Boddington Gold Mine: Rehabilitation strategy

Worsley Alumina Pty Ltd

Proposed changes to environmental conditions

Report and recommendations
of the Environmental Protection Authority

Environmental Protection Authority
Perth, Western Australia
Bulletin 766
December 1994

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.

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

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 contents of the assessment report or recommendations 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 pm on 22 December 1994.

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Summary

The Environmental Protection Authority (EPA) has been requested by the Minister for the Environment, under Section 46 of the *Environmental Protection Act 1986* , to report on proposed modifications to the rehabilitation strategy for the Boddington Gold Mine.

The Boddington Gold Mine was originally assessed by the EPA in 1985. The EPA has subsequently assessed additional project expansions for the mine. In response to recommendations from the EPA, an Environmental Management Programme was prepared by Worsley Alumina in 1987 detailing all aspects of environmental management for the project, including environmental management commitments.

Rehabilitation of the mine site is a key element of the commitments and Worsley Alumina has undertaken on-going studies to assist in the overall rehabilitation of the site. These studies are continuing. Inherent in the original rehabilitation concept for the mine site was the return of waste stockpiles to the mine pits and the maintenance of water quality in Thirty-Four Mile Brook. The proponent provided specific commitments to ensure that this would happen.

Over the past three years, Worsley Alumina and Hedges Gold Pty Ltd, which operates the adjacent Hedges Gold Mine, have worked co-operatively to develop an integrated rehabilitation strategy for the Thirty-Four Mile Brook catchment. The proposed catchment wide rehabilitation strategy involves the development of three lakes established in the mine pits — one at Hedges and two at Boddington Gold Mine. It is proposed that the lakes be connected to Thirty-Four Mile Brook. However, this proposed new rehabilitation strategy is inconsistent with a number of Worsley Alumina's existing environmental management commitments. The EPA has assessed the new rehabilitation strategy and the need for commitments to be amended if the proposed new rehabilitation strategy is to be implemented.

The major environmental issues associated with the proposed new rehabilitation strategy which have been identified through the environmental assessment process include:

1. The status and beneficial use of Thirty-Four Mile Brook;
2. The development of deep lakes in the mine pits;
3. Water quality discharge criteria from the residue disposal areas to the Hotham River and Thirty-Four Mile Brook; and
4. On-going rehabilitation and management of the site, including rehabilitation of the waste dumps, consistent with environmental conditions and proponent commitments.

While there is a substantial cost saving to Worsley Alumina if mine waste is not returned to the pits, it is the environmental impacts associated with the proposed new rehabilitation strategy that have been evaluated by the EPA.

As part of this report, Department of Environmental Protection officers, in consultation with Worsley Alumina, also undertook a reappraisal of all past conditions and commitments set on the proposal since 1988. The objective was to achieve one environmental statement and one list of proponent commitments that provide for protection of the environment and for efficient and effective environmental auditing of compliance criteria. This objective will assist the public, the proponent and relevant agencies to more easily identify environmental management requirements associated with the Boddington Gold Mine.

The EPA has concluded that the modifications to the Boddington Gold Mine rehabilitation strategy are environmentally acceptable in principle and recommends that they could proceed, subject to the recommendations in this report. The following factors led to this conclusion:

1. The EPA acknowledges the decision of the Water Authority of WA that the primary beneficial use of Thirty-Four Mile Brook is recreation;
2. The incorporation of deep lakes in the final landform of the minesite is acceptable subject to resolution and management of hydrological issues, appropriate lake design, including some shallow areas, and rehabilitation of the surrounding disturbed areas;

3. Discharge criteria from the residue disposal areas to the Hotham River and the Thirty-Four Mile Brook should:

   - in regard to heavy metals, meet guidelines for protection of aquatic ecosystems; and
   - in regard to salinity, not cause an increase of more than 10 per cent in the salinity of the Hotham River at any time, and for release into Thirty-Four Mile Brook not exceed 3000 mg/l Total Soluble Salts; and

4. The proponent's intention to implement commitments for environmental management and rehabilitation of the site.

The following table provides a summary of the EPA's recommendations for this proposal. The full recommendations of the EPA are provided in the main text of this report. The recommendations of the EPA have also been drafted into Recommended Environmental Conditions (see Section 7) for consideration by the Minister for the Environment in his negotiations with the decision making authorities for this proposal (the Minister for Mines, the Minister for Resources Development and the Minister for Water Resources).

Recommendation Number	Summary of Recommendation
1	Detailed studies and plans should be developed for the inclusion of lakes as final landform features within the mine pit areas.
2	Rehabilitation of the Boddington Gold Mine should meet the requirements of the Department of Environmental Protection and the State Mining Engineer.
3	The quality of proposed discharge water from the residue disposal areas and D1 Dam to the Hotham River should, in the case of inorganic toxicants, conform with the guidelines for protection of aquatic ecosystems.
4	The quality of proposed discharge water from the residue disposal areas and D1 Dam to the Thirty-Four Mile Brook should, in the case of inorganic toxicants, conform with the guidelines for protection of aquatic ecosystems.
5	A decommissioning and rehabilitation plan should be prepared including the development of a 'walk away' solution for the site.
6	The proposed modifications to the environmental commitments for the Boddington Gold Mine are environmentally acceptable subject to the recommendations contained in this report and the proponent's consolidated commitments.

1. Introduction

The Environmental Protection Authority (EPA) has been requested by the Minister for the Environment under Section 46 of the *Environmental Protection Act 1986*, to report on proposed modifications to the rehabilitation strategy for the Boddington Gold Mine. This report, (Bulletin 766), contains the EPA's recommendations to the Minister for the Environment, who will decide on any modifications to the conditions previously set on the proposal.

