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WORSLEY ALUMINA PTY LTD
BODDINGTON GOLD MINE
EASTERN ANOMALIES OPERATION
CONSULTATIVE ENVIRONMENTAL REVIEW

September 1992



John Consulting Services

HOW TO MAKE A SUBMISSION

The Environmental Protection Authority (EPA) invites persons and organisations to make submissions on this proposal.

The Consultative Environmental Review (CER) has been prepared to assess the potential impacts and management for the proposal by the Boddington Gold Mine (BGM) Joint Venturers to develop the Eastern Anomalies deposits, adjacent to the main BGM orebody, as an extension of the existing operations at BGM, in accordance with Western Australian Government procedures. The CER will be available for comment for four (4) weeks, beginning on 25 September 1992 and finishing on 23 October 1992.

Comments from Government agencies and from the public will assist the EPA in preparing an assessment report, in which it will make a recommendation to Government.

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 useful if you indicate any suggestions you have to improve the proposal.

All submissions received will be acknowledged.

DEVELOPING A SUBMISSION

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

You make an important contribution by suggesting ways to make the proposal more environmentally 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 possible;
- suggest recommendations, safeguards or alternatives.

POINTS TO KEEP IN MIND

It will be easier to analyse your submission if you keep in mind the following points:

- 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 different sections of the CER, keep them distinct and separate, so there is no confusion as to which section you are considering
- Attach factual information you wish to provide and give details of the source. Make sure your information is accurate.
- Please indicate whether your submission can be quoted, in part or in full, by the EPA in its assessment report.

Extra copies of the report can be obtained from Worsley Alumina - Boddington Gold Mine, PO Box 48 BODDINGTON WA 6390, at a cost of \$5.00 (incl. postage and packaging).

Remember to include:

- Name
- Address
- Date

The closing date for submissions is 23 October 1992.

Submissions should be addressed to:

The Chairman
Environmental Protection Authority
38 Mounts Bay Road
PERTH WA 6000
Attention: Mr R. Griffiths

SUMMARY

Ongoing exploration at Boddington Gold Mine (BGM) has identified three small ore zones to the east of the main ore body (the Eastern Anomalies). The BGM Joint Venturers propose to develop these oxide reserves as an extension of existing operations.

The Eastern Anomalies, with a 1.7 Mt reserve which might, through ongoing assessment of resources, be expanded to a maximum of 4.8 Mt, would provide mill feed to the existing CIL plant at BGM. The Eastern Anomalies Operation would simply extend mine life: no increase in plant throughput is proposed, and no additional water supply, residue management or processing facilities are required.

As an extension of existing operations at BGM, it is suggested that environmental management of the Eastern Anomalies Operation could be managed by application, with appropriate modification, of existing statutory controls for the BGM. The April 1987 Environmental Management Programme for the initial BGM 3 Mt/a operation, supplemented and modified as part of the approvals of the 4.5 Mt/a (1988), 6 Mt/a (1989) and Supergene/Basement (1991) expansions, plus Environmental Protection Act Licence No. 2232 and Works Approval No. 750 (for the F3 residue area), provide an appropriate framework for management of this development.

Biological assessments indicate that, while the Eastern Anomalies Operation would involve some loss of habitat, there would be no significant implications for rare and endangered species on a regional scale; potentially affected species are either nomadic or well-represented elsewhere in the region. Moreover, rehabilitation should allow re-establishment of habitats at at least a functional level.

The Eastern Anomalies Area is outside the water catchment in which the main BGM project operates, but protection from land and stream salinisation remains a primary environmental sensitivity. The Operation would involve clearing of no more than 150 hectares in the Wattle Hollow and House Brook catchments. Less than 9% of the forested part of Wattle Hollow Brook catchment, and less than 3% of the forested part of House Brook catchment, would be disturbed. It is considered that the impacts of this clearing on stream and land salinity would be inconsequential - these streams

ultimately report to the already-saline Hotham River, and impacts on upstream forested parts of the catchments are likely to be indiscernible. Nonetheless, the salinity impacts of the Operation are being assessed as part of a project-wide re-evaluation of 1987 studies, this re-evaluation being scheduled for submission to the State in the last quarter of 1992.

Commitments are also made for the development and implementation of rehabilitation strategies and prescriptions, the monitoring of rehabilitation and of surface and groundwater, and the management of mine water, should mine dewatering be required. The forest hygiene programme already proven in the BGM project would be extended to the Eastern Anomalies Operation.

CONTENTS

	Page
Summary	i
1. Introduction	1
1.1 General	1
1.2 The Proponents	3
1.3 Scope and Timing	3
1.4 Benefits of the Proposal	4
1.5 The Approvals Process	4
2. Overview of the Existing BGM Project	6
3. The Proposal, including Alternatives	8
3.1 Strategic Considerations	8
3.2 Mining Operations	8
3.2.1 Location and Access	8
3.2.2 Ore Extraction	10
3.2.3 Ore Haulage	10
3.2.4 Water Management	11
3.3 Ore Processing	11
3.4 Residue Management	12
4. Existing Environment	13
4.1 Physiography, Geology and Land Use	13
4.2 Biological Environment	13
4.2.1 General	13
4.2.2 Flora and Vegetation	14
4.2.3 Fauna	15
4.2.4 Forest Disease	15
4.3 Hydrology	16
4.3.1 Streams	16
4.3.2 Swamps	17
4.4 Hydrogeology	17
5. Environmental Impacts and Management	18
5.1 Regional Conservation Issues	18
5.1.1 Rare and Endangered Species	18
5.1.2 Habitat Significance	18
5.1.3 Forest Disease Management	19
5.2 Water Management	20
5.2.1 Surface Water	20
5.2.2 Groundwater	21
5.3 Landscape and Aesthetic Considerations	22
5.4 Rehabilitation	22
5.5 Dust and Noise	24
5.6 Public Consultation	24

CONTENTS (ctd)

	Page
6. Summary of Environmental Commitments	25
7. References	26
8. Glossary and Abbreviations	28
Appendix A: EPA Guidelines for this CER	30

