Boddington gold mine - Proposal for development of eastern anomalies

Worsley Alumina Pty Ltd

Report and recommendation
of the Environmental Protection Authority

Environmental Protection Authority
Perth, Western Australia
Bulletin 661
December 1992

THE PURPOSE OF THIS REPORT

This report contains the Environmental Protection Authority's environmental assessment and recommendations to the Minister for the Environment on the environmental acceptability of the proposal to develop the Eastern Anomalies as an extension of the existing Boddington Gold Mine operations.

Immediately following the release of this report there is a 14-day period when anyone may appeal to the Minister against the Environmental Protection Authority's recommendations.

After the appeal period, and determination of any appeals, the Minister consults with the other relevant ministers and agencies and then issues his decision about whether the proposal may or may not proceed. The Minister also announces the legally binding environmental conditions which might apply to any approval.

APPEALS

If you disagree with any of the assessment report or recommendation you may appeal in writing to the Minister for the Environment outlining the environmental reasons for your concern and enclosing the appeal fee of $10.

It is important that you clearly indicate the part of the report you disagree with and the reasons for your concern so that the grounds of your appeal can be properly considered by the Minister for the Environment.

ADDRESS

Hon Minister for the Environment
12th Floor,Dumas House
2 Havelock Street
WEST PERTH WA 6005

CLOSING DATE

Your appeal (with the $10 fee) must reach the Minister's office no later than 5.00 p.m. on 18 December, 1992.

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Summary and recommendation

Worsley Alumina Pty Ltd has been operating the Boddington Gold Mine since 1987, during which time there have been three proposals for expansion approved.

This further proposal is to develop three small ore bodies to the east of the main ore body at the Boddington Gold Mine. The three small ore bodies are known as the Eastern Anomalies and it is proposed to mine them as an extension of the existing mining operation.

The Boddington Gold Mine is located approximately 13 kilometres north-west of the town of Boddington in the South-West region of Western Australia.

The proposal was referred to the Environmental Protection Authority in 1992 and assessed at the level of Consultative Environmental Review (CER) owing to a number of concerns, including potential salinisation of land and surface water from land disturbance, spread of forest disease and rehabilitation of the area.

The Eastern Anomalies area is located outside of the 34 Mile Brook catchment in which the main mining operation occurs. It is situated in the two smaller catchment areas of Wattle Hollow Brook and House Brook which discharge into the saline Hotham River. Approximately 150 hectares of land in these two catchments will be cleared which represents less than 9% of the forested portion of Wattle Hollow Brook catchment and less than 3% of the forested portion of House Brook catchment.

Approximately 10% of the seasonally inundated Eight Swamp would be directly affected by the mining operation.

Mining of the Eastern Anomalies ore bodies would utilise conventional open cut mining methods, including blasting of the laterite cap, and loading the ore by excavator or front-end loader onto haul trucks for transport to the existing processing plant. There is no additional infrastructure proposed for the Eastern Anomalies operation.

No evidence of forest disease was detected in the Eastern Anomalies area, however, hygiene procedures employed at the existing mining operation would be used at the new site.

In keeping with current practice for the mining operations at Boddington Gold Mine the pits at the Eastern Anomalies would be backfilled and rehabilitated.

Environmental management at the Boddington Gold Mine is carried out according to an Environmental Management Programme (EMP) prepared in 1987 for the initial development of the mining operation. Commitments contained in that document have been consolidated and up-dated to take into account the expansion of the operation since the initial proposal was approved. These commitments would also apply to the Eastern Anomalies.

The Environmental Protection Authority considers that the EMP and the Environmental Conditions for the Boddington Gold Mine, together with the further commitments contained in the CER for the Eastern Anomalies, would ensure the proposal would be environmentally acceptable.

Recommendation 1

The Environmental Protection Authority has concluded that the proposal to develop the Eastern Anomalies ore bodies, as modified during the process of interaction between the proponent, the Environmental Protection Authority, the public and government agencies that were consulted, is environmentally acceptable.

In reaching this conclusion, the Authority identified the main environmental factors requiring detailed consideration as:

- **potential for salinisation of land and water from clearing;**
- **management of potential impact of forest disease;**

- **impact of operation on Eight Swamp; and**
- **rehabilitation of the area.**

The Environmental Protection Authority notes that these environmental factors have been addressed adequately by environmental management commitments (Appendix 1) given by the proponent, which include adherence to the undertakings given in the Environmental Management Programme (Worsley Alumina, 1987) for the initial Boddington Gold Mine project and the Environmental Conditions of approval (including proponent commitments) for the Boddington Gold Mine (Appendix 2).

Accordingly, the Environmental Protection Authority recommends that the proposal could proceed subject to the Environmental Protection Authority's recommendation in this report, and subject to the proponent's commitments to environmental management as detailed in Appendix 1 of this report.

The Authority's experience is that it is common for details of a proposal to alter through the detailed design and construction phase. In many cases alterations are not environmentally significant or have positive effects on the environmental performance of the project. The Authority considers that such insubstantial changes should be provided for within the assessment process.

The Authority also considers that any approval for the proposal based on this assessment should be limited to five years. Therefore, if the proposal has not been substantially commenced within five years of the date of this report, then such approval should lapse. After that time, further consideration of the proposal should occur only following a new referral to the Authority.

1. Introduction

Worsley Alumina Pty Ltd, as managers of the Boddington Gold Mine, proposes to develop an open cut gold mining operation in the area known as the Eastern Anomalies. The three small ore bodies associated with this deposit are located on private land between 0.3 and 3 kilometres to the east of the existing mining operation, which lies 13 kilometres north-west of the town of Boddington (Figure 1).

Approval for the commencement of the gold mining operation at Boddington was given to the Worsley Alumina Joint Venturers by the State Government in December 1985, following the assessment of the Environmental Review and Management Programme (ERMP) for the project that was submitted to the Environmental Protection Authority (EPA). In response to recommendations from the Authority, an Environmental Management Programme (EMP) was prepared by Worsley Alumina Pty Ltd (1987) detailing all aspects of environmental management for the project. The environmental commitments contained in this document were consolidated and updated in 1989.

The Boddington Gold Mine project was commissioned in July 1987 with initial process plant throughput of 3 million tonnes per annum (Mtpa). In February 1988 approval was given to allow the proposed Stage 1 expansion, involving an increase in throughput to 4.5 Mtpa (EPA Bulletin 313). A further increase in throughput to 6 Mtpa, for the Stage 2 expansion, was approved in December 1988 (EPA Bulletin 361). In November 1989 approval was given for the mining and processing of supergene and basement ores (EPA Bulletin 408).

2. The proposal

This current proposal deals with the mining of the Eastern Anomalies deposit. The Eastern Anomalies are located on private forested land owned by the proponent which was purchased from Bunnings Forest Products Ltd in 1991.

It is proposed to integrate the mining of the Eastern Anomalies into the existing operation. Mining of these areas will be carried out concurrently with that of the main ore body and the ore will be processed using the existing plant. The mining method would be the same as currently in use, with the blasting of the hardcap lying just below the surface, followed by the extraction of ore using hydraulic excavators or front-end loaders, and transporting the ore by haul truck to the processing plant.

Topsoil and root-bearing gravels would be salvaged prior to mining and stored separately in stockpiles for rehabilitation of the area. Waste would also be separately stored, if it were not possible to backfill directly, for use in backfilling of the mined out pits.

3. Public review

During the four week public review period five submissions were received on the proposal. The issues raised in submissions were summarised and provided to the proponent for a response. The proponent's response is set out in Appendix 3.

