.

The Ewington Member (Figure 6.5) consists of sandstone, siltstone, shale, carbonaceous shale and coal. Bedding is lenticular and the sands are poorly sorted. This member was deposited in an energetic environment, dominated by stream channel deposits encroaching into lake-type, finer grained sediments. The carbonaceous shale and coal were deposited in open water to bog conditions during regionally extensive still periods. Rapid changes in the environment of deposition are indicated by widespread coarse-grained sands overlying carbonaceous shale.

The Premier Member conformably overlies the Ewington Member in the Shotts Sub-basin. It consists of up to 220m of shale and sandstone with a minor thickness (up to 18m) of coal in up to fifteen separate seams.

The Nakina Formation unconformably overlies the crystalline basement and Permian sediments in the Collie region. It is an uncompacted clayey, conglomeratic sandstone which was deposited in a lake to stream-like environment. The thickness varies and is less over the basement than over the Coal Basin where it ranges from 10m to 18m just east of the Ewington deposits. These sediments were deposited in a similar environment to the Permian sediments and are derived from the same rock. They were deposited over a long period ranging from Cretaceous to Tertiary.

Overlying the Nakina Formation is a veneer of Quaternary sand. In the valleys this is quite thick, but over hills it thins out. Near-surface rocks in the region were intensely weathered and laterised at various times from the Cretaceous to late Tertiary. This has resulted in development of ferricrete at shallow depths. This rock type ranges from a weak, nodular ferricrete to massive sheets up to 3m thick of strongly cemented nodular to columnar and massive ferricrete.

6.4.3 The Ewington Member

The coal seams in the Ewington deposits all occur in the Ewington Member of the Collie Coal Measures. The coal seams considered to be of economic importance occur towards the base of the Member and are known as the Moira, Stockton and Wallsend seams. Seventeen separate coal seams and other carbonaceous units have now been identified within the Ewington Member (Figure 6.5).

The Moira seam is designated as seam E10. The majority of Stockton and Wallsend seams are designated E20 and E30 respectively. Two beds of clays, shales and associated coal splits close to the floor of the Stockton seam and the roof of the Wallsend seam are identified separately from the main seams as units E22 and E28 respectively. These coal seams are described below.

The Moira seam, the uppermost seam considered to be economically extractable, is present throughout the Ewington deposits, although it deteriorates in an area in the north-west. Within this area it is continuous but is either thin (<0.3m) or contains excessive amounts of clays and shales.

The Stockton seam is one of the two dominant coal seams in the Ewington deposits. A clay/shale horizon near the base of the Stockton seam is the top of unit E22. It is a lenticular body which is not present in the north-western part of the deposit.

Unit E28 is a gradational carbonaceous unit with a restricted distribution within the deposit, being present in the west, north-west and north but commonly absent in the central and south-east parts.

The Wallsend seam is the lower of the two dominant coal seams in the Ewington deposits. It is present throughout the deposit with a sharp lower contact, but variable roof contact.

Unit E32 is a laterally persistent thin coal unit which occurs 1.5 to 4.5m below the floor of the Wallsend seam.

The upper Ewington Member consists of a sequence of up to 170m of sandstone, mudrock (silty shale to clayey siltstone), shale, some of which are highly carbonaceous, and thin coal seams, underlying the lowest Premier Member coal seam. Although this sequence is dominantly clastic, high to low ash-bearing carbonaceous units occur within the interval but the majority are laterally lenticular and therefore not regular and easily recognisable.

Considerable variation in interburden lithologies occurs across the deposit, ranging from coal through clay/shale units to coarse grained sandstones. There are local variations related to the abundance of sandstone rock types, which represent localised channel sand deposition.

6.5 SURFACE HYDROLOGY

6.5.1 Surface Flow

The proposed Ewington minesite is located within the drainage basin of the Collie River east and south branches (see Figure 6.6). These tributaries flow to the west and north respectively to join the Collie River, which enters the Wellington Dam downstream of Collie. Wellington Dam provides domestic water to Collie and the Great Southern towns as well as irrigation water to the coastal plain.

Flow in the Collie River east and south branches are highly seasonal. In summer and autumn, flow is commonly nil, while in July and August flows of up to 60 million cubic metres/month have been recorded.

Definite channels leading north-west from the proposed Ewington minesite (Figure 6.6) indicate seasonal streams draining the area to the Collie River. Photographic records indicate that streamflow in these channels ceases by late summer.

Extensive areas of sparse, sedge-type vegetation on the southern part of the minesite are subjected to annual inundation (Figure 6.6) and there is a definite channel running from the north into this area. Approximately half of the proposed minesite and adjacent lowlands to the south and east naturally drain through seasonal swamplands into the abandoned Stockton Open-Cut which seasonally overflows and discharges along a streambed to the south branch of the Collie River. A proportion also drains north-east into the Collie River East Branch via a network of seasonally inundated low lying areas. The confluence of the drainage from Stockton Open-Cut and the Collie River South Branch occurs just north of Collie Burn.

Although the proposed Ewington minesite is situated in relatively close proximity to the Collie River East Branch, it appears that streamflow to this tributary predominantly results from a series of springs located downstream of the boundary of the Coal Basin sediments. It appears that flow derived from headwaters within the Collie Coal Basin rarely enters the Collie River East Branch. Streamflow in the Basin generally flows in a westerly direction to enter the Collie River or Collie River South Branch.

6.5.2 Water Quality

On average 27% of the annual flow of the Collie River System arises from the south branch and 37% arises from the eastern portion of the catchment, including the Collie River East Branch, Bingham River and Chicken Creek.

The concentration of Total Dissolved Solids in water within the Collie River catchment varies widely. Flow weighted TDS concentrations in the east and south branches of the Collie River are 1,026 and 900mg/L respectively. The former figure includes runoff from the Bingham River. TDS concentrations would therefore be expected to be higher than 1,026mg/L in east branch runoff prior to mixing with the better quality water of the Bingham River. Samples collected from the east branch during site surveys for a proposed power station in 1984 gave TDS concentrations of 1,400mg/L in August and 2,300mg/L in October. Samples collected by Griffin from the Collie River East Branch in 1988 as part of its monitoring programme, give TDS concentrations of 1,800mg/L in August and 2,000mg/L in October. The average annual pH for both the Collie River East and South Branches is 7.0.

6.6 HYDROGEOLOGY AND GROUNDWATER

The following discussion is an overview of the hydrogeological and groundwater aspects of the Ewington area. A more detailed description prepared by a specialist consultant is provided in Appendix C.

6.6.1 Hydrogeology

The proposed Ewington minesite lies adjacent to the edge of the Collie Basin which functions as a boundary between areas of different geology and stratigraphy (refer to Section 6.4). Groundwater hydrology is markedly different on either side of the boundary.

Outside of the Collie Coal Basin, unconfined groundwater occupies fractures in the basement rock and pore spaces in the overlying lateritic soils. The lateritic soils contain relatively permeable zones through which water percolates readily.

Within the Collie Coal Basin, the hydrogeology is more complex. The highly permeable sandstones of the Collie Coal Measures (Figure 6.5) form a multilayered aquifer system. Six or seven aquifers have been identified in the sequence. These are separated by shales, siltstones and coal seams of low permeability that confine groundwater in the sandstone. Although restricted, there is flow between the aquifers due to faults, discontinuous confining beds, washouts, mine workings and poorly constructed bores, which provide vertical pathways for groundwater movement.

Unconfined groundwater occurs in the overlying Nakina Formation and Quaternary alluvium known as superficial sediments. It is recharged by the direct infiltration of rainfall and from flows in branches of the Collie River. In dry periods, groundwater discharges to creeks and rivers from the shallow aquifer.

Recharge to the sandstone aquifers in the coal measures occurs by infiltration from the shallow, unconfined aquifers within the Nakina Formation and Quaternary alluvium and around the margins of the Sub-basins where the sandstone strata subcrop beneath permeable soils. Infiltration rates in many areas are very high due to the presence of deep coarse sands and gravels at the surface. However, downward percolation is limited in places by the presence of clay sediments.

6.6.2 Groundwater Quality

Groundwater in the coal measures and the overlying superficial sediments is generally fresh, with salinities mostly less than 500mg/L TDS. There is some water of higher salinity near the Basin margins, and in the basal Stockton Formation.

As is typical of groundwater in coal measures, the pH is usually slightly acidic and it can have high concentrations of dissolved iron and sulphate, especially near old mine workings. High levels of iron and sulphate bacteria can be present, especially in production bores.

There has been no rigorous assessment of water quality in the Ewington area. The limited water quality data is described below.

Twenty bores sampled in 1984 ranged in salinity from 125 to 832mg/L TDS. The average salinity was 388mg/L TDS and during the ten day pumping test, the salinity of water from a production bore decreased from 388 to 282mg/L TDS.

Eight bores sampled in 1990 ranged in salinity from 52 to 400mg/L TDS and averaged 273mg/L TDS. Seven of these bores had also been sampled in 1984 and all showed significantly lower salinity in 1990.

The pH of water from the bores resampled in 1990 has declined from 4.6-7.5 to 2.8-5.5. Bicarbonate and Total Iron concentration has also decreased. Total Iron concentrations ranged from <0.1 to 7mg/L in 1990 and 0.05 to 13.5mg/L in 1984.

The results of the 1990 samples may be attributable to chemical conditions in the bores caused by iron or sulphur bacteria. The best estimate of short term groundwater quality derived from the 1984 samples is shown in Table 6.1.

TABLE 6.1

ESTIMATED SHORT TERM GROUNDWATER QUALITY

pH	5.4
TDS	388
Na^+	101.5
Cl^-	190.3
SO_4^{2-}	8.0
SiO_2	<5.0
Fe (soluble)	<0.05
Fe (total)	1.5

nb. All units are mg/L except pH

6.6.3 Groundwater Temperature

Temperature at the water table is likely to be about 18°C, the geothermal gradient would probably increase by about 2°C per 100m depth.

6.7 AIR QUALITY

No direct measurements of air quality parameters are available for the proposed minesite or adjacent land. Therefore existing air quality must generally be inferred on the basis of neighbouring land use.

The most significant local sources of atmospheric emissions are the Muja open-cut mine, Muja Power Station and the Collie townsite.

The power station is a source of sulphur dioxide while motor vehicles emit nitrous oxides and minor quantities of hydrocarbons. The power station and Muja open-cut mine are sources of particulates such as dust. Agricultural and forest management activities including fires could occasionally contribute particulates such as dust and ash.

None of the sources discussed above are likely to currently exert a major impact on air quality at the proposed site.

6.8 BACKGROUND NOISE

The noise environment of the proposed Ewington minesite was surveyed by specialist acoustic consultants during December 1990. The survey entailed measurement of the ambient noise levels in the vicinity of the proposed minesite and residential areas in the eastern part of the Collie townsite. The specialist report is included in Appendix D. A brief overview of the background noise of the Ewington area is provided below.

The Ewington area is currently not subject to any significant and continuing sources of noise or vibration, although the pistol range, speedway, airstrip and Bunnings sawmill would all contribute some proportion of noise with varying tonal characteristics. The former three would be either occasional or discontinuous sources, whereas the sawmill would have a much larger impact.

Between 10pm and 7am, which is the period during which urban noise level is generally regarded as being at its lowest, the background noise level was measured to be 27dB(A). The measurements from which this level was determined were taken at the north-east corner of the town boundary. This level is considered to be very typical of a residential area.

6.9 LANDSCAPE

The proposed Ewington minesite is located in close proximity to the Collie township on lateritic uplands which are approximately 20m higher in elevation than the Collie townsite (see Figure 6.6). The majority of the proposed minesite is State Forest and uncleared freehold blocks. Thus the minesite area forms a natural backdrop to the Collie township, although on its own, it would not be regarded as a major aesthetic asset to the township.

The extensive natural area in which the proposed minesite is situated is of value to outdoor recreation and tourism.

6.10 VEGETATION AND FLORA

The vegetation and flora of the proposed Ewington minesite was surveyed by specialist botanical consultants during January 1991. The survey entailed preparing species lists for the area, mapping and describing the vegetation associations present. The specialist report is included in Appendix E. A brief overview of the vegetation and flora of the Ewington minesite is provided below.

6.10.1 Flora

A total of 52 families, 143 genera and 252 species were recorded on the proposed Ewington minesite. Of these 252 species, 12 were introduced weed species. Several groups of plant species were not recorded due to seasonal conditions. An estimated 70% of the total range of flora species were recorded.

Dominant families were Myrtaceae (29 species), Proteaceae (24 spp.), Papilionaceae (24 spp.), Cyperaceae (16 spp.), Epacridaceae (14 spp.), Asteraceae (12 spp.), Poaceae (11 spp.), Dillenaceae (10 spp.), Dasypogonaceae (10 spp.), Restionaceae (9 spp.), Haemodoraceae (9 spp.) and Mimosaceae (8 spp.).

The species list prepared for the Ewington minesite is included in Appendix E.

6.10.2 Rare or Restricted Flora

A range of potentially rare and restricted species were defined by the specialist botanical consultant for the Collie area. Only two of these were recorded near the Ewington minesite, *Restio ustulatus* and *Hibbertia silvestris*. No gazetted rare species were recorded on the Ewington minesite.

Restio ustulatus occurs on the valley floors in the southern extensive clay swamps. This species is known from several localities in the central forest area from Busselton to Scott River, some of which are lands not under immediate threat. Under current listings this species is regarded as vulnerable and is under consideration for declaration as rare flora, but it is in need of further survey.

Hibbertia silvestris occurs on the lower and mid sandy-loam to sandy clays with some gravels on the Ewington minesite. This species is known from several localities from Waroona to Collie. Its status is identical to that of *Restio ustulatus*.

6.10.3 Species of Interest

A range of species are of particular interest as they manifest different patterns of distribution in the Collie Basin from the adjacent forest areas on the Darling Ranges, reflecting the predominance of sandy and moist soils, particularly in the Ewington area. These species include *Adenanthos obovatus, Baeckea camphorosmae* and *Hypocalymma angustifolium*.

Other species reflect local extremes in site conditions, reflecting similar conditions in the adjacent forest areas on the Darling Ranges and Swan Coastal Plain. These species include *Allocasuarina humilis, Actinostrobus pyramidalis* and *Allocasuarina microstachya*.

Some species which appear to be of geographical or taxonomic interest are *Baeckea aff. pressiana, Restio ustulatus, Calytrix ? similis* and *Lachrostachya albicans*. This species require further studies to clarify their significance.

The vegetation survey indicated an overlap in distribution of some plant species with adjacent region and also reflected the significance of the local soils and site conditions on the distribution of plant species.

6.10.4 Vegetation

The vegetation on the Darling Ranges consists primarily of an open forest of *Eucalyptus marginata - Eucalyptus calophylla* on the drier sites and open woodland of *Melaleuca preissiana* on the seasonally moist and wet swamps.

The flora and vegetation of the Collie Basin reflect the underlying geology, landforms and soils. Three vegetation complexes have been previously defined in the Collie Basin, they are Collie, Cardiff and Muja. All three vegetation complexes occur within the Ewington minesite and can be subdivided into 11 site-vegetation types, on the basis of local variations in structural and floristic compositions and site conditions.

- **Collie Complex:** Open forest of jarrah-marri-sheoak with a range of understorey species which reflect the relative proportion of sand and gravel in the soils. Site-vegetation types D, P, S_1, S_2 and S_3.

- **Cardiff Complex:** Open woodland of *Banksia attenuata - Banksia ilicifolia* and *Nuytsia floribunda* with a distinctive understorey which has a range of species that reflects the levels of soil moisture. Site-vegetation types B and J.

Muja Complex: Open woodland of *Melaleuca preissiana - Banksia littoralis* with some admixture of Yarri *(Eucalyptus patens)* dominating the moister areas, and replaced by a woodland of *Banksia* spp. on the drier sites. The understorey species reflect the level of soil moisture. Site vegetation types A_1, A_2, A_3 and C.

The occurrence of the species recorded, detailed descriptions of each site-vegetation type and a map of their aerial distributions are provided in Appendix E. A brief summary of the 11 site vegetation types is given below:

A1: Low open woodland of *Melaleuca preissiana - Banksia littoralis* over dense understorey of shrubs and sedges. Occurs in restricted localised areas within the minesite, where local sandy-peat swamps occur.

A2: Open woodland of *M. preissiana - Eucalyptus rudis - B. littoralis* over dense shrubs and sedges. Widespread within the southern section of the minesite, on soils dominated by clays which are waterlogged in winter.

A3: Low open woodland of *M. preissiana - B. littoralis* over open understorey of shrubs and low sedges. Restricted to a small pocket on the southern extremities of the minesite, it is not typical of the northern Jarrah forest.

B: Open woodland of *E. marginata - M. preissiana - Nuytsia floribunda - Xylomelum occidentale* with occasional stands of *Banksia ilicifolia* and *Banksia attenuata* over low shrubs and sedges. Occurs on the valley systems within the minesite, where local sandy soils are seasonally moist.

C: Low open woodland of *M. preissiana - B. littoralis* over dense understorey of shrubs and sedges. Occurs on the main creeklines within the minesite.

D: Woodland of *E. marginata - E. calophylla*, with scattered *Banksia grandis* and *Persoonia longifolia* over mixed shrub layer. Occurs on the lower valley slopes and is associated with sandy-loams to sand-clays within the minesite.

J: Open woodland to open forest of *E. marginata - E. calophylla - B. attenuata - B. ilicifolia* with some *Allocasuarina fraseriana, X. occidentale* and *N. floribunda* over low understorey of shrubs and sedges. Occurs within the minesite where local deep sandy soils dominate.

P: Open forest of *E. marginata - A. fraseriana* with scattered *B. grandis* and *P. longifolia* over mixed shrub layer. Occurs within the minesite where soils are dominated by deep sands.

S1: Open forest of *E. marginata - E. calophylla - A. fraseriana* with some *B. grandis* and *P. longifolia* over low understorey of shrubs and sedges. Occurs within the minesite where soils on valley slopes and ridges are dominated by sandy-gravels.

S_2: Open forest of *E. marginata - E. calophylla - A. fraseriana* with some *B. grandis* and *P. longifolia* over low understorey of shrubs and sedges. Occurs within the minesite where soils on upper valley slopes and ridges are dominated by sandy-gravels and shallow lateritic outcropping.

S_3: Open forest of *E. marginata - A. fraseriana* over shrubs and sedges. Restricted in occurrence to a localised pocket in the south-west corner due to the presence of shallow outcropping which has resulted in the occurrence of species such as *Allocasuarina humilis* which elsewhere in the northern Jarrah forest are associated with shallow soils.

6.10.5 Physiological Stress

A significant level of stress was recorded on the Ewington minesite related to damage by previous fires (mainly of *Allocasuarina fraseriana*), the presence of insects (mainly of *Eucalyptus marginata)* and the apparent presence of dieback fungal disease *(Phytophthora cinnamomi).* The latter disease is reflected in the loss of vigour and death of *E. marginata, Banksia grandis, Persoonia longifolia, Banksia attenuata, Banksia ilicifolia, Banksia littoralis, Xylomelum occidentale, Xanthorrhoea preissii, Macrozamia riedlei* and a selection of other species from the Proteaceae and Epacridaceae families.

The distribution of dieback disease on the Ewington minesite is illustrated in Appendix E. The disease is concentrated in the plant communities on the lower valley slopes. As many species in the swamp communities are not susceptible to dieback disease, they do not reflect its presence in these areas.

6.10.6 Logging and Burning History

The majority of the forested areas in the Ewington minesite have been logged at least twice. Logging took place mainly on the mid and upper slopes, in the plant communities on these areas. The number of stumps recorded at each site are summarised in Appendix E. The majority of the area has been burnt within the last four years.

6.11 FAUNA

The fauna assessment survey of the proposed Ewington minesite was carried out by specialist zoological consultants during November 1990. The principal aims of the survey were to document the existing fauna, delineate the main faunal habitats and integrate previously published and unpublished information. The specialist report is included in Appendix F. An overview of the fauna of the Ewington minesite is provided below.

6.11.1 Fauna Recorded

The Ewington area lies well within the major zoogeographic region of the South-West of Western Australia and the fauna present is typical of the jarrah forest of the Darling Range. The field survey recorded 34 species of bird, 6 native and 4 introduced mammals, 12 reptile and 2 amphibians. On the basis of the literature and species' known habitat preferences the Ewington area may support approximately 102 bird species, 30 native and 10 introduced mammals, 46 reptile and 12 amphibians. The species lists prepared for the Ewington minesite are included in Appendix F.

The low species' richness recorded during the field survey is indicative of the unexpected inclement weather experienced during 60% of the field survey time. Increased survey duration and appropriate seasonal timing would undoubtedly increase the number of species recorded from the Ewington minesite, particularly reptile and amphibian species.

. Mammals

All species occurring in the Ewington minesite are widely distributed within the Collie Basin and the Darling Ranges. However, as is typical of the region, population densities of most native species, excluding macropods appear to be very low.

The two macropods, the Western Grey Kangaroo and the Brush Wallaby, and the Mardo *(Antechinus flavipes)* are moderately common. A few scattered signs of the Echidna *(Tachyglossus aculeatus)* were found, in keeping with this species' known low densities in the South-West. A single Brush-tailed Possum *Trichosuris vulpecula* was recorded in jarrah-marri forest overlying lateritic outcropping. The Southern Brown Bandicoot *(Isoodon obesulus)* population is of moderate density and is in good condition. It is confined to areas where there is low open woodland over a dense understorey of shrubs and sedges on drainage lines and seasonally moist areas.

Little evidence was found of feral predators, except foxes. No evidence of cats was recorded although they would be present. Rabbits were uncommon and a single House Mouse was captured. Horse tracks and scats were confined to vehicle tracks. None of the introduced species except the fox would significantly impact the native fauna community. The fox would significantly impact the populations of small mammal fauna, particularly the Bandicoots and Mardos.

. Birds

The bird fauna in the Ewington area consists mainly of typically mesic south-western species, many of which are widely distributed such as the Australian Raven, Grey Butcher Bird and Brown Honeyeater. Within the Ewington area the passerines predominate (65%) particularly the honeyeaters, flycatchers, woodswallows and thornbills, with large numbers of Dusky Woodswallows and Western Spinebills being present. Among the non-passerines the granivorous parrots make up 47% with the Red-capped Parrot and Red-tailed Black Cockatoo being the most common.

- **Reptiles and Amphibians**

The herpetofauna is typical of the Darling Ranges jarrah-marri forest habitats and is widely represented throughout the South-West. The skink *(Egernia napoleonis)* was common among dead logs and litter trunks in the jarrah-marri forest along with *Leiolopisma trilineatum* and *Ctenotus labillardieri.* Also widespread and common was the Bobtail *(Tiliqua rugosa).* Notably absent were the agamid dragons *(Pogona minor)*; only one was found due to the absence of suitable rock outcrop habitat.

6.11.2 Rare or Restricted Fauna

Six vertebrate fauna species gazetted as rare, or otherwise in need of special protection occur or are likely to occur within the Collie Basin. They are the Western Native Cat *(Dasyurus geoffroii),* Red-tailed Wambenger *(Phascogale calura),* Numbat *(Myrmecobius fasciatus),* Southern Brown Bandicoot *(Isoodon obesulus),* Tammar Wallaby *(Macropus eugenii)* and Peregrine Falcon *(Falco peregrinus).* It is considered that the only gazetted rare species which are present on the Ewington minesite are the Southern Brown Bandicoot and possibly the Tammar Wallaby.

The Southern Brown Bandicoot *(Isoodon obesulus),* has recently been gazetted as rare and endangered. The species has undergone significant range contraction and local population extinctions in the last twenty years. Coupled with high risk from feral predators and habitat modification, the vulnerable conservation status of this once recently abundant species has prompted the current classification. The Ewington bandicoot population is sizeable and is currently experiencing a period of growth. Sixty per cent of the individuals captured were sub-adults, while the population density compares favourably with other documented populations at Jandakot and Mandurah. The size of the Ewington bandicoot population is estimated to be in the order of 100 individuals.

The Tammar Wallaby *(Macropus eugenii),* is gazetted on Schedule 1 as fauna that is likely to become extinct, or is rare. While the species was not recorded during the current survey, another survey in the area in 1985 listed the species as 'definitely' occurring in the Griffin Leases within the Collie Basin. The Ewington minesite contains limited suitable habitat of dense low vegetation for daytime shelter and open grassy areas for feeding. The species may be present within the Ewington minesite at low densities.

6.11.3 Fauna Habitats

Fauna habitats are closely aligned with landform vegetation associations. Four major fauna habitats occur within the Ewington minesite:

- jarrah-marri forests with various understoreys,
- Banksia woodlands with varying degrees of sedge and shrub understoreys,
- Melaleuca woodlands with varying degrees of sedge and shrub understoreys,
- sedge and shrub wetlands in drainage lines and swamps.

The jarrah-marri forest habitat produced the richest fauna assemblage with 36 species, while the Banksia and Melaleuca woodlands exhibited a similar level of richness with 31 species. The sedge and wetland habitat was the poorest with only 14 species recorded. However its dense understorey and semi-aquatic environment provides for a distinctive fauna assemblage of frogs, reptiles and small mammals whereas the forest and woodland habitats are dominated by a highly mobile avian community and terrestrial lizards.

6.11.4 Ecological Significance

The Ewington area encompasses landform and vegetation associations which are widespread throughout the South West Region and the Darling Ranges. Thus these habitats which support the greatest biodiversity, such as the jarrah-marri forest, are of minor ecological significance.

The level of disturbance from dieback, logging and fire has eroded the conservation value of the area by reducing fauna resources such as hollow logs and deep litter beds. The shrub wetland habitats are in relatively good condition and represent pre-disturbance status.

The habitat-vegetation type present in the Ewington area which is least well represented in the Collie Basin is the sedge-shrub wetland. It is therefore of importance that some such areas are set aside for fauna conservation, particularly rare species within this habitat.

The Southern Brown Bandicoot and the Tammar Wallaby are fauna of significance which occur within the Ewington minesite. Minimisation of impacts on these species by implementation of specific management measures is recommended (refer Appendix F).

6.12 ABORIGINAL HERITAGE

Specialist consultants conducted archaeological and ethnographical surveys of the proposed Ewington minesite during December 1990 and January 1991 for the purposes of this CER. The specialist report is included in Appendix G. An overview of the Aboriginal heritage of the Ewington minesite is given below.

6.12.1 Archaeological Background

The Ewington area was first systematically surveyed for archaeological material in 1980. Records held by the Department of Aboriginal Sites indicate that thirty-three sites are known within a 25km radius of the Ewington minesite, with seven located within its boundaries.

The site types include small stone artefact scatters, stratified archaeological deposits, quarries, stone arrangements and one scarred tree. Most sites are located near water sources, with larger sites most commonly located near swamps and permanent pools in the rivers. All the sites located on the minesite are small stone artefact scatters. All but one site have less than five artefacts associated with them.

The majority of sites so far discovered in the Jarrah forest are small artefact scatters thought to represent short term stops by small Aboriginal family groups that wandered through the area.

6.12.2 Archaeological Survey

No artefact material was located within the northern farmed areas of the Ewington minesite by the most recent survey.

Three isolated finds were located in the forested areas; a chip, a flake and a flaked piece. The former two were discovered in the area surrounding a seasonal swamp. The latter was on a sandy track some distance from the swamp. No trace was found of previously recorded finds, indicating the original collections were indeed complete.

Approximately 40% of the Ewington minesite was actually examined. The study was limited by low ground visibility and human disturbance. The failure of this survey to locate archaeological material of significance is consistent with previous work undertaken in the area. The poor visibility due to heavy vegetation makes discovery of new sites extremely difficult.

The study area has little potential to yield stratified sites as it would have provided little incentive in the past for concentrated Aboriginal occupancy due to limited water supplies.

6.12.3 Ethnographic Background

The survey area lies within the territory of the Ganeang which may have moved to Bunbury and surrounding areas after colonisation. Destruction of Aboriginal culture following European contact blurred socio-cultural boundaries and attenuated connections with traditional lands. As a result, there has been a loss of traditional, mythological and ritual associations with the land along with the knowledge which underpins these connections. However, there is still a substantial degree of knowledge available in Nyungar society concerning traditional mythological and ceremonial sites.

There are two principal kinds of connections between Aboriginal society and the land and sites. They are:

- spiritual, mythological or religious, and
- historical/social associations.

With the attrition of knowledge, in some instances the sites are known but the mythology is lost or vice versa.

