BODDINGTON GOLD MINE PROJECT

MINING AND PROCESSING OF SUPERGENE/BASEMENT ORES

WORSLEY ALUMINA PTY LTD

Report and Recommendations
of the
Environmental Protection Authority

Environmental Protection Authority
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SUMMARY AND RECOMMENDATIONS

Worsley Alumina Pty Ltd (WAPL) have been operating the Boddington Gold Mine since 1987. Subsequently, two proposals for expansion have been approved.

This further proposal is to mine and process ore from the supergene/basement deposits at the Boddington Goldmine. The supergene orebody is that zone of mineralisation which lies at the interface of the weathered oxide zone and the fresh basement rock. Standard open cut methods, as currently employed for the oxide ore mining operation, will be utilised to mine the deeper supergene and basement ores.

The supergene and some basement ores contain copper mineralisation which can interfere with the existing Carbon In Leach (CIL) processing method.This factor together with the hardness of the basement ores will necessitate the construction of a new treatment plant.The new plant will utilise floatation processing of the supergene and those basement ores which have copper mineralisation.The remainder of the basement ores will be treated using the existing CIL process.

In addition,owing to the hardness of some of the basement ores, further crushing and grinding equipment will be required. The new treatment plant will incorporate, a run-of-mine stockpile, separate crushing stations for supergene and basement ores, an intermediate crushed ore stockpile, milling and classification facilities, and a floatation facility housing gravity concentration, froth floatation, and product and residue thickening facilities. An additional throughput of approximately 2,000 tonnes per day would be generated by processing of the supergene/basement ores.

The copper/silver/gold concentrate produced from the floatation processing operation will be transported off-site for smelting, probably overseas.

Residue from the processing operation will be disposed of in the existing Residue Disposal Area, utilising a separate sub compartment for storage of the floatation material so as not to contaminate CIL process water in the existing storage area.

An additional 250 million litres of water per annum will be required for the floatation process.This will be sourced from the existing water supply system based upon pumping from the Hotham River into a water supply reservoir.

An area of 120 hectares of privately owned forest will require clearing for the mine waste stockpile with a further 0.25 hectares for the new treatment plant.

In considering the company's supergene/basement proposal to expand the mining and processing operation at the Boddington Gold Mine the Environmental Protection Authority determined that the potential for environmental impact was such that the proposal would require assessment under Part IV of the Environmental Protection Act, 1986, and that the level of assessment would be a Notice Of Intent.

The major environmental issues considered during the assessment of the proposal were generally related to :

- impacts on the Hotham River from pumping of water for the processing operation;
- potential for acidic drainage from supergene ore and waste stockpiles;
- storage of floatation residue; and
- the acceptability of the proposal within the context of the proponent's Environmental Management Programme for the Boddington Gold Mine, released in 1987.

Upon consideration of the Notice of Intent that was submitted for the project, the Environmental Protection Authority has concluded that the proposal would be environmentally acceptable subject to the following recommendations:

RECOMMENDATION 1

The Environmental Protection Authority concludes that the proposal described in the Notice Of Intent is environmentally acceptable and recommends that it could proceed subject to the Environmental Protection Authority's recommendations in this Assessment Report and the environmental commitments made by the proponent in the Notice of Intent.

As a further incremental development of the original Boddington Gold Mine this proposal should be accommodated within the environmental programme for the overall operation.

RECOMMENDATION 2

The Environmental Protection Authority recommends that the mining and processing of the supergene/basement ores are carried out in accordance with the commitments documented in the Environmental Management Programme for the Boddington Gold Mine of April 1987, (Appendix 2).

The supergene ores and some basement ores contain sulphate compounds which can form acids in the drainage waters from ore and waste stockpiles. These drainage waters need to be specially managed to ensure they do not cause any environmental problems.

RECOMMENDATION 3

The Environmental Protection Authority recommends that the proponent 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 so as to ensure that any acidic drainage waters are utilised within the Processing Plant circuit .

The Environmental Protection Authority notes that as a result of Boddington Gold Mine's Stage 2 expansion the water sharing agreement between Boddington Gold Mine and Alcoa's Hedges Gold Project was re-negotiated to the satisfaction of the Minister for Water Resources. This agreement delineates allowable water extraction levels to meet environmental objectives.