4. Environmental impact and management

4.1 Potential salinity increase

Increased salinity of land and streams is a well recognised potential risk associated with vegetation clearing in the eastern part of the Darling Range where rainfall is comparatively low. Clearing of vegetation can upset the hydrological balance causing accumulated salt to be leached from the soil by a rising water table and deposited on the land surface and into water courses.

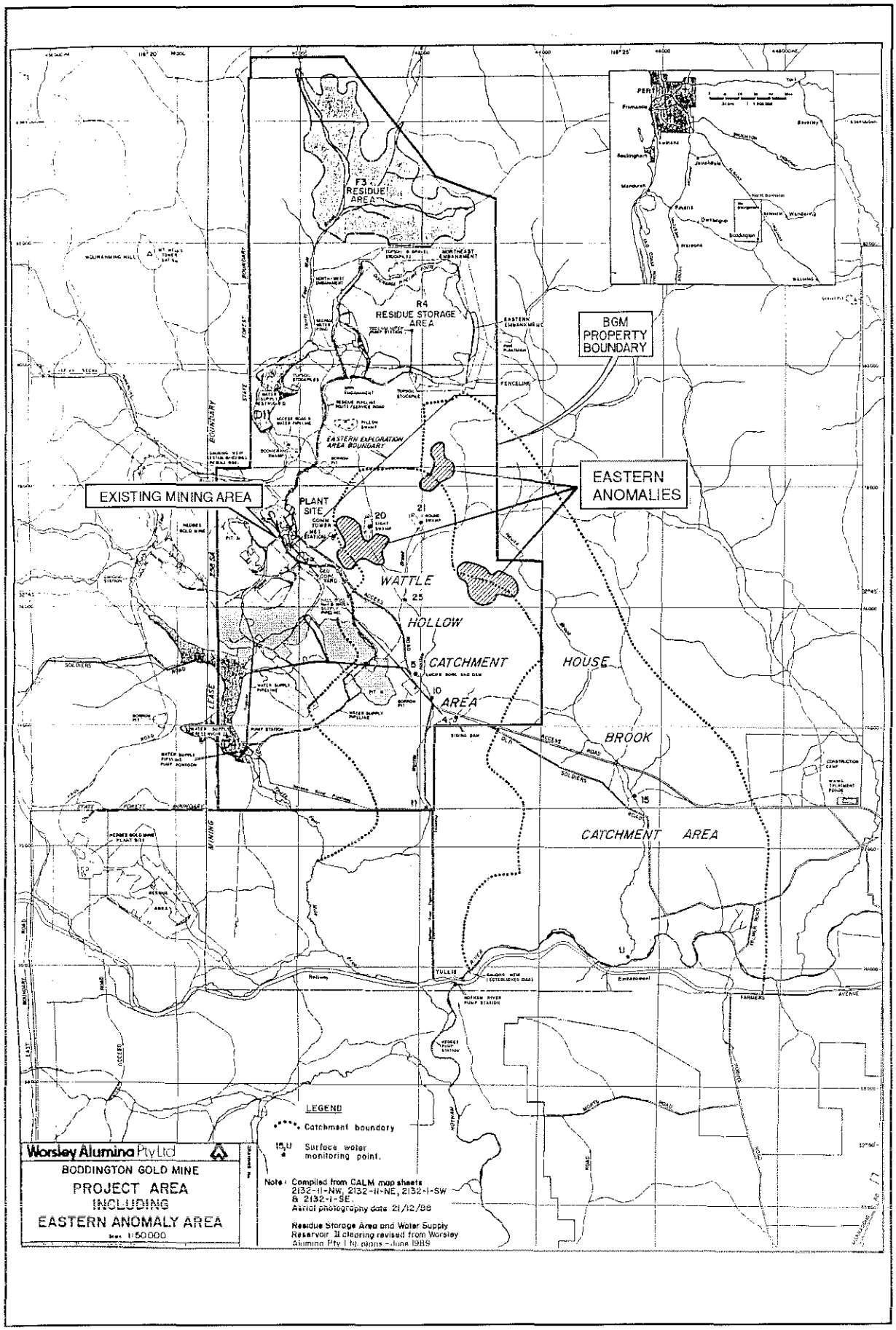

Figure 1: Location of eastern anomalies and existing mining operation

Clearing associated with the Eastern Anomalies would total 150 hectares which is only a small area of the forested catchments. Approximately 9% of the Wattle Hollow Brook and 3% of the House Brook catchments will be cleared during the operation. These streams drain to the already saline Hotham River. Mining of the deposits would take approximately two years with a further two years proposed until the completion of rehabilitation.

As part of a regional water monitoring programme, the proponent monitors the level of salinity along the streams in the Eastern Anomalies area. The monitoring would alert the proponent and regulatory authorities to any increase in salt levels in Wattle Hollow or House Brooks. Action would then be taken to ascertain the cause of the problem and take corrective action.

Drainage management employed at the existing operation would be extended to the Eastern Anomalies including settling ponds and perimeter drains . These measures, as outlined in the 1987 Environmental Management Programme, are aimed at minimising the potential spread of forest disease and reducing the long term salinity and turbidity impacts on water courses.

There is one downstream user of water from House Brook. The water is used as stock water and contained in a dam. It is considered that, given the small amount of catchment (3%) of House Brook that will be disturbed and the drainage management employed at the site, there would not be any significant impact on the quality of water of the brook from the mining operation.

Rehabilitation of the Eastern Anomalies area using local native species should allow rapid re-establishment of the salt and water balances that could be disturbed by mining.

The Environmental Protection Authority considers that the potential for increased salinity resulting from the clearing for the Eastern Anomalies operation would be minimal given the comparatively small area to be cleared and the short period before native vegetation would be returned to the site

4.2 Management of forest disease

A survey to detect the presence of Jarrah Dieback in the Eastern Anomalies area was carried out in 1992. There was no visual evidence of the disease recorded and the results of root sampling of susceptible species did not identify any dieback.

The forest disease management strategy currently operating at the Boddington Gold Mine would be extended to the Eastern Anomalies operation. This strategy establishes hygiene measures to prevent the spread of forest diseases. All vehicles and equipment are cleaned of any soil or plant material prior to entering the mine pit area. A perimeter drain is constructed around the mining area to divert any overland flow of potentially contaminated water. Furthermore, clearing for development is usually carried out in summer when soil conditions are dry and the risk of disease spread is low.

The Environmental Protection Authority considers that the forest disease management strategy currently used at the existing operation has been successful and would be adequate to protect the Eastern Anomalies area.

4.3 Impact on Eight Swamp

Eight Swamp is a seasonally inundated wetland formed naturally by the blocking of a tributary of Wattle Hollow Brook by an earthen embankment.

Wetlands are a habitat of regional significance for a range of fauna including frogs, aquatic invertebrates, reptiles and water birds. Since European settlement a large number of such habitats have been lost owing to changes in land use.

The proposal to mine the Eastern Anomalies would result in the natural embankment of the swamp being excavated and associated impacts on approximately 10% of the swamp area. In order to maintain the natural water levels in the swamp it is proposed to construct a temporary embankment between the pit and the remainder of the swamp. Monitoring of the water levels in

the swamp would be carried out to ensure maintenance of the natural levels during mining. At the end of the mining operation the pit would be backfilled and the original embankment replaced. Rehabilitation would aim to re-establish the range of vegetation existing prior to mining.