1. Introduction

1.1 General

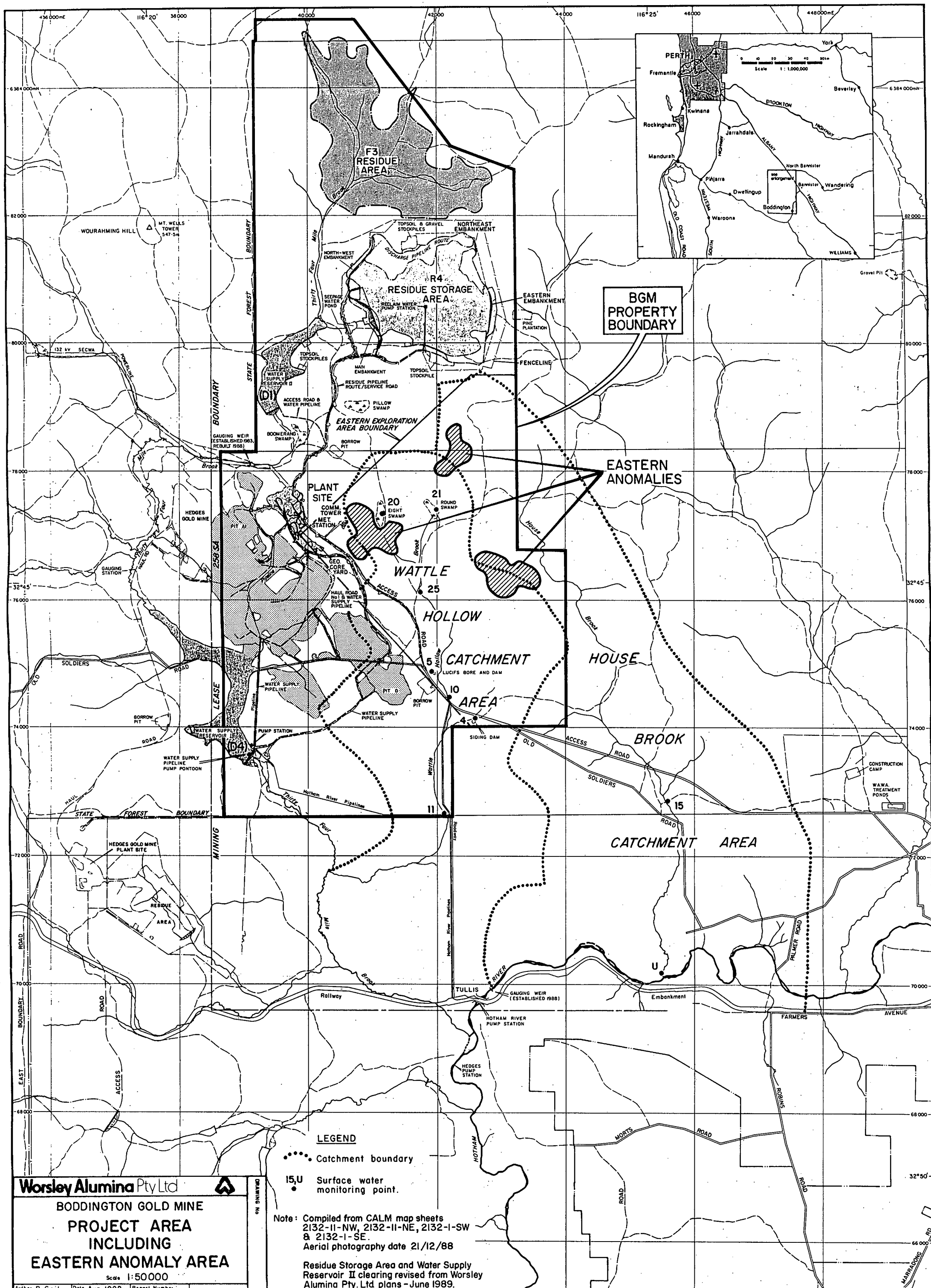
The Boddington Gold Mine (BGM) is a gold mining and processing project located in the Darling Range, predominantly on private land (owned by the BGM Joint Venturers), approximately 13 kilometres north-west of the Town of Boddington (Figure 1).

Since the start of production in July 1987, operations have been expanded three times, reflecting progressive re-evaluation of reserves in the main orebody. The development of the BGM is detailed in Section 2 below.

As part of ongoing exploration, three small ore zones to the east of the main orebody (the Eastern Anomalies) have been identified (Figure 1). Ore reserves of 1.7 Mt have been identified to date; further assessment of ore resources might expand this reserve, to a maximum of 4.8 Mt. It is proposed that these oxide reserves, extending approximately 30 metres below the ground surface, be developed as an extension to current operations, with ore being fed to the existing CIL processing plant at the BGM.

This document addresses the potential environmental impacts and relevant management programmes for the Eastern Anomalies operation. Since the operation is very much a small extension of existing mining operations at BGM, its effective environmental management can be achieved largely through application of existing programmes.

The major environmental sensitivity at the BGM is water quality. The main watercourse in the region, the Hotham River (lying some 5 km south of BGM), has long been moderately saline (averaging 5,000 mg/l Total Dissolved Solids) because of agricultural clearing dating back more than 100 years; however, most BGM operations are located in the catchment of Thirty-four Mile Brook, a fresh-water tributary of the Hotham. Land disturbance in this eastern, low-rainfall zone of the Darling Range is well-recognised as a potential cause of land and stream salinisation, and the State has identified protection of the quality of Thirty-four Mile Brook flows, and of groundwater, as primary aims of environmental programmes at BGM. The Eastern Anomalies lie outside the main catchment of Thirty-four Mile Brook, but the same imperatives apply in terms of protection from salinisation.



Environmental management at BGM is based on the Environmental Management Programme (EMP) submitted to the State in April 1987 as a condition of establishment of initial operations; the EMP was approved in June 1987. Commitments made in the April 1987 EMP have been supplemented and modified as part of the process of environmental approval of the three subsequent upgrades.

1.2 The Proponents

Worsley Alumina Pty Ltd manages the BGM project on behalf of the four BGM Joint Venturers:

- Reynolds Australia Metals Ltd (40%)
- Billiton Australia Gold Pty Ltd (30%)
- Newcrest Mining (WA) Limited (20%)
- Kobe Alumina Associates (Australia) Limited (10%)

1.3 Scope and Timing

It is currently planned that ore extraction commence in the first quarter of 1995. Harvesting of forest produce is scheduled to commence in the first quarter of 1993, with access and haul road construction in the summers of 1993-94 and 1994-95. This comparatively long pre-operations period is necessitated by the Joint Venturers' commercial arrangements with Bunnings Forest Products Ltd, from whom the land was purchased in 1991; Bunnings has rights to timber on the land, and harvesting is scheduled to fit in with Bunnings' broader forestry operations commitments. Moreover, timber harvesting and clearing at BGM are scheduled, where practicable, to the summer season, to minimise risks of spread of forest disease.

While the Eastern Anomalies will provide the equivalent of approximately three months mill feed, mining will be conducted concurrently with that in the main orebody. It is expected that ore extraction from each of the three anomalies will be completed within two years of its opening; pits will be operated concurrently in many instances, with mining completed in all pits by 1998. Rehabilitation will then be undertaken, as part of the

project-wide programme for returning the BGM mining area to stable land forms and land uses compatible with those of the surrounding areas.

There are indications of possible bedrock mineralisation (quartz veins) beneath Anomaly 1 (Figure 1), but reserves have not yet been identified. Should ongoing exploration prove up a mineable bedrock orebody, a separate proposal for its exploitation would be made to the State - this scenario is not addressed in this proposal.

1.4 Benefits of the Proposal

As described in the April 1992 Life of Project Land Use Plan (Worsley Alumina 1992), processing of ore at BGM is currently scheduled to cease in 1998. The Eastern Anomalies, while only a small reserve, are nonetheless an important part of the remaining life of the BGM. Exploration is being continued in an effort to identify additional reserves to sustain the BGM operation, but it is considered unlikely that large oxide reserves will be found close to the main orebody. Potential developments at BGM are described in the 1992 Land Use Plan (Worsley Alumina 1992).