Approval for gold mining 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 (Worsley Alumina Joint Venturers, 1985), submitted to the EPA. In its report on the project (EPA, 1985), the EPA concluded that the project would be environmentally acceptable subject to the proponent adhering to the commitments made in the Environmental Review and Management Programme (ERMP) and 19 specific recommendations of the EPA. This initial proposal for the establishment of the Boddington Gold Mine pre-dated the Environmental Protection Act, 1986 and no binding environmental conditions were set. However, in response to recommendations from the EPA, an Environmental Management Programme was prepared (Worsley Alumina Pty Ltd, 1987), detailing all aspects of environmental management for the project.

The Boddington Gold Mine was commissioned in July 1987 with initial process plant throughput of three 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, 1987a). A further increase in throughput to 6 Mtpa, for the Stage 2 expansion, was approved in December 1988 (EPA, 1988). In November 1989, approval was given for the mining and processing of supergene and basement ores (EPA, 1989) and in January 1993, mining of the eastern anomalies deposit was approved (EPA, 1992).

A number of environmental conditions have been applied to all of the above proposals. The statement of environmental conditions published by the Minister for the Environment for each proposal is included as Appendices 1(a) to 1(e) in this report.

Environmental management at Boddington Gold Mine is based on the 1987 Environmental Management Programme which details the commitments originally made by the proponent. A number of the commitments which were made in the Environmental Management Programme have been supplemented and modified as part of the process of environmental approval of the subsequent project expansions. Rehabilitation is a key element of the commitments. The current consolidated list of environmental commitments, approved as part of the Supergene/Basement extension in October 1989, is included in Appendix 1(c).

Changes to some of these commitments are considered necessary by the proponent to enable a revised rehabilitation strategy for the mine to be implemented. This report evaluates the proposed changes and the proponent's modified rehabilitation strategy.

2. Summary description of the proposal

The Boddington Gold Mine and processing plant is located in the Darling Range, predominantly on private land, approximately 13km north west of the town of Boddington (Worsley Alumina, 1994a).

The Boddington Gold Mine comprises several mine pits, a processing plant, two water supply reservoirs, and two residue (tailings) disposal areas (RDAs) (Worsley Alumina, 1994a). These are located within the catchment of Thirty-Four Mile Brook, which flows intermittently into the Hotham River (Figure 1).