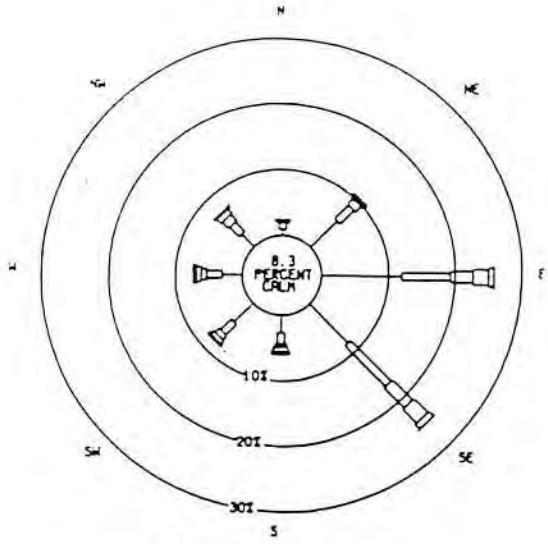
Records of the Department of Aboriginal Sites indicate that the Collie area is rich in ethnographic significance. There are a number of sites in and around the township, mostly associated with the Collie River and the influence of the mythological being, the Waugal. The Collie site complex also includes a series of campsites with both traditional and historical significance.

To the south and east, there are sites of mythological significance. The closest site of significance to the Ewington minesite is Boronia Gully, a campsite which has traditional associations and is the location of burials with strong local sentiments attached to it. This campsite is well outside the Ewington minesite area (refer to Appendix G for location).

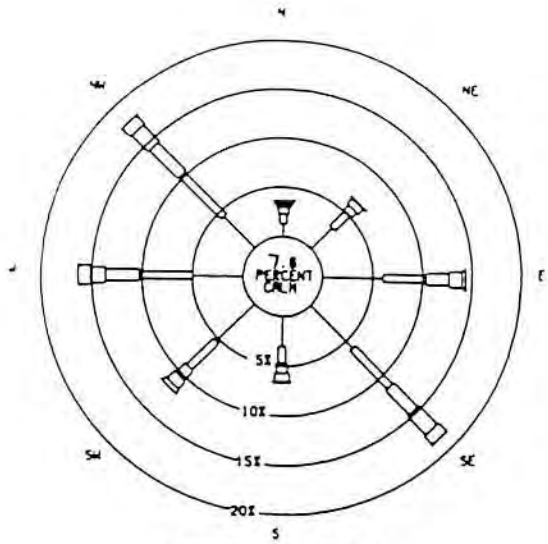
6.12.4 Ethnographic Survey

Extensive recourse was made to local Aboriginal informants concerning the Ewington area through interviews and telephone conversations. Field visits by informants to the Ewington area did not locate any ethnographic sites.

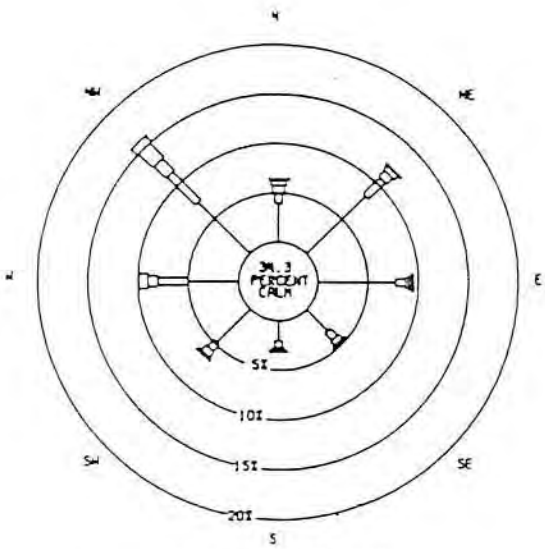
Areas around the Collie waterways were used as campsites by Aboriginal people moving along routes of seasonal movement and in daily hunting and gathering activities. Routes extend from the Collie area, along the rivers and move south, north and west to the coast.



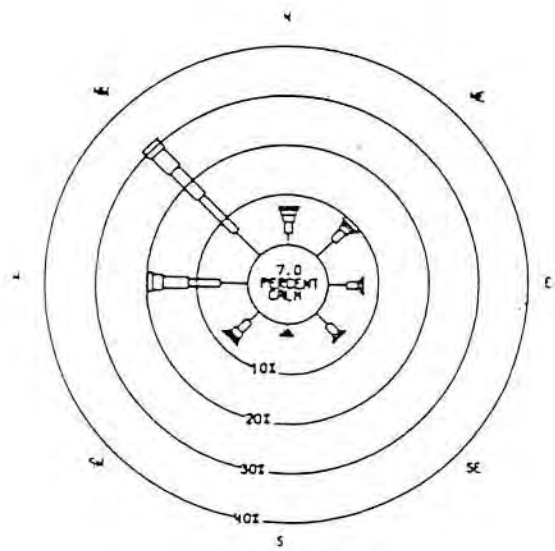
DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
COLLIE WINDS SUMMER 9 AM



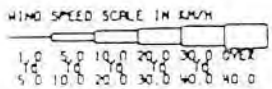
DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
COLLIE WINDS SUMMER 3 PM



DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
COLLIE WINDS WINTER 9 AM

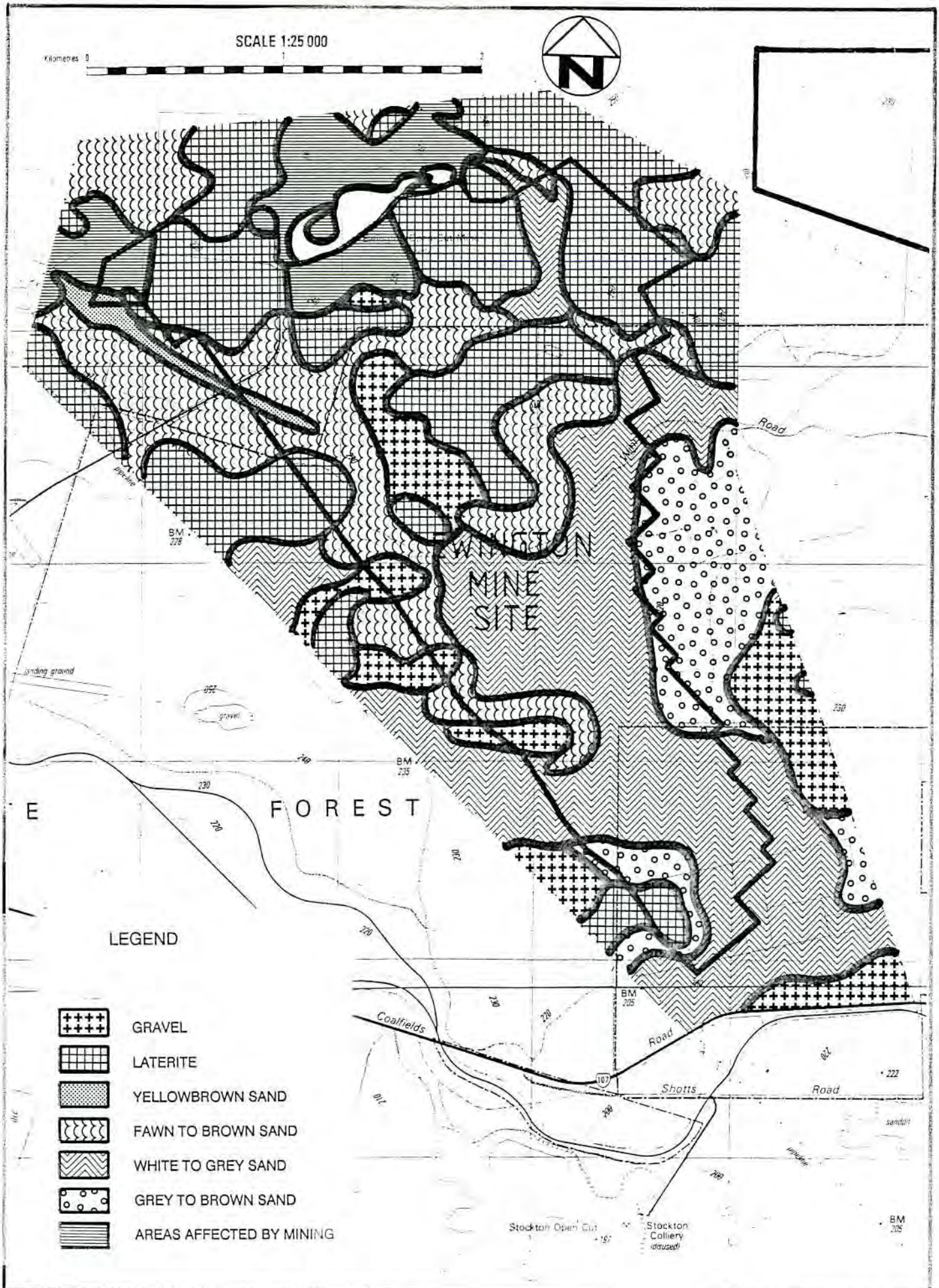


DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
COLLIE WINDS WINTER 3 PM



EWINGTON OPEN CUT MINE
CONSULTATIVE ENVIRONMENTAL REVIEW
for THE GRIFFIN COAL MINING COMPANY PTY LIMITED

SEASONAL WIND ROSES
FOR COLLIE, 9am AND 3pm
FIGURE 6.2



EWINGTON OPEN CUT MINE
CONSULTATIVE ENVIRONMENTAL REVIEW
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SOILS

FIGURE 6.3

EON / PERIOD			UNIT OR LITHOLOGY			THICKNESS RANGE (m)
QUARTERNARY			UNDEFINED SAND AND LATERITE			0 - 10
TERTIARY (EOCENE ?)			NAKINA FORMATION			0 - 18
			CARDIFF SUB-BASIN	SHOTTS SUB-BASIN	MUJA SUB-BASIN	
PERMIAN	Late	COLLIE COAL MEASURES	CARDIFF MEMBER (150)	NOT PRESENT	NOT PRESENT MUJA MEMBER (210)	0 - 210
			?			
	Early		COLLIEBURN MEMBER (350)	PREMIER MEMBER (250)		220 - 350
			EWINGTON MEMBER (120)			50 - 120
			STOCKTON FORMATION			20 - 330
ARCHAEAN			UNDEFINED GRANITOID AND GNEISS WITH MAFIC INTRUSIVES			

UNCONFORMITIES

(210) MAXIMUM THICKNESS OF MEMBERS IN METRES

Modified By Griffin After Lord (1952), GSWA (1975) And Backhouse (1988).

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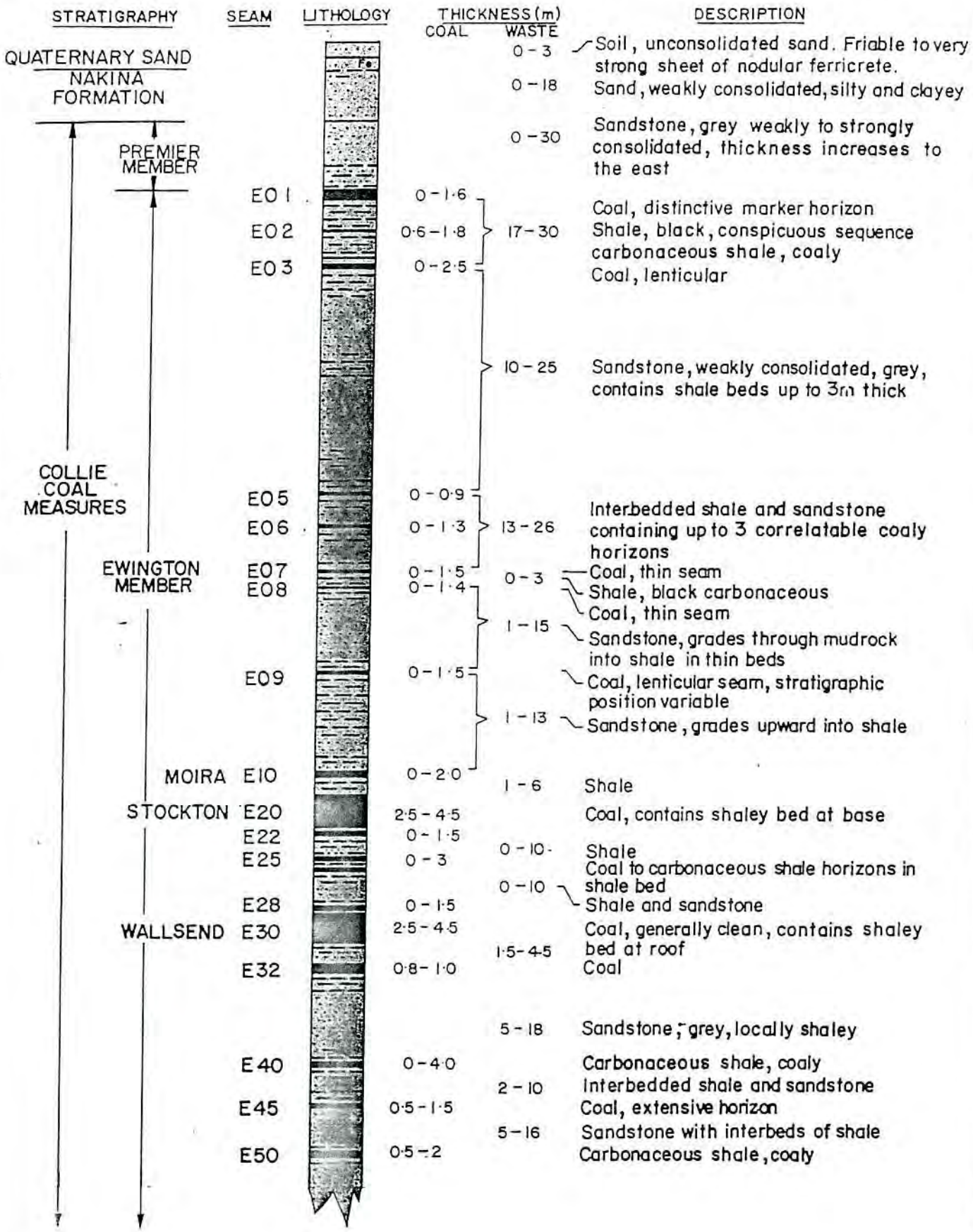
COLLIE BASIN STRATIGRAPHY

FIGURE 6.4



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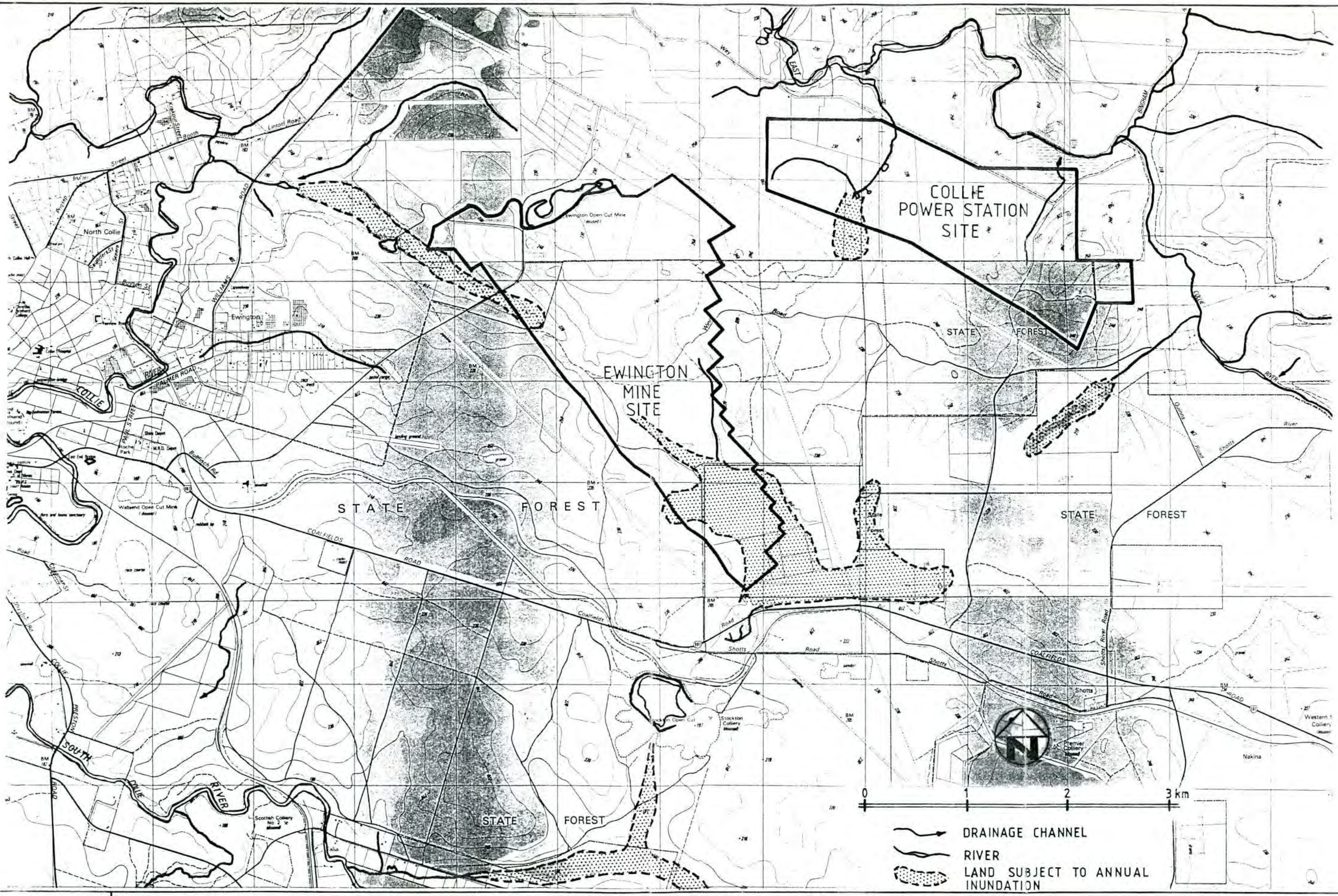
EWINGTON MEMBER

FIGURE 6.5



Halpern Glick Maunsell

EWINGTON OPEN CUT MINE
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SURFACE HYDROLOGY

FIGURE 6.6

7. THE PROPOSAL

7. THE PROPOSAL

7.1 OVERVIEW

Planning for the proposed Ewington mine is at an early stage but through the experience gained by Griffin over 60 years of coal mining in the Collie Basin it is possible, in this CER, to provide a broad outline of the mining activities and procedures that will take place.

In particular, there are a number of aspects of mine procedures and operations described below that reflect current practices as developed by Griffin and as otherwise required of Griffin under the Agreement Act (refer Section 3.2.3). The Agreement Act has provided the statutory framework around which specific procedures, practices and requirements have been progressively developed. It is proposed to largely extend those features of the existing operations to encompass the Ewington mine and, where appropriate, reference to these current practices is highlighted in the following discussions.

The mineable coal reserves in the zone selected for mining, shown in Figure 7.1 are estimated at 60.8Mt. The anticipated total demand for coal by the power station is 50 to 70Mt.

Commencement of mining operations on the Ewington Deposit could begin as early as 1996 with initial dewatering operations beginning two years prior in 1994. This, however, is dependent upon suitable coal supply contracts being signed. The expected life of the Ewington mine is 31 years, delivering an annual aggregate sum of as much as 2.5Mt of crushed coal.

The Ewington deposits will be mined by open-cut strip mining methods commencing in the north-western corner of the deposit. All overburden from the first strip will be dumped out-of-pit along the western edge of the mine pit between the mine pit and the haul roads. Overburden from subsequent strips will be dumped into previously mined-out strips. Replaced overburden will be progressively rehabilitated behind the mining operation.

The mining activities will involve site preparations such as construction of drainage controls and removal of vegetation and topsoil; overburden removal initially by truck and shovel and then by dragline; and mining of the coal seams. Blasting will be required to loosen hard overburden and interburden materials for excavation and also to break-up coal seams for mining.

The Ewington deposits will be dewatered by bores prior to the mining operations. The groundwater abstracted and surface water collected within the mine pit will be discharged to the power station and to natural drainage. There are a number of discharge scenarios and treatment options available.

Rehabilitation procedures will include initial construction of drainage control works, surface preparations, then revegetation with selected local native species.

7.2 MINING METHOD

As previously discussed the Ewington coal mine will be developed as an open-cut mine. This is because

- the coal seams are located relatively close to the natural ground surface,
- modern techniques and equipment ensure open-cut mining methods are cost competitive,
- open-cut mining techniques ensure maximum recovery of coal from the full sequence of coal seams.

The particular method of open-cut mining to be used at Ewington is the strip mining method. The basic stages in the strip mining process are shown schematically in Figure 7.2.

The principle of strip mining is essentially that materials excavated from within the mine area as overburden (ie material overlying the shallowest coal seam) and interburden (ie material between coal seams) are returned to the excavation once the coal has been mined. Operationally this has the advantage of minimising the distance over which waste materials have to be hauled.

Environmentally, the strip mining method minimises the amount of disturbance and visual intrusion outside the limits of the mine. It also, in the long term, provides the opportunity to rehabilitate the mine area in a manner largely compatible with the original landform. The strip mining method also provides the opportunity to progressively rehabilitate mined areas with the first rehabilitation commencing soon after the first sections of the mine are fully backfilled.

Details of the various major activities in the strip mining method are given in Section 7.3. However, it is important to note that in adopting the strip mining method for the Ewington deposits, Griffin is also planning to commence mining on the northern and western edges of the mine area. This is the area of the mine that has least overburden and therefore presents the best opportunity to economically commence mining operations. It is also the area closest to the existing Collie townsite and therefore as mining progresses the impacts of mining on the townsite as outlined in this CER will generally decrease in magnitude.

7.3 MINESITE OPERATIONS

The minesite operations will occur progressively in southerly and easterly directions across the mine area. The various operations will also occur concurrently with one another as dictated by the strip mining method.

The major mining operations that will take place at Ewington are described below. However, it is important to note that final operational details of the various mining activities will be dependent upon the results of further detailed evaluation of the mine area geologically and environmentally. The final, detailed planning of mining operations will be on the

basis of achieving the most efficient and cost effective means of mining the coal while at the same time providing for the achievement of high quality environmental control and management.

Principal minesite operations will include:

- site preparation consisting of vegetation and topsoil stripping and construction of drainage controls,
- overburden removal and dumping,
- coal mining of individual seams as they are exposed,
- interburden removal and dumping to uncover additional coal seams at depth.

7.3.1 Mine Plan

Preliminary work has been done to develop a mine plan that will allow the most economic and efficient means of accessing and removing coal from the Ewington mine. The progress of mining across the mine area is shown in Figure 7.3.

Essentially mining will commence in the northern and western parts of the mine and progress in easterly and southerly directions. Selection of the area in which to commence mining has been based on consideration of factors such as:

- geological structure
- stripping ratio
- coal quality
- geomorphological and hydrogeological features
- the location of existing surface infrastructure.

The overriding consideration is the need for the mine to be able to supply coal to the proposed power station or to potential industrial customers at a time and in sufficient quantities to meet demand.

As shown in Figure 7.3 the total mine area has been divided into a series of strips that presently indicate the anticipated progress of mining at particular times during the life of the mine.

The mine plan currently calls for the construction of five haul road access ramps into the mine. These ramps provide the means for coal and overburden haul trucks and other light traffic to enter and exit the mine. The ramps are connected to a main haul road that is routed around the perimeter of the mine and that also provides access for the haul trucks to and from the proposed power station coal receival point on the far eastern side of the mine, all as shown in Figure 7.4.

Haul road routes shown in Figure 7.4 have been aligned to minimise their elevation with respect to the surrounding terrain thereby maximising the noise shielding effect with respect to the Collie townsite (refer Section 8.8). However, further more detailed design will need to be undertaken before final haul road alignments can be defined.

Coal from the Moira (E10), Stockton (E20 and E22), Wallsend (E28 and E30) seams and the bottom seam of the sequence (E32) will be mined where these seams exist at a thickness of greater than 0.5m (refer Section 6.4.3 for geological background).

7.3.2 Site Preparation

Prior to the commencement of mining a surface water management programme will be developed in consultation with the appropriate authorities. Drainage structures will be constructed to control water movement. Diversion channels and earth bunds will be used to prevent runoff from undisturbed ground around the proposed mining areas from entering the mining areas.

Prior to clearing vegetation, temporary sumps will be constructed to control runoff from future areas of disturbance.

Vegetation will be progressively removed ahead of the mining operation. In order to minimise surface disturbance, the area cleared of vegetation will be kept to the minimum required for safe and efficient mining practices. Consistent with current practices areas proposed for clearing will be identified on an annual basis and a clearing licence will be obtained from WAWA. (The mine is located within the Wellington Dam catchment area.)

Consultation has indicated that CALM would prefer to extract the timber resource from areas proposed for clearing. It is thought that the timber available may be suitable as Jarrah and Marri sawlogs, woodchips and fenceposts. Short lengths of lower quality timber or regrowth may be suitable for use by industries requiring charcoal as a raw material. Where mine safety is not a problem licensed wildflower pickers will also be permitted to remove all suitable material.

Whilst the flora survey did not locate any rare species, if such plants are found within the proposed mining areas they will be used as a seed source for rehabilitation. Where feasible, rare plants which would otherwise be removed will be transplanted into rehabilitated areas or used as nursery stock. No identified rare plants would be removed without approval from the Minister for Environment.

If field trials by Griffin indicate that application of mulched vegetation is of significant benefit to rehabilitation areas any remaining vegetation will be mulched and spread onto recently topsoiled rehabilitation areas to stabilise the prepared surface and provide additional seed.

Topsoil will be collected from the cleared areas and initially stockpiled close to disturbed areas in readiness for later use in the rehabilitation programme. Double stripping of topsoil will be undertaken if field trials suggest that this procedure is beneficial.

As mining progresses, topsoil will be removed and where possible deposited directly onto contoured overburden dumps. This will ensure that the seed contained in the topsoil retains maximum viability and that biological activity in the soil is not reduced.

7.3.3 Overburden Removal

Overburden represents the natural soil and rock material that overlays the uppermost coal seam. It does not include topsoil, the definition and treatment of which has been discussed in Section 7.3.2 above. Removal of overburden for the Ewington mine involves the largest volume of excavation in the sequence of mining operations. As a consequence this phase of the open-cut mining operation has the potential to impact strongly on the costs of coal extracted. These cost impacts can be controlled by selecting the most efficient excavation method for overburden removal.

The following characteristics of the Ewington deposits provide conditions that suit the use of a dragline for overburden stripping operations:

- shallow, flat lying coal seams,
- coal seams that are continuous throughout the deposit,
- the coal seams of interest are not widely separated,
- the deposit consists of competent, weakly cemented strata,
- the topography is gently undulating.

With these characteristics it is generally recognised that a dragline based overburden stripping operation provides the most economic means of exposing the coal seams. A dragline is a large piece of equipment fitted with a long boom on which is suspended an excavating bucket. It has the appearance of a large crane and, in the case of Ewington, will operate on electrical power. Figure 7.5 presents an artistic impression of the dragline and its operating sequence.

The characteristics of the dragline likely to be used that are of relevance include:

- a bucket capacity of $48m^3$
- an operating radius of 87m
- a maximum digging depth of 60m being from 15m above machine level to 45m below machine level.

The dragline will be used to make a single pass within any strip of the mine operation and as detailed above it can achieve a total depth of excavation of 60m. It is currently planned to position the dragline such that it removes the lower 60m of overburden leaving materials above this level to be removed by a truck and shovel operation in an overburden prestripping phase.

Present knowledge of overburden characteristics indicates that materials to be removed in the prestripping operation can be excavated directly. There is, however, a strata of laterite probably extending over the entire mine area. This material will require blasting to loosen it for excavation purposes. In addition, blasting of material to be excavated by the dragline will be undertaken throughout to maximise the efficiency of this operation. Blasting will generally be achieved by the use of a water resistant heavy ammonium nitrate-fuel oil explosive.

As shown in Figure 7.5 the dragline will deposit excavated spoil in stockpiles placed over areas of the mine in which the coal has already been removed. Similarly materials moved by the truck and shovel operation will be deposited onto and between the overburden stockpiles created by the dragline.

In the initial stages of mine operations, the coal seams are at their shallowest depth where use of the dragline will not be efficient. It is therefore anticipated that during the first five years overburden stripping will be based on a truck and shovel operation probably using 85 to 150 tonne capacity off-highway dump trucks appropriately matched with hydraulic shovels of approximately $10.5m^3$ capacity. The same fleet of trucks and shovels will then continue on into overburden prestripping operations ahead of the dragline after it is commissioned.

It is anticipated that the size of the truck and shovel fleet will increase over the life of the mine because the coal seams become progressively deeper to the east therefore requiring greater volumes of prestrip excavation.

7.3.4 Overburden Disposal

As explained above, excavated overburden will be placed into overburden dumps either directly by the dragline or by trucks loaded by hydraulic shovels (refer Figure 7.5). Generally, the overburden dumps will be located within the mine in areas where the coal has already been removed.

This process is not feasible at the commencement of mining operations since there is no area available in which to deposit the waste material without sterilising mineable coal. It will therefore be necessary to create initial overburden dumps along the western edge of the mine area between the mine itself and the perimeter haul road as shown in Figure 7.4.

These dumps will be placed above existing ground levels to heights not exceeding 20m and establishing the top of dump level between RL230m AHD and RL250m AHD. Between these levels the dumps will not generally exceed the natural ground levels of an existing natural ridge that is situated just west of the mine area and between the mine and the Collie townsite.