The Eastern Anomalies operation would involve a capital expenditure of \$2 million and a construction workforce of approximately 10 for a total period of about six months. In operations, no additional workforce would be required, but more than \$20 million of additional expenditure would be made for goods and services during the life of the BGM Project as a whole.

1.5 The Approvals Process

A Development Proposal for the Eastern Anomalies operation was submitted to the Environmental Protection Authority (EPA) in January 1992. A Level of Assessment of Consultative Environmental Review (CER) was set by the EPA, also in January 1992, and guidelines for the CER were provided by the EPA in February 1992; a copy of these guidelines is included as Appendix A to this CER document.

Statutory environmental management controls at BGM are currently effected through the April 1987 EMP and Environmental Protection Act (EP Act) Licence No. 2232. Works Approval No. 750 has also been issued for the

construction of the F3 Residue area, to the north-west of the original (R4) residue area (Figure 1); residue deposition in the F3 area is scheduled to commence in the second quarter of 1993, and the F3 and R4 areas are together sufficient to contain residue from all currently envisaged ore-processing at BGM, including that from the Eastern Anomalies operation. Extraction of water from the Hotham River for ore processing is controlled through a licence issued by the Water Authority under the Rights in Water and Irrigation Act.

Since the Eastern Anomalies operation is very much a small extension of existing operations at BGM, it is considered that, with appropriate modification and supplementation, the April 1987 EMP and EP Act Licence No. 2232 would provide adequate statutory environmental management control. While the Eastern Anomalies lie outside the main water catchment of the BGM Project, they are partly within a subcatchment of Thirty-four Mile Brook (Wattle Hollow Brook) and partly within the partially forested catchment of another tributary of the Hotham River (House Brook) (Figure 1).

After submission of this CER, the preparation of which has involved consultation with the EPA, the Water Authority of WA (WAWA), adjacent landowners and the Shire of Boddington (see Section 5.6), the EPA will seek comments from government instrumentalities and members of the public considered by the EPA to have an interest in, or to be potentially affected by, the proposal. The EPA will then produce a Report and Recommendations to the Minister for the Environment.

If the EPA recommends approval of the proposal, and the Minister subsequently accepts that recommendation, the Minister would authorise implementation, with appropriate conditions, under the terms of the EP Act. The EPA would then issue a Works Approval to allow construction of the development and, as noted above, operations would probably be carried out under the terms of the April 1987 EMP and EP Act Licence No. 2322, modified as necessary to encompass the additional activities.

Appeal against the EPA's Report and Recommendation can be made by any party, and the proponent (the BGM Joint Venture) has right of appeal against conditions proposed by the Minister prior to his issuing of authority to implement the proposal.

2. Overview of the Existing BGM Project

Operations at BGM commenced in July 1987 at the ore-processing rate of 3 million tonnes per annum (3 Mt/a), based on an ore reserve of 45 Mt. The location of facilities is shown in Figure 1.

Through the "Notice of Intent" process of environmental impact assessment operating at the time, a proposal to expand throughput capacity to 4.5 Mt/a was submitted to the EPA in October 1987; approval to implement the expansion was received in February 1988, and the enhancement of facilities completed in late 1988. This first expansion involved no significant increase in areal impacts: mine development was simply hastened within the originally-conceived mining envelope, the capacity of the Water Supply Reservoir D4 was increased without additional clearing being required, and no new residue storage area was required.

Progressive re-evaluation of the orebody resulted in a second Notice of Intent in July 1988 to expand production, based on an increased ore reserve of 60 Mt. The increase from the original reserve involved ore previously classified as marginal which, to that point in time, had been either stockpiled or left in the ground. Expansion of throughput capacity was approved in December 1988 and implemented by the third quarter of 1989.

This second expansion at BGM involved only a marginal increase in the area required for mining activities, since it involved treatment of material previously classified as being of marginal grade, some of which had already been extracted and stockpiled. To meet expanded process water requirements, an additional reservoir (D1) was constructed upstream of the initial one (D4) on Thirty-four Mile Brook (Figure 1). Assessment of residue storage requirements at the time indicated that residue from the processing of the expanded ore reserve could be contained in the original Residue Storage Area (R4).

A third Notice of Intent was submitted in July 1989 for the mining and processing of basement and supergene ores. Due to their mineralogy and/or hardness, these ores were not able to be treated in the existing oxide circuit; new facilities were proposed, involving crushing, grinding, flotation and leaching facilities at the existing plant-site. The proposal was approved in October 1989, and commissioning took place in April

1991. Flotation residues, a relatively small proportion of total residue volume, are stored in a restricted area of the existing residue area, where they are being progressively enveloped in oxide residues.

Progressive re-evaluation of ore reserves, based on additional drilling and operational experience, has resulted in an increase to 70 Mt. Ongoing engineering, financial and environmental appraisal of life-of-project residue management strategies, when combined with the increased ore reserve, culminated in 1991 in a proposal to develop a new residue area (F3) to the north-west of the existing (R4) area (Figure 1). This development is to be implemented in accordance with the provisions of Works Approval No. 750; construction is scheduled for the dry season of 1992/93, the commencement of residue deposition being planned for the second quarter of 1993. The additional ore reserves which contributed to the requirement for this second residue storage area lie within the mining envelope for the previous 60 Mt reserve - no additional clearing is required for the mining of the additional 10Mt of ore.

3. The Proposal, including Alternatives

3.1 Strategic Considerations

As discussed in Section 1.4, the processing of ore at the BGM is currently scheduled to cease in 1998. Exploration is considered unlikely to identify large additional reserves, the major opportunities for further development generally involving small, high-grade deposits (Worsley Alumina 1992). The large, deep and low-grade Diorite Prospect represents the greatest potential for significant extension of the life of the BGM project, but this resource requires much more exploration and assessment before its ultimate potential can be determined.