RECOMMENDATION 4

The Environmental Protection Authority recommends that any additional water used for the expanded operations be in accordance with all licence conditions set by the Water Authority of Western Australia for the extraction of water from the Hotham River .

Thirty - Four Mile Brook which runs through the minesite has been identified by the Water Authority of Western Australia as a possible future source of public water supply. Therefore, the rehabilitation of the site recognises this function as the priority future land use for the area.

RECOMMENDATION 5

The Environmental Protection Authority recommends that rehabilitation of the project area shall be carried out by the proponent in consultation with the Water Authority of Western Australia, the Department of Mines and, where appropriate, the land owner with the aim of maintaining 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 as well as leaving the project area in an environmentally stable condition.
This rehabilitation should be to the satisfaction of the Environmental Protection Authority upon advice from the Water Authority of Western Australia and the Department of Mines.

1. BACKGROUND

Worsley Alumina Pty Ltd as the manager of the Boddington Gold Mine has submitted a proposal to mine and process the supergene and basement ores at the Boddington Gold Mine located approximately 13km 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 its report on the project (EPA Bulletin 219) the EPA concluded that it would be environmentally acceptable subject to the proponent adhering to the commitments made in the ERMP and nineteen specific recommendations of the EPA .An Environmental Management Programme was subsequently prepared by the proponent detailing all aspects of environmental management pertaining to this project.

The project was commissioned in July 1987, with initial process plant throughput of 8,000 tonnes per day (tpd) (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 12,000 tpd (4.5 Mtpa) (EPA Bulletin 313). A further increase in throughput to 16,000 tpd (6Mtpa) (the Stage 2 expansion) was approved in October 1988 (EPA Bulletin 361).

Environmental concerns associated with the increased production subsequent to commissioning focused upon the environmental impact of utilising water from the Hotham River for processing purposes. Consequently,the following conditions were applied to ensure there were no adverse impacts on the river environment from the pumping operation:

i. that the proponent should comply with all licence conditions set by the Water Authority of Western Australia for abstraction of water from the Hotham River;

ii. that pumping from the Hotham River should only take place when the river flow was in excess of 342 kilolitres per hour and that total pumping from the river should not cause the remaining flow to be reduced below the level of 342 kilolitres per hour; and

iii. that the proponent be required to negotiate an agreement, 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. The minimum flow rate of 342 kilolitres per hour to 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.

2. PROJECT DESCRIPTION

This current proposal deals with the mining and processing of the supergene and basement ores which lie below the oxide ore zone that is presently being mined. The proposal, if implemented, will result in an increased treatment plant throughput of approximately 2,000 tpd.

The mining method that is currently employed for the oxide mining will be used for the deeper ores, however changes will be required to the processing operation.