The stockpiles will be shaped to provide natural slopes not exceeding 10^{o} from the horizontal leading to a final appearance of a flat-topped hill with gently sloping sides. The positioning and shaping of these initial out-of-pit overburden dumps will effectively create visual and noise screening of the mine operations particularly from the point of view of the Collie townsite.

It is important to ensure that the overburden dumps both within the mine pit and also the initial dumps placed outside the limits of the pit can be adequately rehabilitated. The details of Griffin's proposed rehabilitation programme are described in more detail in Section 7.6. It is, however, appropriate to note that the management practices that have been developed successfully with existing operations are to be retained to ensure maximum success with rehabilitation.

Griffin currently classifies overburden prior to dumping. There are four classes of overburden based on the potential toxic hazards that the materials present to rehabilitation. Toxicity is associated with acidity, salinity and sodicity (refer Section 7.6.4 for details).

Management procedures ensure the least toxic materials are placed closest to the final surface of overburden dumps. This system has been demonstrated to achieve a high degree of success in rehabilitation at Muja and Chicken Creek and will be implemented at Ewington.

7.3.5 Coal Mining

Due to the relatively lesser quantities involved, smaller equipment is generally used for coal mining compared to that used for overburden removal. This ensures maximum recovery of coal and minimises contamination of the coal by waste material.

The coal seams will be either lightly blasted using ammonium nitrate-fuel oil explosive in the thicker seams (>2m), or ripped with large bulldozers in the thinner seams (<2m). The quantity of explosive will be much lower than that employed in overburden blasting.

The coal will be loaded by front end loaders into rear dump trucks. Trucks will travel along the active mining strip to a ramp leading to the surface, then use the main haul roads to reach the coal crushing and handling facilities at the power station receival point.

There are several coal seams, separated by waste material, termed interburden. The interburden will be removed by hydraulic shovels and loaded into rear dump trucks. All interburden thicker than 2m which cannot be economically ripped and loaded will be drilled and blasted. It will then be loaded and hauled to an adjacent mined out area and ultimately covered by overburden dumps.

7.4 DEWATERING SYSTEMS

Borefield pumping is planned to commence a minimum of 24 months prior to the mining operations. This is essential to allow adequate dewatering of the surface silt bands that would otherwise present mine stability and material handling problems.

The initial dewatering target area for the first three years of mining operations is in the extreme north-west corner of the proposed mining area (Figure 7.6). This area will be dewatered by bores placed just south of the area. In addition, water in both the original Ewington No. 1 open-cut and the old Ewington underground mine will be pumped as early as possible to assist in this dewatering.

The critical dewatering targets in the deposit are the deepest easterly portions of the minesite. Pumping in the westerly area will not completely dewater the eastern area and vice versa. Therefore bores will be required in both these areas.

Although further site investigation and analysis is to be undertaken the current conceptual pit dewatering system consists of three sets of bores as described below:

- Group I Bores: 13 bores up to 100m deep located just west of the low wall of the open pit. These bores will prevent groundwater from entering the western side of the mine and causing instability of the spoil. The bores will intercept groundwater from all aquifer zones.

- Group II Bores: 45 bores up to 135m deep located along the western side of the central fault and in the north-west corner of the deposit. These bores will completely dewater all aquifers in the western half of the deposit. Subdivided into Groups IIa and IIb, Group IIa (24 bores) will be mined out within 12 years and Group IIb (21 bores) within 20 years.

- Group III bores: 31 bores up to 145m deep located along the eastern perimeter of the mining area just outside the final high wall. These bores will dewater all aquifers in the eastern half of the open pit from year 13 through to year 31.

The critical dewatering targets are associated with the lower E30 and E32 seams (refer to Section 6.4) and these are shown below:

- E32, year 5, 85m drawdown, western block
- E32, year 10, 95m drawdown, western block
- E32, year 15, 100m drawdown, western block
- E32, year 20, 105m drawdown, western block
- E32, year 25, 110m drawdown, eastern block
- E32, year 30, 120m drawdown, eastern block

The high wall bores (Group III) will be deep enough to dewater the sediments both above and interbedded with the coal and depressurise the aquifers below the pit floor to prevent floor heave. Depressurisation will also improve traffickability of the pit floor and prevent saturation of the overburden dumps.

A network of pipelines will carry groundwater from the dewatering bores and the mine pit to the mine water discharge point.

7.5 WATER DISCHARGE

Griffin will investigate options for disposal of mine water to be discharged during development of the Ewington mine. This mine water will be derived from the dewatering/depressurisation of the coal seams to be mined and from surface runoff within the open-cut catchment area.

7.5.1 Discharge Quantity

The quantity of mine water to be discharged will vary over the life of the mine because of the variable life of the dewatering bores and aquifer dewatering requirements. It will range from about 20ML/day to 44ML/day with an average discharge of 32ML/day.

Table 7.1 indicates the forecast volumes of water produced to achieve productive and safe working conditions in the mine pit.

TABLE 7.1

FORECAST OF DEWATERING VOLUMES

Mining Year	Typical Daily Volume ML/day	Range ML/day
-3 to -1*	36	-
1 to 2	36	-
2 to 30	32	18-42

* period before mining commences

It is proposed that the mine water discharge be supplied to the new Collie Power Station as process water for cooling purposes during its operation. To achieve ground conditions amenable to mining, dewatering will need to start at least two years prior to mining and at least 2-3 years before commissioning of the power station. There will be surplus mine water during this initial dewatering period when mine water is not being utilised by the power station.

The power station demand for cooling and process water will initially be an average of 14ML/day, increasing to 24ML/day after commissioning with a maximum demand of 31.5ML/day. There is, therefore, the possibility that from time to time mine dewatering volumes may exceed the cooling water requirements of the power station.

Rainfall runoff volumes averaged over a full year are estimated to be in the order of 1.5-1.8ML/day although volumes of up to 21ML/day could be expected during summer thunderstorms.

7.5.2 Discharge Disposal Options

Mine water will be discharged primarily to the Collie Power Station, to satisfy its demand for cooling water requirements with surplus being discharged to the environment. This will provide the most efficient and environmentally responsible resource utilisation and is consistent with WAWA's Management Strategy for water resources within the Collie Basin.

Several options are available for the licensed disposal of surplus mine water from the Ewington mine (refer to Figure 7.6). The first three alternatives for disposal of surplus mine waters are to discharge into the Collie River East Branch, while the fourth discharges water to the Collie River South Branch and the final option relates to use of an existing pipeline to supply water from Ewington into the Muja Power Station.

The various water disposal options considered are:

Option 1 Via a pipeline which skirts to the north of the mine and power station site. This discharge location would utilise a series of lakes within an abandoned river channel, to diffuse the erosional impact of the discharge.

Option 2 Via a swamp at the headwaters of a small tributary of the river, south and upstream of the power station site. This swamp would provide a low gradient discharge route into the river channel thereby minimising potential for erosional scour. However, this route crosses the Premier deposits which may be mined in the future.

Option 3 Pipe all mine water to the power station for treatment, use and discharge of surplus water into the river. The discharge location would be within the power station property and is a swamp draining into the Collie River East Branch.

Option 4 All mine water to be discharged around the southern end of the Ewington minesite, with natural drainage then through swamplands and Stockton open-cut into the Collie River South Branch. The capacity of drainage control structures under the Coalfields Highway and railway, and any plans for development of underground mines or haul roads in this vicinity need to be considered.

Option 5 Pipe the mine water to the Muja Power Station via SECWA's pipeline running along the south-western side of the Ewington mine. However Muja Power Station would not be able to accept all mine water discharge volumes as the pipeline's optimum capacity is 15-20ML/day.

At the present time the preferred option for disposal of water from the mine is to deliver all dewatering water from the Ewington minesite into the power station site where a water treatment facility will be established to ensure water quality is suitable for feeding into the power station or for direct discharge to the environment (refer Section 7.5.4). Preliminary plans call for the early establishment of the water treatment facilities on the power station site such that it can accept initial dewatering flows before the power station is commissioned. On this basis water from the minesite can be treated prior to discharge if this is shown to be necessary (refer Section 7.5.4). This option is only feasible if Griffin is contracted to supply coal to the power station.

If this option is pursued then when the power station has been commissioned it is anticipated that at most times mine dewatering extraction rates can be matched to power station demand to minimise the amount of discharge direct to the environment. However, it will be vital for Griffin to ensure dewatering extraction rates are sufficient at all times to avoid adverse effects on its mining activities. Conversely, the proposed private power station will be supplying power to SECWA on a demand basis and therefore its operational pattern will be heavily dictated by the electrical power demands of the south-west power grid.

It can be seen therefore that the mine dewatering discharge system must be as flexible as possible to meet varying power station demand but at the same time ensuring mine operations are not adversely affected. For this reason it is operationally and economically most effective to direct all dewatering flows into the power station site and then allow for excess flows to be directed to a suitable discharge point.

These arrangements meet with the details of Option 3 for dewatering water discharge as outlined above. Further analysis of the water treatment discharge system would need to be undertaken in conjunction with the private power station owner/operators to ensure adequate performance operationally and environmentally if this option is to be implemented. This will be undertaken as a matter of course under the requirements of the Agreement Act (refer Section 3.2.3) in a manner similar to that currently in place at Muja and Chicken Creek.

Should the Ewington deposits be developed for coal customers other than the power station then more serious consideration will need to be given to the other water discharge options listed above. However, in all cases it will be the principal aim of Griffin to meet all water quality discharge requirements in the most economic and efficient manner possible.

7.5.3 Discharge Quality

The water quality data base for the Ewington deposit is limited. The quality of the groundwater is variable not only between aquifers but throughout the life of the mine. The dewatering bores will, however, be producing from all aquifers. It is therefore anticipated that the quality of water to be discharged from the mine will be reasonably consistent.

Testing of groundwater to date has indicated that its quality is good with less than 500mg/L TDS, a typical pH of 5, and soluble iron content less than 0.5mg/L. The expected long term water quality is recorded in Table 7.2. Experience indicates that as mining proceeds, pH will fall and the iron and sulphate contents will increase. These expected changes have been taken into account in the tabulated values.

TABLE 7.2

EXPECTED LONG TERM WATER QUALITY

Chemical Constituent	Typical mg/L	Range mg/L
pH	4	3-8
TDS	<500	300-800
Na+	100	50-200
Cl^-	180	50-250
SO_4^{2-}	20	<40
SiO_2	5	<15
Fe (soluble)	<1	<4
Fe (total)	4	<10

The expected mine water quality does not include rainfall runoff volumes which are widely variable due to seasonality and the occurrence of major high rainfall events and cannot be reasonably relied upon to improve water quality.

7.5.4 Discharge Treatment Options

All groundwater discharge into the Wellington Catchment area must conform to quality parameters recommended in the Collie Coal Basin Water Resources Management Strategy July 1988 (refer to Section 3.1.5).

Since the water quality data base for the Ewington deposit is limited, it is possible that mine water quality may not meet licence requirements for discharge into local waterways and may therefore require treatment prior to discharge. The exact requirement for treatment can only be determined when the long term quality of the groundwater discharge is further evaluated.

On the basis of existing data it appears that only limited treatment of groundwater discharge will be required to raise pH, reduce Total Iron and perhaps reduce TDS prior to discharge.

Water treatment requirements for discharge will vary according to its destination, ie the power station, to other users or the local river system; and location of discharge, ie marsh, streams or lakes.

The treatments may be chemical, physical, biological or a combination of these, and involve some or all of the mine water. Although the groundwater is expected to be acidic with high iron content, relatively high TDS levels and low Total Suspended Solids (TSS), the rainfall runoff will be of neutral pH, low iron, low TDS and high TSS concentration. Thus the groundwater and rainfall runoff will also require different treatment.

The proposed discharge treatments will be a combination of options listed in Table 7.3, according to the destination and location of discharge.

TABLE 7.3

OPTIONS FOR MINE WATER DISCHARGE TREATMENT

Treatment	Groundwater	Rainfall/Runoff
Physical/ Chemical	. Aeration to precipitate iron . Lime or caustic soda treatment to raise pH . Alum treatment/retention time to settle iron precipitates and minimise turbidity . Reverse osmosis/ ultra-filtration to reduce TDS concentrations	. Alum treatment/retention time to settle suspended solids fractions and reduce turbidity
Biological Filtration	. Complete treatment by biofiltration to lower iron and TDS concentrations, and raise pH to 7-8	

Features of these treatment options are described below.

. **Physical/Chemical Treatment**

The surge pond located beyond the high wall of the mine pit (see Figure 7.6) will be used as a settling pond for the removal of suspended solids and as a blending pond for all mine waters to ameliorate final discharge quality. Water from the surge pond will be discharged untreated to the power station and its treatment facilities.

The end-product from the treatment facilities would be blended with untreated groundwater and runoff to produce water of a quality suitable for disposal to the local river system.

. **Biological Filtration**

Freshwater swamps are used in the State for the removal of nutrients. Analysis of water quality parameters after throughflow within swamps shows substantial reductions (average of 50%) in heavy metals and TDS concentrations and pH approaches neutral levels. The reduction in metal content is thought to be due to a physical response to the increase in pH rather than to any biologically induced uptake of metals by macrophytes or algae.

If biological filtration is used for mine water treatment, its design will be as follows:

- The site will be densely planted with a mosaic of aquatic vegetation. Suitable species include *Paspalum dilitatum, Paspalum distichum, Juncus pallidus, Juncus pauciflorus, Juncus articulatus, Cyperus polystachys, Isolepis prolifera, Eleocharis acuta* and *Typha spp.*

- Biological interaction with the throughflowing water will be maximised by maintaining shallow water depths (300mm maximum) and oxygenating the flow by using shallow weirs or baffles running across the width of the biological filter.

- The biological filter site will be underlain with a relatively impermeable layer of clay or sandy clay to reduce infiltration of discharge water into the underlying aquifer. The filter floor will have about 0.5m or more of sandy soil, over the clay for the plants to grow in.

- Bends in the filter path and pipes to fan the flow as sheetwash over the filter area will be incorporated to slow the rate of water flow.

The biological filter would have a residence time of at least 24 hours. To achieve this and a water depth of at least 300mm, the site will need to cover approximately 150-200ha.

Rainfall Runoff

The runoff sump at the southern end of the mine pit will receive rainfall runoff with high turbidity and TSS concentrations especially after major rainfall events.

The efficiency of the runoff sump in reducing turbidity and TSS concentration will be increased by treating incoming water with alum. Alum acts as a flocculant and encourages suspended material to settle.

All of the disposal options described in Section 7.5.2 would be able to utilise the three treatment options available, to varying degrees:

- Options 1 and 2 would utilise a holding dam and treatment facilities located beyond the high wall of the mine pit and a biofilter at their points of discharge into the Collie River East Branch.

- Option 3 would utilise a holding dam and treatment facilities on the power station site, and a biofilter at the point of discharge into the Collie River East Branch.

- Option 4 would utilise a holding dam and treatment facilities at the southern end of the mine pit and a biofilter as discharged water drains to the Collie River South Branch.

- Option 5 would utilise a holding dam and treatment facilities at the southern end of the mine pit prior to discharge to the pipeline. Only excess water overflowing from the dam would be biofiltered as it drained to the Collie River South Branch.

However, as detailed in Section 7.5.2 it is presently expected that Option 3 will be adopted with some form of physical/chemical treatment on the power station site. There may also be scope to incorporate a biological treatment process for water discharge flows but a decision in this regard requires more detailed evaluation and negotiation between Griffin and the power station consortium.

7.6 REHABILITATION

The areas disturbed by mining will be rehabilitated with local native vegetation with the objective of development of productive forest. The processes of rehabilitation, including topsoil removal, landscape design, drainage control and reseeding will be an integral part of mining. The site environmental officer, engineers, surveyors and specialist consultants will be fully involved in the mining and rehabilitation processes. Details of the rehabilitation procedures will be the subject of a management plan which will be in place prior to the start of mining and will be refined throughout the life of the Ewington mine. The rehabilitation process which will occur as final landforms are created is outlined below.

7.6.1 Rehabilitation Experience

Griffin, having operated coal mines in the Collie area for over 60 years, has a readily available and authoritative database on the local environment and the requirements for its rehabilitation.

In the past, Griffin has concentrated on rehabilitating mined areas to pasture, long considered a suitable end use for land in the Collie region, and a good means of ensuring a self-sustaining and stabilising post-mining groundcover.

However, in the past five years, a decision has been taken to move away from pasture rehabilitation and concentrate on revegetation with local native species. A number of factors influenced this decision, including observations that native species tolerate the acidic conditions far better than pasture species; the amount of effort required for pasture after care; together with salinity and "greenhouse" concerns. Griffin is currently progressively returning existing pasture rehabilitation back to native species. Areas are now being successfully rehabilitated with native vegetation.

Griffin operates the existing Chicken Creek and Muja open-cut mines according to environmental management plans produced to the satisfaction of the Minister for State Development. The progress of the rehabilitation programme is reported to the Minister in both annual and more detailed triennial reports. Ongoing rehabilitation success determines the mines' continued operation.

Griffin's most recent detailed Triennial Environmental Report submitted in November 1990 was highly praised by the Acting Minister for State Development as being a well prepared and detailed report which illustrated *"the responsible approach being taken by Griffin in its commitment to overall environmental management....."*. In particular, Griffin's move to rehabilitation with native seed mixtures and native tree planting was considered a positive move which was fully endorsed.

Government departments with environmental responsibilities in the Collie Basin are pleased with Griffin's current rehabilitation efforts at the Muja and Chicken Creek minesites.

Griffin is also a pioneer in development of its overburden classification programme which results in segregation of different classes of overburden materials in the overburden dumps. Overburden classification ensures that only material which is suitable for rehabilitation is placed on the dump surfaces.

Rehabilitation progress is closely monitored for the purposes of producing the above reports and refining current rehabilitation techniques. Monitoring and field trials to date have accumulated a vast store of knowledge in rehabilitation which Griffin intends to demonstrate in rehabilitating the proposed Ewington minesite.

7.6.2 Overview of Rehabilitation Procedures

The sections below provide an overview of the rehabilitation activities proposed to be carried out on overburden dumps during mining at Ewington. They include initial construction of drainage and erosion control works, surface preparations, then finally revegetation of the overburden surfaces.

Natural revegetation of the Collie Basin overburden dumps is relatively sparse due to the high acidity, low nutrient status, crust-forming potential and erodibility of the overburden dump surfaces. To be successful, a programme of revegetation must take all of these factors into account, in terms of shaping and contouring, surface preparation, fertilising, mulching, selection of species used, and methods of seeding and planting.

7.6.3 Drainage and Erosion Control and Overburden Dump Profile

The overburden dumps will be divided into two zones for rehabilitation. Zone 1 will comprise the dump slope and Zone 2 will be the contoured upper surface of the dump. The drainage and erosion control works will be based on rainfall data for the area.

The dump profile in Zone 1 is a contoured 10^{o} slope from the crest of the dump to its toe. Contour drains of gradient 1:150 will be constructed on the slope surface at 90m slope intervals. These drains will function to control runoff, prevent sheetflow, trap erosion products from the slope above and retain rainfall and runoff which will greatly facilitate establishment of plants.

The drainage and erosion control works for Zone 2 will be designed to prevent as much surface movement of water as possible and to hold as much water as practicable on the dump surface. This will decrease sediment movement across the dump surface and allow maximum use of rainfall for the rehabilitation programme.

The whole dump surface will be ripped to a depth of 1m at 1.25m wide intervals parallel with the absorption banks to break up areas compacted during dumping operations, allow for more even penetration of rainfall and assist in reduction of overland flow.

7.6.4 Substrate Preparation

The mainly sandy and gravelly soils of the Ewington area are physically and chemically infertile and have poor water and nutrient holding capacities. Being sandy or made up of gravels and boulders, they have a low capacity to store moisture. Some are also shallow and underlain by hard lateritic duricrust or rock. These soil characteristics indicate that most local species will be well adapted to the severe conditions which might occur on a rehabilitated landscape.

As the area is to be rehabilitated with local, native vegetation, the returned spoil should simulate the original soil condition. Surficial overburden produced by mining operations is finer textured, less structured and of low pH. The establishment of vegetation on the overburden dumps will require chemical amelioration to raise the pH to levels acceptable to local native plant species and to increase the chemical fertility to levels capable of sustaining the required plant establishment and growth. Chemical amelioration will be achieved by application of lime and gypsum to the dump surface.

Griffin currently operates a specific dump management programme at the Muja and Chicken Creek minesites. This programme concentrates on characterisation of overburden and interburden spoil in order to identify horizons that have the potential to adversely affect the dump rehabilitation programmes through their physical or chemical properties. Spoil with undesirable characteristics is safely disposed of, deep in the dump profile. Only spoil which is of acceptable quality is placed at the surface of dumps to be rehabilitated.

Griffin classifies its overburden and interburden spoil into four classes in terms of its potential hazards associated with acidity, salinity and sodicity. The expression of these forms of chemical toxicity is a function of a number of factors including:

- size of reactive particles,
- weathering and leaching environment,
- neutralising, buffering or attenuation capacity of the spoil, and
- tolerance of plant species to concentration and forms of chemical toxicity.

The characteristics of the various classes of spoil are as listed:

- Class 1 spoil includes all overburden excluding the Nakina Formation and some interburden which is suitable for rehabilitation. Only Class 1 spoil is replaced on the surfaces of overburden dumps to be rehabilitated.

- Class 2 spoil is composed of interburden and is generally used for the core of the dumps or as bulk backfill.

- Class 3 spoil comprises the majority of coal waste, the Nakina Formation and some interburden and is suitable only for placement in the dump core and for bulk backfilling.

- Class 4 spoil comprises the remaining coal waste and shales. These materials are deeply buried in the overburden dumps to ensure they will not adversely affect the rehabilitation.

Where possible, the deep free-draining characteristics of the existing on-site soils will be maintained. The establishment of a comparable habitat is subsequent to the initial stabilisation of the dump surface. The ultimate stability of the habitat developed will depend on the success of erosion control techniques.

Deep substrate preparation will therefore require:

- limited compaction of the overburden, although some will occur as the dumps are formed,
- difficult material such as heavy clays will be dispersed in the overburden so as not to form impenetrable barriers within the soil,
- the overburden dumps will be surfaced with porous, sandy material.

Although the root systems of plants penetrate the soil to varying depths, the majority of Australian plants have roots which occupy only the top 0.5m or so of soil. In the Ewington area, most of the vegetation is growing on very porous and sometimes shallow soil. Plant survival does not depend on the water table but rather on adequate root establishment to capture any water which becomes available.

Contoured overburden dumps will be covered with sandy subsoil and topsoil if they are available. Field trials at existing operations indicate that this procedure is appropriate at Ewington. The entire upper 1m of profile will be deep ripped. This will encourage water penetration and reduce sheet runoff. It will also create microhabitats of drainage, wind protection and soil variation.

7.6.5 Revegetation

The primary functions of revegetating overburden dumps are stabilisation of surfaces, reduction of potential for erosion and establishment of local native plant associations comparable with those existing prior to disturbance of the land by mining. Aesthetic considerations will also be taken into account when selecting species.

Species Selection

The main objective of species selection for rehabilitation will be to return local native species which have a high conservation value to the Ewington area and potential to assist in the development of productive forest.

Selection of native plant species for rehabilitation will be according to several criteria:

- the species must be native and naturally occur locally (no exotic or non-local species will be introduced);
- resistance or tolerance to dieback disease will be preferred;
- native plants which re-establish themselves naturally by migration into the site or by introduction in prestripped topsoil will be favoured initially;
- the source of seed for the rehabilitation will be from the Ewington area;

- species diversity will be as high as possible, but some species will be favoured for direct seeding, particularly those which provide substantial amounts of seed.

Since the existing vegetation of the Ewington area is native Eucalypt forest and woodland, the basic set of species to be used for rehabilitation will be eucalypts and native shrubs. The degree of emphasis on the particular native species to be used will be determined from assessment of field trials, in terms of dieback tolerance, stabilisation, erosion control, acidity tolerance, nitrogen-fixing capacity, rapid growth, habit, leaf density, aesthetics and ability to cope with the generally harsh growing conditions of the overburden dumps.

With respect to revegetation the emphasis in the short term will be upon a dense groundcover of low shrubs and herbaceous plants which will reduce erosion, and reduce or eliminate acid formation. Trees, initially unsatisfactory in stabilising dumps or reducing erosion, do have aesthetic value and will slowly increase in importance as substrate stabilisers and dominants of developing plant associations.

Table 7.4 presents a list of species which have been successfully re-established in Griffin's rehabilitation programmes for its existing mining operations. They have also been used successfully to rehabilitate bauxite pits in the Darling Range. The trees and large shrubs to be used have been selected for various criteria including capacity to grow at low pH values, tendencies to produce dense, spreading foliage over most of trunk length, to grow rapidly under adverse soil conditions, to resist dieback and to harmonise with the natural landscape and native vegetation.

The understorey and low cover species have been chosen for similar reasons and additionally for their capabilities to stabilise the substrate surface, fix nitrogen and resist the spread of dieback.

. Direct Planting and Seeding

The seeds, primarily of native legumes and low spreading shrubs that are the most common native colonisers of overburden dumps in the Collie Basin, will be broadcast at rates of 0.5 to 5kg/ha, depending on the species, method of broadcasting and zone being revegetated. If necessary, areas where regrowth is poor will be supplemented by hand seeding.

Where possible, if field trials indicate that mulching is beneficial to rehabilitation in protecting the soil surface, contributing seed or creating a suitable micro-environment for germination and establishment of seedlings, mulched plant debris from clearing of new mining areas will be placed on the seeded area. If there is no plant debris and if there is a risk of wind or water erosion, or destabilisation, the surface of the topsoil may be hydromulched with native seed incorporated in the mulch.

Areas of revegetation will be monitored. Areas of poor germination will be retreated, soil ameliorants added or reseeded accordingly.

The details of techniques used in revegetation and the choice of species selected will be modified and refined on the basis of continuing assessment of field trials.

TABLE 7.4

LIST OF SPECIES WITH POTENTIAL FOR USE IN REVEGETATION

Trees and Large Shrubs (over 3m tall)
- *Casuarina fraserana*
- *Eucalyptus calophylla*
- *Eucalyptus diversicolor*
- *Eucalyptus marginata*
- *Eucalyptus muelleriana*
- *Eucalyptus patens*
- *Eucalyptus platypus* var. *heterophylla*
- *Eucalyptus resinifera*
- *Eucalyptus rudis*
- *Eucalyptus wandoo*
- *Kunzea ericifolia*
- *Melaleuca preissiana*

Medium Shrubs (1-3m tall)
- *Acacia extensa*
- *Acacia pulchella*
- *Agonis linearifolia*
- *Chamaecytisus proliferus*
- *Melaleuca laterita*
- *Melaleuca viminea*
- *Pultenaea ochreata*
- *Sollya heterophylla*
- *Viminaria juncea*

Low Shrubs (under 1m tall)
- *Aotus ericoides*
- *Euchilopsis linearis*
- *Hypocalymma angustifolium*

Prostrate Shrubs and Vines
- *Hardenbergia comptoniana*
- *Hemiandra pungens*
- *Kennedia coccinea*
- *Kennedia prostrata*

Herbaceous Plants - Legumes (Introduced)
- * *Lotus angustissima*
- * *Trifolium subterraneum*
- * *Vicia sativa*

Herbaceous Plants - Grasses (Introduced)
- * *Aira cupaniana*
- * *Lolium rigidum*
- * *Pennisetum clandestinum*
- * *Secale cereale*
- * *Vulpia myuros*

Herbaceous Plants - Sedges
- *Loxocarya fasciculata*
- *Lepidosperma* spp.
- *Schoenus* spp.
- various species of Restionaceae

. **Fertiliser**

Following preparation of the dump surfaces to be revegetated, fertilisers will be applied prior to planting of seedlings, broadcasting seeds of the other species and mulching.

The fertiliser will be incorporated into the hydromulch if and where this technique is used. On-site trials will be undertaken to determine which fertilisers are appropriate and optimum fertilising rates.

. **Seed Collection and Treatment**

The seed to be used in revegetation will be collected directly from local vegetation in order to maintain local genetic diversity. Seed will be hand-collected when mature, at the time of year appropriate for each species.

Generally, most native plant species do not require special treatment of seed for germination, and most have high germination success. Seed of *Acacia, Daviesia* and other Fabaceae will be soaked in hot water before use. Most other seed will germinate without treatment. *Acacia, Banksia* and *Grevillea* seeds are very attractive to ants, which carry the seed away and bury them too deep to germinate successfully, or eat them. These seeds may be treated with insecticide to repel ants. The Acacia seedlings will be inoculated with root nodule forming rhizobia bacteria, and mycorrhiza inoculations may be used with the tree seedlings.

. **Vulnerable Species**

If the vulnerable species are required to be included in the rehabilitation the procedure for their reintroduction will be as follows.

The propagation characteristics of each vulnerable species will be determined individually. Once vegetation cover is established and the local soil ecosystem begins to stabilise, the vulnerable plant species will be reintroduced as seedlings.