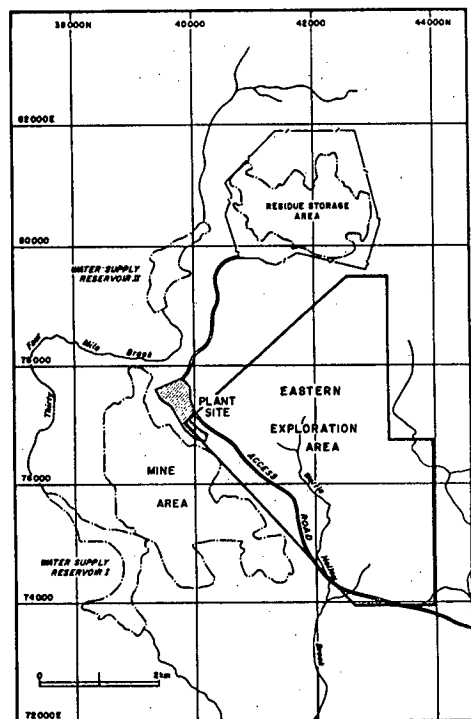
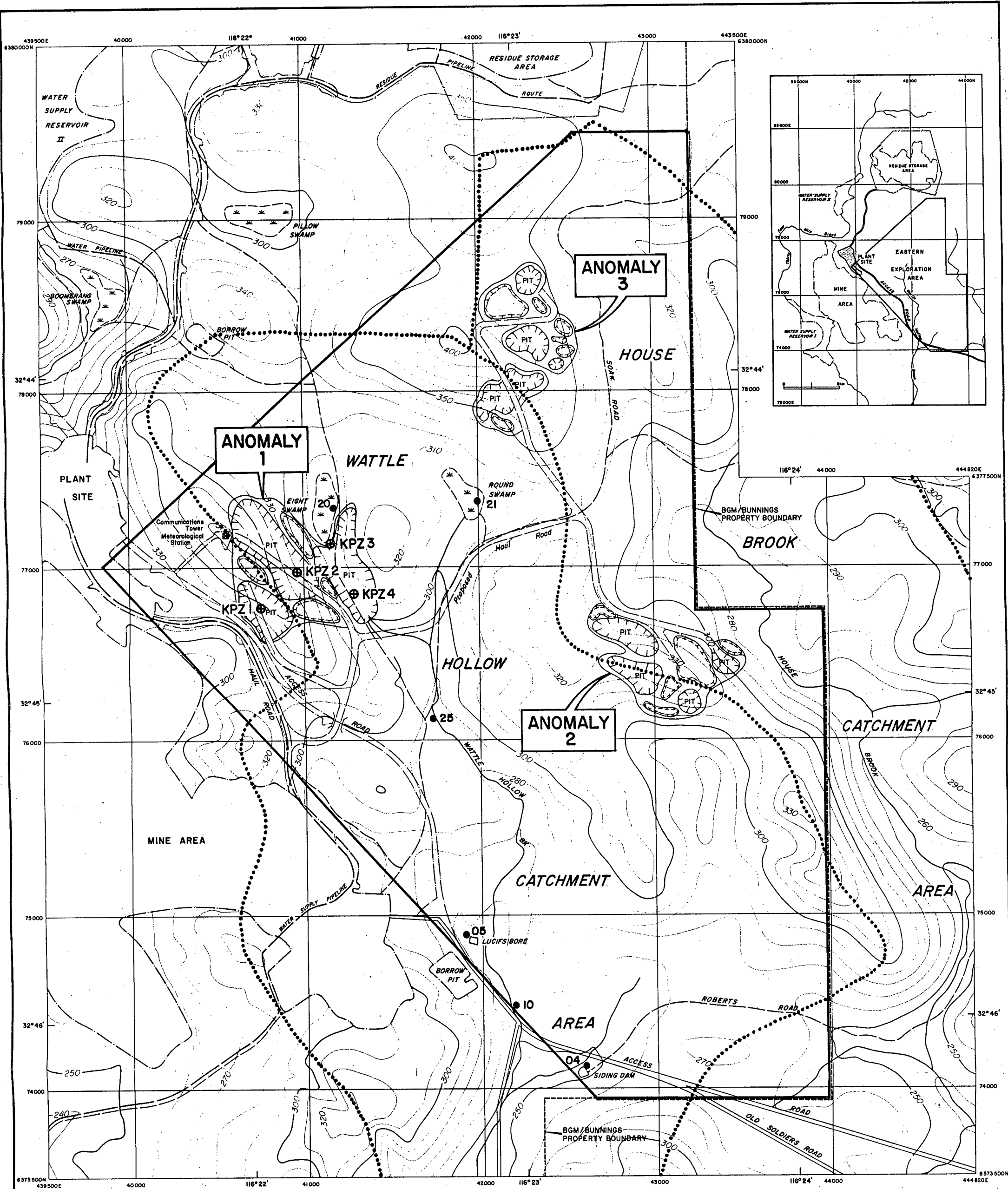
With an estimated 1.7-4.8 Mt of ore, the Eastern Anomalies provide a small but timely extension to the mine life. The ore zones lie within a 1,300-hectare area of land purchased from Bunnings Forest Products Limited in 1991 (Figures 1, 2). Exploration is continuing in this area, known as the Eastern Exploration Area, but it is currently believed that significant additional reserves are unlikely to be discovered; it is possible that exploitable basement mineralisation exists below Anomaly 1, but this potential development is not addressed in this proposal (see Section 1.3).

The three Eastern Anomalies can be developed with a total area of disturbance of 150 hectares, including mine-pits, access roads and waste and topsoil stockpiles. Residue management can be effected using the already-approved R4 and F3 areas, so that this 150 hectares represents the maximum areal impact of the Eastern Anomalies operation. In comparison, the total projected area of disturbance for the BGM Project as a whole is 1,723 hectares (Worsley Alumina 1992) - this includes the Eastern Anomalies, which would thus comprise less than 9% of the total area of disturbance for the BGM Project.

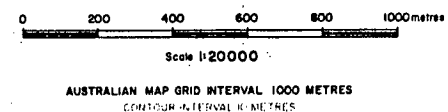
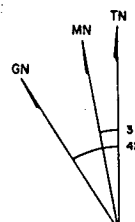
3.2 Mining Operations

3.2.1 Location and Access

The Eastern Anomalies lie between 0.5 and 3 km from the existing BGM orebody (Figure 1), on private forested land purchased in 1991. Gold mineralisation extends generally to about 30 metres below natural surface,



- Pits
- Topsoil, gravel and waste stockpiles
- Catchment boundary
- 25 Surface water monitoring location
- KPZ 1 Ground water monitoring bores



PART OF 1:25000 C.A.L.M. TOPOGRAPHIC SERIES MAPS
2132-II-NW, 2132-II-NE, 2132-I-SW & 2132-I-SE.
ENLARGED TO 1:10000

Worsley Alumina Pty Ltd

**BODDINGTON GOLD MINE
EASTERN ANOMALY
OPERATION
SITE PLAN**

Scale: 1:20000

Author: R.Coll Date: April 1992 Report Number: FIG. 2
Drawn: C.Pennedy Revised:

shallower than in the main orebody; in some areas it extends to the bedrock contact some 45 metres below the surface.

Anomaly 1 extends into the southern part of the seasonally-filled Eight Swamp (Figure 2); approximately 10% of the 4-hectare swamp would be directly affected by mining. Winter water levels will be maintained by the construction of a low embankment at the edge of the mine-pit, and overflow from the swamp diverted around the pit.

Reflecting their close proximity to the main orebody, the Eastern Anomalies would be developed as an extension to current operations. Ore haul roads would be fed into the existing Main Haul Road (Figure 2), with the Mine Access Road being maintained via an underpass to be constructed as part of this proposal (Figure 2).

Other than a possible pipeline to return mine water to the processing plant (see Section 3.2.4), no infrastructure would be required for the Eastern Anomalies - it would simply operate as part of the main mining operation.

3.2.2 Ore Extraction

Mining would involve the same techniques as those currently used at BGM. Typically, 3-metre benches would be developed, with ore extracted by excavator, bulldozer and front-end loader. In some instances, contour-mining (with benches sloped to follow the land surface, rather than using horizontal benches) would be used to improve resource recovery - this technique is also in current use in the main BGM mining operation. Blasting would be required to break up the concreted laterite (hardcap) zone just below the surface.