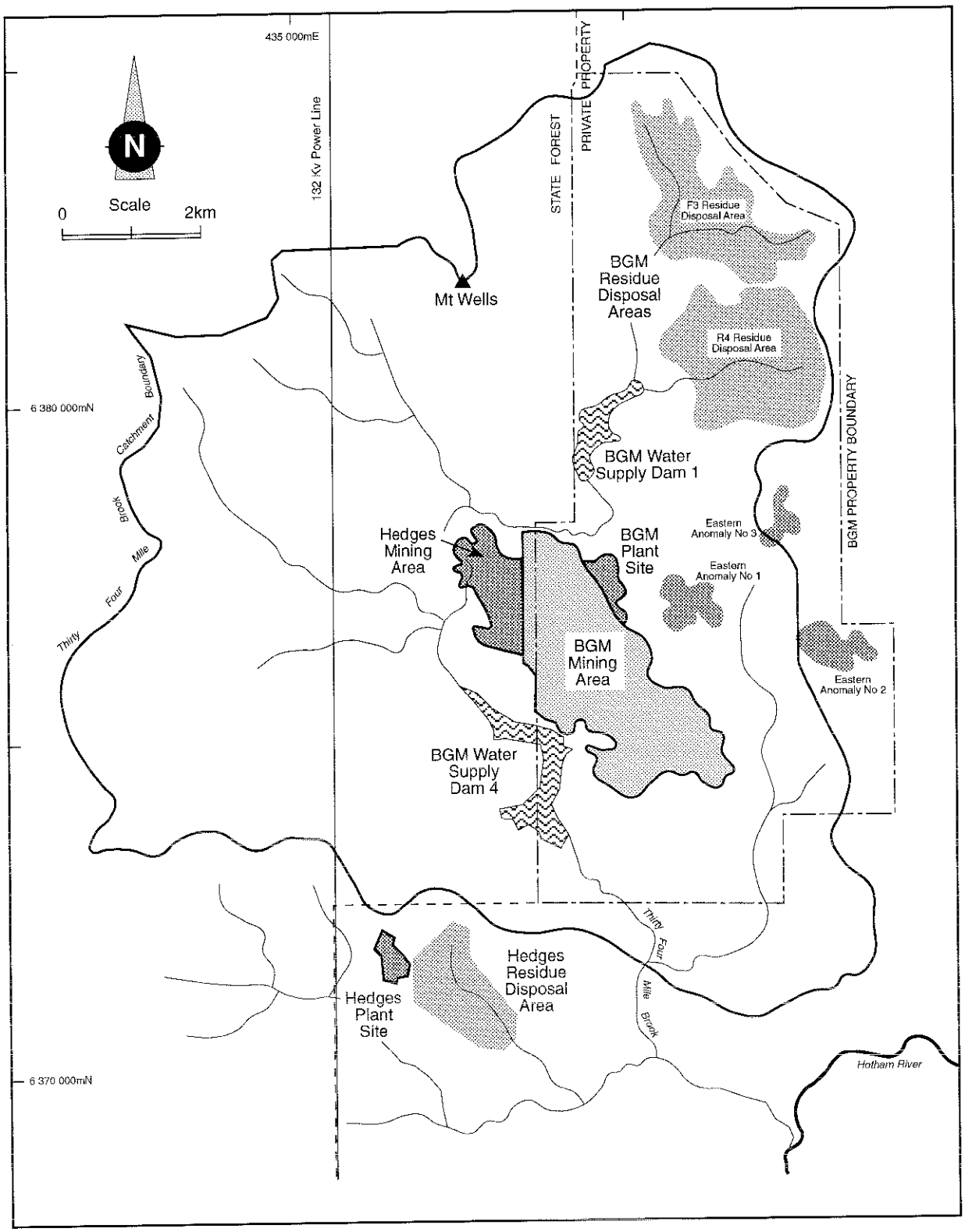

Figure 1. Boddington Gold Mine site plan (from Worsley Alumina Pty Ltd 1994c).

The 1987 Environmental Management Programme, and subsequent environmental conditions published by the Minister for the Environment for the mining and processing of supergene/basement ores (EPA, 1989) require rehabilitation planning and implementation to be carried out in consultation with the State.

The main objectives for rehabilitation at the Boddington Gold Mine are:

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

To achieve these broad aims, a number of specific commitments were originally made by the proponent, including the following:

- topsoil from areas cleared for project activities will be stockpiled for use in decommissioning and other rehabilitation programmes;
- mine waste not used in construction will be returned as back-fill to mine pits during the life of the project;
- if it is decided not to process marginal ore, this material will be returned to mined out pits;
- shallow mine pits will be contoured to slopes generally consistent with natural landforms;
- final rehabilitation will ensure that runoff will drain to natural watercourses or into the deeper pits; and
- rehabilitation would be undertaken with the aim of maintaining the water quality in Thirty-Four Mile Brook so that the downstream water supply reservoir could be a viable long-term source of public water supply.

A number of landform designs are compatible with the rehabilitation objectives. Most of these involve the development of lakes, since the available back-fill (waste and unprocessed marginal-grade ore) is only about half the excavated volume of the pits (the other half having been processed and deposited in the residue areas) (Worsley Alumina Pty Ltd, 1994b).

Hedges Gold Pty Ltd, a wholly owned subsidiary of Alcoa of Australia Limited, operates the adjacent Hedges Gold Mine (Hedges) which is located wholly within State Forest and is also within the catchment of Thirty-Four Mile Brook. Mining operations at Hedges are due to be completed in early 1997 (Worsley Alumina Pty Ltd, 1994a).

Over the past three years, Worsley Alumina Pty Ltd and Hedges Gold Pty Ltd have worked co-operatively to develop an integrated rehabilitation strategy for the Thirty-Four Mile Brook catchment. The proposed catchment wide strategy involves the development of three deep lakes established in the mine pits — one at Hedges (Hedges lake) and two at Boddington Gold Mine (Lakes B and G). The relative position of the lakes is shown in Figure 2. Characteristics of the proposed Boddington Gold Mine Lakes B and G and Hedges Lake are provided in Table 1. The creation of deep lakes as a feature in the final landform design would obviate the need to return large volumes of stockpiled waste to the mine pits. Worsley Alumina propose that the lakes be connected to Thirty-Four Mile Brook.

Table 1. Characteristics of the proposed Boddington Gold Mine Lakes B and G and Hedges Lake (Worsley Alumina Pty Ltd, 1994c)

Parameter	Lake B	Lake G	Hedges
Overflow Level (m AHD)	225	255	233
Lake surface area (ha)	45	8	35
Volume (ML)	8150	1050	5130
Perimeter (km)	3.5	1.4	3.1
Mean depth (m)*	18	13	15
Maximum depth (m)*	70	30	45