The Environmental Protection Authority considers that the disturbance to the swamp would be of a limited areal extent, duration and nature that would not significantly impair the swamp's function as a faunal habitat in the medium to long term.

4.4 Rehabilitation

Rehabilitation of the area would be integrated into the rehabilitation for the rest of the Boddington Gold Mine operation. The main objectives for rehabilitation are:

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

Rehabilitation planning and implementation would be carried out in consultation with the State, as set out in the Environmental Management Programme (1987) for the Boddington Gold Mine.

The Environmental Protection Authority is satisfied with the status of rehabilitation planning and implementation at the Boddington Gold Mine and considers it appropriate that rehabilitation of the Eastern Anomalies operation be integrated into the programme for the whole site.

The Environmental Protection Authority considers that the environmental management framework for the Boddington Gold Mine provided by the Environmental Management Programme (1987), the Environmental Conditions (including proponent commitments) applying to the operation, and the further commitments associated with the current proposal would ensure that the Eastern Anomalies proposal would be environmentally acceptable.

Recommendation 1

The Environmental Protection Authority has concluded that the proposal to develop the Eastern Anomalies ore bodies, as modified during the process of interaction between the proponent, the Environmental Protection Authority, the public and government agencies that were consulted, is environmentally acceptable.

In reaching this conclusion, the Authority identified the main environmental factors requiring detailed consideration as:

- **potential for salinisation of land and water from clearing;**
- **management of potential impact of forest disease;**
- **impact of operation on Eight Swamp; and**
- **rehabilitation of the area.**

The Environmental Protection Authority notes that these environmental factors have been addressed adequately by environmental management commitments (Appendix 1) given by the proponent, which include adherence to the undertakings given in the Environmental Management Programme (Worsley Alumina, 1987) for the initial Boddington Gold Mine project and the Environmental Conditions of approval (including proponent commitments) for the Boddington Gold Mine (Appendix 2).

Accordingly, the Environmental Protection Authority recommends that the proposal could proceed subject to the Environmental Protection Authority's recommendation in this report, and subject to the proponent's commitments to environmental management as detailed in Appendix 1 of this report.

The Authority's experience is that it is common for details of a proposal to alter through the detailed design and construction phase. In many cases alterations are not environmentally significant or have positive effects on the environmental performance of the project. The Authority considers that such insubstantial changes should be provided for within the assessment process.

The Authority also considers that any approval for the proposal based on this assessment should be limited to five years. Therefore, if the proposal has not been substantially commenced within five years of the date of this report, then such approval should lapse. After that time, further consideration of the proposal should occur only following a new referral to the Authority.

5. Conclusion

The Environmental Protection Authority considers that the environmental impacts associated with the Eastern Anomalies operation are environmentally acceptable and that it could proceed subject to the recommendation made in this assessment report and the commitments provided by the proponent.

6. References

Department of Conservation and Environment 1985, *Worsley Alumina Joint Venturers-Boddington Gold Mine proposal - Environmental Protection Authority Report and Recommendations*. Bulletin 219. Department of Conservation and Environment, Perth.

Worsley Alumina Pty Ltd 1987, *Boddington Gold Mine - Environmental Management Programme*. Worsley Alumina Pty Ltd and Kinhill Stearns/BHP Engineering.

Worsley Alumina Pty Ltd 1992, *Boddington Gold Mine - Eastern Anomalies Operation*, Consultative Environmental Review. Worsley Alumina Pty Ltd/John Consulting Services.

Appendix 1

Proponent's commitments

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/Basement 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.

4. To maintain the water quality of Thirty-Four Mile Brook so that the Water Supply Reservoirs will be a viable long-term source of public water supply and to leave the site in an environmentally stable condition, the proponent shall undertake rehabilitation of the site and its environs in consultation with the Water Authority of Western Australia, the Department of Mines and, where appropriate, the land owner, to the satisfaction of the Environmental Protection Authority upon advice from the Water Authority of Western Australia and the Department of Mines.

   The proponent shall be responsible for decommissioning, and at least six months prior to decommissioning, shall prepare a decommissioning and final rehabilitation plan to the satisfaction of the Environmental Protection Authority.

5. No transfer of ownership, control or management of the project which would give rise to a need for the replacement of the proponent shall take place until the Minister has advised the proponent that approval has been given for the nomination of a replacement proponent. Any request for the exercise of that power of the Minister shall be accompanied by a copy of this statement endorsed with an undertaking by the proposed replacement proponent to carry out the project in accordance with the conditions and procedures set out in the statement.

Bob Pearce, MLA
MINISTER FOR ENVIRONMENT

22 NOV 1989

Appendix 2

Environmental conditions for the Boddington Gold Mine

Yellow file

WESTERN AUSTRALIA
MINISTER FOR ENVIRONMENT

STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED (PURSUANT TO THE PROVISIONS OF THE ENVIRONMENTAL PROTECTION ACT 1986)

BODDINGTON GOLD MINE, MINING AND PROCESSING OF SUPERGENE/BASEMENT ORES

This proposal may be implemented subject to the following conditions:

1. The proponent shall adhere to the proposal as assessed by the Environmental Protection Authority and shall fulfil the commitments made in the Notice of Intent of July 1989 (as amended) and shall carry out the mining and processing of the Supergene/Basement Ores in accordance with the relevant commitments documented in the Environmental Management Programmme for the Boddington Gold Mine of April 1987. (A copy of commitments summarized and consolidated on 30 October 1989 is attached).

2. To ensure that any acidic drainage waters are utilised within the Floatation Processing Plant Circuit, the proponent shall, prior to mining of potentially acidic ores, prepare and implement plans for the management and monitoring of the drainage from the waste and ore stockpiles, to the satisfaction of the Environmental Protection Authority.

3. The proponent shall extract any additional water from the Hotham River for the expanded operations in accordance with the conditions in the Statement for the Boddington Gold Mine Enhancement of Facilities issued by the Minister for Environment on 15 February 1988. (Copy attached).

Published on

22 NOV 1989

MINISTER FOR ENVIRONMENT

STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED (PURSUANT TO THE PROVISIONS OF THE ENVIRONMENTAL PROTECTION ACT 1986)

BODDINGTON GOLD MINE ENHANCEMENT OF FACILITIES

WORSLEY ALUMINA PTY LTD

This proposal may be implemented subject to the following conditions:

1. The proponent adhering to the proposal as assessed by the Environmental Protection Authority and to the commitments given in the Environmental Management Programme for the Boddington Gold Mine (copy of commitments attached).

2. The proponent shall only pump water from the Hotham River when the river flow is in excess of 342 kilolitres per hour. Total pumping from the river must not cause the remaining flow to be reduced below a level of 342 kilolitres per hour (River flow measured at Marradong River bridge gauging station).

3. The proponent shall negotiate agreements, to the satisfaction of the Minister for Water Resources, with any other major user of water from the Hotham River in order to ensure that overall pumping does not reduce flow below 342 kilolitres per hour.

4. The minimum flow rate of 342 kilolitres per hour shall be reviewed by the Water Authority of Western Australia after two winter flows and advice given to the Environmental Protection Authority as to whether this rate is having undesirable environmental impacts.

5. Subsequent to receiving the advice of the Water Authority of Western Australia pursuant to Condition 4, the Environmental Protection Authority may modify the minimum flow rate set in Condition 2.

B Hodge.