Waste, root-bearing gravels and topsoil would be stored separately in stockpiles prior to backfilling and rehabilitation (see Figure 2). Stockpiling requirements will be minimised by directly backfilling mined-out areas where practicable, as is the current practice in the main BGM operation.

3.2.3 Ore Haulage

Trucks with capacities up to 120 tonnes would haul ore to the existing processing plant over distances of up

to 4 km. For both ore extraction and haulage, no additional equipment would be commissioned: existing equipment would be re-directed from current operations in the main orebody.

A conveyor is not proposed for the delivery of ore from the Eastern Anomalies to the processing plant; a conveyor would be neither economically nor environmentally as flexible as trucking, for which haul roads can be constructed along curved alignments, minimising environmental impacts related to forest disease, drainage water management and erosion.

3.2.4 Water Management

Runoff would be managed using techniques already established at BGM: perimeter drains would be constructed as part of initial clearing operations, with runoff collected in sumps to allow suspended material to settle before discharge to existing watercourses. The Eastern Anomalies lie in the catchment of Wattle Hollow Brook, a subcatchment of Thirty-four Mile Brook, a tributary of the Hotham River, and House Brook, a direct tributary of the Hotham River (Figure 1).

It is considered unlikely that mining operations would intersect significant groundwater bodies. However, should mine dewatering be required, water would be directed to Wattle Hollow Brook, via settling sumps as appropriate, or pumped to the processing plant for use as process water; current EP Act Licence conditions would determine the destination of mine water (see Section 5.2.1).

No potential for acid generation is expected from material mined from this oxide orebody, as no sulphidic material has been or is expected to be encountered.

3.3 Ore Processing

Ore from the Eastern Anomalies would be treated in the existing CIL plant at BGM to recover gold. Eastern Anomalies ore would simply be treated like that from the main orebody - no increase in rate of throughput would be involved, so that no new processing or water supply facilities would be required.

3.4 Residue Management

As noted in the 1992 BGM Land Use Plan, the existing R4 and the approved F3 residue areas have ample capacity for the storage of residue from all currently-identified reserves and resources at BGM. The total capacity of these two areas is approximately 100 Mt; the total requirement, based on past processing and on currently-known reserves, is 70 Mt.

Thus, no additional facilities or clearing would be required to allow storage of residue from the processing of the 1.7-4.8 Mt of ore from the Eastern Anomalies operation.

4. Existing Environment

4.1 Physiography, Geology and Land Use

The Eastern Anomalies area is private forested land typical of the eastern Jarrah Forest. It has for many decades been exploited for timber on a selective logging basis.

The Eastern Anomalies have formed through laterisation of gold-bearing greenstone rocks. The basement consists of an Archean sequence dominated by mafic (containing dark minerals) volcanics and intrusions including basalts, dolerites and gabbro. Granite and Proterozoic dolerite dykes are common. This sequence is termed the Marradong Formation, which also underlies the northeastern sections of the main BGM orebody.

Typical of the Darling Plateau, the Eastern Anomalies area comprises a weathered lateritic profile. Gold mineralisation extends from near-surface in some areas to depths of approximately 30 metres, extending to about 45 metres to the bedrock contact in some areas. The area is thus closely comparable with the main BGM orebody, although the maximum depth of mineralisation is generally less.

4.2 Biological Environment

4.2.1 General

The Eastern Anomalies area was included in the initial biological studies of the BGM Project area; these studies, by E M Mattiske & Associates and Ninox Wildlife Consulting, have yet to be published, but were provided to the EPA in 1986 as part of the approvals process for the initial BGM operation. These studies complemented the much wider study of the Worsley Alumina Project area (Worsley Alumina 1985), which included the bauxite mining area near Mt Saddleback - the same techniques and methodologies were employed in both studies.

Additional studies by Mattiske and Ninox were carried out in 1991 and 1992 specifically for the Eastern Anomalies operation, as was a dieback survey (Hart, Simpson and Associates 1992).

4.2.2 Flora and Vegetation

Mattiske & Associates (1992) recorded 55 families, 154 genera and 246 species of vascular plants in the Eastern Anomalies area; no gazetted rare species were found. Fifteen species were recognised as being potentially rare, geographically restricted, poorly collected or in need of further investigation. Three species are designated by the Department of Conservation and Land Management (CALM) (1991) as being in need of monitoring; of these, Daviesia cordata and Senecio leucoglossus are relatively widespread, while Lasiopetalum cardiophyllum is geographically restricted. Additionally, Calothamnus planifolius and Lasiopetalum cardiophyllum have a restricted distribution of less than 160 km from the Boddington area.

Although Lasiopetalum cardiophyllum is on the CALM Declared Rare and Priority Flora List (CALM 1991), its conservation status should be evaluated in light of its previous recording in nearby native forest areas:

- (i) on the Saddleback Timber Reserve (Worsley Alumina 1985);
- (ii) on the BGM area (Mattiske & Associates 1985, 1991a);
- (iii) on the Marradong Timber Reserve (Mattiske & Associates 1990a);
- (iv) on bauxite mine rehabilitation areas on the Saddleback Timber Reserve (Mattiske & Associates 1991b); and
- (v) on a number of conservation reserves in the Eastern Jarrah Forest (Mattiske & Associates 1990b).

Vegetation community types have been mapped for the Eastern Anomalies Area using the system developed by Havel (Mattiske & Associates 1992). Eleven types were identified: 5 Jarrah, 1 Proteaceous/Myrtaceous heath, 1 Myrtaceous low shrubland and 4 Wandoo. Of these community types, the L-type (a Wandoo community) is the most restricted in conservation reserves in the region; it is naturally restricted to localised pockets and has been extensively cleared for agriculture in the Northern Jarrah Forest - it comprises less than 1% of

the 1,300 hectare area in which the Eastern Anomalies lie, but no L-type area is proposed for disturbance in this proposal.

4.2.3 Fauna

Vertebrate fauna studies in the Eastern Anomalies area by Ninox Wildlife Consulting in 1992 involved re-assessment of detailed studies conducted by Ninox in 1984 (Worsley Alumina 1985) and of other studies in the area and region (Ninox 1986, 1987, 1990). A site re-evaluation was conducted prior to this re-assessment, in co-operation with the flora and vegetation work (Mattiske & Associates 1992). Because the Eastern Anomalies area was studied in detail in Ninox's 1984 investigations, and because the faunal ecology of the area is relatively well understood in principle, it was considered unnecessary to carry out a quantitative fauna trapping programme.

Based on previous sampling and observation in the area and its immediate environs, 77 birds, 22 native mammals, 7 introduced mammals, 14 frogs and 35 reptiles are known or expected to occur (Ninox 1992).

Eight rare species have been recorded in the area or are expected to be present:

- the Peregrine Falcon Falco peregrinus
- Carnaby's Cockatoo Calyptrorhynchus funereus laterostris
- Baudin's Cockatoo C. baudini
- the Crested Shrike-tit Falcunculus frontatus
- the Red-eared Firetail Emblema oculata
- the Chuditch Dasyurus geoffroii
- the Southern Brown Bandicoot Isodon obesulus
- the Carpet Python Python spilota imbricata

Little or no impact of the Eastern Anomalies operation is expected for the first four species because of their highly nomadic habits. Some loss of habitat is predicted for the remaining four species, but it is considered likely to be extremely localised; no significant regional implications are predicted.