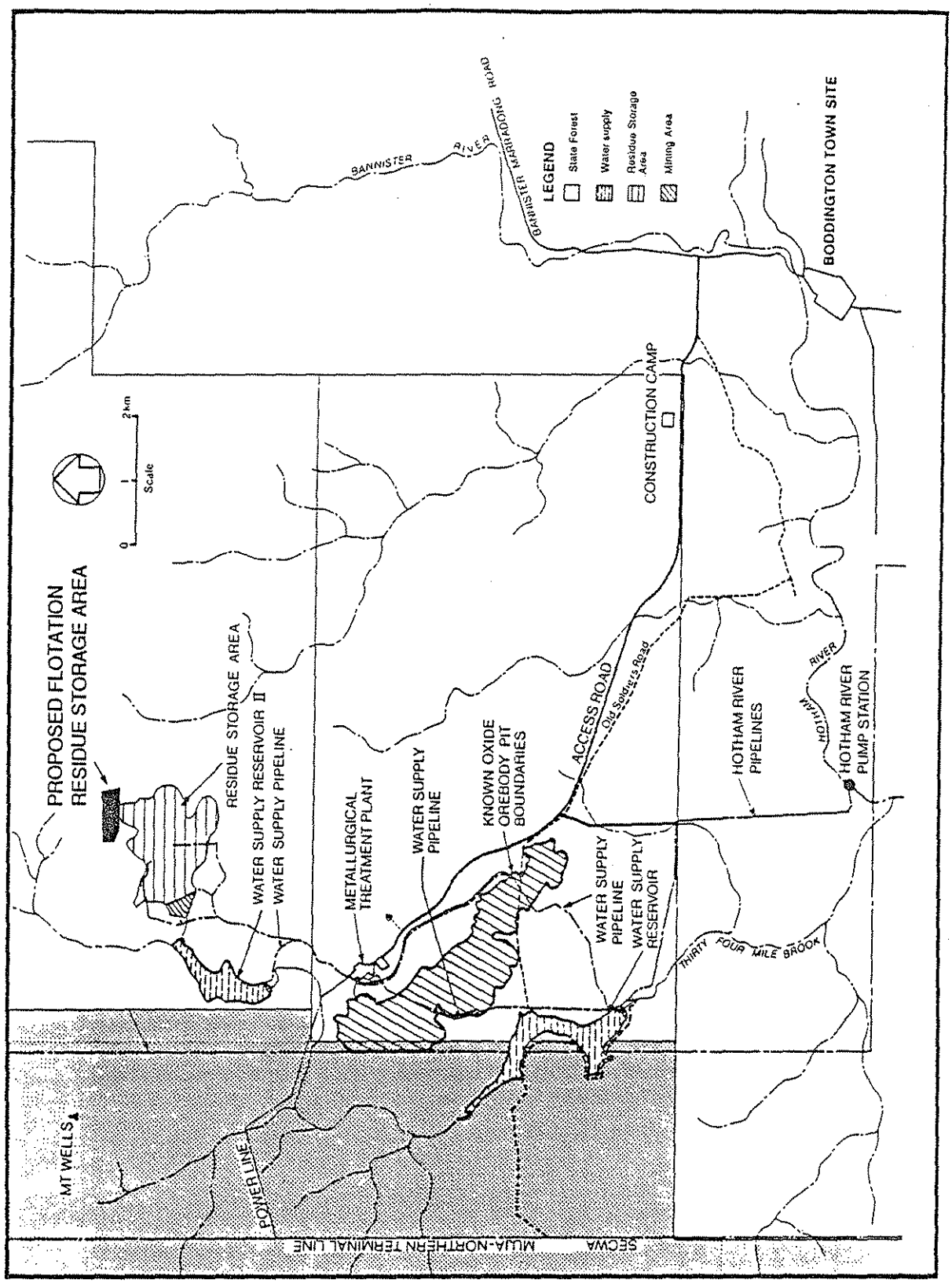

FIGURE 1: LOCALITY PLAN FOR BODDINGTON GOLD MINE
(FROM BODDINGTON GOLD MINE NOTICE OF INTENT, JULY 1989)

2.1 Ore Processing

The presence of copper in the supergene and some basement ores may have adverse affects on the existing CIL process as it can remove cyanide from the process circuit by precipitation.Therefore, it is proposed to process the supergene and copper-rich basement ores in a new floatation facility. The floatation process will utilise a range of chemicals to allow collection and concentration of the minerals from the crushed ore to produce a gold/silver/copper concentrate.

As the supergene ores need to be processed separately from oxide ores and the basement ores are much harder than the oxide material, new stockpiling, crushing and grinding facilities are required.

It is proposed to construct a new treatment plant to process the supergene and basement ores. This will include two primary crushers, a secondary crusher, and a ball mill and cyclone. These new treatment facilities will be integrated with the existing facilities to allow flexibility of processing (Figure 2).

The new floatation facility will also be contained within the proposed plant. Most of the new facilities will be located on the current site of storage areas, thus only approximately 0.25 hectares of privately owned forest will require clearing for the construction of the facilities.

2.2 Residue Storage

Reagents used for the floatation process can interfere with the CIL process by reducing the ability of the activated carbon to adsorb gold. Consequently, the residue from this source needs to be separated from the CIL residues so as not to contaminate the recycled process water from the existing CIL residue storage.

It is proposed to deposit the floatation residues, mainly from supergene ore processing, in an isolated sub-compartment in the north-eastern section of the existing Residue Storage area. Basement ores are likely to be processed through the CIL circuit with the residue being deposited in the existing storage area.