Barry Hodge, MLA
MINISTER FOR ENVIRONMENT

15 FEB 1988

MINISTER FOR ENVIRONMENT

STATEMENT THAT A PROPOSAL MAY BE IMPLEMENTED (PURSUANT TO THE PROVISIONS OF THE ENVIRONMENTAL PROTECTION ACT 1986)

BODDINGTON GOLD MINE PROJECTS
EXPANSION OF FACILITIES
STAGE 2

WORSLEY ALUMINA PTY LTD (182)

This proposal may be implemented subject to the following conditions:

1. The proponent shall adhere to the proposal as assessed by the Environmental Protection Authority and shall fulfil the commitments made in the Notice of Intent (copy of commitments attached).

2. The proponent shall ensure that the upgraded facilities are operated in accordance with the commitments documented in the Environmental Management Programme for the Boddington Gold Mine.

3. The proponent shall ensure that construction techniques used for both the new water storage reservoir and modifications to the existing residue storage area are to the satisfaction of the Water Authority of Western Australia.

4. The proponent shall only extract water from the Hotham River in accordance with an agreement between the major users of water from the Hotham River which is to the satisfaction of the Minister for Water Resources. This agreement shall ensure that the environmental objectives already delineated relating to the Hotham River are met.

Barry Hodge, MLA
MINISTER FOR ENVIRONMENT

Published on

WORSLEY ALUMINA PTY LTD

BODDINGTON GOLD MINE

Consolidated and Updated Environmental Commitments – October 1989

1. Clearing for project activities will be kept to a minimum, consistent with safe operating practices.

2. Topsoil from areas cleared for project activities will be salvaged for use in decommissioning and other rehabilitation programmes.

3. Environmentally-sensitive construction and operational practices, including stringent forest hygiene measures, will be employed throughout the project area (see April 1987 Environmental Management Programme – Exhibit H, Appendix A; Environmental Checklist, Appendix E).

4. The operation will be licensed in accordance with the requirements of the Environmental Protection Act, 1986 (includes air, water and noise pollution control).

5. The State will continue to be compensated for clearing of State Forest under terms of the Alumina Refinery (Worsley) Agreement Act, 1973.

6. Alternative access from private land around the downstream Water Supply Reservoir to State Forest to the west of the project area will be maintained for local bush fire brigades and CALM.

7. Biological monitoring programmes, based on information provided to the State in the draft report on baseline biological investigations, will be developed in consultation with the State. Results of these monitoring programmes will be reported to the State and changes to management and procedures developed as necessary with the State.

8. A quantified assessment of likely impacts of project clearing on streamflow and quality of Thirty-Four Mile Brook has been carried out with the Water Authority of Western Australia (see Appendix B of the April 1987 Environmental Management Programme). In consultation with the EPA and the Water Authority, surface and groundwater monitoring programmes will be developed and implemented to facilitate progressive planning and management of project activities, particularly mining and residue storage, to minimize adverse hydrological and hydrogeological effects.

9. Rehabilitation of project areas will be carried out in consultation with the State and, where appropriate, the land owner, with the aim of maintaining the water quality of Thirty-Four Mile Brook so that the downstream Water Supply Reservoir could be a viable long-term source of public water supply. If, at the time of decommissioning, the State requires the Water Supply Reservoir as a potable water source, the water quality in the reservoir will be reassessed and, should it prove to be unsuitable, the Joint Venturers will drain the dam, allowing it to refill naturally.

10. If unacceptable quality is detected in groundwater monitoring bores around the Residue Disposal Area, the remedial actions described in Section 8.3.3 of the April 1987 Environmental Management Programme will be evaluated as part of the development of a response to such a situation.

11. Material from residue and reclaim pipeline leaks/breakages will be contained at low points along the residue pipeline route and transported to the Residue Disposal Area. If spills are not fully contained, WAPL will carry out clean-up and rehabilitation of affected areas in consultation with the State.

12. In the unlikely event of a dam failure, including the overtopping of the Process Water Pond, the Joint Venturers will assume responsibility for clean-up and rehabilitation to the satisfaction of the State.

13. All waste and spilt materials in the Metallurgical Treatment Plant area will be contained within the process operation for reuse, or disposed of as appropriate.

14. Caustic soda used in the Metallurgical Treatment Plant will have a mean mercury content of less than 100 µg/L, with a maximum value of 1,000 µg/L.

15. Stormwater runoff from the cleared area of the Plant Site will flow into the Process Water Pond, which has been lined with clay and plastic to minimize leakage. The pond will have sufficient capacity to accommodate rainfall runoff from a one in one hundred year storm event.

16. Blasting operations will be managed in accordance with the relevant conditions of the Environmental Protection Act Licence for the Project and with any requirements of the Department of Mines.

17. Drainage (other than acidic mine drainage) will be installed in the mine pits, with runoff either used for dust suppression, or drained via silt traps to natural watercourses.

18. Perimeter drains will be installed around mine pits and stockpiles; water (other than acid mine drainage water) from these and from haul roads will drain through silt traps into natural watercourses.

19. The objective of the management of runoff from the mining operations will be to minimize the potential spread of forest disease and to reduce the long-term salinity and turbidity impact on Thirty-Four Mile Brook.

20. Mine waste not used in road construction will be returned as backfill to mine pits during the life of the project.

21. If it is decided not to process marginal ore, this material will be returned to mined-out pits.

22. Shallow mine pits will be contoured to slopes generally consistent with natural landforms.

23. Deeper pits will be rehabilitated if, at the time of completion of mining the weathered profile, no decision to mine bedrock has been made. Should a decision to mine bedrock to be made, detailed plans will be submitted to the State for approval.

24. Final rehabilitation will ensure that runoff will drain to natural watercourses or into the deeper pits.

25. Life-of-project land use plans will be prepared and submitted to the State on an annual basis.

26. The State will be provided with brief annual and comprehensive triennial environmental management reports as part of existing arrangements for the Worsley Alumina Project.

27. Water will be extracted from the Hotham River in accordance with licence conditions set by the Water Authority of Western Australia under the terms of the Rights in Water and Irrigation Act 1914.

28. Agreements will be negotiated and operated to the satisfaction of the Minister for Water Resources, with any other major users of water from the Hotham River to ensure that pumping does not reduce instantaneous flow below the minimum rate set by the Water Authority of Western Australia.

29. After two winter flows (i.e. after the winter of 1989), a report will be submitted to the Water Authority of Western Australia and to the Environmental Protection Authority on biological studies in, and details of pumping from, the Hotham River, enabling advice to be given to the Environmental Protection Authority as to the adequacy of the minimum flow rate set by the Water Authority in protecting the ecological integrity of the Hotham River.

30. Water and residue management structures will be constructed, modified and maintained to the satisfaction of the Water Authority of Western Australia under the terms of the Rights in Water and Irrigation Act.

31. Any acidic mine drainage from mine pits or stockpiles will be reclaimed for use in the Flotation Processing Plant, and the treatment of sources of such acid drainage will include evaluation of techniques such as encapsulation of acid-forming materials with inert material.

Appendix 3

Proponent's response to submissions

WORSLEY ALUMINA PTY LTD

BODDINGTON GOLD MINE

EASTERN ANOMALIES OPERATION CONSULTATIVE ENVIRONMENTAL REVIEW

RESPONSE TO EPA SUMMARY OF SUBMISSIONS

1. *Reference is made in the CER to 15 species of flora which are "potentially rare, geographically restricted, poorly collected or in need of further investigation". Only four of these species are named in the text . Evaluation of the potential impact on flora would require information on what species are to be affected and the size of the populations that would be affected.*
The Mattiske and Associates survey of 1992 is mentioned but is not listed in the references.