Each vulnerable species will be assessed on its merits, and their reintroduction will be carried out according to the most successful method for each particular species. This will not be done early in the revegetation programme because:

- successful establishment of vulnerable species may be harder to achieve in the early stages of rehabilitation,
- many vulnerable species have poor seed set or low levels of successful germination,
- vulnerable species may have special soil requirements and are difficult to establish.

Most vulnerable species will be propagated from seed if it is available and from shoot cuttings. Initially seed will be collected and germinated in the nursery to establish parent plants. Cuttings will then be taken from the parent plants for pot establishment. Potted plants will then be planted in the field in appropriate soil types. Special care will be given to them to ensure their successful establishment.

7.7 MINESITE CONSTRUCTION

At its earliest, the construction phase of the Ewington minesite could commence up to three years prior to commissioning of the power station in 1996 to ensure that coal can be delivered for power generation at the appropriate time.

Construction activities will be concentrated on the building of on-site facilities and the erection and commissioning of large pieces of equipment, eg hydraulic shovels. Construction of the dragline will commence in Year 3 of the mining operation. On-site facilities will include offices, workshops and coal handling equipment.

The coal handling equipment will comprise a dump hopper, coal crushing plant and conveyors located near the boundary of the new Collie Power Station.

A 13m high plateau will be constructed to accommodate the dump hopper which will receive run-of-mine coal from haul trucks and feed it by conveyor to the coal crushing plant. A conveyor will also be constructed to carry crushed coal to the power station receival point.

7.8 INFRASTRUCTURE

Provision has been made for all necessary infrastructure to support the mining operation. The major infrastructure requirements for the Ewington open-cut mine are as follows:

- minesite complex
- roads and hardstands
- electrical power reticulation system
- ancillary facilities and systems

The overall site layout for surface infrastructure development is shown on Figure 7.4.

7.8.1 Minesite Complex

The minesite complex will include the following facilities:

- workshop, warehousing, storage and support services
- offices for administration, accounting, technical services and production personnel
- crib and workforce meeting facilities
- bath and changehouse facilities
- occupational health, training, safety and first aid facilities
- ancillary buildings.

These facilities would be strategically located to support and service the Ewington open-cut mine. The complex will occupy an area of approximately 700m by 300m. The proposed site is generally flat and situated on high ground above RL230. Approach to the site would be by means of a new sealed access road from the Coalfields Highway.

7.8.2 Roads and Hardstands

Pavements for various purposes will consist of the following:

- major coal haul roads - unsealed
- main minesite access road - sealed
- equipment laydown area, hardstands, storage yards - unsealed
- minesite maintenance road - unsealed.

Each pavement construction will be designed to sustain the required loading, traffic frequency and vehicle configuration.

7.8.3 Electrical Power Reticulation System

The electrical power reticulation is likely to consist of the following (see Figure 7.4):

- A 132kV dedicated overhead feeder from Muja Power Station to the minesite.
- A 66kV overhead and spurline network which would service dragline, drill rigs, equipment assembly pad and laydown area.
- An 11kV overhead line which would service the minesite complex and dewatering pumps.
- Lighting for in-pit, dumps and sealed roads.
- All necessary substations, transformers and ancillary equipment.

7.8.4 Ancillary Facilities and Systems

Major ancillary minesite support facilities and systems will include the following:

- Fast fuelling and lubrication facility for mobile equipment with sufficient supplies of fuels, oils and lubricants in appropriately bunded storage tanks.
- Washdown facility for all equipment prior to undergoing servicing, maintenance or repair works in the workshop.
- Water truck filling station which will accept water from the fast fuelling facility, washdown facility and any other water sources possibly contaminated by free or emulsified oil for use on road wetting and general dust suppression. The station will be supplemented with water from mine dewatering.
- Package treatment plant which will process domestic type sewerage and wastewaters. The treated effluent together with any other water sources that are free of oil, will be contained in lagoons and returned for landscaping use.

Water reticulation from the mine dewatering system which will supply the following independent water systems:

- raw water for the mine workshop, washdown facility and watertruck filling station
- raw water for firefighting services, and
- treated water for showers and potable use.

Coal crushing station located near boundary of new Collie Power Station. Within this facility a dump hopper will receive run-of-mine coal from haul trucks and feed it onto conveyors leading to the coal crushing plant where coal will be fed through both primary and secondary crushers. Conveyors will carry crushed coal to the power station receival point.

7.9 MINE SCHEDULE AND DEVELOPMENT PROGRAMME

A summary of the mine schedule is presented in Table 7.5. Detailed scheduling for coal, interburden and prestrip based on power station coal supply contracts will be undertaken by mine planning staff both prior to and during operations. This schedule of events would not necessarily apply to mine development for supply of coal to customers other than the power station. However, for the purposes of this CER the activities and duration given in Table 7.5 are indicative of the overall mine development programme.

The major events prior to the commencement of mining are also indicated. The critical elements in this programme of work are establishing dewatering, power supply and minesite infrastructure in order to supply coal to the new power station by 1996. Section 7.7 describes the construction activities which will occur prior to mining.

The dewatering operation will commence two years in advance of mining to ensure that conditions amenable to mining in working areas are established and maintained from the commencement of operations. The early mining operations could commence in early 1996 to ensure coal is delivered to the power station at the appropriate time.

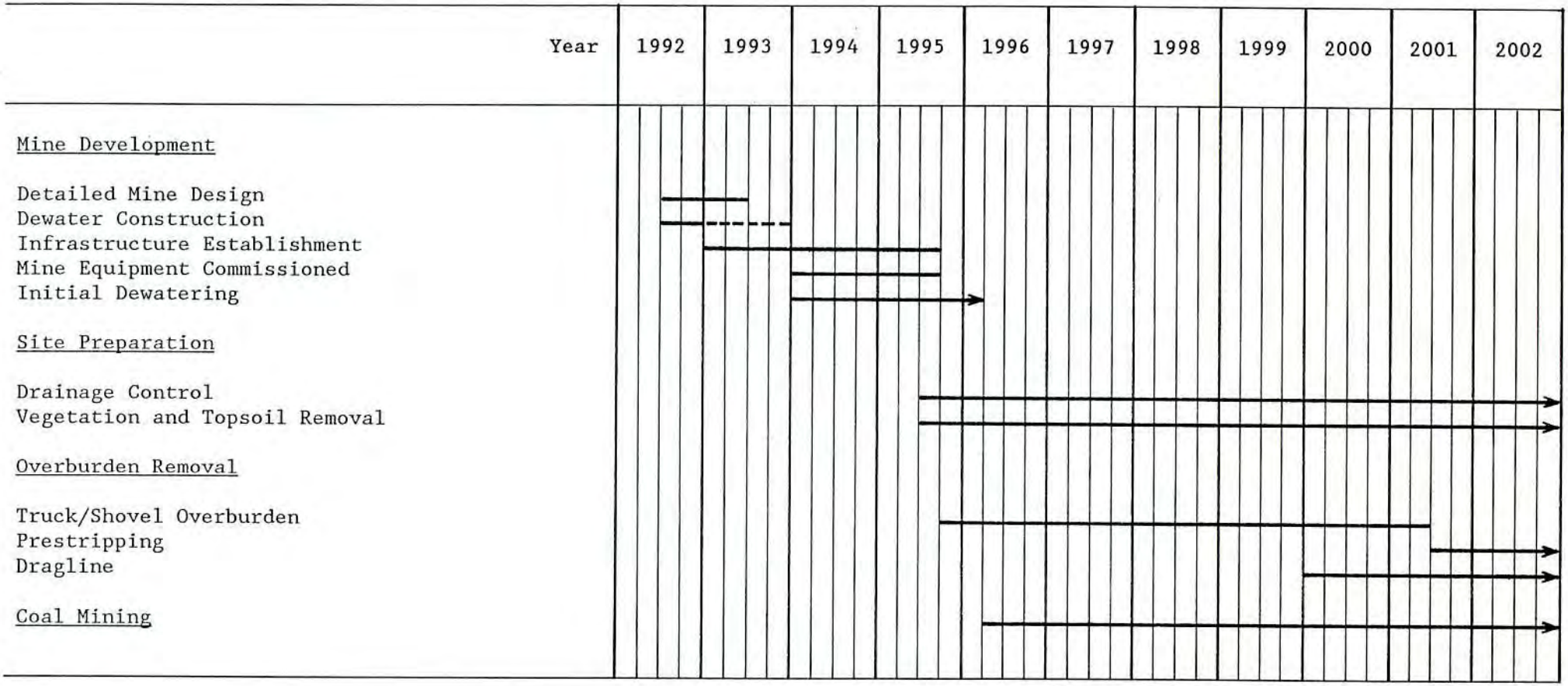
Current mine planning indicates that mining will commence in the north-western corner of the mine pit. Mining in this area will continue for about two years when it will begin to move down the western edge of the mine pit. The western edge will be mined out by the end of Year 5. Mining will then continue in the central eastern area of the mine pit for the remaining 26 years of anticipated mine life.

7.10 WORKFORCE

The size of the workforce employed at the proposed Ewington minesite will vary in number as the mine infrastructure is established. Numbers will be very low for the initial two year period of dewatering but will begin to grow once the mine complex begins to be established and when activities in preparation for mining are commenced. The construction workforce will probably peak at some 100, the majority being contractors.

TABLE 7.5

MINE DEVELOPMENT AND OPERATION SCHEDULE



As the mining operations expand, the workforce will grow to an average size of between 200 to 250 personnel. They will be supported by certain technical and advisory functions at the Muja and Chicken Creek minesites and by the existing financial, technical and management team based in Perth.

7.11 DECOMMISSIONING

Mine planning and scheduling were undertaken to confirm coal production over a 31 year period as this is the usual life expectancy for a coal-fired power station. The mining operation could be continued past the initial 31 year period, but detailed plans for this have not yet been developed.

Rehabilitation will attempt to recreate a near natural vegetation cover consistent with the mine's surroundings. Outlined below are the current plans for decommissioning of the Ewington mine. However, it must be acknowledged that society's expectations can change over a 31 year period.

Details of decommissioning procedures will be developed during the life of the mining operation. Decommissioning plans will be regularly reviewed with the appropriate Government authorities during the life of the mine.

7.11.1 Landform

The proposed mine and overburden dump areas will be rehabilitated. An overall rehabilitation scheme has been designed to achieve the following long term goals:

- development of a stable ground surface,
- rehabilitation of the disturbed surface to produce a habitat as similar as possible to that which existed prior to ground disturbance and mining,
- revegetation to lessen the visual impact of overburden dumps, and
- minimisation of site erosion.

At the completion of mining, a final void will remain. This void will not be filled because the initial overburden will have been fully rehabilitated and be unavailable for backfilling. Backfilling of the final void would also restrict access to the remaining coal resource if it is required in the future.

At the completion of mining, the exposed coal face will be covered with overburden to prevent deterioration of coal quality and spontaneous combustion of the coal seams.

The final high wall will be reshaped by dozers to a stable angle and the pit will be isolated by an earth bund. Permanent drainage structures will be constructed on the slopes to control water movement on the rehabilitated minesite and minimise erosion. The slopes will then be rehabilitated. The pit will be allowed to fill with water from rainwater and groundwater inflow.

The permanent drainage control structures will ensure that as much runoff as possible is diverted around the minesite. Runoff from rehabilitated areas into the pit will be minimised.

7.11.2 Infrastructure

Upon decommissioning of the mining operation, all facilities such as structures, foundations, equipment, pipelines and powerlines will be dismantled or removed. These areas will be rehabilitated with native vegetation.

Long term post mining land use will be determined by the Collie Development Structure Plan.

Consultations with the Government will be held prior to the time of decommissioning in order to determine which facilities might be required to be left in place for Government purposes such as industry, recreation or land management. Such facilities might include roads, powerlines, pipelines and the mine complex depending on the future of the power station.

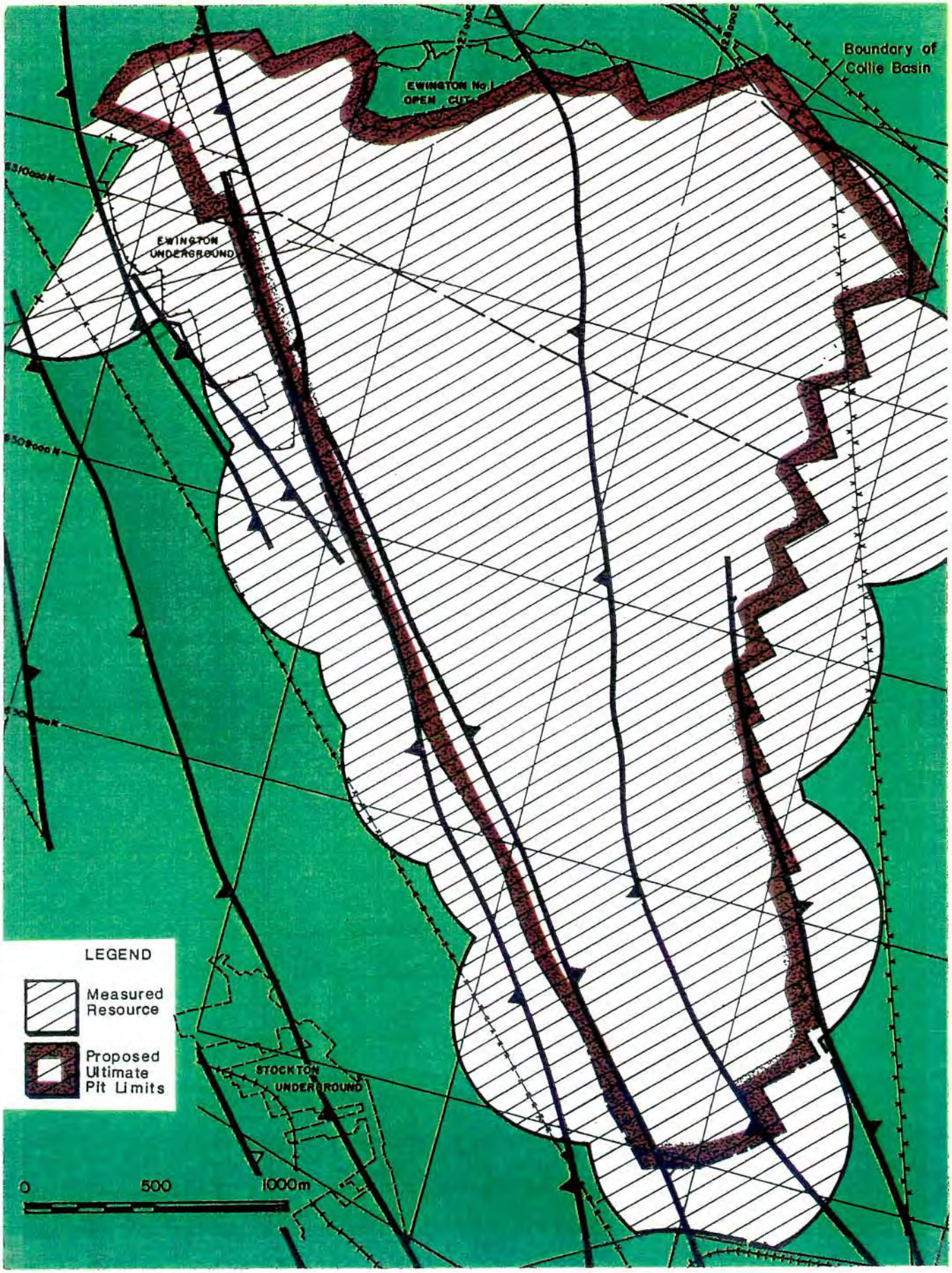
It is likely that a large proportion of the facilities would be relocated for utilisation in development of the Premier coal deposit east of the Ewington deposit or alternatively the Stockton leases. A number of facilities such as the water discharge infrastructure and mine complex might be left in place. If the Premier deposits or Stockton leases are not developed, all constructed facilities would be decommissioned.

7.11.3 Workforce

The social impacts of decommissioning and their appropriate management will be addressed prior to mine closure. It is likely that social impacts would be minimised by Griffin's long term plans to develop the Premier deposits or the Stockton leases following closure of the Ewington mine.

It is also likely that heavy industry will establish in the Collie region in the long term, such developments would be able to absorb the possible social impacts of unemployment, and surplus specialist services.

As heavy industry establishing in the region will certainly require coal as a fuel or reductant it is expected that there will be long term growth in the region's coal industry. Thus other mines will be opening up, and therefore the workforce will continue to be deployed.



EWINGTON OPEN CUT MINE
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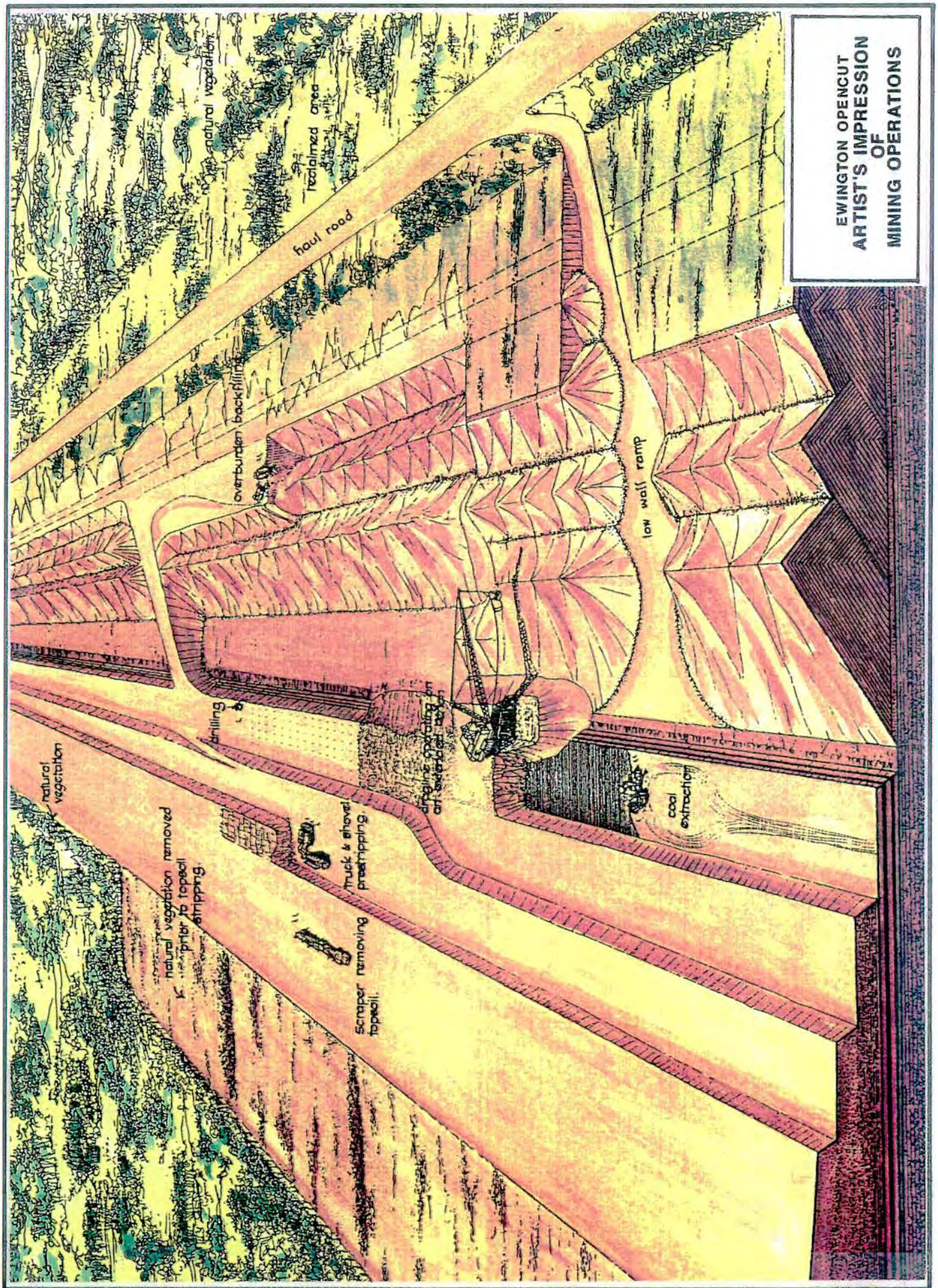
MINEABLE RESERVES

FIGURE 7.1



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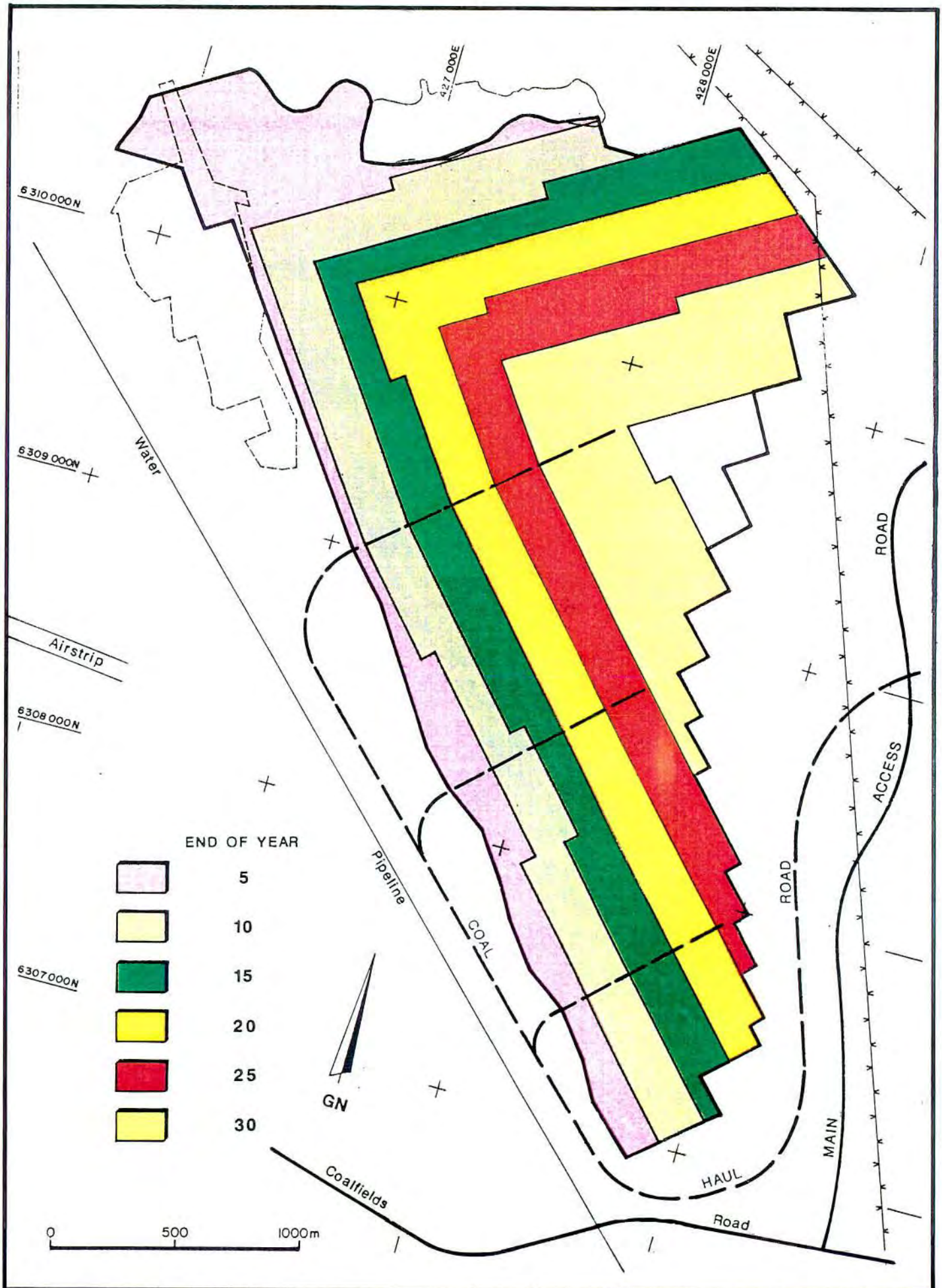
STRIP MINING CONCEPT

FIGURE 7.2



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MINE PLAN

FIGURE 7.3

426 000E
428 000E
430 000E
432 000E
6311000N
6309000E
6307 000E
Approximate
HAUL
COAL
Collie
ROAD
PROPOSED POWER STATION SITE
Ewington Open Cut No. 1
Ewington Underground
PIT 2
PIT 4
PIT 5
PIT 3
11KV POWER RETICULATION
11KV
66KV
DRAGLINE ERECTION SITE
MINE FACILITIES
MAIN
ROAD
Basin
RECEIVAL POINT
CRUSHING STATION
Boundary
Water
POWER
RETICULATION
Pipeline
Airstrip
Railway
CABLE LAYDOWN AREA
ACCESS
132KV SUB STATION
132KV POWER SUPPLY
Line
Coalfields
Road
GN
0
500
1000m
GRIFFIN PREMIER DEPOSIT

LEGEND

- ELECTRICAL POWER SUPPLY
- HAUL ROADS
- MAIN ACCESS ROAD
- PIT OUTLINE
- WATER PIPELINE
- OVERBURDEN STOCKPILES

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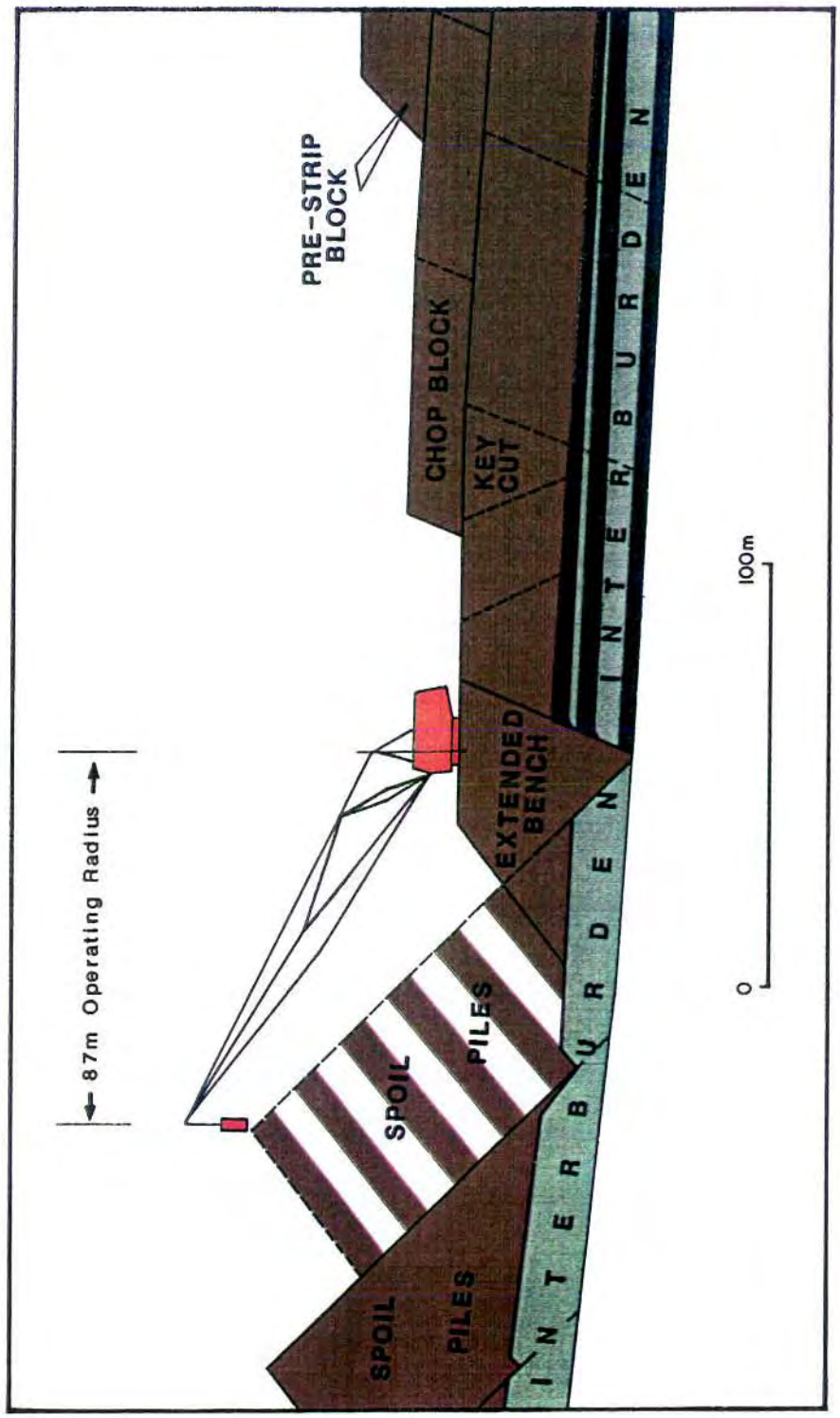
MINE INFRASTRUCTURE

FIGURE 7.4



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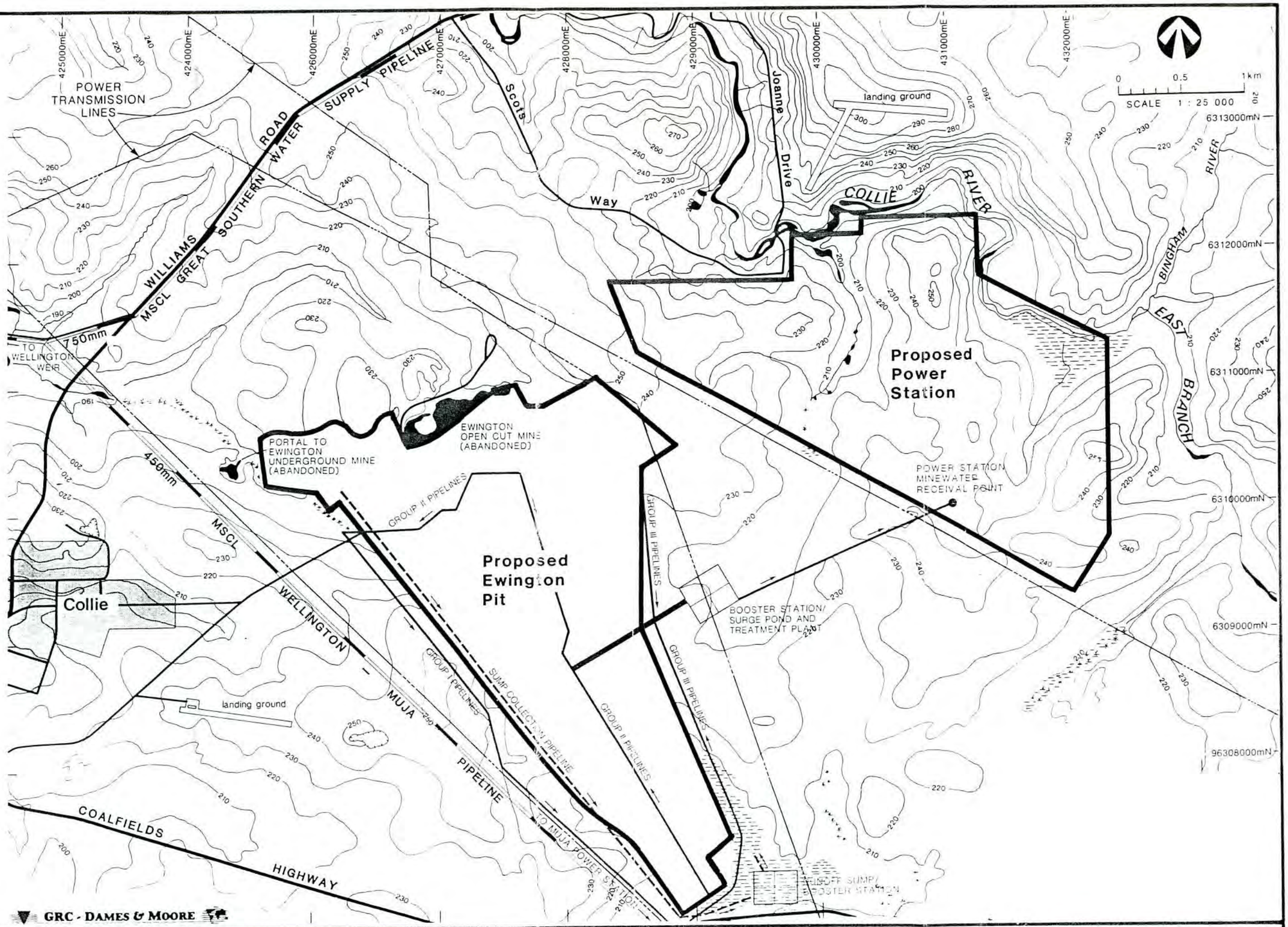
DRAGLINE OPERATION

FIGURE 7.5



GRC - DAMES & MOORE

Halpern Glick Maunsell

EWINGTON OPEN CUT MINE
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DEWATERING SYSTEM LAYOUT

FIGURE 7.6

8. ENVIRONMENTAL IMPACTS

8. ENVIRONMENTAL IMPACTS

8.1 INTRODUCTION

By its nature the coal mining process results in a number of impacts on the environment and on the local community that may work or reside in close proximity to the minesite. Coal mining operations have existed in the Collie Coal Basin for over 100 years and will continue for at least another 50 years.