* R Williams, Worsley Alumina Pty Ltd, *pers. comm.*

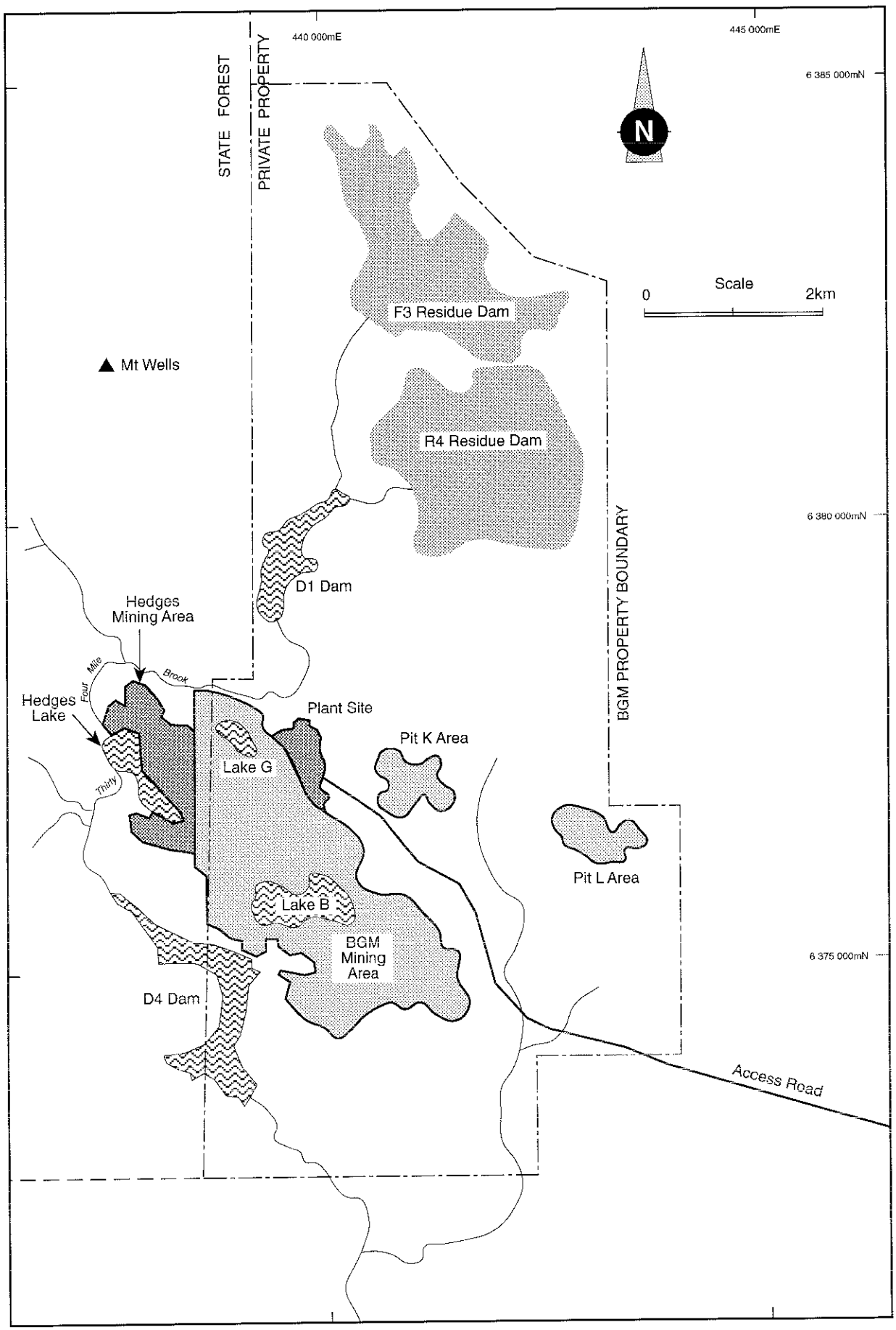

Figure 2. Proposed location of lakes (from Worsley Alumina Pty Ltd 1994c).

In its 1990 Environmental Management Programme, Hedges Gold proposed the development of a permanent waterhole in the Hedges mine pit as a feature in the post mining landform (Hedges Gold Pty Ltd, 1990). Hedges Gold has subsequently submitted a more detailed rehabilitation plan for the development of a deep recreational lake in the Hedges mine pit consistent with the Environmental Management Programme. Development of a recreational lake has been supported by the Department of Conservation and Land Management (CALM) which manages the State Forest. The Department of Environmental Protection is currently considering the environmental acceptability of the Hedges Gold rehabilitation plan.

Worsley Alumina (1994a), has indicated, however, that the proposed integrated rehabilitation strategy is inconsistent with the existing environmental management commitments for the Boddington Gold Mine; specifically those commitments which require the return of all mine waste into pits at project completion, and the preservation of Thirty-Four Mile Brook as a potable water resource.

Worsley Alumina (1993) suggest that if the mine waste was to be returned to pits B and G, thereby creating shallow lakes, one of the most significant impacts would be to limit the contact between the resultant lakes and the groundwater aquifer (exposed in the floor of the completed mine pit). This would inhibit the flow of groundwater through the lakes, and reduce the flushing effect of the groundwater aquifer, increasing the risk of salinisation in the lakes through evaporation. With no groundwater inflow, lake water levels would also fluctuate seasonally. A maximum lake level variation of 10m for lake B and 3.5m for lake G was projected (Worsley Alumina Pty Ltd, 1994c). Such variations in lake levels would diminish the environmental value of the lakes especially in regard to the establishment of suitable shallow areas or islands for wildlife and the establishment and survival of fringing plants.

The development of deep lakes, by not back-filling, would maintain the close contact with the groundwater aquifer, and promote the throughflow of groundwater. Although the deep lakes would be predominantly groundwater fed, and the groundwater has a salinity of about 3,000 mg/l, studies have shown that groundwater through-flow (to the west and south-west) is sufficiently large to prevent hyper-salinisation through evaporation (Worsley Alumina Pty Ltd, 1993). In addition, the proposed connection of the lakes to Thirty-Four Mile Brook would further improve lake water quality by combining lake water with largely fresh water from the forested catchment of Thirty-Four Mile Brook.

However, the proposal to connect the Boddington Gold Mine lakes to Thirty-Four Mile Brook would cause an increase in stream salinity in the brook to above potable levels and is therefore at variance with a current requirement to maintain the water supply reservoir (known as the D4 dam) as a potential public water supply (Worsley Alumina Pty Ltd, 1994a). As a consequence of the above, Worsley Alumina has proposed replacement of these commitments with several new commitments which address the management of environmental impacts arising from the proposed new rehabilitation strategy. These are detailed fully in section 4.4 of this report.

In summary, the proponent believes that backfilling the mine pits would result in shallow lakes at risk of becoming hypersaline through evapo-concentration of salts already present in the groundwater. The proponent believes that retention of deep pits flushed by marginal to brackish groundwater and fresh to marginal surface flows from Thirty-Four Mile Brook would result in better overall water quality and stabilise water levels in the lakes. The proponent claims this would not compromise future recreational values of the lakes, Thirty-Four Mile Brook or the present uses of the Hotham River. Worsley Alumina has also proposed that runoff from the residue disposal areas be managed in the medium term and then allowed to drain naturally, via Thirty-Four Mile Brook to the Hotham River, once water quality parameters (salt and heavy metals) have reduced to acceptable levels.