The 15 native species collected and recorded during the Eastern Anomaly survey, by E M Mattiske & Associates, and initially identified as rare, vulnerable, restricted, poorly collected, or in need of further research and monitoring, are summarised in Table 1. (Table 2 from Mattiske & Associates 1992).

Of these species, five classified as poorly collected now have suitable specimen numbers lodged at the State Herbarium viz: *Dampiera alata, Haemodorum laxum,Tetraria capillaris, Tetraria octandra* and *Xanthorrea preissii* (Mattiske & Associates 1992). Records at the State Herbarium also show that one further species, *Hibbertia rhadinopoda*, referenced as having a restricted distribution, is more widespread than originally thought and not threatened by restricted distribution (Mattiske & Associates 1992).

Three of the remaining nine species, *Boronia crenulata* var. *gracillis, Comesperma virgatum* and *Gonocarpus cordiger* have distribution ranges extending 160kms from Boddington. In addition Mattiske & Associates (1992) report that *Lomandra hermaphrodita* and *Lomandra spartea*, previously considered to be poorly collected and geographically restricted, have regularly appeared in Jarrah forest survey work in recent years and are thus not considered threatened or vulnerable.

Daviesia cordata and *Senecio leucoglossus* have previously been recorded in the northern jarrah forest, including Mt Saddleback and the Marradong Timber Reserve (Worsley Alumina 1985, Mattiske & Associates 1985, 1990a, 1991) and thus are not considered by Mattiske & Associates to be under threat (Mattiske & Associates 1992).

Lasiopetalum cardiophyllum, the third species on the Department of Conservation and Land Management Declared Rare and Priority Flora List (CALM 1991), is designated Priority Two by the Department and was mapped during the 1992 survey of the Eastern Anomaly area. The species was found to occur on a range of site conditions and topographic locations (Mattiske & Associates 1992). It occurs as restricted populations within the Boddington Area with local population numbers varying from 100 to 2000. Of the 36 populations identified in the Eastern Anomaly Area, five would be disturbed by anticipated clearing requirements.

As pointed out in the September 1992 CER, the conservation status of this species may warrant re-evaluation in light of its previous recording in a number of nearby native forest areas, including a number of conservation areas in the Eastern Jarrah Forest (Mattiske & Associates 1990b).

The last of the 15 species, *Calothamnus planifolius*, is geographically restricted to the Boddington - Marradong area, with a distribution radius of less than 160 kilometres. This species was also mapped during the 1992 survey of the Eastern Anomaly area by Mattiske & Associates. The species occurs as restricted populations within the Boddington area, with local population numbers varying from 100 to 2000. Two populations were identified during the 1992 survey. Neither population would be impacted by the 150 hectares of clearing proposed for the Eastern Anomalies operation.

2. *It is stated in the CER that swamps are a habitat of regional significance and approximately 10% of Eight Swamp in the Eastern Anomalies area will be directly affected by the mining operation with a wall constructed to maintain water levels. The significance of this swamps vegetation and the impact on its hydrology require more detailed description.*

Eight Swamp is formed by a natural earthen embankment which dams one of the tributaries of Wattle Hollow Brook. The swamp is surface fed and only seasonally inundated.

Eight Swamp has been mapped by Mattiske & Associates (1992) as Havel site vegetation type A - consisting of a tall shrubland to closed heath of mixed Myrtaceae species. Other species include *Acacia saligna, Baeckea camphorosmae, Hakea prostrata, Hakea varia, Leptocarpus scariosus and Melaleuca viminea.*

Boddington Gold Mine recognises the importance of riparian and swamp habitats to fauna, their low representation per unit area within the northern jarrah forest and vulnerability to silting and wildfires. Although the swamp complexes are at the lower end of species richness they provide valuable habitat for frogs, aquatic invertebrates, burrowing reptiles and other specialised fauna that prefer the dense vegetation, higher humidity and overall productivity.

To preserve these habitat values, the area of Eight Swamp not directly impacted by the eastern anomalies operation is to be managed to ensure that its hydrological regime is maintained, as described below. In addition, runoff from the mine area would be managed to prevent siltation of the swamp.

Mining of Eastern Anomaly 1 is planned to include a pit which will excavate the natural retaining embankment of Eight Swamp, (Figure 1). To maintain natural water levels in the swamp for the duration of mining activities, a temporary embankment would be built between the edge of the mine pit and undisturbed section of the swamp, effectively replacing the natural embankment. Upon completion of mining and backfilling operations, the original embankment would be restored and rehabilitation of the area would be aimed at re-establishing the pre-mining floral characteristics of the area.

During the mining operations runoff from up to 30% of the Eight Swamp catchment will be diverted around the mining areas in perimeter drains or fall directly into mine-pits. It is expected that even with a 30% reduction in catchment area Eight Swamp will still discharge water during the winter months. If monitoring indicates that this is not the case, clean decant water from perimeter drain silt traps adjacent to the swamp will be diverted through the swamp to maintain natural water levels.

As the swamp is a perched, naturally inundated waterbody, seepage from which is controlled by the comparative impermeability of the floor, pit excavation adjacent to the swamp is not expected to significantly increase water loss from the area via seepage.

Saline groundwater in the Eight Swamp area is more than 15m below natural ground surface in the swamp. Clearing of the areas proposed for mining will not cause salinization of the swamp due to groundwater rise.

3. *The fauna description is insufficient to assess the potential impacts of mining on fauna. Without a copy of the fauna species list for the area it is impossible to determine the overall habitat quality of the sites. Also without any information on the abundance of fauna species relative to surrounding areas it is impossible to assess the regional conservation issues.*

A list of vertebrates recorded or expected to occur in the Eastern Anomaly Area is provided in Table 1 (Appendix 1 from Ninox 1992).
The list has been constructed from:

- actual species recorded during the 1992 field evaluation;

- actual species records from the pre-existing, extensive database for the BGM field survey which included sites within the Eastern Anomaly Area;

- actual records from typical Eastern Anomaly Area habitats occurring within two kilometres of the boundary of the study area;

- provisional records of species as yet not recorded in the habitats of the Eastern Anomaly Area but expected to occur. These have been drawn from the large body of information available for the Boddington area; and

- the very few species which have distributions encompassing the Boddington area but have not been recorded in any surveys to date (Ninox Wildlife Consulting 1992).

Figure 2 illustrates the expected vertebrate species richness of the Eastern Anomaly Area habitats. (Figure 4 from Ninox 1992).

4. *There is potential for the Southern Brown Bandicoot to be affected by mining around Eight Swamp. What steps are proposed to minimise this potential impact?*

Specific and intensive searches for signs of this animal, which has only recently been placed on the rare list (November 1990), were made during the survey of the Eastern Anomaly Area (Ninox 1992). No signs were found. Their typical conical diggings are very obvious when the animal is present. If at all present, they are likely to be in very low numbers as this species is on the extreme north-eastern edge of its range (Ninox 1992).

A range of environmental management strategies are already in place at the Boddington Gold Mine to minimise project impacts on fauna. These strategies, described below, will be extended to proposed operations in the Eastern Anomaly area:

- minimisation of clearing for mining laydown sites and associated facilities and where their removal is not strictly necessary, the protection of isolated stands of native vegetation within such areas;

- integration of haul roads, powerline easements and pipelines along the same route wherever practical and minimisation of clearing during construction of these facilities;

- rehabilitation of borrow pits, verges and other disturbed areas as soon as is practicable after construction of the above roads and easements;

- minimisation of excessive disturbance to and turbidity within all seasonal stream zones and swamps; and

- prohibiting the bringing of firearms or pets on the site.