The design of the storage area will be carried out in consultation with the Water Authority of Western Australia and will require Works Approval and Licensing under Part V of the Environmental Protection Act, 1986.

An area of approximately 30 hectares of private forest will be cleared for the extension to the Residue Storage area. This lies within the previously defined and approved storage area for residue.

2.3 Water Supply

Process water for the treatment operation is supplied by pumping water from the Hotham River into the lower Water Supply Reservoir (Figure 1). Extraction of water from the river is undertaken during the high flow winter months and is licenced by the Water Authority of Western Australia (refer to Summary of this Report).

An additional processing water requirement of approximately 250 million litres per annum will be needed for treatment of the supergene and basement ores, this is within the terms of the existing Water Authority licence.

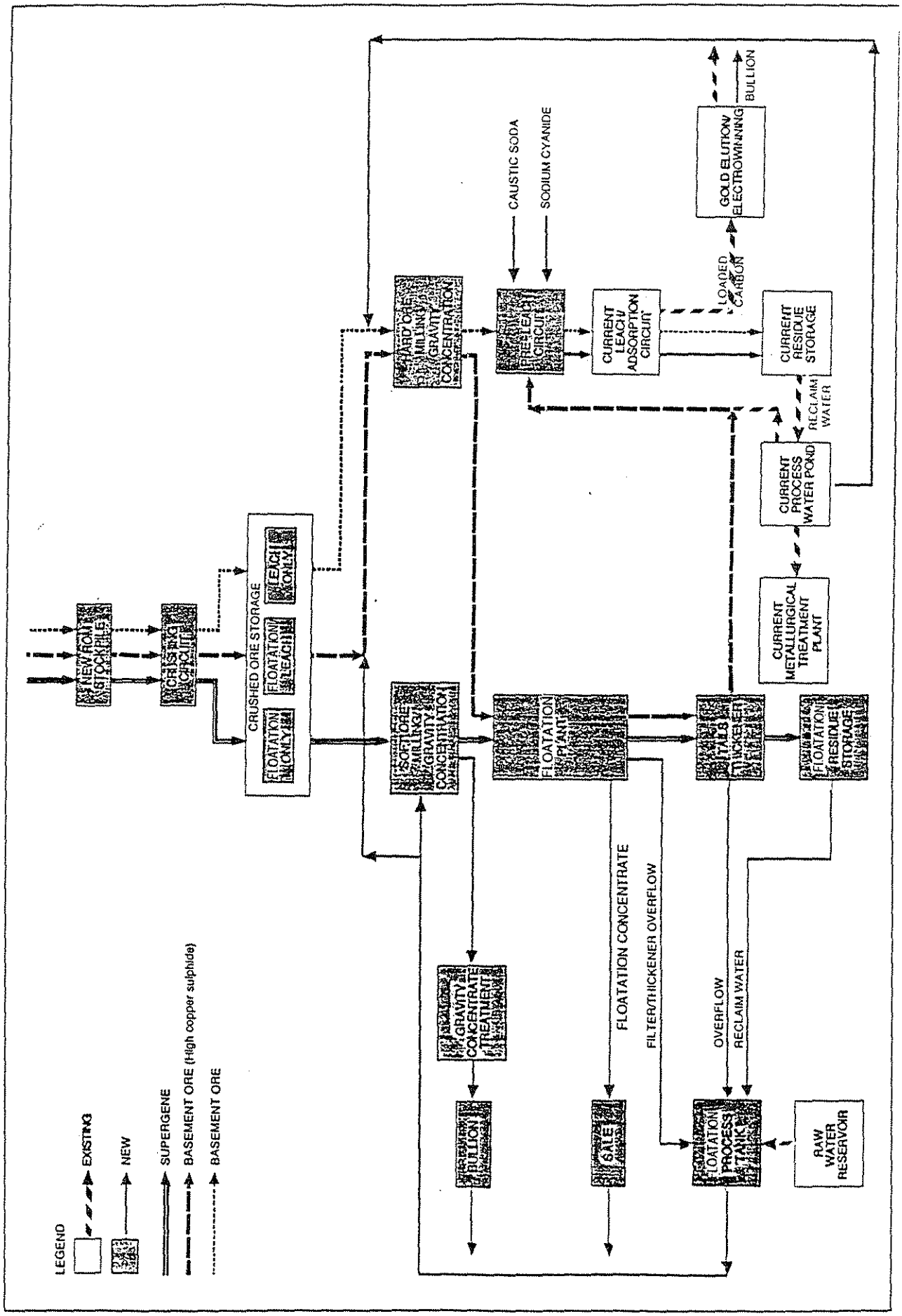

FIGURE 2: FLOW DIAGRAM FOR PROPOSED SUPERGENE/BASEMENT TREATMENT PROCESS

3. ENVIRONMENTAL ISSUES

In considering the proponent's supergene/basement proposal, the Environmental Protection Authority determined that the potential for environmental impact was such that the proposal would require assessment under Part IV of the Environmental Protection Act, 1986, and that the level of assessment would be Notice of Intent. The Notice of Intent was submitted for the proposal addressing the environmental aspects of the proposal in the context of the Environmental Management Programme that has been adopted for the existing operations.

Following a review of the environmental aspects of the proposal and the commitments made in the Notice Of Intent the Environmental Protection Authority concludes that the proposal would be environmentally acceptable, subject to a number of conditions as discussed in the following sections of this report.

Recommendation 1

The Environmental Protection Authority concludes that the proposal described in the Notice of Intent is environmentally acceptable and recommends that it could proceed subject to the Environmental Protection Authority's recommendations in this Assessment Report and the Environmental commitments made by the proponent.

3.1 Environmental Management

In its assessment of this proposal, the Authority recognised that the proposal for the mining and processing of supergene/basement ores was a further incremental development of the original Boddington Gold Mine proposal and hence should be accommodated within the environmental management programme for the overall operation.

RECOMMENDATION 2

The Environmental Protection Authority recommends that the mining and processing of the supergene/basement ores are carried out in accordance with the commitments documented in the Environmental Management Programme for the Boddington Gold Mine of April 1987.