While there is a substantial cost saving to Worsley Alumina if mine waste is not returned to the mine pits, it is the environmental impacts associated with the proposed new rehabilitation strategy that have been evaluated by the EPA.

3. Environmental impact assessment process

Department of Environmental Protection (DEP) officers undertook the actions identified in Table 2 below to assist the Environmental Protection Authority in its evaluation of this proposal.

Table 2. Actions undertaken between the DEP and others to assist in the preparation of Bulletin 766.

Date	Activity	Outcome/issues discussed
3/6/94	Meeting: Worsley Alumina, Hedges Gold and Department of Environmental Protection (DEP)	First outline of proposal. Requirement for section 46 amendment discussed.
19/7/94	Letter from Water Authority of WA (WAWA) to Department of Resources Development	WAWA advise that the beneficial use of Thirty-Four Mile Brook is now recreation.
16/8/94	Section 46 assessment set by the Minister for the Environment	
17/8/94	Meeting: Worsley Alumina and DEP	Discuss proposed changes to beneficial use of Thirty-Four Mile Brook.
20/8/94	Meeting: Worsley Alumina , DEP and WAWA	Discuss beneficial use of Thirty-Four Mile Brook.
6/9/94	Meeting: Worsley Alumina and DEP	Discuss Worsley Alumina draft report
15/9/94	Meeting: Worsley Alumina , DEP and WAWA	Discuss Worsley Alumina draft report
27/9/94	Meeting: WAWA and DEP	Discuss Worsley Alumina draft report
24/10/94	Meeting: Worsley Alumina and DEP	Review of previous environmental conditions and proponent commitments, and discussion of issues raised in submissions
9/11/94	Boddington Gold Mine—Site visit	Inspection of mine site and discussion of issues.

In undertaking its evaluation of this proposal, the EPA invited specific comment from the organisations, agencies, landholders and individuals listed in Appendix 2 of this report. DEP officers also undertook a reappraisal of all past conditions and commitments set on the proposal since 1988.

Limitation

This evaluation has been undertaken using information currently available. The information has been provided by the proponent through preparation of the Environmental Review document and, in response to specific issues, by DEP officers utilising their own expertise and reference material, by utilising expertise and information from other State Government agencies and others listed in Appendix 2, and by contributions from EPA members.

The EPA recognises that further studies and research may affect the conclusions. The EPA notes that Worsley Alumina prepares brief annual and comprehensive triennial environmental management reports as part of existing arrangements for the Worsley Alumina Project in addition to annual Life of Project land use plans. These reports provide a mechanism for on-going review of environmental management performance including the results of studies and research at the Boddington Gold Mine.

3.1 Previous decisions

In its assessment of all previous proposals at the Boddington Gold Mine site, the EPA has focussed on three primary objectives:

- the environmental acceptability of on-going operations;
- the commitment to 'whole of mine site' rehabilitation; and
- protection of the designated beneficial use of Thirty-Four Mile Brook.

At the time of the original proposal, the designated beneficial use of Thirty-Four Mile Brook was as a potential public water supply. Consequently, the rehabilitation plan for the mine site involved the return of all mine waste to the pits and isolating the remaining 'lakes' from the brook.

The return of waste to the mine site represented a substantial cost and the proponent sought clarification from appropriate State government agencies regarding the beneficial use of Thirty-Four Mile Brook. The Water Authority, as the responsible State agency, agreed that the beneficial use for the brook is no longer as a potable public water supply but water based recreation. As a result, a revised rehabilitation plan has been developed by the proponent involving *in situ* rehabilitation of mine waste stockpiles and linkage of the (deeper) lakes to Thirty-Four Mile Brook subject to meeting certain water quality criteria.

The EPA's objectives with regard to this development remain the same and the purpose of this assessment is to determine whether the proposed amended rehabilitation plan adequately protects the (new) beneficial use of Thirty-Four Mile Brook and its associated environmental values.

4. Evaluation

Those elements of the Boddington Gold Mine rehabilitation strategy which now require evaluation by the EPA include:

(1) The status and beneficial use of Thirty-Four Mile Brook (Section 4.1);

(2) The development of deep lakes in the mine pits (Section 4.2);

(3) Water quality discharge criteria from the residue disposal areas to the Hotham River and Thirty-Four Mile Brook (Section 4.3); and

(4) On-going rehabilitation and management of the site consistent with environmental conditions and proponent commitments (Section 4.4).

These are dealt with in turn below. Sections 4.1, 4.2, and 4.3 provide the context for section 4.4 of this report which evaluates the specific changes to the environmental management commitments proposed by the proponent.

4.1 Thirty-Four Mile Brook

Objective

To determine the environmental acceptability of the proposed rehabilitation strategy in relation to the beneficial use of Thirty-Four Mile Brook.

Technical information

The Boddington Gold Mine is located in the catchment of Thirty-Four Mile Brook, which flows during winter into the Hotham River, which is itself a tributary of the recreationally important Murray River. Thirty-Four Mile Brook is a largely forested, relatively fresh water catchment, although the catchment of the last 3km of the Brook's course before its confluence with the Hotham River is predominantly cleared (Worsley Alumina Pty Ltd, 1992). Downstream of the

Boddington Gold Mine, Thirty-Four Mile Brook flows through about 1.2km of forest and then through largely cleared private property.