In addition, the following recommendations of Ninox Wildlife Consulting (Ninox 1992) will be implemented in the Eastern Anomalies Area and throughout other areas of the project where beneficial:

- where practical, additional culverts will be placed under roads in order to reduce habitat partitioning and reluctance of small terrestrial vertebrates to cross open areas which make them more liable to predation. In addition these culverts will reduce road casualties; and

- reasonable quantities of logs of varying sizes will be stockpiled for future use as fauna refuge areas within areas where this is possible.

The hydrological regime of Eight Swamp will be maintained and siltation from the surrounding mine-pits will be prevented, to ensure that the habitat values of the swamp are maintained.

5. *The CER does not provide evidence in support of the statement in the text that dieback hygiene has been effective.*

The system of forest disease management described in the CER has been operating at the BGM since 1987.

Recently two large areas of the project were surveyed for the presence of dieback; the proposed F3 residue disposal area and the Eastern Anomaly Area (Hart, Simpson & Associates 1991, 1992a). In the past these areas have been extensively drilled. No evidence of dieback was found in either area suggesting that practices to minimise the introduction of the disease to the site or its transfer from the mine area to surrounding project areas have been effective to date.

In addition to these surveys, two programmes of waterbody baiting have been conducted in and around the project area (Hart, Simpson & Associates 1992b 1992 in press). To date no samples from this program have tested positive for *Phytopthora cinnamomi.*

In conjunction with the survey work, a control sample was taken from a Dryandra plant, collected from an area of known infection within the mine that has been managed as a dieback infected site since commencement of the project. *P.cinnamomi* was isolated from this sample.

6. *Will there be any impact on the water quality of House Brook from the proposed mining development?*

As less than 3% of the forested House Brook catchment would be cleared for the Eastern Anomalies operation it is considered that resultant increases in stream salinity would be marginal if detectable.

In addition to the small proportion of the catchment cleared, the water management practices developed by BGM for their mining operations and their commitment to rehabilitation are expected to further reduce the likehood of increases in stream salinity.

The magnitude of the impact of clearing on stream salinity is related to the amount of recharge that is allowed to occur on the cleared area. Perimeter drainage will be constructed around all areas to contain surface runoff which will be directed via silt traps to natural drainage features. Also the compacted surface of haul roads, hard stand areas and stockpile areas will not be conducive to infiltration; surface runoff will, as for the mine-pits, be contained within perimeter drainage structures and be directed via silt traps into existing drainage channels. In these ways, water recharge through mine-pit floors will be minimised, thus reducing the potential for increases in saline groundwater discharge to the House Brook system. In addition, these management practices will prevent discharge of silt to the stream system.

The duration over which deep-rooted vegetation is not present to control groundwater discharge is also a factor in the likely impact of clearing on stream salinity. The Eastern Anomalies Operation is a short term mining operation - mining in each anomaly is expected to last no longer than two years, with rehabilitation commencing as soon as practicable after the completion of mining and completed within a further two years. Rehabilitation prescriptions for the areas would comprise deep-rooted species.

While it considered unlikely that mine dewatering activities will be required in the Eastern Anomalies operation, Anomaly One is the only area where it could be a possibility. If this action is required discharge would be to Wattle Hollow Brook not House Brook. As noted in the September 1992 CER such discharge would be managed to ensure continuing compliance with current licence conditions for receiving waters.

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TABLE 2: **List of vertebrates recorded or expected to occur in the plant community types of the Eastern Anomoly Area, Boddington Gold Mine. Data drawn from the opportunistic field survey (16 March 1992), Worsley Alumina Pty Ltd 1985 and Ninox Wildlife Consulting 1986, 1987, 1991.**

KEY

R = Species recorded during the field surveys conducted in the BGM in 1984 (includes Eastern Anomaly Area).
X = Recorded in similar habitats during previous surveys in the Boddington area
\+ = Species expected to occur
* = Gazetted rare fauna
i = Introduced species

VERTEBRATE HABITAT TYPES

1 = Jarrah mid to upper slopes and ridges
2 = Jarrah lower to mid slopes
3 = Wandoo and Yarri communities
4 = Heath and stream zone complex
5 = Swamp complex

VERTEBRATE HABITAT TYPES	1	2	3	4	5
BIRD SPECIES					
DROMAIIDAE					
Dromaius novaehollandiae, Emu	R	R	R	R	R
ACCIPITRIDAE					
Lophoictinia isura, Square-tailed Kite	X	X	X	X	+
Haliastur sphenurus, Whistling Kite	+	+	+	+	+
Accipiter fasciatus, Brown Goshawk	R	X	R	R	+
A. cirrhocephalus, Collared Sparrowhawk	X	X	R	X	+
Aquila audax, Wedge-tailed Eagle	R	R	R	X	R
Hieraaetus morphnoides, Little Eagle	R	X	X	X	+
FALCONIDAE					
Falco peregrinus, Peregrine Falcon *	X	X	+	+	+
F. longipennis, Australian Hobby	+	R	+	+	+
F. berigora, Brown Falcon	X	+	X	X	+
F. cenchroides, Australian Kestrel	+	X			
TURNICIDAE					
Turnix varia, Painted Button-quail	R	R	R	X	+
COLUMBIDAE					
Phaps chalcoptera, Common Bronzewing	X	R	R	X	+
CACATUIDAE					
Calyptorhynchus magnificus, Red-tailed Black-Cockatoo	X	X	R	R	+
C. baudinii, Baudin's Black-Cockatoo *	R	R	X	R	+
C. f. latirostris, Carnaby's Black-Cockatoo *	X	R	R	X	+
LORIIDAE					
Glossopsitta porphyrocephala, Purple-crowned Lorikeet	+	R	X	X	+
PLATYCERCIDAE					
Purpureicephalus spurius, Red-capped Parrot	R	R	R	R	+
Platycercus icterotis, Western Rosella	X	R	R	R	+
Barnardius zonarius, Port Lincoln Ringneck	R	R	R	R	+
Neophema elegans, Elegant Parrot	+	X	R	R	+
CUCULIDAE					
Cuculus pallidus, Pallid Cuckoo	X	R	R	X	+
C. pyrrhophanus, Fan-tailed Cuckoo	R	R	R	R	+
Chrysococcyx basalis, Horsfield's Bronze-Cuckoo	X	X	X	R	+
C. lucidus, Shining Bronze-Cuckoo	X	X	R	X	+
STRIGIDAE					
Ninox novaeseelandiae, Southern Boobook	X	R	R	X	+

Table 1 Rare and Restricted Species in the Eastern Anomaly Area.

SPECIES	Marchant and Keighery (1979)	Rye (1982)	Leigh et al. (1981)	Barrett (1982)	W.A. Herbarium Status	CALM (1991)
Boronia crenulata var. gracilis				E	E	
Calothamnus planifolius		F	2RC		F	
Comesperma virgatum		E			F	
Dampiera alata	D				-	
Daviesia cordata						9
Gonocarpos cordiger			3V			
Haemodorum laxum	D				-1	
Hibbertia rhadinopoda	F	F			-	
Lasiopetalum cardiophyllum	D	E	2V	B	D,E	2
Lomandra hermaphrodita	D		2V	D	D,E*1	
Lomandra spartea	A	E		B	D,E*1	
Senecio leucoglossus	E	F	2V	F	F	2
Tetraria capillaris	D				-	
Tetraria octandra	D				-	
Xanthorrhoea preissii	D				-	

NOTES:

* Indicates the need for further research and monitoring

1 T.D.MacFarlane pers.comm. (W.A.Herbarium)

\- Insufficient information available from either W.A.Herbarium or local collection to justify reassessment to status.