Whereas early coal mining operations commenced at a time when there was little or no residential development in the Basin or in close proximity to minesites and when social attitudes towards environmental impacts were poorly defined, present mining operations are subject to far more concerted pressures from all areas. It is as a direct result of these pressures that positive steps have been taken to plan and implement a programme designed to minimise the impacts that inevitably result from coal mining activities.

It must be recognised that this proposal to develop the Ewington minesite will result in ongoing impacts to the Collie community and the environment and it is the purpose of this section of the CER to outline the anticipated impacts of the proposal and indicate whether adverse impacts are manageable or not.

There are no forecast impacts of the proposed minesite on Aboriginal sites (see Appendix G), existing services and land uses, community facilities or safety measures and emergency procedures currently in place for Collie industries.

The forecast impacts of the proposed minesite on individual components of the environment will be discussed separately before synthesising these impacts as a whole to show the overall effect on the total environment. This will be done for two reasons, firstly to allow conclusions to be drawn on the environmental acceptability of the proposed development and secondly to show that any adverse impacts can be controlled to within acceptable levels by diligent management, ameliorative measures and monitoring programmes.

It must be noted that a number of the impacts detailed in the following sections will be of a short term nature only as a result of construction and preparatory activities. Once these activities are completed, their impacts will cease. However there are impacts that are inherent to coal mining and which will continue to affect the environment and Collie community in the long term.

8.2 AESTHETICS

The area of the proposed Ewington minesite forms a natural backdrop to the Collie township and its scenically attractive surrounds. The development of the proposed minesite will superimpose on these surrounds overburden dumps, haul roads and the minesite complex. A natural ridge of high ground between the township and the mine pit will, however, mask a large proportion of these elements. The majority of the mining activities will occur within the pit and are therefore not expected to significantly affect the area's aesthetic values. The impact the former elements will have on the area's aesthetic values is detailed in the following sections.

It must be noted that although the Collie area is scenically attractive, there are numerous abandoned open-cut coal mine workings, underground portals, railways and gravel and sand pits already in the area which detract from its aesthetic values.

On the other hand old rehabilitated coal mine workings in the Collie Basin have become extremely popular recreation areas. Examples include the Stockton recreation area and the Black Diamond picnic area.

It should be noted that there are no scenic vantage points or elevated areas within or in the vicinity of the Collie townsite from which the proposed mine pit and associated facilities will be visible to the extent of having significant visual impact.

8.2.1 Overburden Dumps

Overburden dumps will be created by the initial mining operations as the north-west boxcut and the western margin of the workings are opened up. This material will not be returned into the mine pit. The initial overburden will instead be dumped along the north-western margin of the pit as shown in Figure 7.4. Overburden dumps will generally not exceed 20m above surrounding terrain levels.

If required, overburden material will be used to construct noise barriers in the vicinity of the north-west corner of the mine pit. These will probably be about 10m high. Both overburden dumps and noise barriers will be contoured with shallow outer slopes to ensure they blend into the surrounding landscape. They will have stabilising and erosion control structures and will be fully revegetated with native plant species to ensure their forms remain stable. Their revegetation will be according to comprehensive rehabilitation programmes prepared for the whole minesite.

As these overburden dumps and noise barriers will be located on higher ground than the Collie townsite, it is possible that portions of these structures will be visible from some locations within the township. However a natural ridge of high ground between the township and the mine pit parallel to the western margin of the minesite will function to mask a large proportion of the overburden dumps. Effective revegetation on the outer slopes of the overburden dumps combined with this natural masking will result in a very minor aesthetic impact.

It should be noted that the overburden dumps by virtue of their location, will ameliorate a number of other impacts the mining operations would otherwise impose on the townsite including containment of dust within the mine pit and noise emitted from the mining equipment and airblast over-pressure from blasting.

8.2.2 Haul Roads

Haul roads will be constructed around the perimeter of the minesite to haul run-of-mine coal from the pit face to the coal crushing station and then to the Collie Power Station receival point or outload point to other customers. Currently planned haul road routes are shown in Figure 7.4.

Those located north of the minesite will be constructed at as low a level as is practicable to reduce noise emitted to the townsite from haul truck movements. In addition to this a noise barrier may be constructed at the north-western corner of the minesite to supplement the natural ridge in this area. Thus the haul roads in this region will not be visible to the Collie townsite or environs immediately to the west of the minesite.

Those haul roads which extend along the western margin of the mine pit will be masked by the natural ridge in this area and the surrounding forest.

Coalfields Highway approaches the minesite from the west and passes only 0.5km south of the minesite although the mine pit will not be visible to commuters on the highway. The mine's haul roads, however, will be within 100m of the highway in this area which is not forested. Natural topography will mask the minesite and haul roads from the highway as travellers approach the minesite. However, where the highway is closest to the minesite the workings may be visible.

If the aesthetic impacts of the mine workings and haul roads from the highway are significant, Griffin will commence an earthworks and planting programme to mask the mining activities from road users. This will only occur after considerable mine development has occurred.

8.2.3 Minesite Complex

The minesite complex will be located on high ground at an elevation of greater than RL230 in a forested area. It is not expected to present a significant aesthetic impact.

8.2.4 Airstrip

Aeroplanes taking off from and landing on the Collie airstrip will have a clear view of the mine workings in their entirety. This will be in contrast to the previously forested approaches to the airstrip.

8.2.5 Final Void

A final void will be left following decommissioning of the mine. This void will be contoured and rehabilitated to fit into the surrounding landscape and allowed to fill with water to become a lake. It is hoped that this feature would become a regional recreational and aesthetic asset.

8.3 LANDFORM/GEOMORPHOLOGY

An inherent and permanent impact of coal mining is the removal of open-cut coal from the landscape. As has been demonstrated in Section 7.6, the concurrent disturbance and displacement of overburden can be ameliorated by well designed rehabilitation programmes. Rehabilitation following mining will create a new landscape which will blend into the surrounding undisturbed natural landscape. Design of final landforms will be determined by future planned land uses which will include State Forest and farming.

Griffin uses the latest in blasting technology to reduce ground vibration and therefore the proposed coal mining activities will not affect the stability of the surrounding geological formations.

Following completion of mining at Ewington, the remaining pit faces will be shaped to a stable condition, as required by the relevant statutory authorities.

8.4 EROSION

Soil erosion, both within and surrounding the Ewington minesite is a potential cause of several possible impacts such as gullying, soil degradation and siltation of watercourses. Soil erosion could occur if runoff/drainage around and within the mine pit is not carefully controlled. Griffin recognises that soil erosion is costly to mitigate once its effects are evident and that it is entirely manageable. Section 9.2 details the management procedures with which Griffin intends to control and prevent soil erosion.

Of particular importance to Griffin will be the control of runoff from the rehabilitated overburden dumps and stockpiles of topsoil and other materials. The successful rehabilitation of the overburden dumps will be dependent primarily on control of runoff. Thus drainage control will be a key management issue (see Section 9.2).

If drainage from these areas is not properly controlled, the valuable topsoil replaced on overburden dumps would quickly be lost, compounding the difficulties associated with achieving successful revegetation. The revegetation programme will ensure the long term stability of the new landform thus minimising sheetflow and loss of soil by erosion.

The overburden dumps and stockpiled material will also be subject to potential soil erosion by wind. Careful contouring of these dumps and revegetation of their surfaces will prevent loss of topsoil by wind erosion. Initial rehabilitation activities such as mulching will stabilise the surfaces until adequate revegetation occurs. If areas cleared of vegetation in preparation for mining are at risk of wind erosion, they will be watered.

Runoff permitted to flow across the mine workings could collect soil from disturbed, cleared areas leading to siltation of surrounding watercourses. Where possible, runoff will be prevented from entering the minesite and diverted into the natural drainage system. The primary control for runoff will be diversion channels and bunds.

Ephemeral streamlines intercepted by the minesite will be diverted by drainage structures around the minesite. By maintaining the flow of water, these measures will prevent erosion of streamlines and creation of compensating streamlines.

The discharge point for disposal of excess mine water will be subject to potential erosion leading to siltation of downstream watercourses. Structures will be installed to diffuse the erosional impact of the outflowing mine water. Slopes immediately upstream of and at the discharge location would be stabilised by a weir and spillway if necessary. The majority of the disposal options would utilise low gradient well vegetated discharge routes through marshes which would minimise the potential for erosional scour.

Natural drainage channels receiving discharge water would be carefully assessed to determine the probability of erosional scour. There are a number of options to prevent the banks from becoming degraded, including controlling the rate of flow and installing bank protection structures.

8.5 HYDROLOGY

During the initial two years of dewatering mine water will probably be discharged to a natural watercourse associated with either the east or south branches of the Collie River. Following commissioning of the power station these discharge volumes will be much lower (refer to Section 7.5).

Discharge of mine water and runoff from the Ewington minesite will be subject to a water discharge licence issued by WAWA, the conditions of which will specify criteria to which the quality and volume of the water discharged must abide. These criteria will be set at a level so that the discharge would not be expected to significantly impact on the biological or social environments and would be according to the Water Resources Management Strategy for the Collie Basin (refer Section 3.1.5).

Griffin, in consultation with the power station consortium will prepare a water management programme to be submitted to WAWA for approval prior to commencement of dewatering. This will detail the method of treatment if it is required, the volumes to be discharged and erosion control structures. Discharge from the minesite will be carefully managed as set out in the water management programme.

Present planning indicates that the water treatment facilities associated with the power station will be commissioned prior to the power station itself, for the purpose of treating mine water to be discharged. If this is not the case, and the mine water from early dewatering requires treatment, Griffin will construct treatment facilities to be commissioned in conjunction with the dewatering system. However, mine water is not expected to require treatment prior to its discharge, particularly in the early stages of the mine's life.

Water meeting the conditions of the discharge licence and in accordance with the water management programme while reducing the impacts on the flow and quality of natural watercourses to acceptable limits, will have an impact on the natural environment, albeit significantly smaller than if no management measures were implemented.

The potential impacts of discharge on surface hydrology surrounding the Ewington area are detailed in the following discussion.

8.5.1 Seasonal Effects of Discharge

The south and east branches of the Collie River undergo pronounced seasonal changes as a result of the highly seasonal rainfall which occurs in the catchment. Potential impacts of mine water discharge on the quality of water in natural watercourses will include siltation leading to increased turbidity, a decrease in Total Dissolved Solids and pH and an increase in Total Iron. These changes will, however, be greatly modified (and ameliorated) by the considerably larger flow of the watercourses and seasonal influences.

During summer and autumn, freshwater discharges into the east and south branches of the Collie River and resultant river are virtually nil. During these seasons, discharge of mine water (on average, 32Ml/day) prior to commissioning of the power station would significantly increase the volume of water which passes downstream.

During winter and spring, freshwater discharges are greatest, in the order of 2,000Ml/day, therefore discharge of mine water during these seasons would make only a small contribution (approximately 1.6%) to the total volume of water flowing in the east and south branches. Following commissioning of the power station, mine water discharge would be reduced to on average 8Ml/day which would continue to increase the volume of flow during summer and autumn, although much of the mine water would be lost to the water table.

During winter and spring, discharge of mine water would make only a small contribution to the total volume of water which passes downstream, thus the effect of the discharge on pH and TDS in the rivers would be expected to be negligible.

As natural river flow declines over the spring and early summer, the marginally brackish (high TDS) and slightly acidic river water would be replaced by mine water of low TDS and pH. Most of the natural river water would be replaced by mine water within a short period.

As runoff volumes fall markedly in spring and summer, the east and south branches of the Collie River dry up and become reduced to a series of deep pools. Downstream, considerable amounts of river water would remain in the deep pools for several months. Thus mine water would become rapidly diluted by 'natural' river water downstream of the discharge area. Much of the mine water would be lost to the groundwater table.

Following the onset of river flow in early to mid-winter, the mine water would be rapidly flushed out of the discharge area, resulting in a rapid rise in pH to levels comparable with those upstream.

Based on data recorded from existing mine water discharge points on the Collie River it could be expected that the following scenario would occur.

The pH of the water in both branches of the Collie River is 7.0, generally higher during winter and spring, becoming lower in summer and autumn. Addition of generally acidic mine water to these watercourses would result in a negligible effect on pH in the river which would decrease only slightly to between 6.0 and 7.0 during the winter and early spring. These levels would become depressed in summer and autumn to between 5.0 and 5.5, however levels as low as 4.0 could be experienced for limited periods. The pH would slowly increase downstream of the discharge area.

Total Dissolved Solids in both branches of the Collie River also follow a seasonal trend, reaching exceptionally high levels (approximately 3,000mg/l) in the summer and falling to approximately 1,000mg/l in the winter and early spring.

The introduction of mine water would reduce this seasonal effect so that although TDS in the discharge area would also start rising in the late spring, it would fall significantly in mid-summer because as natural freshwater discharge decreases, much of the water would now be coming from mine water discharge. Thus, during mid-summer, TDS in the discharge area would lie between 400mg/l and 1,200mg/l, considerably less than that coming from upstream. Taking seasonal differences into account, the introduction of mine water would reduce TDS downstream. It would also lead to a decline in hardness and alkalinity.

The mine water would be expected to maintain flow along the rivers downstream of the discharge point during summer and autumn. The lack of water movement upstream in summer and autumn results in pools becoming stagnant with very low oxygen levels. In contrast the water levels of pools in the discharge area and downstream would be maintained with the water being well oxygenated.

Nutrient levels in the discharge area in summer and autumn would be much lower than those upstream. Whereas pools upstream become eutrophic from spring to autumn, pools in the discharge area and downstream would be expected to be mesotrophic.

During summer and autumn a considerable amount of the discharge would be lost to the groundwater table, thereby helping to replenish the water table which would be somewhat depleted as a result of the mining operations.

Thus in summary, the effects of discharging mine water would be as follows:

- reduction in pH during summer and autumn,
- marked reduction in Total Dissolved Solids (beneficial),
- maintenance of water levels and oxygen concentrations (beneficial),
- reduction in nutrient levels and therefore production of algae (beneficial),
- reduction in hardness and total alkalinity (beneficial),
- a small amount of mine water would pass some distance downstream of the discharge area but most would rapidly re-enter the water table (beneficial),
- maintenance of downstream flow during long, dry summer and autumn periods (beneficial).

The above discussion is based on untreated mine water being discharged. It is expected that this will be the case. However, if the licence conditions call for improvement in water quality by treatment any negative effects detailed above will be ameliorated to some extent. The seasonal trends will still be evident however, as the mine water would not be anticipated to be of the same quality.

The mine water will have a greater environmental impact during the first two years when the power station is not commissioned and large volumes of mine water are discharged into a natural watercourse. Following commissioning of the power station mine water discharge volumes will be much lower (refer Section 7.5). Therefore the temporary increased water source should not be assumed by riparian users to be a long term situation.

8.5.2 Wellington Dam

It should be noted that although the TDS of the untreated mine water will be considerably lower than that of the river water, the resultant larger volumes of water will result in larger quantities of dissolved solids entering the Collie River and thence the Wellington Dam. One of the main objectives of the Collie Coal Basin Water Resources Management Strategy is to reduce the amount of dissolved solids entering the Wellington Dam Catchment with the long term objective of restoring the water in Wellington Dam to potable quality.

Increasing the TDS load to the Wellington Dam will be a downstream impact of the mine water discharge, although the local effects of the discharge are desirable from the viewpoint of users who draw water from the east and south branches of the Collie River.

8.5.3 Catchment Runoff

Development of the Ewington minesite and subsequent control of drainage in its vicinity will result in interception of a proportion of the catchment runoff into watercourses which drain the area.

This will result in smaller seasonal flows in the watercourses affected. However drainage from only a small portion of the Ewington minesite will be intercepted at any one time. This impact will not be permanent because the catchment area affected by mining will be progressively rehabilitated with the original drainage patterns being restored. Discharge of mine water in excess of that taken by the power station will also ameliorate this impact.

The north-western streamline seasonally drains a proportion of the Ewington minesite area into the Collie River. The seasonal flow in this stream is utilised by riparian users to water stock and for irrigation. Retaining structures have been built along this streamline to increase its storage capacity so that water can be held for use throughout the year. This water supply may be affected by the mining activities in its head-waters, particularly during the first 5 years when the mining operations will be concentrated in the north-western corner of the minesite. Impacts on this water supply will be possible increased siltation during seasonal periods of streamflow and a reduction in streamflow resulting in smaller quantities of water being stored for later use.

8.6 HYDROGEOLOGY

The proposed mining operations at Ewington will require groundwater levels/heads to be lowered by up to 120m. This will be achieved by the planned dewatering scheme. Extraction of groundwater for this purpose will result in drawdown of the groundwater level around the proposed mine. The estimated extent of drawdowns in the coal measures (Permian sediments) and superficial sediments are given below.

8.6.1 Permian Sediments

Based on observed changes in hydraulic heads around WD7 (Collie-Cardiff) underground mine, groundwater level drawdowns of more than 10m are likely to extend to at least 2km from the pit, particularly to the east and south of the mine. Smaller drawdowns will extend to greater distances, and will probably increase total drawdowns in SECWA's Shotts borefield. In turn, this drawdown may reduce the borefield capacity and therefore its operation.

8.6.2 Superficial Sediments

A numerical groundwater model was constructed to assess the potential effects of dewatering on groundwater levels in the shallow aquifer. Drawdowns were calculated in the model for the surrounding area. The results (illustrated in Figure 8.1) indicate that after a long period (10 years), there will be drawdowns of 3m or more within a few hundred metres of the mine, decreasing to about 1m at between 0.5km and 1km from the mine, and to 0.1m at about 2.5km from the mine.

The drawdown in the vicinity of the Collie townsite will be 0.1-0.05m. This is not expected to have an effect on bore capacities in this area. Private bores in the Shotts townsite would not be expected to be impacted by the predicted groundwater drawdown.

Drawdowns where the Collie River East Branch crosses the Basin in and south of Collie will be less than 0.01m. In practice, drawdowns of less than 1m will probably be indistinguishable from seasonal or long term climatic effects. Also, additional recharge may be induced by lowering the water table, thereby reducing drawdowns.

East and north-east of the proposed Ewington mine, the Collie River East Branch is within basement granitic and gneissic rocks, and so in these areas there is very little possibility that dewatering will affect streamflows.

There are small tributaries to the Collie River East and South Branches in the vicinity of the proposed mine. In the present relatively undisturbed conditions, it is likely that these tributaries are effluent, ie shallow groundwater discharges to the streams, particularly at times of high groundwater levels. If the water table is lowered, these tributaries will become influent, with streamflow infiltrating to the groundwater.

8.7 DUST

The major sources of dust at the Ewington minesite will be associated with clearing of vegetation, blasting, overburden removal and coal mining. Dust will also be generated from stockpiles, the haul roads, other vehicle movement on unsealed roads and from any surface which is not covered with vegetation.

The surface soils in the Ewington minesite are mostly sands, and although they are fairly immobile, they contain some clay, silts and organic debris which will tend to be lifted by wind. Mine overburden and coal particles are finer materials and will readily generate dust if not controlled.

There are two aspects of dust generated by the mining operation which need to be considered as potential impacts, atmospheric concentration and surface deposition.

Under dry, windy conditions high dust emissions may be produced from dumps, stockpiles, roadways and the like, which can lead to unpleasant conditions in their vicinity. However, by experience these effects will be of a local nature only.

Given its close proximity to the Collie townsite, the fugitive dust could potentially become a nuisance to nearby residents if carried towards Collie during certain periods when the wind is of sufficient strength and in a westerly direction. However, the distance between the stockpile areas, overburden dumps and the nearest residents should be sufficient to provide more than adequate protection against such impact.

Dust from the minesite, if severe enough, will deposit on the leaf surfaces of plants surrounding the minesite and this covering could adversely affect plant photosynthesis by blocking the sunlight. Coal dust would have a much greater sunlight blocking effect than soil dust. Seasonal rainfall would regularly remove this cover of dust from plant leaves.

The Environmental Protection Act forms the basis for legislative control of dust levels emitted from minesites. However this legislation does not specify maximum levels for surface deposition or atmospheric concentration. The Environmental Protection Act does require that adequate dust controls are implemented on the minesite and haul roads. Provided these dust controls are in operation, dust levels associated with the minesite will be minimised and would not be expected to pose a nuisance to the communities living in its vicinity. Dust control measures proposed for the minesite are detailed in Section 9.5.

8.8 NOISE AND VIBRATION

The Ewington minesite will emit noise and vibration generated by the mining operations. The major sources of noise will be haul trucks, hydraulic shovels, bulldozers, the dragline and blasting.

All noise generated within the Ewington minesite will be subject to the provisions of the Noise Abatement (Neighbourhood Annoyance) Regulations, 1979, administered by the EPA. For the purposes of the Act, vibration is classified with noise.

8.8.1 Acceptable Noise Levels

The EPA document 'Environmental Noise Management Procedure' (unpublished) establishes the maximum acceptable noise environments in the State for residential and commercial/industrial premises which are subject to intrusive noise emissions from other premises. These are the "worst case" noise levels that can be experienced. Generally the noise levels generated by a source cannot exceed the existing background noise level.

Compliance with this procedure will result in noise emissions acceptable to the Environmental Protection Act 1986. Acceptable maximum noise levels for residential premises specified by the procedure, providing no tonal, impulsive or other annoying characteristics exist, are as follows:

Monday to Saturday	daylight hours	7am to 7pm	50dB(A)
Any day	night-time hours	10pm to 7am	40dB(A)
Any other time			45dB(A)

The background noise level at Ewington between the hours of 10pm and 7am is 27dB(A). It is generally accepted that levels up to 5dB(A) above the background level, ie 32dB(A) do not cause annoyance providing tonal or other characteristics do not exist.

From the EPA procedure, 40dB(A) would be the worst case acceptable level for night-time operations. For noise with tonal characteristics an acceptable level would be 35dB(A).

8.8.2 Noise Emissions

Measurements of existing open-cut operations where noise sources included haul trucks, hydraulic shovels and bulldozers concluded that the noise emissions were generally tonal and typically in the octave bands of 125 or 250Hz.

The haul trucks will be the most significant source of noise emission, particularly when hauling up inclines out of the mine pit and on the haul roads leading to the power station. The reversing beepers on haul trucks will be a significant source of tonal noise. The hydraulic shovels and bulldozers will be located at the base of the mine pit and thus will not contribute significantly to noise emissions from the minesite.

The dragline will be electrically powered and thus will not contribute significantly to the noise levels emitted from the minesite. It will also be located at the base of the mine pit for the majority of the mining operations.

The ambient noise level in the vicinity of the minesite at any stage will be affected by the amount of machinery operating, the direction and strength of the wind, the temperature and other effects such as screening from the tree line.

8.8.3 Noise Propagation

Computer modelling (refer to Appendix D) was used to predict noise level propagation from the Ewington minesite taking into account the area's topography and atmospheric conditions, both of which have an effect on noise propagation.

The worst case noise propagation scenarios for both the north-western and a southerly location of the operations were modelled under cool, calm conditions. The noise level contours, in dB(A), are shown in Figures 8.2 and 8.3. In terms of the nearest residents in the eastern part of the Collie townsite, the mining operation will result in noise levels up to 34dB(A) when the mining operations are in the north-western corner of the pit. This level is unlikely to cause annoyance under normal atmospheric conditions. When the mining operation is in the south-western part of the mine pit these levels will decrease to 20dB(A) (Figure 8.3) which is well below the night-time noise background level.

The north-western location was also modelled under worse case conditions of dominant propagation towards the Collie townsite, ie a north-easterly light breeze of 2-3m/s. The results are shown on Figure 8.4. Residents in the eastern part of Collie would experience noise levels of up to 44dB(A) under these conditions. Such wind conditions occur intermittently throughout the year for around 10% of the time at the Collie townsite. Higher wind speeds increase the background levels and hence will not present a problem. The resultant level of 44dB(A) is not expected to be a problem due to its limited occurrence.

8.8.4 Acceptable Airblast Levels and Vibration

Whereas noise is the audible portion of the spectrum of a compressional wave produced by an explosion, airblast is the non-audible portion lying below 20Hz. Low frequencies cause the higher frequency vibrations inside buildings which are perceived as noise.

The EPA currently utilises a guideline limit of 115dB (peak linear) measured with a lower, limiting frequency of 2Hz at the most affected noise sensitive residence. To allow for misfires etc., a 10% exceedence rate of this level is specified. There is a further, never to be exceeded limit of 120dB (peak linear) as a damage risk criterion.

The current levels of airblast in Griffin's Muja and Chicken Creek operations are well below the EPA and the Department of Mines guidelines. Ground vibration levels generated by blasting are kept to within 10mm/s peak particle velocity which is well below the 100mm/s safety limit.