In regard to the regional conservation value and condition of Thirty-Four Mile Brook, Worsley Alumina (1994d) has indicated the following:

1. The Boddington Gold Mine and the adjacent Hedges Gold Mine have resulted in significant construction along Thirty-Four Mile Brook. The R4 and F3 residue disposal areas, constructed on the headwaters of the brook, receive tailings piped from the Boddington Gold Mine's gold refinery plant. Construction of these facilities involved forest clearing, stripping and stockpiling of topsoil and gravel for use in rehabilitation, and the building of clay embankments to contain the residue. Two water supply reservoirs, which contain water for the refining process, have been constructed on Thirty-Four Mile Brook, inundating approximately 5km of the stream. The original course of Thirty-Four Mile Brook passed through what is now the Hedges Gold Mine. Mining has required the diversion of the Brook through a channel constructed around the perimeter of the Hedges mine.
2. The site vegetation types which occur on Thirty-Four Mile Brook are relatively widespread in the Boddington area and the flora are not considered exceptional.
3. The Red-eared Firetail, listed on Schedule 2 of the Wildlife Conservation Act (species in need of special attention) is closely associated with Thirty-Four Mile Brook. This is because the Firetail feeds on the seeds of sedges, which are common along the full length of the stream.
4. Baseline surveys identified the lower catchment of the Thirty-Four Mile Brook system to be depauperate in fish fauna, in terms of both species richness and abundance.
5. There are no unique elements in the benthic invertebrate fauna of the Thirty-Four Mile Brook, many of which are found in lakes and swamps across southern Australia.
6. The distribution of freshwater crayfish in the region is related to water permanence. In the ephemeral Thirty-Four Mile Brook, only *Cherax plebeians* (Koonacs) occur. This species is able to burrow to avoid the effects of prolonged drying.

Studies of the distribution of the Red-eared Firetail (*Emblema oculata*), in relation to bauxite mining in the northern jarrah forest and nearby areas of south-western Australia (Nichols et al, 1982), suggested that this species may be more abundant than previous records indicated. The study concluded that the conflict between current land-use practices in the northern jarrah forest (including bauxite mining) and the distribution and abundance of this species appeared minimal, provided streamside vegetation was preserved (Nichols et al, 1982). Worsley Alumina (1994d) indicated:

- most of Thirty-Four Mile Brook would remain undisturbed by the development of the lakes, and would continue to be available for the Red-eared Firetail to feed; and
- laboratory studies and field trials have demonstrated that sedges can be successfully restored in the permanent wetland areas [lakes], which should expand the food resource available to this bird species.

The water supply system for the Boddington Gold Mine is based on a water supply reservoir located on Thirty-Four Mile Brook, some 2.5km south-west of the plant site (Worsley Alumina Pty Ltd, 1987). This reservoir is known as the D4 dam (Figure 1). The water supply in D4 dam is augmented by pumping from the Hotham River during periods of high flow. The only downstream user of Thirty-Four Mile Brook is Worsley Timber Company, and arrangements for compensatory water supplies have been negotiated: offtakes have been provided at five points along the pipeline from the Hotham River to the water supply reservoir, to meet stock watering requirements (Worsley Alumina Pty Ltd, 1987).

The Water Authority of Western Australia has previously identified Thirty-Four Mile Brook as a potential potable water supply and has indicated its long term desire to incorporate the water supply reservoir [D4 dam] into its domestic water supply scheme (EPA, 1985).

In its 1985 report and recommendations (EPA, 1985), the EPA indicated the following:

- "As a result of the water resource and environmental importance of the Thirty-Four Mile Brook it is considered important that its long term water quality is not significantly impaired by the presence of the residue disposal areas."
- "The design, construction and operation of the project should be such that at completion, any pollutants introduced to the stream [Thirty-Four Mile Brook] from the residue areas would not exceed acceptable limits for potable water for public and environmental use."
- "The Thirty-Four Mile Brook could be developed as a small water resource as it has been unaffected by downstream agricultural development. The Water Authority of Western Australia has considered the resource for development some time after the year 2000."

The EPA (1985) recommended that the Worsley Alumina Joint Venturers should conduct progressive rehabilitation, to a land use suitable for ensuring that the water quality of the water supply reservoir [D4 dam], was such that it would be a viable source for public water supply at the completion of the project. In 1987, the Water Authority of Western Australia identified the forested catchment of Thirty-Four Mile Brook as a potential future supply of potable water, and stipulated that this resource should be protected (Worsley Alumina Pty Ltd, 1994a).

In view of the above, Worsley Alumina provided the following commitment in the 1987 Environmental Management Programme:

Commitment 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 [D4 dam] 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.

As a result, the rehabilitation measures proposed and implemented by Worsley Alumina to date for the project have been directed at minimising the potential for adverse water quality deterioration in Thirty-Four Mile Brook, and in particular to minimise increases in water salinity.

In April 1994, Worsley Alumina submitted the Boddington Gold Mine, Life of Project-Rehabilitation Plan for review by the EPA. Worsley Alumina indicated that the proposed strategy was the result of extensive investigation undertaken jointly with Hedges Gold, which operates the adjacent Hedges Gold Mine, and reflects a "whole of catchment" approach to planning. (Worsley Alumina Pty Ltd, 1994b)

Determination of the desired post mining land use(s) for the Thirty-Four Mile Brook has been a key issue in setting the policy framework for developing and progressing the proponent's rehabilitation strategy. In consultation with various government agencies, Worsley Alumina and Hedges Gold have sought to redirect the beneficial use from public water supply to developing the recreation potential of lakes in the Thirty-Four Mile Brook catchment. Inflow of water from Thirty-Four Mile Brook to the proposed lakes is essential for the maintenance of adequate water quantity and quality in the lakes. The fresh yield from the watercourse is essentially required for seasonal flushing of the lakes thereby preventing them from becoming excessively saline. However, connection of the lakes to Thirty-Four Mile Brook will cause an increase in stream salinity levels and as a result water downstream will not be potable. Maintenance of a potable supply is also not consistent with recreational use of the waterbodies upstream.