3.2 Acidic Drainage

The supergene ore and some basement ores are acid-forming and have the potential to generate acidic drainage from waste and ore stockpiles. This drainage if not adequately managed may contaminate Thirty - Four Mile Brook.A number of management strategies have been proposed in the Notice of Intent should monitoring identify acidic drainage, these include; encapsulation of acid forming waste with inert waste to restrict sulphate oxidation, grading stockpiles to prevent water accumulation and percolation, collection of run-off water from stockpiles for re-use in the process circuit and, compaction of mine waste stockpile to reduce infiltration of water. All of these options should be used to manage the generation of acidic drainage,however, any drainage of an acidic nature that is generated should be finally disposed of in the process water dam.This will ensure that any such drainage does not contaminate the surrounding environment.

Recommendation 3

The Environmental Protection Authority recommends that the proponent 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 so as to ensure that any acidic drainage waters are utilised within the Processing Plant circuit .

3.3 Water Supply

Processing of the supergene and copper-rich basement ores will require an additional 250 million litres per annum of water. This water will be sourced from the Hotham River under the terms of Water Authority Licence No. 23670 which allows pumping to a maximum rate of 3,300 kilolitres per hour from the river provided the flow rate of the river is at least 342 kilolitres per hour. Owing to the presence of Alcoa's Hedges Gold Mine, an agreement was reached in 1988 to share the available water flow without causing undesirable impacts to the river environment.

Recommendation 4

The Environmental Protection Authority recommends that any additional water used for the expanded operations be in accordance with all licence conditions set by the Water Authority of Western Australia for the extraction of water from the Hotham River .

3.4 Residue Storage

The Floatation Residue Storage Area will utilise a sub-compartment of the existing CIL Residue Storage area. Design of the storage will incorporate a range of seepage control mechanisms including; compaction of underlying clays to provide an impervious blanket, an up-stream interceptor drain, an up-stream clay blanket, a cut-off trench beneath the embankments and downstream monitoring/recovery bores.

The new residue storage area and the Supergene/Basement Treatment Plant are subject to the provisions of Part V of the Environmental Protection Act, 1986, which require Works Approval and Licensing.