8.8.5 Airblast and Vibration Emissions

Airblast, vibration and associated noise from blasting will require strict management and control at the Ewington minesite (see Section 9.6) as it will be required to operate within limits specified in its Works Approval licence issued by the EPA.

Griffin currently uses the latest in technology in drilling and blasting to reduce vibration and airblast levels produced in its existing operations. Sequential delays and non-electric firing methods are used, which ensure that the maximum instantaneous charge is kept to a minimum, thereby lowering the amount of energy fired on any one delay. Griffin has also developed a drill and blast programme to lessen the effect of noise propagation to the surrounding environs.

Griffin intends to use the latest technology in its drill and blast programme for the Ewington minesite to lessen the impact of blasting on the surrounding environs. Better placement of holes and downhole surveying will allow correct burden and spacing of holes, redrilling of unsatisfactory blast holes and reduced noise emission by confinement of explosives.

Griffin will seek to further research and develop a drill and blast programme for the Ewington minesite in order to reduce noise and vibration effects.

8.8.6 Expected Effects of Blasting

The eastern portion of the Collie townsite will experience some effects of blasting at the Ewington minesite. These effects will be noise, airblast and vibration.

Since the potential effects are reduced with separation distance from the source of the blasts it is expected that impacts of the blasting operation will be conducted within operational limits specified by the EPA. As mentioned previously these criteria are designed to prevent excessive vibration and structural damage in the immediate vicinity of the minesite, therefore impacts to residents in the eastern part of Collie townsite will be minimised. The minesite will operate within acceptable levels set in the licence conditions. There is no reason to expect that these standards cannot be met.

All material will be blasted with the exception of Nakina Formation. Where possible, blasting will be restricted to a single blast at a regular time during daylight hours, six days a week, in order to reduce any effects of noise and vibration.

Blasting during overburden removal will be integrated with the blasting operation in the coal seams, all of which will be blasted prior to removal. There is expected to be only limited transmission of vibration in the coal seams towards the Collie townsite. This is because of major and complex faulting east of the minesite (see Figure 7.1) which will function as an absorptive barrier.

The natural topography will screen the Collie townsite from the direct effects of airblast. The blasting operation will be at the base of the mine pit, thus the mine pit walls will act as an absorptive barrier to reduce airblast emission. As the overburden dumps are developed, these structures will increase the height of this barrier and increase absorption.

Residents may receive some effects of airblast in unusual circumstances. This situation may be caused by atmospheric conditions when there are low winds and cool temperatures.

During an atmospheric temperature inversion (which is infrequent and usually in the early morning) it is possible for the reflection of the airblast to result in increased vibration levels sometimes by factors as high as two or three (ie by up to 6 or 9dB linear). Where possible, blasts will be fired between the hours of 10.30am and 3.30pm to reduce the possibility of this situation occurring.

The blasting operations of the Ewington minesite will be relatively close to the Collie townsite during the initial few years. However the mining operation will begin to move southwards and eastwards over time away from the townsite. Additional separation distances to the townsite and residences will increase the attenuation of both vibration and airblast and thus will aid the control of airblast and vibration emission impacts.

8.9 VEGETATION AND FLORA

8.9.1 Vegetation Removal

The total area of land to be disturbed during the life of the Ewington mine is approximately 10km^2 (1,003ha). This includes the mine area (583ha), associated mine facilities (22ha) and haul roads. The Ewington minesite will affect 377ha of State Forest, the remainder has already been cleared for rural activities. The major surrounding land use is State Forest (see Section 5.5).

The minesite will not significantly impact the majority of vegetation associations existing on-site and in its vicinity as they are all regionally widespread in the Collie Basin and Northern Jarrah Forest region. Sedgeland associations in seasonally moist areas comprise approximately 30% of the proposed minesite, with areas surrounding the minesite supporting only limited pockets of sedgelands.

A small pocket (approximately 3ha) of sedgeland association (A3) located on the southern boundary of the proposed minesite is the exception, being considered atypical of the Northern Jarrah Forest. A second small pocket of this association occurs to the south. The mining operation will remove approximately 75% of its area. It is not known whether this association occurs elsewhere in the Collie Basin, but, given the extent of the underlying soil type (white to grey sands), drainage network and the degree of vegetative cover in the area, it is highly likely that it does.

The prime management objective will be to minimise vegetation removal. There will be no disturbance of vegetation outside those areas designated for clearing. Management procedures are detailed in Section 9.8.

Vegetation within the Ewington minesite will be cleared progressively as individual strips are prepared for mining (see Section 7.3). Thus it is considered that the impact of clearing vegetation for the Ewington mine will be of a progressive nature rather than extensive which would be the case if the total area of vegetation were to be cleared at the same time.

As mining progresses, rehabilitation will follow behind, ameliorating the aesthetic impacts of clearing vegetation by replacing the previous native vegetative cover and stabilising soil. The overburden dumps would be in various stages of revegetation, and areas in advance of mining would be as yet undisturbed.

8.9.2 Dewatering

Continuous dewatering of the Ewington deposits to enable mining to commence will result in drawdown of groundwater levels in the surficial aquifer in the vicinity of the mine pit. As discussed in Section 8.6 and shown on Figure 8.1 this drawdown will be significant (3m) around the mine pit, but will decrease rapidly further from the mine pit.

The Jarrah forest vegetation in the Ewington area is typically not dependent on direct root contact with the water table. It is also very well adapted to seasonal groundwater drawdown and therefore restricted water availability. The limited areas of sedgelands in the vicinity of the minesite are more dependent on seasonal inundation through rainfall and a perched water table due to underlying clay sediments. Thus it is highly unlikely that the slight lowering of groundwater levels in the vicinity of the Ewington minesite will adversely impact the surrounding vegetation. This is consistent with experience at Muja and Chicken Creek.

The drawdown effect will probably induce additional recharge to the aquifer from rainfall and watercourses, thus partially reducing drawdown effects except in the immediate vicinity of dewatering bores. As water levels are reduced by dewatering, swamp areas with semi-aquatic plants further afield may experience adverse impacts as such plants are dependent on direct contact with the water table.

Expected changes would be limited as sedgeland and swamp associations in the Collie Basin are adapted to seasonal inundation through rainfall. This is indicated by the extensive areas of sedges over sandy gravel on higher ground throughout the minesite and its surrounds. The swamp areas and streamlines which may be affected are located within the minesite in the southern portion to be mined and in the north-western corner which has previously been affected by mining. The vegetation bordering other streamlines and watercourses in the vicinity of the minesite would not be expected to experience a significant change in water levels. Again this is reflected in current activities and effects at the Muja and Chicken Creek mines.

It should be noted that discharge of mine water to marshy areas associated with either the eastern or southern branches of the Collie River would ameliorate the above impacts by maintaining higher water levels. Higher water levels during summer and autumn might result in an increase in plant diversity and density of growth along the affected watercourses. This effect will be long term as limited volumes of mine water (on average approximately 8mL/day) above the requirement of the power station will continue to be discharged to watercourses.

8.9.3 Restoration of Diversity

The proposed rehabilitation programme will ameliorate the aesthetic impact of clearing vegetation by recreating a native vegetation cover. However, the existing great diversity can never be fully replaced during this process. In the long term, slow re-establishment and recolonisation of species from surrounding vegetation will gradually approach the previous diversity. Seed in the mulch and topsoil, if these materials are used, applied to rehabilitation areas will contribute to this re-establishment.

8.9.4 Rare Species

No species of Gazetted Rare flora are known to occur in, or close to, the areas at the Ewington minesite that are to be disturbed. There are two vulnerable species which do occur. Clearing will remove part of these populations.

However, it must be realised that these species are vulnerable due to their habitat/vegetation requirements which are by nature discontinuous and restricted to particular localities. Where they occur in the Collie Basin, these populations are quite abundant and are not endangered.

Other localities where they occur are at present not under threat of development.

Griffin is committed to preventing those two populations of vulnerable species from becoming endangered by its mining activities. If feasible, these species will be included in the rehabilitation programme.

Any rare or poorly known plant species which may be found during the mining operations will be protected in areas where removal is not essential. Management procedures will ensure such protection are detailed in Section 9.8.

8.9.5 Dieback Disease

Dieback disease *(Phytophthora spp.)* is a microscopic soil-borne fungus of great significance to native vegetation in the South-West of the State. It affects many native plants if the infection becomes sufficiently severe. The only species which are not affected are the sedges, rushes, grasses and related species because of their rapid root turnover which removes infected roots before they can affect the plants' physiology.

Many native shrubs and trees are dieback resistant, providing the infection is not too severe. Some groups of plants are particularly susceptible to dieback, the Epacridaceae, Fabaceae, Proteaceae and Myrtaceae being amongst the most susceptible.

Jarrah dieback is caused by *Phytophthora cinnamomi* infection. The main source of introduction of the disease to previously uninfected areas of the Northern Jarrah Forest is by transport of infected soil. This usually occurs when mud or soil is accidentally carried on the wheels or tracks of vehicles or when soil or gravel is moved from place to place, such as in road construction activities.

Vegetation of the Collie area has a very high proportion of the most susceptible and sensitive plant groups and jarrah dieback is widely distributed in the area. A number of infestations (refer to Appendix E) were identified in the Ewington minesite and surrounding areas by the recent vegetation survey. The potential for spread from these infestations is recognised.

The risk of dieback spread will increase when soil movement during general earthworks and mining activities expose and disturb infected soil which could then be transported by wind or runoff to infect other areas.

Griffin proposes to use cemented laterite present in the overburden in a number of upland areas of the Ewington minesite as a source of roadmaking material for haul roads and access roads on and around the minesite. This material will be stockpiled separately during the overburden stripping activities and used when required. Depending on the depth from which it is sourced, this material could be infected with *Phytophthora* which resides in the upper few metres of soil in areas where plant roots reach down to 4-5m. This material used in uninfected areas would be a source of dieback infection carried by wind or runoff.

Topsoil stripped from dieback infected areas would also be contaminated and probably overburden material to a depth of 4-5m. Stockpiling or disposal of infected materials on or near uninfected areas would put these areas at risk of becoming infected by wind or runoff borne infected soil.

Creation of firebreaks on the Ewington minesite could introduce infected vegetative or soil material into uninfected areas. The vector in this case would be machinery. Use of infected vegetative material or topsoil on rehabilitation areas would be detrimental to the rehabilitation programme.

Runoff from infected minesite areas could present a serious threat of infection if not properly controlled. Runoff from infected areas such as undisturbed vegetation and stockpiles must be prevented from entering uninfected areas and the rehabilitation areas.

Infected runoff could contaminate water in the runoff sump and mine water to be discharged. Contamination of the mine water with dieback disease is not likely to pose problems with the discharge as a large proportion will be used as cooling water by the power station. Exposure to such heat would be expected to sterilise the water.

Susceptible vegetation bordering the east and south branches of the Collie River would be expected to be already infected by dieback since these tributaries receive water from an extensively infected catchment area. Some areas in the Collie Basin have a Disease Risk designation and are quarantined. Thus discharge of contaminated mine water into the Collie River would not have a significant impact on downstream areas bordering the rivers because they would probably be already infected. *Phytophthora* zoospores would only survive a couple of days in the river without refuge in soil or vegetation.

Low lying swamplands which would receive the mine water discharge would most likely be already infected. The impact of dieback on these areas would be small since the vegetation in these areas is not susceptible to the disease.

The field survey indicated that the infection of the Ewington minesite appears to be widespread, although the swampland areas do not show evidence of infection as susceptible species are not as typical of this habitat. Thus mining in the Ewington area would not be expected to exacerbate the existing infection. In this case management procedures for mining activities will concentrate on preventing the disease from spreading to uninfected areas outside the minesite. Dieback management procedures are detailed in Section 9.8.5.

The rehabilitation areas may have to be revegetated with dieback resistant species. This will restrict the number of suitable species that could be used and hence the diversity of the revegetation. Great care will need to be taken to prevent runoff from other areas of the minesite entering such rehabilitation areas as normally dieback resistant species may not be as tolerant in their younger stages.

8.9.6 Fire

CALM currently conducts a fuel reduction programme in the Ewington area to aid in fire prevention and control. The Ewington area, being in close proximity to the Collie townsite, would present an unacceptable fire hazard to residences and facilities if fire control measures were not continued during mining of the Ewington deposits.

CALM currently burns the Ewington area by aerial drops. However once mining begins, this will not be possible due to the proposed infrastructure facilities, roads and the like. Thus additional firebreaks and access roads will need to be created to enable the fuel reduction programme to be continued by hand. This means smaller areas will be burnt each time.

The mining operation itself would not be expected to significantly increase the likelihood of fires in the Ewington area although hot vehicle exhausts or welding sparks do present a risk. The increased presence of people and vehicles and creation of additional access into the Ewington minesite could increase the risk of accidental fires started from carelessness, such as a discarded cigarette butt. However, the improved access into the Ewington area would also facilitate more rapid control of fires if they did break out in the area.

Although regular fires in the Ewington area would be beneficial to a large number of plant species, Griffin is committed to the prevention of fire in the area as a fire through the rehabilitation areas would seriously set back the rehabilitation programme. No waste coal will be left uncovered in the overburden and waste dumps. It is intended that such materials with the potential to ignite will be buried deeply in the overburden dumps.

The protection of populations of vulnerable plant species from destruction by severe fires must also be considered.

Management procedures to prevent outbreak of fire associated with Ewington minesite are detailed in Section 9.8.4.

8.9.7 Weeds

A weed may be either an exotic, an introduced species or native plants which have become extensively abundant due to human activities. If weeds become abundant, they can affect the natural environment by:

- competing with more desirable plants for moisture, nutrients or light,

- replacing native vegetation in areas where native vegetation is of greater significance,
- interfering with transport, services, fire protection or management.

Twelve introduced weed species already occur on the Ewington minesite due to past human activities such as logging. Thus protection of the Ewington minesite from weed invasion will concentrate on prevention of further introduction of weed seeds and vegetative matter, and control of weeds which already occur or which may be accidentally introduced.

A major management concern will be prevention of weeds spreading into the rehabilitation areas. However, topsoil which will be respread where possible over the rehabilitation areas will probably already contain a large number of weed seeds.

Management measures in respect of weeds are detailed in Section 9.8.3.

8.10 FAUNA

8.10.1 Habitat Destruction

The principal impacts of the proposed Ewington minesite will be the loss of vegetated area, reduction in area of forest and woodland habitat and the impositions on the wetland drainage system. The area of vegetation lost due to the proposal (1,003ha) is insignificant in comparison to the widely distributed ecological habitat-vegetation units represented in the Collie Basin. The area is already of a degraded nature due to historical forestry practices.

The impact on the fauna is generally secondary. There will be major local impacts initially with destruction of habitat, loss of sedentary species and relocation of mobile species into adjacent habitats. Impacts will be minimised by staged clearing, limiting clearing to a minimum (refer to Section 8.9.1), fencing off dangerous areas and limiting road and track development.

Increased traffic may cause localised death of larger mobile species, predominantly kangaroos, wallabies and monitor lizards.

The quality of the existing habitat in the vicinity of the Ewington minesite could potentially be further reduced by the increased risk of spread of dieback infection and weeds (refer to Sections 9.8.5 and 9.8.3 for management of dieback and weeds). The increased risk of outbreak of fire is also a consideration with respect to fauna and its habitats (refer to Section 9.8.4 for management of fire risks).

8.10.2 Rare Fauna

Modification to the sedge-shrub wetlands due to removal and dewatering effects will be of significance to fauna, although only at the local level.

However, the local population of the Southern Brown Bandicoot *Isoodon obesulus*, currently gazetted as "rare and endangered" will be adversely affected by the minesite. Removal of a significant proportion of low lying wetland will reduce the area of local habitat available to this population, displacing it into adjacent less optimal habitat or causing its enforced migration to other areas of suitable habitat. Both of the above scenarios will result in increased individual mortality due to increased exposure to predators and territorial fighting if displaced bandicoots migrate into already populated areas.

The eradication of feral predators such as foxes and cats from the Ewington area will significantly enhance the survival of remaining bandicoot populations in the area.

Despite the intensive survey of the Ewington minesite, the Tammar Wallaby was not found. Further consultation and/or field survey to ascertain the presence of this rare species is required as the minesite may also impact on this species if it is present.

8.10.3 Dust

Excessive dust could, through localised mortality of vegetation adjacent to the minesite, potentially impact on fauna. However, the proposed dust suppression measures and rehabilitation will keep dust to acceptable levels.

8.10.4 Noise

The only fauna which respond to noise are large mobile species of macropods and birds where it may act as a local deterrent in the vicinity of the minesite and haul roads. The result of localised noise would be the avoidance of the noise source area. This behaviour will be beneficial to the fauna by causing them to avoid potentially hazardous areas. Fauna response to noise is also confounded by other factors such as habitat disturbance, mining activities and continual human presence. It is considered that no significant impact will occur to the biota through noise.

8.10.5 Recolonisation

Progressive rehabilitation of mined out areas will increase the rate of fauna recolonisation of the Ewington minesite. Once a sufficiently diverse and complex vegetation is re-established which offers suitable habitats and shelter, recolonisation will rapidly follow, providing noise, dust and human disturbances are not too great. Such disturbances will decrease as the mining activities move away from rehabilitated areas.

8.10.6 Aquatic Fauna

Research has been conducted into the impacts of mine water on fauna in the Collie River. Native fish species which occur in the south and east branches of the Collie River are known to migrate into tributaries and/or floodwaters in winter and early spring to spawn. Thus the sexually maturing, embryonic and early larval stages, which are most likely to be susceptible to environmental changes, are not exposed to the low pH conditions found in the discharge area during summer. Thus it is not expected that mine water discharge would have any adverse impact on fish in the rivers.

The introduced fish species, *Gambusia* produces live young which may protect the critical life cycle stages during spawning which extends into summer.

Higher oxygen levels in the discharge area and downstream would possibly result in increased numbers of large benthic invertebrates such as marron and gilgies.

The abundance and number of species of macrobenthic invertebrates might be expected to be reduced in the mine water discharge area. The freshwater prawn might not tolerate low pH conditions due to mine water discharge, possibly because it breeds in spring and summer, when its early life history and potentially susceptible stages would be exposed to low pH levels.

The non-eutrophic water in the vicinity of the mine water discharge would result in lower densities of zooplankton and less likelihood of algal blooms. The faunal composition of the plankton would not be expected to change.

Aquatic fauna could probably tolerate restricted periods where the water in the area of discharge is of pH 4.0; however, pH levels lower than this would be damaging. Should mine water discharge result in extremely low pH levels in the area of discharge for a short period due to unseasonal influences such as drought or systems failure at the minesite, the aquatic fauna could be destroyed. However this impact would only be temporary as deep pools in the branches of the Collie River, which normally function as a refuge for fauna during summer when the rivers dry up, would replace the fauna community destroyed when they are flushed out during the winter flows. Thus the impact of a temporary low pH discharge would be similar to the seasonal influences already experienced by fauna in the discharge area.

8.11 TRAFFIC

Traffic levels in the vicinity of Ewington minesite are currently very low, apart from Coalfields Highway which is the primary eastern route out of Collie to Darkan, Narrogin and other wheatbelt towns.

8.11.1 Mine Activities

The minesite and minesite complex will be accessed solely from Coalfields Highway. A slight increase in traffic levels at certain times of the day (during shift changeovers) may be experienced between Collie and the mine access road. If mine personnel turning left off the highway cause disruption to road users, a turning lane could be constructed.

During construction of the minesite facilities, contractors would also use Coalfields Highway and construction materials and mining equipment would be transferred along it.

8.11.2 Local Users

The Ewington area is crisscrossed with forestry tracks which have been used in the past by horse riders, trail bikers, four wheel drive enthusiasts and people who access other areas through this region. Once the minesite infrastructure begins to be established, access to certain parts will be restricted with access routes obstructed by infrastructure such as pipelines, powerlines and haul roads. This infrastructure will be in place from an early stage in the operations and although the majority of the area will not be mined for some time, Griffin would probably not allow free access across this infrastructure due to considerations for public safety, the risk of damage to the installations, risk of spread of dieback and damage to rehabilitated areas.

It will be a long period before access through the area is restored to its former level in order to give the rehabilitated areas time to stabilise. This would probably not be until the minesite is decommissioned and all infrastructure removed.

8.12 LAND USES

Apart from the State Forest and rural uses of the land in the actual minesite area, mining at Ewington will impact on few other land uses in the area.

The minesite is not expected to impact on use of the Collie airstrip. There will be no encroachment on its required clearance distances for takeoff and landing.

The minesite's 24-hour operations will require night lighting. However the Collie airstrip is not normally used at night, except in the case of an emergency when portable lighting can be used to light the airstrip. It is not expected that the night-time lighting at the minesite will cause any problems for aeroplanes landing at the airstrip at night.

The minesite will have an impact on several powerlines which skirt its boundaries (see Figure 5.1). The haul road running parallel with the long western boundary of the minesite will be located at least 80m from the easement of the 132kV powerline and water pipeline. At this distance the mining operation will not affect these structures.

The northern haul road will cross under the 66kV powerline passing east of the Ewington minesite twice. The haul road crossings will be made central to the pylons, thus there is not expected to be any conflict with this situation. SECWA does have restrictions to the extent of earthworks permitted beneath its installations.

The mining operation will impact on the 330kV powerline which is located immediately east of the minesite. The southern haul road will cross under this powerline twice and the mine access road will cross it once. The points of crossing will be located halfway between the pylons so there is not expected to be any problems with conflict.

However, as can be seen in Figure 7.3, the mining operation will begin to approach the 330kV powerline by Year 10 when it will be on the edge of the 60m easement. The mining operation will then begin to move away from the 330kV powerline so that by Year 15, the pit will be approximately 40m from the easement. However during Years 20 to 26 the mine pit will encroach upon the powerline.

Griffin will comply with the restrictions on blasting in the vicinity of SECWA's powerlines. Blasting operations are only permissible beyond 100m from its installations due to problems associated with damage by flyrock, dust emission and ground vibration. Such restrictions will be subject of future negotiations between Griffin and SECWA. It is expected that the powerline will not be impacted to a significant extent. The long term situation has not yet been considered in detail. It is quite likely that any affected area will not be mined, as mine planning 20-26 years hence will depend on the demand for coal.

An alternative would be to relocate the affected 330kV powerline which will prove extremely costly and may result in extraction of the coal in this area becoming uneconomical. These options will be examined in more detail in the long term, in consultation with SECWA.

SCALE 1:25 000

Kilometres 0 1 2

COLLIE COAL BASIN

COLLIE POWER STATION SITE

EWINGTON MINE SITE

STATE FOREST

STATE FOREST

STATE FOREST

0·1 m

0·5 m

1·0 m

3·0 m

3·0 m

1·0 m 0·5 m

0·1 m

Ewington

Ewington Open Cut Mine

Shire Depot

M.R.D. Depot

Bullfinch Rd.

COALFIELDS ROAD

Coalfields Road

Shotts Road

Shotts River Road

COALFIELDS ROAD

Shotts

Halpern Glick Maunsell

EWINGTON OPEN CUT MINE
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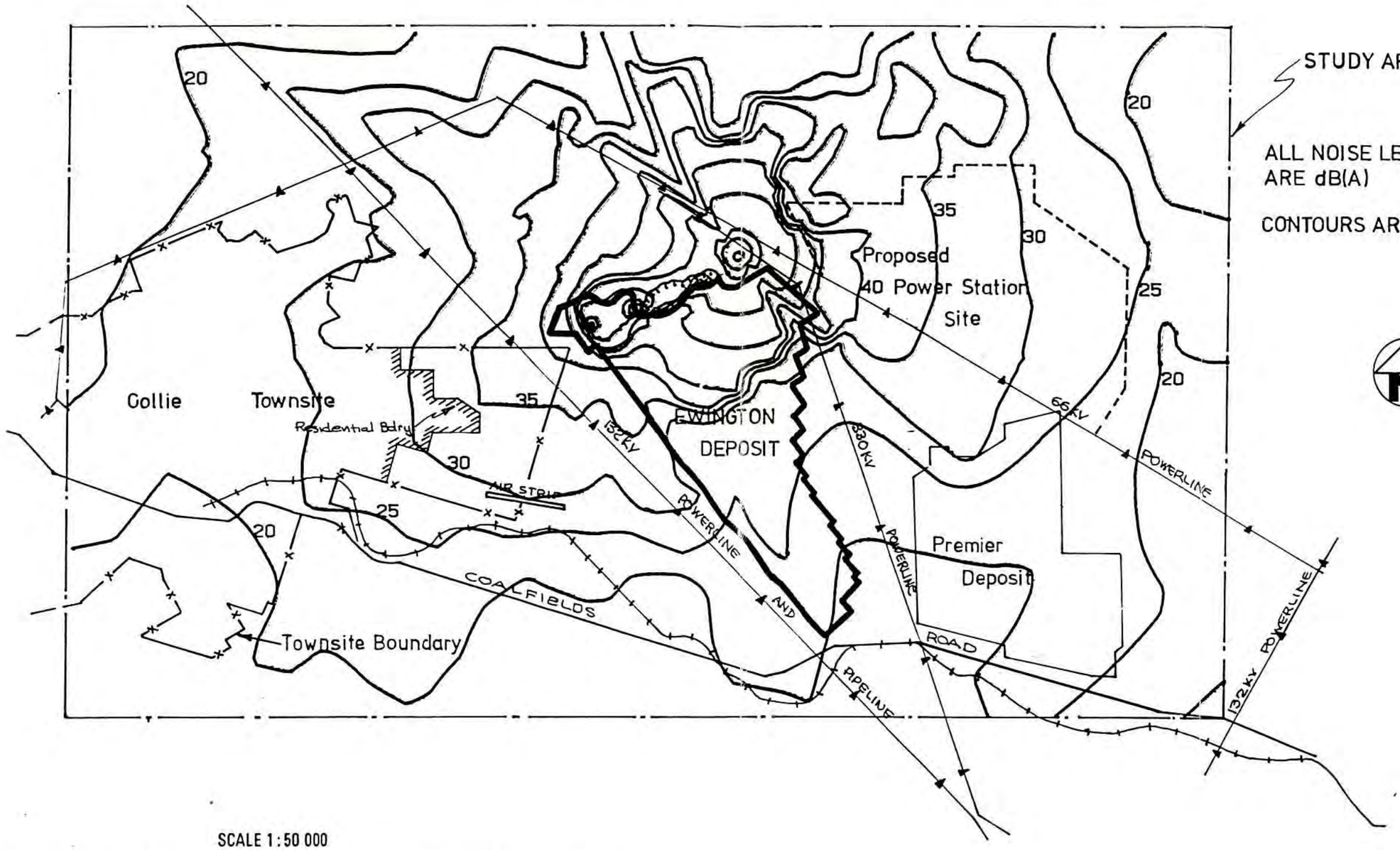
CALCULATED DRAWDOWN IN SHALLOW AQUIFER

FIGURE 8.1



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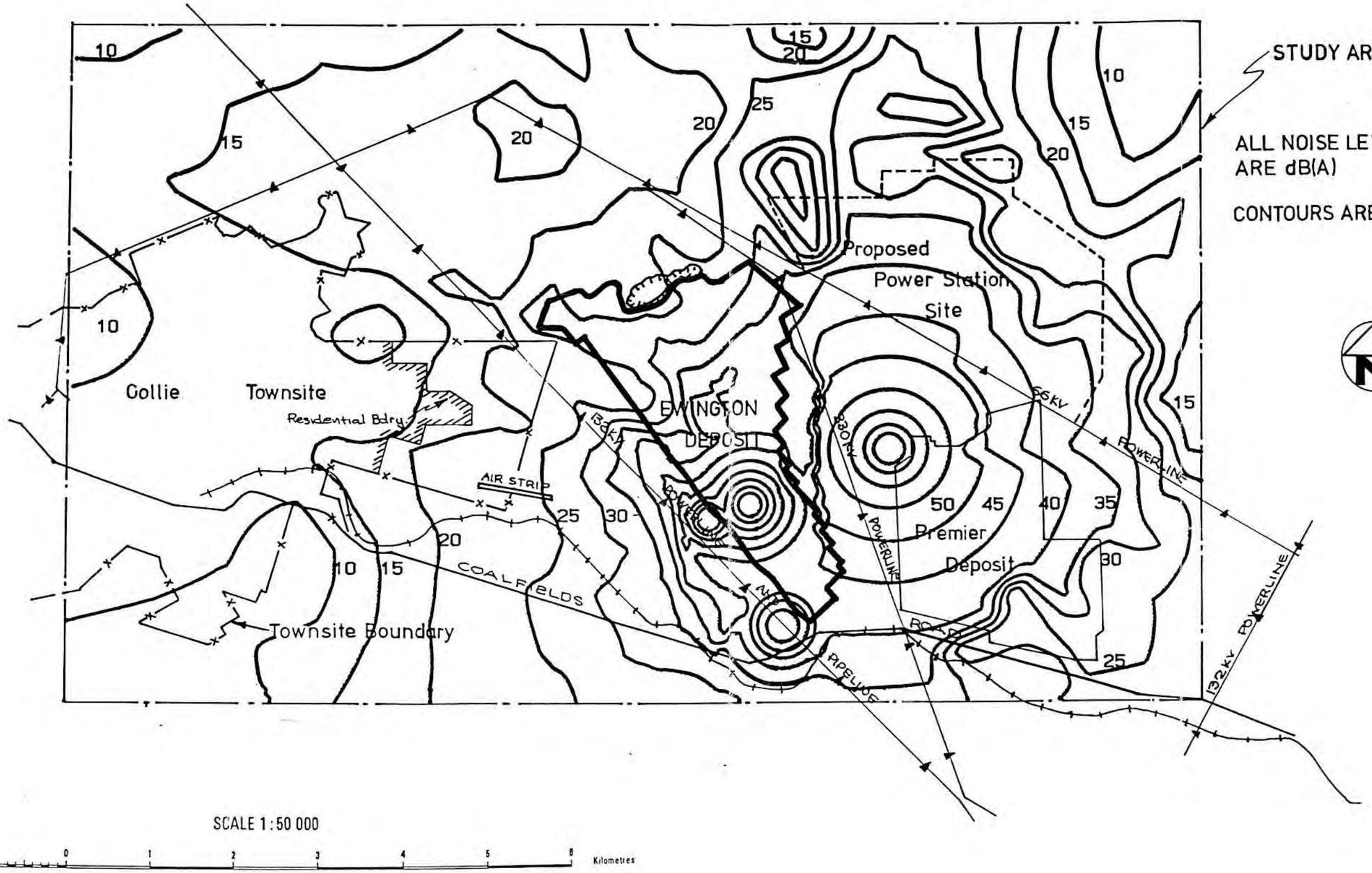
for THE GRIFFIN COAL MINING COMPANY PTY LIMITED