The development of lakes in the mine pits at both the Hedges and Boddington Gold Mines has been proposed consistent with the emphasis towards recreational use of the catchment.

Comments from submissions

Views of Water Authority of Western Australia

Initial rehabilitation strategies at Boddington Gold Mine were directed principally at protecting the forested catchment of Thirty-Four Mile Brook as a potential future supply of potable water.

In December 1992, Worsley Alumina and Hedges Gold approached the Water Authority of Western Australia (WAWA) to propose an alternative use for Thirty-Four Mile Brook, which incorporated the development of three lakes for recreation and conservation. In response to these enquiries, the economic value of Thirty-Four Mile Brook was assessed for both public water supply and recreational purposes. Neither the potential potable water supply nor the recreational value of the resource was clearly dominant. However, other selection criteria such as the planning, environmental and operational complexities associated with Thirty-Four Mile Brook's small yield increment make it a low priority source for the future water supply strategy for Perth (D Boyd, WAWA, *pers. comm.*).

Accordingly, the Water Authority indicated in a letter of 19 July 1994, to the Department of Resources Development, that it was prepared to forgo use of Thirty-Four Mile Brook for public water supply and support water-based recreation as the primary beneficial use for Thirty-Four Mile Brook on the understanding that recreational use would be of similar value to the State. However, it also stated in the above letter that there should be a secondary beneficial use that required stream flow at the site of the former D4 dam to be of the lowest practical salinity.

Views of the Department of Conservation and Land Management

In its letter of 25 October 1994, to the Department of Environmental Protection, the Department of Conservation and Land Management indicated that it had provided technical advice to Hedges Gold Pty Ltd in support of options for recreational development of the Hedges lake. However, CALM was mindful of WAWA's objectives for development of a potable water supply and deferred to WAWA's position on this matter.

Views of the Department of Minerals and Energy

In its letter of 22 November 1994, to the Department of Environmental Protection, the Department of Minerals and Energy indicated support for the rehabilitation concept proposed by Worsley Alumina.

Evaluation

The EPA recognises that the Water Authority, as the responsible State agency, has designated recreation as the primary beneficial use of Thirty-Four Mile Brook. In regard to the Hedges lake proposal, Croton and Dalton (1993), suggest that the Hedges lake will be the central feature of a proposed recreation area. In responding to issues raised in submissions, the proponent confirmed that the recreational use of Thirty-Four Mile Brook will be focussed primarily on the proposed lakes (Worsley Alumina Pty Ltd, 1994d).

The EPA notes that the proposed lakes will provide the principal focus for future recreational opportunities within Thirty-Four Mile Brook, and notes that water-based recreational opportunities in parts of State Forest are limited, due in part to the need to protect water supply catchments throughout much of the forest. Accordingly, the EPA acknowledges the decision of the Water Authority that the primary beneficial use of Thirty-Four Mile Brook is recreation and considers that with appropriate design and management, lakes should be compatible with this use. The EPA further considers that other opportunities, such as protection of the natural environment and meeting the Water Authority's preferred secondary objective that requires stream flow at the former D4 dam site to be the lowest practical salinity, should also be taken into account.

4.2 Rehabilitation of mine pits and waste dumps

Objective

To ensure that the development of lakes in the mine pits, and overall mine pit and waste dump rehabilitation, is environmentally acceptable.

Technical information

Mining and processing of currently defined gold oxide reserves will be completed in 1999, with basement mining and processing continuing until 2002 (Worsley Alumina Pty Ltd, 1994e). Worsley Alumina (1994a) indicated that at the completion of mining operations, mineral resources would remain beneath most mine pits. These resources could become economically viable in the future and therefore returning unprocessed material to the completed mine pits at the end of mining operations (as is currently required at the Boddington Gold Mine site) would adversely affect the potential for future development of these mineral resources. In addition, Worsley Alumina (1994a) indicated that, because of the shortfall of material available to fill the mine pits, options for final landform design after mining require the formation of lakes, unless additional fill material is mined simply to fill the pits.

Both the proponent and the adjacent Hedges Gold Pty Ltd have conducted detailed studies to determine the optimum lake system. Hedges has carried out studies to assess the extent to which stream flow in Thirty-Four Mile Brook could sustain a lake established in the main mine-pit at Hedges, around which Thirty-Four Mile Brook is currently diverted (Worsley Alumina Pty Ltd, 1994b). If designed as a closed lake system, without connection to Thirty-Four Mile Brook, water levels in the Hedges lake would be likely to fluctuate significantly. In addition, moderately saline groundwater inflow with subsequent evaporation could result in increasing salinity. Following hydrological studies, which suggested that a substantial perpetual lake was feasible based on connection to Thirty-Four Mile Brook, Hedges has developed a conceptual proposal for a deep lake in State Forest, which due to its size (35ha), can provide a water based recreational opportunity. Attention to issues such as public safety will be required at the detailed design stage.