3.5 Rehabilitation and Decommissioning

A further stockpile area will be required for the expanded mining operation. This will necessitate the clearing of approximately 120 hectares of privately owned forest. During the life of the project mine waste not used for road construction is to be returned to the pits. Decommissioning and rehabilitation of the operation will be as outlined in the Environmental Management Programme of April 1987. The long term objectives of the rehabilitation are to stabilise the modified landforms, re-establish the hydrological regime in the immediate area, and to restore floral and faunal characteristics of the area, so that a self sustaining vegetative cover can be maintained.The Water Authority of Western Australia has identified Thirty - Four Mile Brook as a potential future source of public water supply.

Recommendation 5

The Environmental Protection Authority recommends that rehabilitation of the project area shall be carried out by the proponent in consultation with the Water Authority of Western Australia, the Department of Mines and, where appropriate, the land owner with the aim of maintaining 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 as well as leaving the project area in an environmentally stable condition.

This rehabilitation should be to the satisfaction of the Environmental Protection Authority upon advice from the Water Authority of Western Australia and the Department of Mines.

4. Conclusion

Upon assessment of the Worsley Alumina Pty Ltd proposal, the Environmental Protection Authority has concluded that the proposed mining and processing of the supergene/basement ores at the Boddington Gold Mine would be environmentally acceptable subject to the operation being carried out in accordance with the commitments made by the proponent in the Notice of Intent (Appendix 1) and the Environmental Protection Authority's Recommendations.

SUMMARY OF ENVIRONMENTAL COMMITMENTS FROM NOTICE OF INTENT

The specific environmental commitments made by Worsley Alumina Pty Ltd (WAPL) relating to the proposed development are summarised as follows:

1. **Statutory requirements**

   1.1 adherence to all existing policies, procedures and commitments to environmental management, as outlined in the April 1987 EMP and the conditions of the State's approval of the 4.5 Mtpa (February 1988) and 6 Mtpa (December 1988) enhancements;

   1.2 compliance with all relevant Acts and associated regulations pertaining to the construction and operation of all components of the proposal;

   1.3 compliance with appropriate regulations for underground mining, should investigations into the most effective mining method result in the adoption of these techniques;

   1.4 compliance with all conditions of Water Authority Licence No. 23670, including the submission, of a detailed study of the effects of water abstraction from the Hotham River following two winter flows;

2. **Design**

   2.1 extension of the capacity to pump from recovery bores in the Residue Storage Area should seepage from the Floatation Residue Storage Area become a problem;

   2.2 design of the northern and extended embankments of the Floatation Residue Storage Area in consultation with the Water Authority;

   2.3 containment of all waste and split materials in the Supergene/Basement Treatment Plant within the process area for reuse or disposal as appropriate;

   2.4 containment of possible residue and reclaim pipeline leaks/breakages at low points along the residue pipeline route. Split material would be returned to the Flotation Residue Storage Area;

3. **Forest clearing**

   3.1 minimization of forest clearing, consistent with safe and efficient operations;

   3.2 continuation of forest hygiene measures currently in use in all forest operations;

4. Drainage

4.1 management of water quality, drainage and stormwater to prevent runoff, particularly from the Mining Area and the mine waste stockpile, from either contaminating or physically damaging (eroding) surrounding areas;

4.2 should it become necessary, encapsulation of potentially acid-forming wastes within compacted inert wastes, to prevent acidic leachates escaping from the mine waste stockpile;

5. Noise

5.1 continuation of current practices ensuring that noise levels from blasting, for 95% of blasts, are less than 115 dB (peak) linear and never exceed 120 dB linear at the nearest residence;

6. Dust

6.1 implementation of measures to control dust in the Mining Areas, mining waste stockpile area and the Supergene/Basement Treatment Plant;

7. Plant operations

7.1 use of requisite safety equipment and procedures in the handling and storage of hazardous chemicals;

8. Monitoring

8.1 the extension and expansion, where required, of existing monitoring programmes (detailed in the April 1987 EMP and in the conditions of Licence No. 847 issued under the terms of Section 57 of the Environmental Protection Act, 1986 (as amended)) to include monitoring programmes outlined in this NOI;

8.2 incorporation of additional data from monitoring programmes in the existing quarterly reporting mechanism required by Environmental Protection Act Licence No. 847;

9. Rehabilitation/decommissioning

9.1 compliance with the existing agreement with Bunning Bros Pty Ltd (in consultation with CALM and the Water Authority) concerning rehabilitation and decommissioning of the project area.