4.2.4 Forest Disease

The presence of the Jarrah Dieback disease in the Eastern Exploration Area has been assessed by

observation of plant health, testing for the presence of Phytophthora in roots of dead plants and baiting of water bodies to detect the fungi (Hart, Simpson and Associates 1992).

No visual evidence of dieback was recorded, and analysis of 19 root samples from potentially-affected plants identified no dieback fungi. However, it is not considered appropriate to state that no dieback exists in the area: in this comparatively dry region of the Jarrah Forest, dieback is notoriously difficult to identify, possibly because its ecology and epidemiology is subtly but significantly different from that which prevails in wetter regions.

4.3 Hydrology

4.3.1 Streams

Almost all of the current activities of the BGM Project are contained within the main catchment of Thirty-four Mile Brook (Figure 1). The easternmost extremity of residue area R4 has potential to contribute saline flows to Wattle Hollow Brook, a subcatchment of Thirty-four Mile Brook, although this possibility is minimised by the operation of monitoring and recovery bores immediately downstream of the eastern embankment of the R4 area.

The proposed Eastern Anomalies Operation is located within the Wattle Hollow Brook and House Brook catchments (Figure 2) - House Brook reports directly to the Hotham River, and Wattle Hollow Brook reports to the Hotham River via Thirty-four Mile Brook.

The BGM area has been included in Worsley Alumina's regional water monitoring programme since the early 1980s. Wattle Hollow and House Brooks are ephemeral streams which are generally fresh (less than 750 mg/l TDS) except where they flow through cleared agricultural areas to the south of the BGM Project area. Similarly, Thirty-four Mile Brook below the BGM Water Supply Reservoir D4 is generally fresh until it reaches agricultural land before its confluence with the already-saline Hotham River - the salinity of the Hotham River varies between 2,000 and 7,500 mg/l TDS.

Strategically, the aim of water management in the Eastern Anomalies Operation would be to protect the forested sections of Wattle Hollow and House Brooks.

4.3.2 Swamps

The Eastern Exploration Area contains two small, seasonally inundated areas: Eight Swamp immediately north of Anomaly 1 and Round Swamp in the geographic centre of the Eastern Anomalies area (Figure 2). Only Eight Swamp would be directly affected by the mining operation: approximately 10% of the southern end of the Swamp would be disturbed.

Swamps, which provide floral diversity and faunal habitats, are not uncommon in the area and region. They are shallow depressions which, because of their relatively impermeable clay floors, fill in winter and overflow to nearby streams. Both Eight and Round Swamps report to Wattle Hollow Brook.

4.4 Hydrogeology

Groundwater in the BGM area, including the Eastern Exploration Area, lies between 0.5 and 30 metres below natural surface. The water table generally follows the ground surface, but with greater relative depths to groundwater in upslope areas. Perched water tables occur during the winter months, providing the main source of stream flows.

Groundwater quality varies throughout the area, both horizontally and with depth - it is compartmentalised, especially at depth, with little mixing taking place on a regional scale. Salinities of 100 to 8,000 mg/l TDS have been recorded over the BGM project area in general.

Because of these relatively high salinities, groundwater generally has limited potential use, other than for stock water, but protection against land and stream salinisation as a result of disturbed hydrological balance is considered an appropriate management strategy. Regional salinity impacts of the BGM Project were assessed as part of the environmental approvals process for the initial project (Worsley Alumina 1987), and these impacts, particularly those from residue storage areas, are currently being re-assessed under the terms of Works Approval No. 750 for the F3 residue area, with a report scheduled for completion in the third quarter of 1992; the potential impacts of the Eastern Anomalies Operation, while likely to be comparatively small (see Sections 5.2.2 and 5.2.2), will be addressed in that re-assessment.

5. Environmental Impacts and Management

5.1 Regional Conservation Issues

5.1.1 Rare and Endangered Species

As noted in Section 4.2.3, the Eastern Anomalies Operation is considered unlikely to have significant regional impacts on rare fauna. Four bird species (the Peregrine Falcon, Carnaby's Cockatoo, Baudin's Cockatoo and the Crested Shrike-tit) are considered likely to be virtually unaffected, because of their highly nomadic habits; habitat losses are predicted for four other species (the Red-eared Firetail, the Chuditch, the Southern Brown Bandicoot and the Carpet Python), but these impacts are likely to be extremely localised (Ninox Wildlife Consulting 1992).

Fifteen plant species have been recognised as possibly requiring protection or further investigation (see Section 4.2.2). Of these, only Lasiopetalum cardiophyllum is potentially of some concern because of its apparently restricted distribution; however, it is abundant in the BGM area, and in the Marradong and Saddleback Timber Reserves to the south, and is regularly recorded in rehabilitated bauxite mining areas on Saddleback (Mattiske & Associates 1992). This knowledge of the distribution and abundance of Lasiopetalum cardiophyllum is derived primarily from biological studies sponsored by Worsley Alumina in its bauxite- and gold-mining project areas; a reconnaissance of a number of areas in the Eastern Jarrah Forest, including several conservation areas, suggests both greater range and higher abundance of this species (Mattiske & Associates 1990b).

5.1.2 Habitat Significance

Swamp, stream zone and Wandoo habitats have been identified by Ninox Wildlife Consulting (1992) and Mattiske & Associates (1992) as having particular ecological significance in the Eastern Anomalies Area. The swamp and stream zone areas support specialised fauna, are generally poorly represented in the Darling Range and are vulnerable to siltation and fire. The L-type Wandoo vegetation identified by Mattiske & Associates represents less than 1% of the Eastern Exploration Area, but would not be impacted by the Eastern Anomalies Operation.

Ninox (1992) estimate that 31% of the individual species listed in its report could be affected by the Eastern Anomalies Operation in that some of their populations would be reduced by habitat loss - these species are primarily small, sedentary or resident species with limited territorial range and/or capacity to travel long distances. However, none of these species is rare, and all have distribution patterns extending well beyond the project area - at worst, small proportions of individual populations would be lost, without major regional significance, and rehabilitation should provide replacement habitats in the medium term.

5.1.3 Forest Disease Management

Although a recent study of the Eastern Exploration area (Hart, Simpson and Associates 1992) did not reveal positive evidence of the presence of Phytophthora cinnamomi, the fungus responsible for the Jarrah Dieback Disease, it has not been assumed that the organism is not present - the problems of detecting the disease in this comparatively dry part of the Darling Range were discussed in Section 4.2.4.

Phytophthora drechsleri was isolated from almost all swamps and drainage lines tested; while this species is not known to cause significant damage to vegetation, strategies to minimise its spread will be included in the forest disease management programme for the Eastern Anomalies Operation.

It is proposed that the forest disease strategy already operating at BGM be extended to the Eastern Anomalies Operation. This strategy treats the mining envelope as a single "dieback-suspect" area: vehicles and equipment are washed down with water treated with sodium hypochlorite, or blown down with compressed air (in dry conditions), to remove potentially infected soil or plant material prior to initial entry to a mine pit area; a perimeter drain is then established as part of the clearing operation, to minimise risks of overland flow of potentially contaminated water. Clearing and timber harvesting are generally carried out in the summer months, when risks of disease spread are at their lowest.