CLASSIFICATIONS USED:

. Marchant and Keighery (1979), Barrett (1982), and Rye (1982) use the same code, viz.:

- A - no specimens available
- B - rare
- D - poorly collected (less than five collections)
- E - restricted distribution of less than 100km
- F - restricted distribution of less than 160km

CLASSIFICATIONS USED: (Continued)

. Leigh et al. (1981) use a code related to the conservation status of the species, viz.:

- 2 - restricted distribution of less than 100km
- 3 - distribution greater than 100km, but present as small populations only
- E - endangered
- V - vulnerable
- R - rare, but not currently considered endangered or vulnerable.
- K - poorly known and in need of further information
- C - known to be found in a conservation reserve.

\# Codes based on Marchant and Keighery (1979), Barrett (1982) and Rye (1982), with the exception of V (vulnerable) category which was based on Leigh et al.(1981).

DECLARED RARE & PRIORITY FLORA LIST - Codes (CALM 1991)

2 Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered)

9 Taxa that are commercially exploited by the Western Australian Wildflower Industry.

Table 2 - Continued.

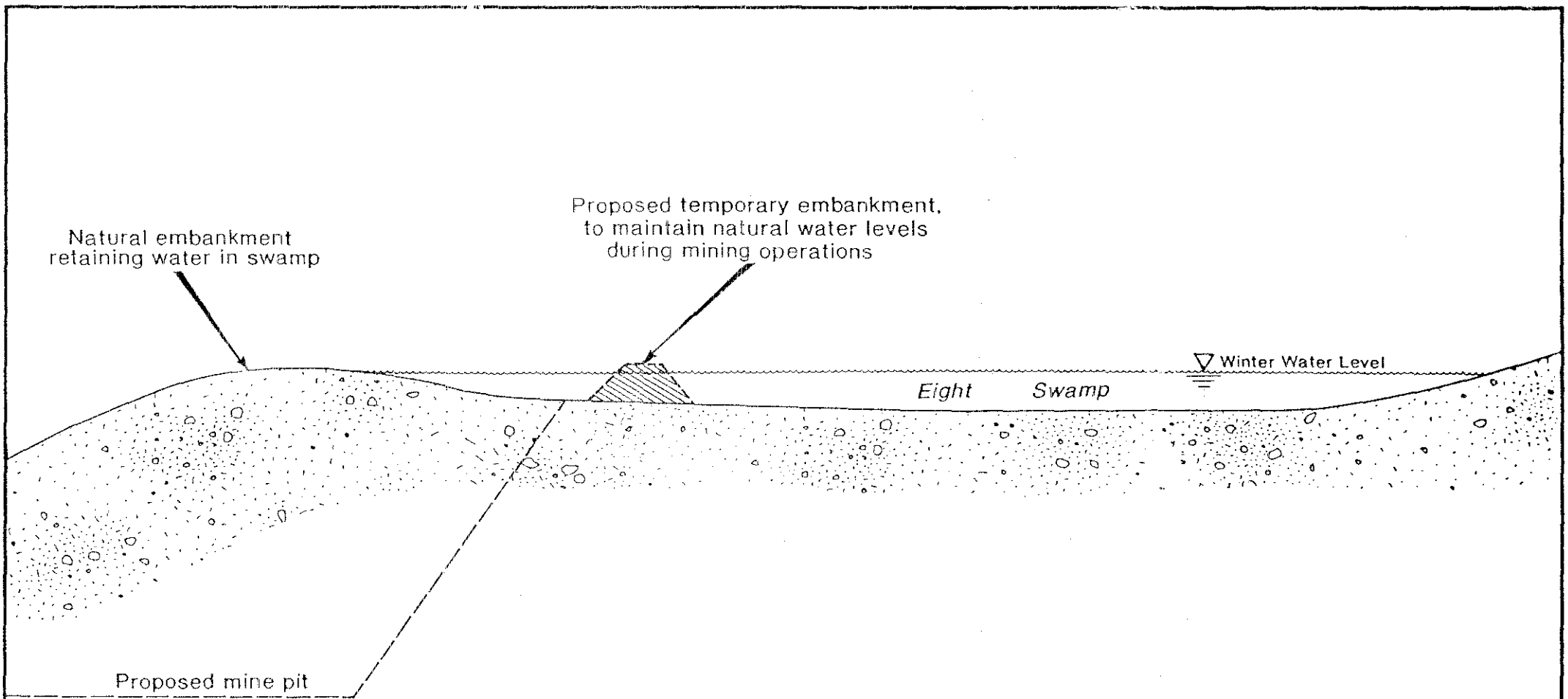
VERTEBRATE HABITAT TYPES	1	2	3	4	5
PODARGIDAE					
Podargus strigoides, Tawny Frogmouth	X	R	R	+	+
AEGOTHELIDAE					
Aegotheles cristatus, Australian Owlet-nightjar	R	R	R	R	+
ALCEDINIDAE					
Dacelo novaeguineae, Laughing Kookaburra I	R	R	R	X	+
Halcyon sancta, Sacred Kingfisher	X	X	R	R	+
MEROPIDAE					
Merops ornatus, Rainbow Bee-eater	R	X	R	R	R
HIRUNDINIDAE					
Cecropis nigricans, Tree Martin	X	X	R	R	R
CAMPEPHAGIDAE					
Coracina novaehollandiae, Black-faced Cuckoo-shrike	R	R	R	X	+
Lalage sueurii, White-winged Triller		R	+		
MUSCICAPIDAE					
Petroica multicolor, Scarlet Robin	R	R	R	R	R
P. goodenovii, Red-capped Robin	X	X	+	R	+
Eopsaltria georgiana, White-breasted Robin	R	+	R	R	+
E. griseogularis, Western Yellow Robin	R	X	X	X	
Falcunculus frontatus, Crested Shrike-tit *			+	+	+
Pachycephala pectoralis, Golden Whistler	R	R	R	R	R
P. rufiventris, Rufous Whistler	X	+	R		
Colluricincla harmonica, Grey Shrike-thrush	R	R	R	X	R
Myiagra inquieta, Restless Flycatcher			X	+	+
Rhipidura fuliginosa, Grey Fantail	R	R	R	R	R
R. leucophrys, Willie Wagtail			X	X	+
MALURIDAE					
Malurus splendens, Splendid Fairy-wren	R	R	R	R	R
M. elegans, Red-winged Fairy-wren			X	R	+
ACANTHIZIDAE					
Sericornis frontalis, White-browed Scrubwren	R	X	R	R	R
Smicrornis brevirostris, Weebill	X	R	R	R	+
Gerygone fusca, Western Gerygone	R	R	R	R	R
Acanthiza apicalis, Inland Thornbill	R	R	R	R	R
A. inornata, Western Thornbill	R	R	R	R	R
A. chrysorrhoa, Yellow-rumped Thornbill	R	R	R	X	
NEOSITTIDAE					
Daphoenositta chrysoptera, Varied Sittella	R	R	R	R	+
CLIMACTERIDAE					
Climacteris rufa, Rufous Treecreeper	X	R	R	X	
MELIPHAGIDAE					
Anthochaera carunculata, Red Wattlebird	R	R	R	X	R
A. chrysoptera, Little Wattlebird	X	R	R	R	R
Lichenostomus virescens, Singing Honeyeater			R	X	
L. leucotis, White-eared Honeyeater			+	X	+
L. ornatus, Yellow-plumed Honeyeater			X	R	
Melithreptus brevirostris, Brown-headed Honeyeater	+	+	+	+	+
M. lunatus, White-naped Honeyeater	R	R	R	R	R
Lichmera indistincta, Brown Honeyeater	X	X	R	R	R
Phylidonyris novaehollandiae, New Holland Honeyeater	X	X	R	R	R
P. nigra, White-cheeked Honeyeater	+	+	+	R	+
P. melanops, Tawny-crowned Honeyeater		X	+	X	
Acanthorhynchus superciliosus, Western Spinebill	R	R	R	R	R
DICAEIDAE					
Dicaeum hirundinaceum, Mistletoebird	X	X	R	X	+
PARDALOTIDAE					
Pardalotus punctatus, Spotted Pardalote	R	R	R	R	R
P. striatus, Striated Pardalote	R	R	R	R	R
ZOSTEROPIDAE					
Zosterops lateralis, Silvereye	R	R	R	R	R
PLOCEIDAE					
Emblema oculata, Red-eared Firetail *			R	R	+
GRALLINIDAE					
Grallina cyanoleuca, Australian Magpie-lark				+	+
ARTAMIDAE					
Artamus cyanopterus, Dusky Woodswallow	X	R	R	R	+
CRACTICIDAE					
Gymnorhina tibicen, Australian Magpie	R	R	R	X	R
Strepera versicolor, Grey Currawong	R	R	R	X	R
CORVIDAE					
Corvus coronoides, Australian Raven	R	R	R	R	R