NOISE LEVEL CONTOURS – NORTH CALM CONDITIONS

FIGURE 8.2



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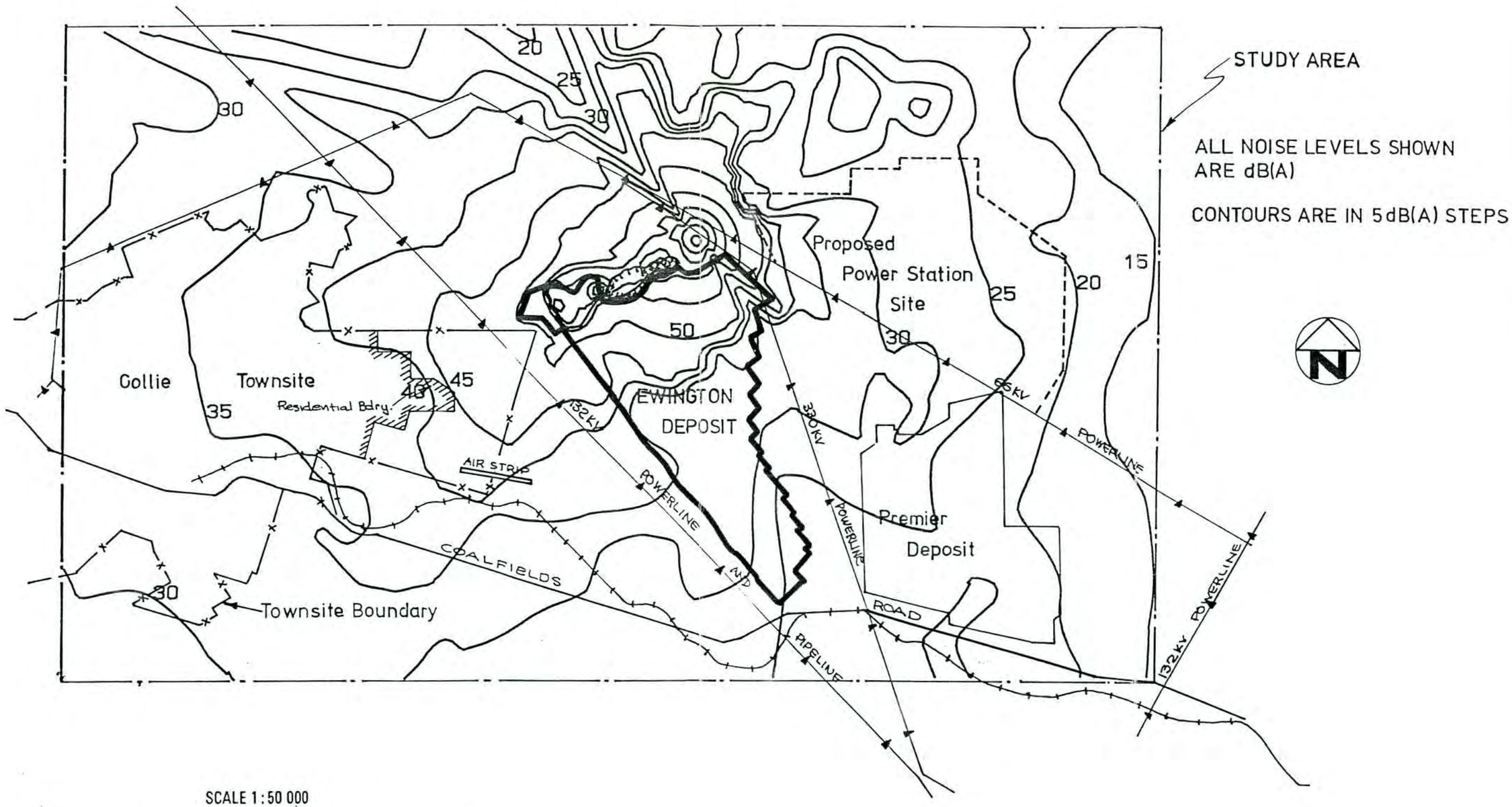
NOISE LEVEL CONTOURS — SOUTH CALM CONDITIONS

FIGURE 8.3



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NOISE LEVEL CONTOURS — NORTH DOWNWIND CONDITIONS

FIGURE 8.4

9. ENVIRONMENTAL MANAGEMENT

9. ENVIRONMENTAL MANAGEMENT

9.1 INTRODUCTION

Control of the Ewington minesite will be the sole responsibility of Griffin who will undertake all operational, administrative and managerial aspects of the minesite on a day to day basis. This is a situation similar to that currently operating at the Muja and Chicken Creek open-cut mines in the Collie Basin.

These existing operations are carried out by Griffin in accordance with the terms and conditions set down in the Collie Coal (Griffin) Agreement Act, 1979 (refer Section 3.2.3). As a result of having to comply with the terms and conditions of the Agreement Act numerous management and operational procedures and practices have been developed and proven up in these existing operations. All these aspects of the Muja and Chicken Creek operations are fully documented in the various periodic reports prepared by Griffin in accordance with the Agreement Act.

The Ewington mine will be operated under the Agreement Act in a manner similar to that described above. As a consequence it is anticipated that the particular procedures and practices developed at Muja and Chicken Creek will be extended to the Ewington mine. In this way the experiences and advances in techniques gained in the existing operations can be incorporated into the Ewington operation.

As a consequence many of the environmental management priorities and procedures outlined below are based on current practices at Muja and Chicken Creek. Clearly there will be the need to modify and adjust some aspects to suit the particular situation at Ewington but the essential principles will be very similar, The background, experience and proven record of Griffin in the Collie Basin is seen as a major advantage in being able to achieve effective environmental management of the mine.

A number of impacts, both potential and unavoidable, of the Ewington minesite have been identified (see Section 8). However, the majority can be almost completely ameliorated by careful management and control measures.

Griffin undertakes to minimise all foreseeable impacts by careful management of coal mining methods and implementation of ameliorative measures. Separate, detailed management programmes will be designed to minimise all impacts by controlling them to within acceptable limits.

Monitoring programmes will be conducted in order to detect changes in the environment due to mining activities. Monitoring will enable Griffin to review and refine the management techniques employed.

Major management issues concerning the Ewington minesite development are:

- mine water discharge
- groundwater extraction

- drainage
- noise and vibration
- dust
- vegetation and dieback
- fauna
- rehabilitation
- aesthetics

Procedures proposed for their management and control are detailed in the following sections.

9.2 SURFACE WATER

Water management will be essential to the mining operation in order to protect the environment from potentially contaminated runoff from workshops, stockpiles and disturbed areas, and prevent runoff generated outside the minesite from flooding the operations. Prior to commencement of mining, a surface water management programme will be developed in consultation with the appropriate authorities.

Potential impacts on watercourses surrounding the Ewington minesite will include an increase in sediment load and risk of dieback infection as a result of runoff from disturbed areas. A number of management strategies will be implemented to reduce runoff from the minesite to an absolute minimum.

Runoff from all work areas will be carefully controlled because it is likely to carry more sediment than runoff from undisturbed bushland. Runoff from the minesite may also contain acid contaminants from coal and oil residue or detergents from the workshop areas. Table 9.1 summarises the management of water on the Ewington minesite. It is based on careful separation and treatment of the different effluent streams.

9.2.1 Natural Drainage

The primary control for runoff will be diversion channels and earth bunds which will be constructed around the minesite operations. These structures will prevent water entering or leaving the site in an uncontrolled manner.

Diversion channels and bunds will be constructed ahead of mining to intercept runoff from undisturbed ground and to direct it to the existing drainage system.

If riparian usage of the seasonal water supply provided by the north-western streamline is adversely affected by the minesite's interception of its headwaters, Griffin will investigate the possibility of seasonally discharging some of its minewater or collected runoff, in excess of the power station's requirements, into the streamline to ensure this water supply is maintained. This practice would depend on the quality of the minewater or collected runoff available to be discharged.

TABLE 9.1

SUMMARY OF WATER MANAGEMENT

Source	Quality	Management
Undisturbed Ground		
Runoff from ground outside mine perimeter	Unaffected	Diversion channels and bunds direct runoff to existing drainage lines
Disturbed Ground		
Runoff from ground inside minesite	Sediment laden	Collected in sumps which overflow into sedimentation pond, then pumped to southern surge pond
	Dieback infected	Diversion channels and bunds direct runoff to separate sumps
In-pit		
Direct rainfall Groundwater inflow	Sediment laden, coal particles	Collected in-pit bottom sumps then pumped to southern surge pond on surface
Overburden dump seepage	Brackish Acidic	Pumped to surge pond and treatment plant east of pit, discharged
Overburden		
Mining face runoff Dump runoff	Sediment laden	Directed by drains to sumps, which overflow into sedimentation pond then pumped to southern surge pond
Contaminated		
Workshop runoff Vehicle washdown Explosive storage	Sediment laden Oil and detergents Ammonium nitrate	Directed via sumps to water truck filling station, or package treatment plant thence lagoon for irrigation
General Site		
Office area runoff Haul road runoff Undisturbed areas	Some sediment	Directed via drains to sumps, or vegetated filters

9.2.2 Disturbed Areas

Sumps will be constructed immediately downstream of any disturbed areas. Coarse sediment will settle out in these sumps before the water overflows into a small sedimentation pond. Water which collects in this pond will be pumped into the surge pond located at the southernmost end of the mine pit.

9.2.3 In-pit Drainage

The mine pit will collect water from direct rainfall, groundwater inflow and overburden dump seepage. There will be pumping capacity to dewater the active portion of the pit in less than 24 hours after a 2 year storm event. This water will collect in sumps from where it will be pumped to a surge pond located on the surface at the southernmost end of the mine pit. Runoff water can be discharged from the southern surge pond if treatment is not necessary

If treatment is required water will be pumped to another surge pond to the east of the mine pit from where it can be combined with groundwater from the dewatering programme (refer Section 7.4).

9.2.4 Disturbed Dieback Areas

If an area to be disturbed by the mining operations is identified as being dieback infected assessment will be made to determine if runoff from this area will need to be segregated from other effluent streams. If so every reasonable effort will be made to ensure that runoff is contained within the dieback infected area by diversion channels and bunds which will direct runoff into sumps within the area. It will be disposed of in a manner acceptable to the relevant authorities.

9.2.5 Overburden Drainage

There will be runoff from the overburden mine faces and benches and from the top and faces of the overburden dumps. Spoon drains will be constructed where necessary, on benches and surfaces along the contour (refer to Section 7.6.3). These will channel water into small temporary sumps which will discharge into a small sedimentation pond from where it will be pumped to the southern surge pond. Sumps are designed to remove the coarse sediment close to the area of disturbance. Many sumps will be temporary, and will be replaced when overtaken by the mining operation.

This two-pond system will ensure that any overflow from the sedimentation pond will be sediment free, and will discharge into natural drainage in a controlled manner.

9.2.6 Contaminated Drainage

Water from the workshops may be a source of potential contamination. Water from this source will be retained on-site and used for road wetting and general dust suppression in a manner similar to that used at Muja.

Water from the workshop area, including the vehicle washdown facility, will flow into a sump which will allow the coarse sediment to settle out. As the water may contain free or emulsified oil, it will be used in the water truck filling station.

Runoff from the explosives storage facility will be retained within a surrounding bund as it may contain ammonium nitrate. It will be used for irrigation of landscaping as the ammonium nitrate acts as an effective fertiliser.

9.2.7 General Site Drainage

Water from all other areas within the minesite, including the office area and undisturbed areas, will be directed via drains to sumps in order to control sediment in the runoff. Where possible vegetative filters will also be used for sediment control. The general site drainage water will be of good quality and will probably be utilised in a number of ways for irrigation purposes.

9.2.8 Monitoring

The small streamlines that drain north-westwards and southwards from the Ewington minesite to the Collie River will be monitored monthly. Monitoring of streamflow will commence as soon as possible and will continue once dewatering begins. During streamflow events, water samples will be collected from downstream of the mine, as well as various locations on the minesite.

If monitoring indicates any potential impacts from the minesite, remedial action will be taken as required. All monitoring activities will be undertaken in accordance with the surface water management programme.

9.3 WATER DISCHARGE

Management of mine water discharge has been discussed in Section 7.5 as part of the minesite proposal. A number of options are available for treatment and disposal of mine water, these being detailed in Section 7.5.2.

Mine pit runoff collected in the southern surge pond if requiring treatment will be pumped to the eastern surge pond where it will be combined with groundwater abstracted from the dewatering operation.

Combining these two effluent streams will improve the quality of water to be discharged from the eastern surge pond. Water to be discharged will be treated if required.

Water from the eastern surge pond is presently planned to be pumped to the power station as described in Section 7.5.2.

Contingency plans for water discharge in the event of severe systems failure or rainfall deluge are outlined in Section 9.13.

Monitoring of the various effluent streams will be undertaken. This will involve collection of water samples which will be analysed for a range of constituents depending on the source. Water discharged from the surge ponds, which includes water from dewatering and in-pit runoff sumps, will be analysed monthly for pH, TDS, sulphate, Total Iron, Total Manganese, magnesium, suspended solids, oil and grease and dissolved oxygen. It will be treated appropriately before its discharge.

9.4 GROUNDWATER

The groundwater in the vicinity of the Ewington minesite will be closely monitored to assess dewatering progress and the effect of dewatering on the surficial aquifer and therefore vegetation and private bores in the Collie townsite and the deeper Permian sediments. The following groundwater monitoring programme will be implemented to allow meaningful assessment of the effects of mining in the future.

- Water table levels will be monitored monthly;
- Water levels in all dewatering bores and associated monitoring bores will be monitored at least monthly.

All dewatering bores will be sampled quarterly, or more frequently if results indicate that this is necessary, for temperature, electrical conductivity and pH. Representative bores will be sampled monthly for laboratory analysis of pH, TDS, Sulphate, Total Iron, Total Manganese and Magnesium. Every six months water samples will be analysed for all major ions.

9.5 DUST

Normal mining procedures will be adopted to reduce dust emissions from the Ewington minesite. These will include:

- use of water sprays on stockpiles,
- watering haul roads under dry conditions,
- minimising exposed areas by early implementation of rehabilitation, and
- monitoring dust levels to identify dust problem areas should they occur.

With these measures it is unlikely that any adverse impacts will result from dust emissions due to the mining operation. Additional measures to be utilised will include dust suppression, sealing the main access road to the minesite complex and selection where practicable of blasting times during periods of favourable wind direction or still conditions.

A comprehensive dust monitoring programme will be implemented for both background and operational dust levels. If dust levels emitted from the minesite are found to be excessive further dust control measures will be implemented.

The EPA may also monitor dust emissions from the Ewington minesite. If dust emissions exceed statutory levels, management and control measures will be reviewed and upgraded.

9.6 NOISE AND VIBRATION

9.6.1 Noise

Noise emission limits will be specified for all mining equipment purchased. These limits will reflect the most recent noise control technology for mining equipment. Griffin recognises that there may be some marginal impact on the acoustical amenity of residences in the vicinity of the Ewington minesite and would be prepared to take remedial action if the impacts prove significant. Such action might include modification of mining procedures, erection of acoustic barriers or treatment of dwellings.

As discussed in Section 8.8, noise in residential areas in Collie are not expected to be either excessive or annoying. Noise level monitoring will be undertaken in the initial phase of the mining operations to identify any unforeseen problems in noise propagation, particularly that during downwind propagation. If excessive noise levels beyond statutory limits are experienced in the vicinity of the minesite, a number of noise control measures will be introduced. The most effective controls would be as follows:

- Use overburden to construct an acoustic barrier at the western end of the northern haul road.
- Reduce mining equipment noise levels even further.

If sundry noise problems, such as reversing 'beepers' and warning sirens are detected through monitoring, they will be solved by reducing the tone and level of beepers and the use of flashing lights.

Griffin will prepare a noise and vibration management and monitoring programme to the satisfaction of the relevant authorities prior to commencement of mining at Ewington. Ongoing noise level monitoring will be undertaken during a range of operational and meteorological conditions in accordance with the noise monitoring plan.

9.6.2 Vibration

Ground and air vibrations will be minimised by:

- ensuring that explosion gases are essentially devoid of energy when they reach the atmosphere; and
- blasting when there is a low probability of an atmospheric temperature inversion being present.

All blasting equipment purchased for the Ewington minesite will reflect the state of the art technology. As new technology becomes available, its suitability and potential effectiveness at the Ewington minesite will be assessed by Griffin. If appropriate, it will be used to update the blasting equipment in operation.

All vibration airblast and noise generated by blasting will be managed to within the statutory limits specified and the mine's licence conditions.

Blast generated noise is impulsive and, therefore, tends to startle people, especially at times of low background noise. To minimise this impact Griffin will restrict blasting to a regular time during daylight hours and where possible between 10.30am and 3.30pm.

Monitoring of the blasting effects will be ongoing in accordance with the noise and vibration management and monitoring programme in order to evaluate their impacts and ensure that licence conditions are met. Data will be collected for a variety of operating and meteorological conditions throughout the life of the Ewington mine.

It will also be possible to identify whether a particular combination of events has a greater than predicted impact. Where possible these particular conditions will be predicted, using a blast prediction model and the proposed blast rescheduled to a more appropriate time.

If monitoring indicates that vibration, airblast and noise levels generated by blasting are excessive, blasting procedures and technology will be carefully reviewed and refined in order to reduce these impacts to levels acceptable to the licence conditions. Other measures to reduce such blasting effects would be to construct acoustic barriers to restrict their propagation to sensitive areas in the vicinity of the minesite.

9.7 REHABILITATION

The rehabilitation procedures intended to be used on the Ewington minesite are detailed in Section 7.6. While the operations staff will undertake rehabilitation procedures, under the supervision of the Environmental Officer who will be responsible for ongoing management and monitoring of rehabilitation success and field trials.

9.7.1 Rehabilitation Trials

As detailed in Section 7.6, Griffin has gained a great deal of rehabilitation experience in the Collie Basin since 1982. Rehabilitation success to date has been the result of extensive field trials which tested a variety of contouring, surface preparation, fertilisers and plant species in a range of combinations and application timetables. Aspects which have been tested and the results fully incorporated into the rehabilitation programme include:

- effects of various surface and slope configurations on vegetation establishment and on inhibition of erosion,
- soil improvements through addition of fertilisers and lime and their effect upon revegetation rates,
- identification of local native species with characteristic tolerance of acidic and low nutrient soils,
- classification of overburden and interburden spoil enabling segregation of materials unsuitable for rehabilitation,
- seeding rates and species combinations in relation to achievement of maximum short term and long term vegetative cover and surface stabilisation.

To ensure the highest possible degree of success, rehabilitation of the Ewington minesite will be based upon a continuing programme of field trials to be conducted on overburden dumps concurrent with the rehabilitation work. Tests conducted will be replicated and will be monitored on a regular basis. The field trials will concentrate on:

- assessment of the benefits to rehabilitation derived from application of topsoil and mulched vegetation,
- further identification of local native species with tolerance to acidic and low nutrient soils,
- further manipulation of seeding rates and species combinations to achieve adequate vegetative cover, surface stabilisation and species diversity,
- development of a stable, integrated, complex, self-perpetuating plant community that harmonises with the indigenous vegetation,
- heavy reliance upon species that are native to the Collie Basin, including marri, jarrah and wandoo, the dominants, and leguminous and non-leguminous shrubs,
- resistance and tolerance of native species to dieback infection.
- research into the ecology and propagation characteristics of rare and vulnerable flora species.

A management plan for rehabilitation will be prepared prior to the commencement of mining and incorporated into the environmental management programme. This document will outline procedures for the rehabilitation of disturbed areas. It will be refined as a result of regular review of results from the field trials.

9.7.2 Monitoring

Monitoring procedures will be specific to the requirements of each rehabilitation area. In the early stages, monitoring will consist of recording germination success, seedling establishment rates, competitive interaction of species, soil selectivity and the effect of fertiliser applications.

When plants are more established, monitoring will extend to studying success in increasing species diversity, introduction of vulnerable species, degree of self-seeding, natural recruitment and fauna colonisation.

The prime aim in monitoring will be to improve knowledge on successful techniques, suitable species and density problems in their early stages.

9.8 VEGETATION AND FLORA

Griffin is committed to preserving the existing vegetation surrounding the Ewington minesite. Management of vegetation and flora by Griffin will concentrate on ensuring that the minesite activities do not adversely affect the vegetation surrounding the Ewington minesite.

The major management issues concerning vegetation and flora at the minesite include vegetation removal, rare or vulnerable flora, weeds, fire and dieback. Management procedures for vegetation and flora are presented below. The management details will be addressed in consultation with CALM.

9.8.1 Vegetation Removal

The primary management objective will be to minimise vegetation removal. To limit further conflict with the biological environment outside the mine pit, no clearing will occur outside the defined mine limits unless absolutely necessary. No clearing of any bushland will be permitted without prior approval. Vegetation will be cleared only as far as required for each progressive stage of mine development.

The area required for clearance will be designated prior to commencement. Licences will be obtained from WAWA prior to clearing vegetation. Vegetation to be cleared will be mulched for use in rehabilitation if field trials indicate this practice is beneficial. All employees will be required to undergo an environmental awareness programme.

9.8.2 Rare Flora

Any rare or vulnerable plant species which may be found during mining operations will be protected in areas where removal is not essential. Where possible, this will be achieved by relocation of facilities which might impact on them and erecting fences around the plants to prevent accidental damage.

Approval would be sought from the Minister for the Environment prior to the removal of any rare plants located in areas to be disturbed. Griffin undertakes to investigate the feasibility of cultivating species of rare or vulnerable flora to replace those populations which may be destroyed by the Ewington minesite. These plants will then be used either as sources of cuttings for nursery stock or to provide tissue for tissue propagation. A seed bank will also be established for seeds of rare and vulnerable plants and some seed will be used for nursery purposes. Plants produced will be used in rehabilitation and in field establishment trials.

Griffin will conduct flora studies, concentrating on research into the general ecology and propagation characteristics of any rare or vulnerable species affected by the Ewington minesite. If they can be cultivated successfully, these species will be included in the rehabilitation programme.

9.8.3 Weeds

Protection of the area from weed invasion will comprise prevention of introduction of weed seeds and control of weeds which already occur or which may be accidentally introduced.

The introduction of weeds will be controlled by the same washdown process as will be used to prevent introduction of dieback disease. This will remove most weed seeds from heavy machinery and vehicles entering the site. Any seeds not removed will tend to accumulate on road verges or runoff sumps where weed monitoring and removal will be simple.

Control of weeds which already occur on the Ewington minesite will consist of monitoring and remedial action as required. Invasion from areas surrounding the minesite will be possible.

Monitoring of weeds will be the responsibility of the Environmental Officer during all site inspections. Weeds will be dealt with when found, or tagged for control at a later date. Weed control will be by hand-pulling or the use of herbicides if appropriate, which are considered safe and environmentally acceptable.

9.8.4 Fire

The implications of the Ewington minesite for fire protection and management in the region include the possibility of accidental fires starting from the minesite as a result of mining operations or carelessness, and the role of minesite management in fire suppression.

Griffin intends to ensure the following fire management measures are implemented on the Ewington minesite:

- trained fire-fighting crews will be available at all times,
- all personnel will be educated in fire prevention,
- suitable fire suppression equipment such as 4WD vehicles with mounted tank and pump, knapsack sprays etc. will be provided on the minesite, and
- an adequate firebreak system will be provided surrounding the minesite.

The firebreak system will be an extension of the existing system of firebreaks. It will serve to protect the minesite infrastructure and rehabilitation areas from destruction by fire, as well as surrounding forest from any fires that might originate from the minesite itself. Firebreaks will be regularly inspected and maintained.

Fire control working arrangements will be developed in conjunction with CALM, the Bush Fires Board and the local Bushfire Brigade.

9.8.5 Dieback

The primary aim in management of dieback in the Ewington minesite will be to prevent spread of the disease into previously uninfected areas in adjacent forest. The use of fungicides to treat established infections is often not practical, is extremely costly, and cannot be justified on a large scale. It can also have severe environmental consequences to the beneficial mycorrhizal fungi associated with the roots of a large number of local flora, resulting in death of the plants.

Griffin will develop a dieback management programme in consultation with CALM. A detailed dieback map will be prepared to identify those areas that are infected. Regular surveys will be undertaken to assess the effectiveness of dieback control measures.

Griffin proposes to follow the guidelines set out in CALM's Dieback Hygiene Manual (1986). As part of the management programme the following control measures will be taken:

- A washdown area for dieback hygiene purposes will be established before commencement of works. Its location and design will be determined in consultation with CALM.
- All heavy machinery to be introduced for sitework will be washed down.
- All heavy machinery leaving the site will be washed down.
- The work areas will be monitored for dieback disease and if new infestations are found, assistance and advice on the most appropriate procedures will be obtained from CALM.

The dieback map will be used to determine management procedures for areas proposed to be mined. Vegetation from dieback infected areas will be cleared, piled up and burnt on-site. No vegetation from infected areas will be used as mulch on rehabilitation areas.

The infected topsoil and upper 5m of overburden will be removed and placed deep in the dump profile where it cannot infect the rehabilitation.

If infected material is stockpiled, it will be located on already infected areas, and drainage controlled so that runoff will not infect other areas and stabilised as far as is practicable.

Care will need to be taken in installation of mine infrastructure and firebreaks to ensure that dieback disease is not spread.

Runoff and drainage on the minesite will be controlled to prevent infection of rehabilitation areas and uninfected areas.

Prior to discharge of minesite runoff to natural watercourses in the region, the water of these watercourses will be monitored for the presence of *Phytophthora* zoospores. If the watercourse is uninfected, contaminated runoff will not be discharged to it.

9.9 FAUNA

Specific fauna management and monitoring activities will be addressed in consultation with CALM. Management actions which will be undertaken to protect fauna include:

- minimisation of vegetation disturbance
- maintenance of strict fire control procedures
- capping of all boreholes and pipes when no longer required
- establishment of a feral animal eradication programme
- prohibition of domestic pets at the minesite, and
- prohibition of public off-road driving and shooting on the minesite.

Guidelines for the minimisation of disturbance to vegetation, which will also preserve fauna habitats, are set out in Section 9.8.

The use of firearms by minesite workers will be prohibited for the protection of native fauna. Pets, especially cats and dogs, will not be permitted on-site. These animals are major predators of small native fauna, and no matter how carefully controlled, tend to wander and catch prey.

An eradication programme for feral predators such as foxes and cats will be implemented in the Ewington area. This will significantly enhance the survival of the remaining Southern Brown Bandicoot populations in the area once mining commences. An eradication programme will be prepared in consultation with CALM and the Agricultural Protection Board (APB). Target species will be poisoned with 1080 (sodium monofluoroacetate) in accordance with APB guidelines.

9.10 ABORIGINAL SITES

Ethnographic and archaeological surveys have been carried out over the area that will be directly affected by the Ewington mine. No sites of Aboriginal significance were found. These surveys have also indicated that there is little potential for encountering sites in surrounding areas.

If a suspected Aboriginal site or artefacts are located during development of the site or the mining operation itself no further disturbance will occur until after the find has been examined by specialist consultants and the Department of Aboriginal Sites has been consulted.

Appendix G details the obligations of persons relating to sites under the Aboriginal Heritage Act 1972-1980.