Once haul roads have been established and topsoil removed, the mine-pit is treated as part of the broader mining envelope, washdown (or blowdown) being required

only when vehicles and equipment leave the envelope. Equipment and vehicles new to the site are washed or blown down before entering the mining envelope. Mine vehicles and equipment are effectively "captive" to the mining envelope on a day-to-day basis.

In this way, the mining envelope is treated as "dieback free" for incoming equipment, and "dieback suspect" for outgoing equipment. This conservative but practical approach has operated effectively at BGM since 1987.

5.2 Water Management

5.2.1 Surface Water

Streams

Stream flows in the ephemeral Wattle Hollow and House Brooks will continue to be monitored for salinity, as part of the regional water monitoring programme established by Worsley Alumina in the early 1980s. There are currently six monitoring points along Wattle Hollow Brook (Figure 2); this intensity of monitoring is considered adequate for assessment of impacts of the Eastern Anomalies Operation. Two points are monitored along House Brook (Figure 2), and additional points closer to the Eastern Anomalies could be established if considered necessary for effective assessment of impacts in the forested part of this subcatchment.

Since the Eastern Anomalies Operation is a short term one - mining in each anomaly area is likely to be completed within two years of its commencement and rehabilitation after another two years - and since the total areal disturbance is relatively small (150 hectares in catchments whose total forested area is 2,800 hectares), only marginal increases in stream salinities are predicted. These considerations will be addressed as part of the project-wide salinity impact study currently in progress and due to be reported to the State in the last quarter of 1992; this study is primarily focussed on the significance of residue storage areas, which contain large volumes of moderately-saline interstitial water - mining impacts are considered to be both comparatively less significant and less manipulable, but are nonetheless addressed, so that a whole-of-project assessment is made.

While it is currently considered unlikely that mine dewatering will be required in the Eastern Anomalies Operation, a strategy has been developed should this action be required. Provided the salinity of mine water was unlikely to damage vegetation, it would be released to Wattle Hollow and House Brooks (Anomaly 1 is the only area where dewatering is a possibility, so that only Wattle Hollow Brook would potentially be impacted). Existing EPA Licence conditions for the BGM place an upper salinity limit of 5,000 mg/l for receiving waters in the BGM area, and it is proposed that this standard be applied to the discharge of mine water, subject to monitoring of impacts on downstream vegetation.

Swamps

As noted in Section 3.2.1, only about 10% of Eight Swamp would be directly affected by mining operations. A low embankment at the edge of the Anomaly 1 pit would maintain winter water levels in the Swamp, and overflows would be accommodated by diversion around the pit. The eastern lobe of Anomaly 1 would be mined first, and any overflow from the Swamp directed to Wattle Hollow Brook to the south, using silt traps as appropriate to prevent siltation of the Brook downstream of the mining area.

Rehabilitation of Anomaly 1 would be designed to re-establish the existing hydrological regime of Eight Swamp.

Outflows from Round Swamp (Figure 2) would be unaffected by the Eastern Anomalies Operation, since culverts under the main haul road to Anomalies 2 and 3 would allow uninterrupted flow to Wattle Hollow Brook.

5.2.2 Groundwater

In the absence of mine dewatering, effects of the Eastern Anomalies Operation on groundwater in the area are most unlikely to be discernible. The operation is short term, and rehabilitation should permit quick re-establishment of salt and water balances in an area where less than 9% of the 1,200 hectares of forested Wattle Hollow Brook catchment, and less than 3% of the 1,600 hectares of forested House Brook catchment, would

be cleared. (Mining operations will involve the clearing of 105 hectares and 45 hectares in Wattle Hollow and House Brooks, respectively.)

Should dewatering (Anomaly 1) be required, it would likely be of even shorter duration than that of the entire operation, and drawdowns of groundwater restricted to a few metres. Impacts on the groundwater resource, and on surrounding vegetation, can thus reasonably be expected to be inconsequential.

Nonetheless, groundwater levels and quality would be monitored in the Eastern Anomalies Area, using four bores already in existence (Figure 2).

5.3 Landscape and Aesthetic Considerations

The Eastern Anomalies Area is remote from casual public view, and the short duration of the operation makes aesthetics a minor consideration. As discussed in Section 5.4, rehabilitation will re-establish a stable and safe landform which is landscaped and vegetated in congruity with the surrounding undisturbed areas. Some access ways may be left after mining, but these would be low-use tracks, with attention given to maintaining drainage lines and avoiding erosion.

Being private land, recreation is not an important consideration, although the post-mining landscape would not prevent passive recreation, such as bushwalking, should such a land use be appropriate at some future time.

As discussed in Section 5.4, one option for rehabilitation includes man-made swamps or lakes, especially in Anomaly 1. Should this eventuate, appropriate personal safety considerations would be included in the rehabilitation design.

5.4 Rehabilitation

Since the Eastern Anomalies Operation is essentially an extension of the existing BGM mining operation, rehabilitation would be planned as part of the project-wide programme. The main objectives of this programme are:

- to stabilise landforms

- to re-establish hydrological balance
- to restore the functional floral and faunal characteristics of the area
- to minimise risks of spread of forest disease.

Topsoil and other soil materials, especially root-bearing gravels, would be salvaged from all cleared areas for subsequent use in rehabilitation. Mine-pits would be backfilled with waste to produce stable landforms, and salvaged topsoil and other soil materials replaced after ripping as necessary to relieve compaction and promote infiltration. The final surface would be scarified on contour to control erosion, and revegetated.

Using prescriptions and techniques already established at the BGM and at Worsley Alumina's Boddington Bauxite Mine, tree, understorey and groundcover vegetation would be planted and/or sown and fertilised. Species selection would be based on the flora and vegetation studies already carried out in the area, and would aim at re-establishment of vegetation types comparable with those which currently exist. Vegetation would be maintained until it was self-sustaining and able to be treated as part of the surrounding vegetation, especially in terms of fire management.

Monitoring of rehabilitation would be carried out as part of the broader programme developed for the BGM, based on experience at the Boddington Bauxite Mine on Saddleback Timber Reserve some 25 km to the south.

Should there be insufficient mine waste to provide a stable and safe post-mining landform with slopes similar to those of the surrounding land, man-made lakes or seasonal swamps would be developed. As noted in Section 5.3, personal safety would be addressed if lakes were established: shallow beaches and lake margins would be engineered as part of the backfilling operation.

Since swamps are a reasonably common, and ecologically rich, element of the existing landscape, such a rehabilitation strategy can be considered both appropriate and desirable.

As for the existing BGM Project, rehabilitation of the Eastern Anomalies Area would be planned and implemented in consultation with the State, especially the EPA, the

Water Authority and CALM. Rehabilitation progress and planning would continue to be reported to the State in Worsley Alumina's Annual and Triennial Environmental Management Reports, and in the BGM annual Life of Project Land Use Plans.