Table 2 - **Continued.**

VERTEBRATE HABITAT TYPES		1	2	3	4	5
MAMMAL SPECIES						
TACHYGLOSSIDAE						
Tachyglossus aculeatus,	Short-beaked Echidna	R	R	R	R	R
DASYURIDAE						
Dasyurus geoffroii,	Chuditch *	R	R	X	+	
Phascogale tapoatafa,	Brush-tailed Phascogale	+	R	+		
Antechinus flavipes,	Yellow-footed Antechinus	R	R	R	R	R
Sminthopsis gilberti,	Common Dunnart	R	+	+	+	+
S. griseoventer,	Common Dunnart	R	+	R	+	+
PERAMELIDAE						
Isoodon obesulus,	Southern Brown Bandicoot *			X	+	+
PHALANGERIDAE						
Trichosurus vulpecula,	Common Brushtail Possum	+	+	+	+	
BURRAMYIDAE						
Cercartetus concinnus,	Western Pygmy-possum	R	R	R	R	
TARSIPEDIDAE						
Tarsipes rostratus,	Honey-possum				X	
MACROPODIDAE						
Macropus irma,	Western Brush Wallaby	R	R	R	R	+
M. fuliginosus,	Western Grey Kangaroo	R	R	R	R	R
MOLOSSIDAE						
Tadarida australis,	White-striped Mastiff-bat	R	R	R	R	+
Mormopterus planiceps,	Little Mastiff-bat	+	+	+	+	+
VESPERTILIONIDAE						
Nyctophilus major,	Greater Long-eared Bat	+	R	X	+	+
N. gouldi,	Gould's Long-eared Bat	+	X	+	+	+
N. geoffroyi,	Lesser Long-eared Bat	+	X	X	+	+
Chalinolobus gouldii,	Gould's Wattled Bat	+	X	X	+	+
C. morio,	Chocolate Wattled Bat	+	X	+	+	+
Falsistrellus mckenziei,	Great Pipistrelle	+	+	+	+	+
Eptesicus regulus,	King River Eptesicus	+	X	R	+	+
MURIDAE						
Hydromys chrysogaster	Water Rat			X	+	+
Rattus rattus,	Black Rat I		X	+	X	+
Mus musculus,	House Mouse I	R	R	R	R	+
LEPORIDAE						
Oryctolagus cuniculus	Rabbit I			X	R	R
CANIDAE						
Canis familiaris,	Dog I	+	+	+	X	+
Vulpes vulpes,	Fox I	X	X	R	R	+
FELIDAE						
Felis catus,	Feral Cat I	+	R	+	X	R
SUIDAE						
Sus scrofa,	Feral Pig I	R	R	R	R	R
AMPHIBIAN AND REPTILE SPECIES						
LEPTODACTYLIDAE	Frogs					
Crinia georgiana		R	+	R	R	R
C. glauerti				X	X	+
C. pseudinsignifera		R	R	R	R	R
Geocrinia leai				X	+	+
Heleioporus albopunctatus		+	+	R	X	R
H. barycragus		+	R	R	R	R
H. eyrei		+	R	R	X	R
H. inornatus				R	R	R
H. psammophilus				R	+	+
Limnodynastes dorsalis		R	R	R	R	R
Neobatrachus pelobatoides					X	R
Pseudophryne guentheri		R	R	R	R	R
HYLIDAE	Frogs					
Litoria adelaidensis				R	R	R
L. moorei				X	+	
GEKKONIDAE	Geckos					
Diplodactylus polyophthalmus		R	R	R	R	R
Oedura reticulata				R	X	R
Phyllodactylus m. marmoratus		R	R	X	X	
Underwoodisaurus milii		R	R	R	R	
PYGOPODIDAE	Legless Lizards					
Aprasia pulchella		X	X	X	X	
Delma fraseri		X	+	R	X	R
Lialis burtonis		R	X	+	X	+
Pygopus l. lepidopodus				+	X	+

Table 2 - Continued.

VERTEBRATE HABITAT TYPES		1	2	3	4	5
AGAMIDAE	Dragon Lizards					
Pogona m. minor		R	R	R	R	R
SCINCIDAE	Skinks					
Bassiana trilineata				R	R	+
Cryptoblepharus plagiocephalus		R	R	R	R	R
Ctenotus delli				+	R	
C. labillardieri		X	X	X	X	
Egernia kingii					+	
E. luctuosa					+	
E. napoleonis		R	R	R	R	+
E. p. pulchra		+	+	X	X	
Hemiergis i. initialis		R	R	R	R	R
H. p. peronii			+	X	X	
Lerista distinguenda		R	R	R	X	
L. microtis				X	X	
Menetia greyii		R	R	R	R	R
Morethia obscura		R	R	R	R	R
Tiliqua r. rugosa		R	R	R	R	+
VARANIDAE	Monitors					
Varanus gouldii		X	X	+	X	+
V. rosenbergi		X	R	R	+	+
TYPHLOPIDAE	Blind Snakes					
Ramphotyphlops australis		X	R	X	X	
R. pinguis			+	+	+	
R. waitii			+	+	+	
BOIDAE	Pythons					
Morelia spilota imbricata *		X	R	+	X	+
ELAPIDAE	Elapid Snakes					
Notechis scutatus occidentalis				+	+	+
Pseudonaja a. affinis		X	X	+	X	+
Rhinoplocephalus gouldii		+	X	R	R	+
R. nigriceps		+	X	+	+	+
Vermicella bimaculata			X	+	X	



SCHEMATIC NORTH–SOUTH SECTION THROUGH EIGHT SWAMP

November 1992

FIGURE 1

FIGURE 2 *Graph of individual vertebrate groups illustrating the expected species richness of the EAA habitats. Based on known records and data from the Boddington area.*