SUMMARY OF ENVIRONMENTAL COMMITMENTS FROM ENVIRONMENTAL MANAGEMENT PROGRAMME (WAPL, APRIL 1987)

The following list is a summary of the major environmental commitments for the Boddington Gold Mine Project. Some of the commitments relate to the recommendations of the EPA report on the project proposal (October 1985), as noted emboldened in round brackets after these commitments:

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 **(EPA Recommendation 12).**

3. Environmentally-sensitive construction and operational practices, including stringent forest hygiene measures, will be employed throughout the project area (see 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 the terms of the Alumina Refinery (Worsley) Agreement Act, 1973 (as amended).

6. Alternative access from private land around the Water Supply Reservoir to State Forest to the west of the project area has been provided for the 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 **(EPA Recommendation 1 and 2).**

8. A qualified 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). In consultation with the EPA and the Water Authority, existing surface and groundwater monitoring programmes are being extended to facilitate progressive planning and management of project activities, particularly mining and residue storage, to minimize adverse hydrological and hydrogeological effects **(EPA Recommendations 9 and 10).**

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 Water Supply Reservoir would 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 **(EPA Recommendation 11).**

10. The downstream user of Thirty-Four Mile Brook is being compensated for reduced flows due to the construction of the Water Supply Reservoir.

11. A programme for regular assessments of forest health, including tree growth monitoring, is being established adjacent to the Mining Area in consultation with the EPA and CALM. If disease spread unacceptable to the State is detected, operational practices will be reviewed and modified (**EPA Recommendation 3**).

12. The State has been provided with the results of studies and assessments on the likely effects on the environment of cyanide, caustic soda and viscosity modifier used in the process and deposited with residue (**EPA Recommendation 5**).

13. As part of applications for permission to divert water (Rights in Water and Irrigation Act, 1914 (as amended)) and for a Works Approval (Environmental Protection Act, 1986), the State has been provided with the detailed design reports and reports on geotechnical, hydrological and hydrogeological investigations carried out for the Water Supply Reservoir and the Residue Management System, including monitoring/recovery borefields (**EPA Recommendations 6 and 8**).

    Additional information has been provided in relation to atmospheric emissions and noise aspects of the Works Approval.

14. If unacceptable quality is detected in groundwater monitoring bores around the Residue Disposal Area, one of the remedial actions described in Section 8.3.3 will be adopted.

15. 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.

16. 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 (**EPA Recommendation 7**).

17. The Hotham River Pump Station has been designed (size of structure, colour of structure and equipment) to minimize visual impact. Noise from the electrically-driven pumps and from temporary diesel alternators (permanent power was scheduled for connection in mid-1987) has been evaluated in relation to neighbourhood noise legislation and appears unlikely to be a problem; however, equipment modification will be evaluated should problems arise (**EPA Recommendation 17**).

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

19. Caustic soda used in the Metallurgical Treatment Plant will have a mean mercury content of less than 100 ug/L, with a maximum value of 1,000 ug/L (**EPA Recommendation 4**).

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

21. Noise during blasting operations will be limited, by the conditions of the Mining Contractor's contract, to less than 120 dB linear at the nearest residence, some 6 km from the blast site.

22. Drainage will be installed in the mine pits, with runoff either used for dust suppression, or drained via silt traps to natural watercourses.

23. Perimeter drains will be installed around mine pits and stockpiles; water from these and from haul roads will drain through silt traps into natural watercourses.

24. 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.

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

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

27. Shallow mine pits will be contoured to slopes generally consistent with natural landforms **(EPA Recommendation 13).**

28. Deeper pits will be rehabilitated if, at the time of completing the mining of the weathered profile, no decision to mine bedrock has been made. Should a decision to mine bedrock be made, detailed plans will be submitted to the State for approval **(EPA Recommendations 15 and 16).**

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

30. Ten-year mining plans will be prepared and submitted to the State as part of the existing arrangements for the Worsley Alumina Project, and will be regularly updated **(EPA Recommendation 14).**

31. The State will be provided with brief annual and comprehensive triennial environmental management reports as part of existing arrangements for the Worsley Alumina Project **(EPA Recommendation 19).**