5.5 Dust and Noise

Dust and noise in the Eastern Anomalies Operation would be managed by extension of the programmes already operating at BGM. Dust would be controlled by application of water (treated with sodium hypochlorite to reduce risks of spread of forest disease) to trafficked areas, and by vegetation of other open areas where fugitive dust emissions are likely. Noise from blasting would be monitored and reported according to the requirements of EP Act Licence No. 2322.

5.6 Public Consultation

In addition to dealings with the EPA, the Water Authority and CALM in relation to statutory requirements, Worsley Alumina has consulted the Shire of Boddington and adjoining landowners (Hedges Gold Mine, Bunnings Forest Products, Worsley Timber Company and Nullaga Pastoral Company). These consultations have outlined the nature of the Eastern Anomalies proposal, identifying potential impacts on neighbours and benefits of the proposal for the Boddington area. These liaisons will be maintained as the proposal develops and is implemented.

Additionally, a poster display has been set up in the Shire of Boddington offices, to allow the local community to examine the project proposal and seek additional information. This display, established in early August 1992, will be maintained for several weeks.

6. Summary of Environmental Commitments

In implementing and operating the Eastern Anomalies Operation, Worsley Alumina would meet the following commitments.

- (1) Adherence to the relevant policies, procedures and commitments contained in the April 1987 Environmental Management Programme (EMP) for the initial BGM Project, supplemented by the State's conditions of approval of the 4.5 Mt/a (February 1988) and 6 Mt/a (December 1988) expansions of the oxide operation and the October 1989 Supergene/Baseament Project.
- (2) Adherence to the conditions of EP Act Licence No. 2322, concerning noise, dust and water and residue management - it is envisaged that this Licence may be supplemented and/or modified to include the Eastern Anomalies Operation.
- (3) Include the Eastern Anomalies Area in the regional salinity impact re-assessment currently being carried out as a requirement of Works Approval No. 750 for the F3 residue area - the report on this study, which is necessarily concerned primarily with the impacts of residue storage, is scheduled for submission to the State in the fourth quarter of 1992.
- (4) In the event of mine dewatering being necessary, ensure that the salinities of water bodies and water courses receiving discharges do not exceed 5,000 mg/l TDS as a result of those discharges; monitor and report impacts of such release on downstream vegetation, and adjust procedures as appropriate.
- (5) Continue to monitor surface and groundwater in the area, as part of the regional programme established in the early 1980s, and report findings to the State.
- (6) Develop rehabilitation strategies and prescriptions in consultation with the State, and monitor and report on the success of rehabilitation.

7. References

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8. GLOSSARY AND ABBREVIATIONS

Archean	refers to geological age - around 4,500 million years (synonymous with Early Precambrian)
basalt	any fine-grained dark igneous rock
BGM	Boddington Gold Mine
CER	Consultative Environmental Review
CALM	Department of Conservation and Land Management
CIL	Carbon-in-Leach - a method for extracting gold from ground ore wherein the gold-adsorbing carbon is in contact with the ore pulp (ore plus extraction liquor) only during the latter (leaching) stages of the extraction process (<u>cf.</u> Carbon-in-Pulp or CIP)
dolerite	fresh basaltic rock
EMP	Environmental Management Programme
EPA	Environmental Protection Authority
gabbro	any coarse-grained dark igneous rock
igneous	adjective describing rocks formed by solidification from molten or partially molten rock (magma)
lateritic	(soil or geological) depletion through leaching of silica, leaving iron and aluminium hydroxides
mafic	basic (not acidic) rocks or strata
mg/l	milligrams per litre (concentration)
Mt	million tonnes or megatonnes
Mt/a	million tonnes per annum

Proterozoic (geol.) the younger of two Precambrian eras (cf. Archean)

supergene relates to ores or minerals formed by enrichment associated with downward movement of water.

TDS Total Dissolved Solids

APPENDIX A:

EPA guidelines for this CER

PROPOSED DEVELOPMENT OF EASTERN ANOMALY PROSPECT

BODDINGTON GOLD MINE

CONSULTATIVE ENVIRONMENTAL REVIEW GUIDELINES

Overview

In Western Australia all environmental reviews are about protecting the environment. The fundamental requirement is for the proponent to describe what they propose to do, to discuss the potential environmental impacts of the proposal, and then to describe how those environmental impacts are going to be managed so that the environment is protected.

If the proponent can demonstrate that the environment will be protected then the proposal will be found environmentally acceptable; if the proponent cannot show that the environment would be protected then the Environmental Protection Authority (EPA) would recommend against the proposal.

Throughout the process it is the aim of the EPA to advise and assist the proponent to improve or modify the proposal in such a way that the environment is protected. Nonetheless, the environmental review in Western Australia is proponent driven, and it is up to the proponent to identify the potential environmental impacts, and design and implement proposals which protect the environment.

These Guidelines identify issues that should be addressed within the Consultative Environmental Review (CER). They are not intended to be exhaustive and the proponent may consider that other issues should also be included in the document.

The CER is intended to be a brief document, its purpose should be explained, and the contents should be concise and accurate as well as being readily understood by interested members of the public. Specialist information and technical description should be included where it assists in the understanding of the proposal. It may be appropriate to include ancillary or lengthy information in technical appendices.

Key issues

The important issues for this proposal are likely to be associated with the removal of native vegetation in an area where concern exists related to rising salinity from vegetation loss. The key issues for the project should be clearly identified and the content of succeeding sections determined by their relevance to these issues.

In this case the key issues should include:

- regional conservation issues:
 - representation of affected habitats elsewhere in the region;
 - protection of similar habitats in secure reserves in the region;
 - representation and protection of rare/restricted/endangered flora and fauna;
 - management of potential impact of forest disease.
- Landscape and recreation values:
- alternative options - explanation of other possible options for extraction and reasons for selecting the preferred option;

- water management issues:
 - predicted groundwater drawdowns from dewatering, zones of influence and impacts on other users (including vegetation);
 - dewatering and discharges, erosion and siltation control;
 - surface water supplies, relationship to groundwater, protection of ground and surface water quantity and quality;
 - maintenance of stream and overland flow patterns, particularly in relation to road construction;
- operational management issues:
 - dust and noise control;
 - overburden and topsoil management, rehabilitation and final land use;
 - future mining plans;

plus any other key issues raised during the preparation of the report.

Public participation and consultation

A description should be provided of the public participation and consultation activities undertaken by the proponent in preparing the CER. This section should describe the activities undertaken, the dates, the groups and individuals involved and the objectives of the activities. This section should be cross referenced with the "environmental management" section which should clearly indicate how community concerns have been addressed. Where these concerns are dealt with via other departments or procedures, outside the Environmental Protection Authority process, these can be noted and referenced here.

Detailed list of environmental commitments

The commitments being made by the proponent to protect the environment should be clearly defined and separately listed. Where an environmental problem has the potential to occur, there should be a commitment to rectify it. They should be numbered and take the form of:

- a) who will do the work;
- b) what the work is;
- c) when the work will be carried out; and
- d) to whose satisfaction the work will be carried out.

All actionable and auditable commitments made in the body of the document should be numbered and summarised in this list.

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