The Department of Aboriginal Sites will recommend to the Minister whether the site may be disturbed or destroyed; or whether the site is to be protected. Management procedures for the site would then be prepared to ensure further disturbance is minimal.

9.11 TRAFFIC

All traffic associated with minesite construction and operation will access the minesite from Coalfields Highway via the main access road rather than through the eastern part of the Collie townsite. No minesite personnel, contractors or materials will be permitted to access the Ewington minesite via the eastern residential portion of the Collie townsite.

9.12 WASTES

Domestic biodegradable waste will be conventionally disposed of in an approved landfill site. Scrap metal, timber and other non-hazardous waste will be either recycled or buried deep in the overburden dumps.

All workshop waste (oil, grease, petrol etc) will be collected and then either recycled or taken off-site for disposal in an approved waste disposal facility, or for resale.

A package treatment plant will process all domestic type sewerage and waste waters. The treated effluent, together with any other oil-free water sources will be contained in lagoons and used for landscape irrigation. Water contaminated by free or emulsified oil will be used for road wetting and general dust suppression.

Fines and sludge cleared from silt traps and settling ponds will be backfilled deep in the overburden profile.

9.13 CONTINGENCIES

Work at the Ewington minesite will be regulated by the Western Australian Coal Mines Regulation Act (1946-1974) and Regulations supplemented by the Occupational Health, Safety and Welfare Regulations and the Explosives and Dangerous Goods Act, 1961-1978. These regulations are administered by the appropriate statutory authorities.

Emergency guideline procedures are provided by the various authorities for the management of spills, mine face collapse and other such occurrences. In the event of a spill, the planned drainage system and water quality control structures for the minesite will be adequate to delay polluting substances from entering local natural watercourses so they can be removed.

Griffin has an established, highly-trained mines rescue unit to service its minesite operations over the various shifts worked. This will be extended to the Ewington minesite. The units are made up of production and maintenance personnel. The rescue crews are trained in all areas of emergency response appertaining to open-cut coal mines. Emergency response exists in the areas of fire, first aid, vehicle extrication and extrication from heights and depths.

Disposal options outlined in Section 7.5.2 detail means by which mine water may be discharged. In the event of severe systems failure, rainfall deluge or other unusual occurrences, groundwater/mine water disposal means may be jeopardised. For example, main pipeline failure or pumping station malfunction may prevent several disposal options discharging mine water once the surge dams are filled to capacity.

However, a large drainage catchment extends from the south-eastern portions of the proposed minesite and beyond, and drains naturally into the Stockton Open-Cut. Therefore, all mine waters in an emergency situation will be pumped to the south-east high wall of the mine pit to provide for gravity drainage of the discharge into the Stockton Open-Cut.

Contingency plans will be made to use overburden to create an acoustic barrier at the western end of the northern haul road, should the downwind propagation of noise from this area prove to be excessive.

9.14 COMMUNITY LIAISON

Staff of Griffin will be available at the Muja minesite office to respond to any queries or problems which may arise in the community regarding the Ewington minesite. Councillors and staff of the Shire of Collie are similarly invited to discuss with Griffin's staff and resolve any issues which may arise. Griffin will invite Councillors and nearby residents to inspect the mining operations and rehabilitation progress on an annual basis.

All contacts with community and Council representatives will be recorded and maintained to ensure that problems are addressed and resolved.

10. PUBLIC CONSULTATION

10. PUBLIC CONSULTATION

10.1 INTRODUCTION

It is now usual for the public to be involved in basic decision making. Public involvement from an early stage is desirable in order to minimise major conflict after a project is committed or has reached a stage where modification is difficult.

The benefits of public involvement include the following:

- accurate public understanding of the nature, scope and objectives of the development leading to more community support,
- relevant and possibly new information, especially local knowledge, and
- an assessment of the emphasis to be accorded to potential development benefits and losses.

10.2 ACTIVITIES

The development proposal was referred to the EPA on 25th July 1990, when the EPA determined that a Consultative Environmental Review would be required. The EPA advertised the proposal referral on 4th August 1990. No appeals against the level of assessment were received.

The proposal was presented to members of the Collie Shire Council on 17th December, 1990. The details of the proposal were subsequently addressed at a full Council meeting in the same week and the minutes of this meeting were reported in the Collie Mail on the following Thursday.

A plan showing the location of the Ewington Mine was made available to the public at the Council Chambers.

An article was published in the Collie Mail on 10th January, 1991. This article informed the Shire of Collie of the proposal, provided details of the minesite location and programming, and announced that the CER would be available for public comment.

On Thursday, 31st January 1991 a public notice and accompanying plan addressed to the residents were dropped into all letterboxes in the Ewington area, the eastern portion of the Collie townsite. This notice described the proposed mining operation, development schedule, and informed the resident that the CER would be released and public comments would be called for. This notice is provided in Appendix B.

Release of the CER to the public for four weeks review with the opportunity to submit comments on the proposal will complete a carefully planned strategy for public consultation which has ensured Collie residents were fully informed and involved in the environmental assessment of this proposal from its initial stages.

10.3 CONCERNS RAISED

Contact names of Griffin's personnel both in Collie and Perth, and the Environmental Consultant preparing the CER were provided in the public notice. Griffin has also been available to answer queries concerning the proposal throughout the environmental assessment period.

The concerns raised by the public in response to media information and letter-drops have involved blasting, namely noise, ground vibrations and the possibility of damage to structures; groundwater drawdown and its impact on private bores; traffic access; and the local Bandicoot population.

The Shire of Collie Council raised additional concerns involving access routes of mine personnel from the townsite, noise emission and a desire for adequate and timely public consultation. This CER outlines measures planned by Griffin to satisfactorily address all these issues.

11. CONCLUSIONS

11. CONCLUSIONS

This Consultative Environmental Review document has been prepared by the Proponent, The Griffin Coal Mining Company Pty Limited, to acquaint the public community and relevant authorities with the proposal to mine coal from the Ewington deposits.

In proposing to mine at Ewington, Griffin aims to meet the demand for continued supply of coal for power generation and private customers. In doing so the development will boost the economy of the Collie area.

The proposal will involve mining operations in the Ewington area for approximately 31 years at the intended production rates. The long life of the minesite will ensure continued employment opportunities for the Collie workforce.

The proposal for the Ewington minesite contained in this document will be achieved within acceptable environmental constraints. The EPA guidelines to this document (Appendix A), note that it is essential that the CER shows an understanding of the environmental issues in the area to be mined and their relationship to disturbances due to the proposal. Griffin has undertaken ecological surveys in the area and the resultant documentation is available in the Appendices for more detailed appraisal.

Griffin believes that all key issues listed in the EPA guidelines have been identified and are being appropriately dealt with, in particular water discharge and treatment, noise and vibration, and rehabilitation.

Mining will be undertaken in such a manner that there will be minimal visual intrusion on the Ewington area as viewed locally. Measures will be taken to ensure adequate camouflaging to further reduce visual impacts. The rehabilitation programme will be co-ordinated with development of the minesite. This will ensure that the area of disturbance at any one time will be kept to a minimum.

Several environmental impacts to the natural environment as a result of the Ewington minesite have been identified. Griffin is confident that the likely environmental impacts associated with the development and operation of the Ewington minesite are understood, and can be managed within acceptable levels.

Nevertheless, Griffin undertakes to minimise any potential impacts by using suitable mining procedures and implementing appropriate management and monitoring programmes which will help ensure that the Ewington mining operations will be environmentally acceptable.

Overall, the minesite will have minimal impact on the natural environment outside the minesite confines. Those that do occur will be far outweighed by the economic benefits to the Collie region, the State of Western Australia as a whole and to Griffin.

12. PROPONENT'S COMMITMENTS

12. PROPONENT'S COMMITMENTS

Griffin undertakes to fulfil the following commitments in accordance with the applicable State laws and regulations and with standards and procedures agreed with the State.

1. CONSTRUCTION

- Access to the mine construction site will be strictly controlled, and all vehicles will be subject to strict dieback hygiene control. A construction phase dieback management programme will be prepared, in consultation with CALM, prior to the commencement of construction.

- Site clearing during construction will only be undertaken in accordance with prior approvals obtained from WAWA. A generally applicable minimum disturbance policy will be implemented.

- All employees will be instructed on the environmental policy of Griffin before commencing work on-site.

2. VEGETATION

- Vegetation clearing ahead of mining will be restricted to the minimum required for safe working practices. No clearing of any bushland will be permitted without prior approval from WAWA.

- Griffin will conduct a flora study for the location and mapping of rare and vulnerable plant populations. Research into the propagation characteristics of these species will be undertaken to investigate the incorporation of such species into the rehabilitation programme.

- Any rare plants within proposed mining areas will only be removed after Ministerial approval.

- Where feasible, rare plants which would be removed as part of the mining operations will be transplanted into rehabilitated areas, used as a source of seed for rehabilitation purposes or used as nursery stock.

3. DIEBACK

- An operational phase dieback management plan will be developed in consultation with CALM prior to the commencement of mining.

- A detailed dieback hazard map will be produced and regularly updated.

As part of the management programme the following control measures will be taken:

- A washdown area for dieback hygiene purposes will be established before commencement of works. Its location and design will be determined in consultation with CALM.
- All heavy machinery to be introduced for site work will be washed down.
- The work areas will be monitored for dieback disease, and if it is found, assistance and advice on the most appropriate procedures will be obtained from CALM.
- Regular surveys will be undertaken to assess the effectiveness of the control measures.

4. WEEDS

The introduction of weed seeds will be minimised by the rigorous dieback disease hygiene procedures.

Weeds that become established will be controlled by regular site inspection and, where necessary, eradication programmes.

5. DUST

Dust will be managed to the satisfaction of the EPA by:

- the use of watersprays on stockpiles,
- the watering of haul roads in dry conditions,
- the early and progressive implementation of rehabilitation.

A comprehensive dust monitoring programme will be implemented, so that any problems may be readily identified and rectified.

6. FIRE

Fire control will be implemented by:

- the education of all personnel in fire prevention requirements,
- the provision of trained fire-fighting crews at all times,
- the maintenance of firebreaks around and within the minesite area.

Fire control working arrangements will be developed in conjunction with CALM, the Bush Fires Board and the local Bushfire Brigades.

7. NATIVE FAUNA

Native fauna will be protected by the following actions:

- minimisation of vegetation disturbance,
- prohibition of firearms and pets on the minesite.

8. FERAL ANIMALS

The introduction of potential feral species will be prevented by the banning of all pets from the project area.

Feral fauna will be monitored on a regular basis and appropriate control programmes implemented where necessary, in consultation with the Agriculture Protection Board Pest Control Division.

9. LANDFORM

Final pit design will ensure that the highwall is left at a stable angle, as determined in conjunction with the Department of Mines.

Overburden dumping will be conducted in accordance with the overburden management programme developed prior to the commencement of mining. Overburden will be selectively dumped so that overburden materials likely to inhibit successful rehabilitation are buried at depth.

The visual impact of mining will be minimised by:

- designing overburden dumps so that wherever possible they are no higher than the natural topographic high points,
- progressive rehabilitation,
- screening from view where appropriate and practical.

10. WATER

A surface water management programme will be developed, prior to the commencement of mining, in consultation with the appropriate authorities.

Prior to the commencement of mining activities in any area, drainage structures will be constructed to control water movement and divert runoff from undisturbed areas around the proposed mining area.

Mine water will be managed to meet effluent discharge quality criteria consistent with achieving the water quality objectives defined in the Draft Water Resources Management Strategy for the Collie Coal Basin.

Monitoring of the various effluent streams will be undertaken in accordance with the programme developed in the management programme and results reported to the appropriate authorities.

Runoff management and drainage will be undertaken so that uncontaminated runoff from outside mining areas does not impinge on the operations. Contaminated water will be retained within the operational area and only discharged to the natural environment after treatment to a suitable quality.

11. NOISE AND VIBRATION

Blasting noise and vibration will comply with the appropriate licence standards issued by the EPA and will be controlled by:

- ensuring that explosion gases are essentially devoid of energy by the time they emerge into the atmosphere,
- firing blasts when there is a low probability of an atmospheric inversion being present,
- firing blasts during daylight hours at regular times and wherever possible between the hours of 10.30am and 3.30pm,
- using firing delays and detailed blast hole loading design.

Regular monitoring will be undertaken to develop a blast prediction model.

General mine noise will be managed by specifying noise emission limits on all mining equipment purchased.

Noise monitoring will be undertaken in accordance with a noise monitoring management programme, and will take place under a range of operational and meteorological conditions. If monitoring identifies any significant adverse impact on nearby residents, remedial action will be taken.

12. REHABILITATION

A rehabilitation management programme will be prepared prior to the commencement of mining.

Rehabilitation trials will be undertaken.

Rehabilitation to local native species will be undertaken progressively throughout the life of the mine.

Species selected for rehabilitation will meet the following criteria:

- species which occur naturally in the development area,
- species which are known to be able to readily establish themselves will be favoured,
- species which have proved suitable for rehabilitation purposes in the Collie Basin will be favoured.

Rehabilitation monitoring will be undertaken in accordance with the management programme.

Griffin will liaise with the appropriate authorities to develop completion criteria.

13. PUBLIC CONSULTATION

Griffin's staff will be available to respond to queries and problems raised by the local community. Every effort will be made to resolve any issues which may arise and records will be kept of all enquiries and complaints to facilitate this.

14. REPORTING

Griffin will report to the appropriate Government authorities regarding environmental management matters in accordance with the requirements of the Collie Coal (Griffin) Agreement Act, 1979.

15. ADDITIONAL PROPOSALS

Additional proposals under Clause 10 of the Collie Coal (Griffin) Agreement Act will be submitted as necesssary.

13. REFERENCES

13. REFERENCES

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14. GLOSSARY

14. GLOSSARY

14.1 ABBREVIATIONS

a	annum (year)
AHD	Australian Height Datum
CALM	Department of Conservation and Land Management
CER	Consultative Environmental Review
Cl	Chloride
CML	Coal Mining Leases
d	day
dB	(peak linear) maximum unweighted peak sound pressure level measured in decibels
dB(A)	A- weighted sound pressure level measured in decibels
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Environmental Protection Authority
Fe (soluble)	Soluble Iron
Fe (total)	Total Iron
g	gram
Government	Government of Western Australia
Griffin	The Griffin Coal Mining Company Pty Limited
h	hour
ha	hectare
Hz	hertz
kg	kilogram
km_2	kilometre
km^2	square kilometres
kV	kilovolt
L	litre
m_2	metre
m^2	square metres
m^3	cubic metres
mg	milligrams
mm	millimetre
ML	megalitre
Mt	million tonnes
Mtpa	million tonnes per annum
MW	megawatts
Na	Sodium
RL	ground reference level
s	second
SiO_2	Silicon dioxide
SO_4^{2-}	Sulphate
sp.	species (singular)
spp.	species (plural)
State	State of Western Australia
SECWA	State Energy Commission of Western Australia
t	tonnes
TDS	Total Dissolved Solids
tpa	tonnes per annum
TSS	Total Suspended Solids

ug	microgram
WAWA	Water Authority of Western Australia
^{o}C	degree Celsius
>	greater than
<	less than

14.2 TERMINOLOGY

Acidic	contain an excess of hydrogen ions - the degree of acidity is determined by the type of atom that holds the hydrogen ion describing a solution in which the concentration of hydrogen ions is greater than that of hydroxide ions.
Acoustic	of sound, of sense of hearing.
Aggregate	to bring together, to collect or to gather into a mass.
Alkaline	containing cations of strong bases in excess of the anions of strong acids.
Alluvium	a deposit of detritus and sediment laid down by water.
Anticline	a fold that is convex upward.
Aquatic	of or relating to water as distinct from land or air.
Aquifer	a permeable rock formation which stores and transmits sufficient groundwater to yield quantities to wells, bores or springs.
Archaeology	study of antiquities.
Artefact	a man-made object.
Association	a group of plants with a characteristic form, structure and dominant species.
Audible	a frequency in the range of 20-20,000 hertz which is the range in which the human ear can detect sound, termed noise.
Australian Height Datum	(AHD) the national basis for describing the elevation above sea level of land features and structures.
Benthic	animals and plants living on the bottom of seas, lakes or streams, either free-moving or attached.
Biodegradable	capable of being decomposed by bacteria.
Biology	the study of living things.
Bore	a hole drilled into the ground and lined with a suitable casing to supply water or monitor water levels.
Boxcut	in strip mining the overburden from the first strip is removed to expose the deposit - the pit created is termed a boxcut.
Brackish	describing water which is slightly salty.
Broadcast	seed scattered freely and widely.
Bund	a retaining wall generally designed to contain liquids.
Carbonaceous	geological materials containing organically derived carbon.
Catchment	an intake area and all parts of the drainage basin which drain into it.
Clastic	rocks built up of fragments of pre-existing rocks which have been produced by weathering and erosion.
Clay	a fine grained sediment composed primarily of clay-mixed particles (2 microns), characterised by high plasticity.
Colluvium	loose material and incoherent deposits usually at the foot of a slope of a cliff and laid down primarily by gravity.

Community	ecological term for any naturally occurring group of different organisms inhabiting a common environment, interacting with each other, especially through food relationships, and relatively independent of other groups.
Conductivity	transmit heat, electricity etc. by contact.
Conduit	a channel or pipe.
Conglomerate	rocks consisting of rounded fragments formed from cemented accumulations of pebbles.
Confined aquifer	an aquifer confined by relatively impervious layers.
Contour	a line connecting points of equal value on a map.
Cretaceous	the latest period of the Mesozoic Era, about 135 million years ago.
Crustacean	invertebrate, generally aquatic or marine, with a hard carapace or exoskeleton, eg marron.
Crystalline	rocks composed of interlocking crystals, eg granite.
dB(A)	the measurement of sound pressure level in which the amplitude of the sound signal is negatively weighted in frequencies below 1,000Hz in accordance with a weighing scale known as the "A" weighing scale. This scale was established to closely simulate human perception of the relative level of pure tone sounds. The dB(A) scale is most commonly used to measure sound levels which will affect human beings.
Dewatering	the removal of water from a water-bearing formation either by pumping or natural discharge at a rate greater than the natural or induced recharge.
Dicotyledon	flowering plants with two cotyledons, broad leaves with branching veins, flower parts in fours or fives and a tap root, can be woody or herbaceous (eg,trees or shrubs).
Dip	the angle at which a rock stratum or any flat feature is inclined from the horizontal.
Direct seeding	a term referring to direct application of seed to the ground by hand or mechanically. Seed may be dispersed in a medium to enable proper distribution.
Dominant species	the most abundant species in the tallest or most important stratum of a plant association.
Drawdown	the decline in groundwater level due to abstraction.
Duricrust	a case-hardened crust of soil formed in semi-arid climates by the precipitation of minerals at the surface of the ground as the groundwater evaporates. Minerals may be of aluminium, iron, silica or lime origins.
Ecosystem	a community of organisms, interacting with one another, plus the environment in which they live and with which they also interact. An ecosystem is usually defined by its dominant vegetation and plants species or by the habitat in which it occurs. Ecology is the study of ecosystems.
Effluent	liquid waste.
Emulsion	a colloidal dispersion of one liquid in another - oil and water form emulsions of small globules of oil in water or small drops of water in oil.
Endemic	confined to a given region.

Ephemeral stream	a stream that flows briefly only in direct response to precipitation in the immediate locality and whose channel is at all times above the water table.
Ethnography	scientific description of the races of man.
Eutrophication	process of high organic production resulting from enrichment of plant nutrients to a waterbody; a natural process of aging of lakes but greatly accelerated by man-made sources of pollution.
Exotic species	not native, usually implying an unacclimatised introduction by human agency.
Fault	a fracture in the earth's crust along which there has been some displacement of the sides relative to one another.
Fauna	the species of animals present within a community or vegetation of a geographic area.
Ferricrete	iron-containing material that is cemented.
Ferruginous	containing iron.
Flocculant	a substance which causes the deposition of settling out of solid particles out of suspension.
Flora	the species of plants present within a community or vegetation of a geographic area.
Formation	the ordinary unit of geological mapping consisting of a large and persistent stratum of some one kind of rock.
Freehold	tenure of land, property etc, possessed absolutely as one's own.
Frequency	symbol - f or v. The number of complete cycles of a periodic process occurring in unit time. Frequency is measured in hertz.
Geology	the study of earth as a whole, its origin, structure, composition and history and the nature of the processes which have given rise to its present state.
Geomorphology	the description and interpretation of landforms.
Geothermal	the name given to any geological processes which involve heating.
Gneissic	a term applied to banded rocks formed during high-grade regional metamorphism.
Graben	a downthrown block between two parallel faults.
Granite	a coarse-grained rock containing a high proportion of quartz and feldspar, as well as some mica.
Gravel	fragments of rock worn by the action of air and water, larger and coarser than sand.
Groundwater	underground water contained within a saturated zone or rock (aquifer).
Greenhouse Effect	a natural phenomenon which warms the earth's surface. Greenhouse Gases in the atmosphere such as carbon dioxide act like the glass of a greenhouse trapping some of the sun's warmth. Man's activities on earth are increasing the proportion of greenhouse gases in the atmosphere with detrimental environmental effects.
Habitat	a place where species or populations of plants and animals live. A habitat contains a system of components which satisfies the requirements of the organism and includes both living and non-living features.

Hardness	referring to the concentration of soluble calcium and magnesium salts in a solution.
Hardstand	large surfaced area for parking, storage and laydown of vehicles, equipment, materials etc.
Herbs	non-woody plants. May be perennial or annual - generally small in stature.
Hydraulic head	the level of groundwater in a monitoring bore.
Hydrogeology	the science dealing with groundwater and its relationship with geology.
Hydrology	the science of water.
Hertz	Hz - a unit of frequency of a periodic process with a period of one second. This unit replaces the cycle per second.
Impact	(environmental) the effect that some specific change in the environment has on other particular parts of an ecological community.
Indigenous	native to a particular area, not introduced.
Infrastructure	the supporting installations and services that supply the needs of the project.
Inoculate	introduction of a material into a medium to initiate a culture. In nature this is the manner by which healthy plants become infected with disease.
Interburden	non-coal deposits between the coal seams.
Landform	the shape, form and nature of a specific feature of the earth's land surface.
Laterite	iron-rich material which hardens on exposure to the atmosphere and is associated with deeply weathered profiles.
Lenticular	biconvex or lentil-shaped.
Lithology	the character of a rock described in terms of its structure, colour, mineral composition, grain-size and arrangement of its component parts.
Macroinvertebrate	animals without backbones, eg protozoa, koonac, insects, spiders, worms etc. are known as invertebrates. Macroinvertebrates are the larger invertebrates such as insects etc. which can be studied without using microscopic techniques.
Mesotrophic	a waterbody displaying moderately enriched characteristics.
Metamorphic	(in geology) refers to rock which has been transformed by great heat and/or pressure.
Meteorology	the science of climate.
Monocotyledon	flowering plants with only one cotyledon, lack secondary stem thickening (ie, herbaceous), narrow leaves with parallel veins, flower parts in multiples of threes and a fibrous root system (eg, palms, grasses).
Mulch	organic material such as peat, leaf, shredded bark, newspaper that is spread on the ground to suppress weeds, absorb and retain water and add nutrients. Hydromulch is mulch combined with water to enable it to be sprayed onto soil surfaces.
Mycorrhizal	Symbiotic association between a fungus and the roots of a plant. When soil nutrients are in short supply, plants forming such associations fare better than uninfected plants.

Nitrogen fixation	conversion of atmospheric nitrogen into organic nitrogen compounds. A process that can be carried out only by certain soil-inhibiting bacteria and certain blue-green algae.
Normal fault	a fault in which the fracture has not been vertical and in which the overlying (hanging) wall has moved downward, relative to the underlying (foot) wall.
Octave	an interval between two notes such that the frequencies of the two are in the ratio 2:1. An octave covers eight notes of a scale of music.
Open-cut	a form of surface mining where the overburden is removed from the coal deposit or orebody.
Organic	being, containing, or relating to carbon compounds, especially in which hydrogen is attached to carbon whether derived from living organism or not.
Outcrop	the part of a rock formation which appears at the surface of the ground.
Overburden	material which overlies a deposit of useful materials or ores.
Passerines	a member of the Passeriformes, a group of birds. A perching bird, with large first toe directed back, other three toes forward.
Permian	the period of time from 280 to 225 million years ago, marking the end of the Paleozoic Era.
pH	a measure of acidity or alkalinity of soil or water. pH 7.0 is neutral, pH 0-6.9 is acid, and pH 7.1-14 is alkaline.
Photosynthesis	a process occurring in plants where carbohydrates are synthesised from light carbon dioxide and water. Involves the production of oxygen and the consumption of carbon dioxide.
Physiographic	factors such as topography, altitude, drainage, erosion and slope which affect the prevailing conditions within a habitat and the distribution of the plants and animals.
Physiology	the study of the processes and functions associated with life.
Plankton	free-floating microscopic plants and animals found in waterbodies, both marine and freshwater.
Predator	an animal which subsists by the capture and killing of other animals.
Quaternary	referring to rocks up to 2 million years old.
Quartz	a crystallised silicon dioxide.
Recharge	water arriving at the water table.
Reductant	a compound that causes reductant where oxygen is removed from or hydrogen is combined with a compound, for example hydrogen and carbon.
Rehabilitation	processes necessary to return disturbed land to a predetermined surface, land use or productivity.
Riparian	pertaining to, or situated on, the bank of a body of water.
Sandstone	a medium grained sedimentary rock which is the consolidated equivalent of sand. Composed mainly of grains between 60 microns and 2mm size which usually consist of quartz.
Sediment	solid material settled from suspension in a liquid.
Sedimentary	rocks originating from materials laid down as sediments, eg windblown sands, riverine muds etc.

Shale	a fine-grained sedimentary rock, formed by the consolidation of clay, silt or mud. Characterised by finely laminated structure.
Siltstone	an indurated silt having the texture and composition of shale but lacking its fine lamination. A rock whose texture is intermediate between those of sandstone and shale and of which at least two-thirds of the material is silt-size.
Sodicity	relates to sodium content of a soil, specifically the amount of sodium ions occupying the exchange sites on a soil's particles. Sodic soils tend to be unstable, hard setting, dispersive and do not readily absorb water. They are also saline.
Specialised	having special adaptations to a particular habitat or mode of life which tend to restrict the range of habitat which can be occupied and the variety of mode of life.
Species diversity	a botanical term indicating the number of species of plants present in a habitat.
Species richness	a botanical term indicating a measure of the number of species of plants occurring in a given area.
Specific energy	the energy expended or work done in removing a unit volume of work material.
Spoil	referring to waste overburden or interburden material.
Spontaneous combustion	automatic ignition arising from a heat-generating chemical reaction.
Strip mining	a method of surface mining where the overburden is removed in strips.
Sub-bituminous	the third of six stages in the process of coal formation where peat is converted by heating and pressure to coal.
Substrate	ground or other solid object on which animals and plants walk/grow or to which they are attached.
Sump	a pit or drain.
Superficial	pertaining to, occurring in, or affecting only, a surface or surface layer.
Surficial	superficial, generally a collective term for near-surface geological formations.
Synclinal	basin-shaped fold.
Taxonomic	taxonomy, the study of the principles and practices of classification. Strictly the description of variation in the natural world and the subsequent compilation of classifications.
Tertiary	referring to rocks 2 million to 65 million years old. The earlier of two geological periods in the Cenozoic Era.
Tone	an audible note with no harmonics.
Topography	the physical features of a region (land or sea) such as are represented on maps, taken collectively; especially relief and contour.
Topsoil	the general term applied to the surface portion of the soil including the average plough depth or the A-horizon where this is deeper.

Total Dissolved Solids	(TDS) amount of dissolved solids in a given quantity of water.
Turbidity	the stirring-up of sediment by water.
Unconfined aquifer	a permeable bed only partly filled with water and overlying a relatively impervious layer. Its upper boundary is formed by a free water table or phreatic level under atmospheric pressure.
Unconformable	unconformity is a geological term indicating a change in conditions of deposition of sediments. It is regarded as a planar structure separating older rocks below from younger rocks above. A plane of unconformity may be a surface of weathering, erosion or denudation, or a surface of non-deposition.
Understorey	vegetation beneath the dominant (tallest) tree species in an association but not part of the tree canopy.
Vertebrates	an important group of animals possessing a skull, surrounding a well-developed brain and a skeleton of cartilage or bone. Contains the fish, amphibians, reptiles, birds and mammals.
Vibration	rapid oscillatory motion, as of a tuning fork, stretched string etc.
Weathered	changed by long exposure to atmospheric conditions.
Wetlands	lakes, pools, rivers, streams and swamps and their associated moist margins.
Windrose	a diagram summarising the frequencies of winds of different strengths and directions as measured at a specific point over an extended period of time.
Yilgarn Block	name given to a large Proterozoic and Archaean rock mass underlying most of southern Western Australia. It represents the remnants of a stable continental craton.
Zoogeographical	study of the geographical distribution of animals.
Zooplankton	the animal portion of the plankton.
Zoospore	a motile spore with one or more flagella, dependent on water for dispersal.