It is proposed that two other deep lakes should be created in forest within the Boddington Gold Mine site (Lakes B and G) (Figure 2). The proponent's preferred option would be for Thirty-Four Mile Brook to be linked to all three lakes as this would ensure that each waterbody would be sustained by a combination of groundwater throughflow and catchment runoff (Worsley Alumina Pty Ltd, 1994a). Thirty-Four Mile Brook is an ephemeral stream which is generally fresh (less than 750 mg/l Total Soluble Salts). Worsley Alumina (1994c) indicated that the Hedges lake is located in the stream zone of Thirty-Four Mile Brook whereas the two Boddington Gold Mine lakes (Lakes B and G) are remote from the stream zone. It is intended to divert the stream through both lakes B and G by means of weirs and channels or pipes although the details of these stream diversion structures have not been finalised (Worsley Alumina Pty Ltd, 1994c).

Worsley Alumina (1994b), suggested that the principal advantages of connection of the Boddington Gold Mine lakes to Thirty-Four Mile Brook would be:

- greater consistency of water levels, through provision of defined overflow levels;
- greater opportunity for creation of engineered shallows (and hence, wetland vegetation); and
- increased flushing of lake waters, minimising risks of lake salinisation.

In response to issues raised in submissions, Worsley Alumina (1994d) has indicated the following in relation to the connection of Lake B to Thirty-Four Mile Brook:

- Lake B will receive overflow from the upstream lakes, so its connection to Thirty-Four Mile Brook cannot rob those lakes of surface water;

- if Lake B were to be isolated from the brook, surplus water would simply flow to the Hotham River. In this situation, the net evaporative loss from Lake B could affect the performance of the other lakes through groundwater drawdown;
- directing surplus water to Lake B serves to counteract this evaporative loss, and retains the surplus water within the overall lake system;
- present estimates are that the outflow from Lake B will be of suitable quality [salinity] for direct release to Thirty-Four Mile Brook;
- should this not prove to be the case, it may be necessary to pipe overflow from Lake B to a point further downstream on Thirty-Four Mile Brook, where the Brook is more saline.

Worsley Alumina (1994a) indicated that the efficacy of the lake system would depend largely on water quality and hydrological stability and that this may be enhanced by not backfilling the deeper mine pits so that groundwater flow into the lakes from the bedrock aquifer remains unimpeded. Any placement of mining waste, which is predominantly clay, into the proposed lakes will have the effect of sealing the lake bed, thereby impeding groundwater flow from the bedrock and reducing lake flushing (Worsley Alumina Pty Ltd, 1994a). This could increase the risk of salinisation because evaporation from the lakes exceeds rainfall by 600mm/yr (Croton & Dalton, 1993). Lake salinity stabilises at very high groundwater inflow rates, due to the flushing effect of the groundwater (Worsley Alumina Pty Ltd, 1994c).

With no groundwater inflow, lake water levels would also fluctuate and a maximum lake level variation of 10m for lake B and 3.5m for lake G was projected (Worsley Alumina Pty Ltd, 1994c). Worsley Alumina also indicated that significant level variations could influence the environmental and recreational value of the lakes and suggested that the establishment and viability of wetland and fringing lake vegetation and shallows or islands for wildlife could be adversely affected. However, Worsley Alumina (1994c) has acknowledged that rates of groundwater flow into the Boddington Gold Mine lakes are the most significant area of uncertainty regarding the hydrology of the lake system and that on-going studies are required to improve the detailed understanding of groundwater hydrology and/or establish means of minimising its significance.

The construction of shallows before filling is essential to the establishment of a viable aquatic ecosystem, and will enhance the accessibility of the lake for recreational purposes. The Boddington Gold Mine lakes would provide a valuable drought refuge to migratory water-birds and would have moderate biological activity (Worsley Alumina Pty Ltd 1994b)

Worsley Alumina (1994e) indicated that recreational use of the Boddington Gold Mine lakes was inappropriate in the short to medium term, due to the proximity of Worsley Alumina's bauxite mining operations. The Boddington Gold Mine area forms a significant part of the medium-term bauxite reserve of the Worsley Alumina project, with bauxite mining scheduled to take place in the area in about 25 years (Worsley Alumina Pty Ltd, 1994b). However, the lakes would provide an ecologically valuable wetland system in the interim and a potential recreational resource in the longer term.

Worsley Alumina (1994a) has indicated that it is not sufficiently advanced in its mine development to produce detailed lake designs. Worsley Alumina also indicated that before rehabilitation, plans depicting lake contours, water inflow and outflow structures, and proposed vegetation types will be developed in consultation with the State. The Hedges lake will be progressively developed from 1997 and will provide a model for the subsequent development of the Boddington Gold Mine lakes.

Landforms within the mining area (including waste stockpiles, water supply reservoirs D1 and D4, haul roads, processing plant areas etc) will be shaped to complement the regional topography. All disturbed land will be rehabilitated. Worsley Alumina (1994a) has provided a new commitment (commitment 27, Appendix 3), that detailed rehabilitation prescriptions for the mining area will be developed with the primary objectives of stabilising land surfaces, minimising erosion, minimising the risk of saline groundwater seepage, and providing a sustainable vegetation system. Local provenance native species will be used where possible, although other species may be used where they provide advantages in meeting the primary objectives. Rehabilitation choices will depend on the wishes of the land holder. This land is currently owned by Worsley Alumina.

Comments from submissions

Views of the Water Authority of Western Australia

The Water Authority in its letter of 17 October 1994, has indicated that overall, Worsley Alumina's report, "Boddington Gold Mine Rehabilitation Strategy and Review of Environmental Commitments", satisfies the Water Authority's requirements for rehabilitation of the mine site.

Views of the Department of Conservation and Land Management

The Department of Conservation and Land Management has indicated in its letter of 25 October 1994, that the option to isolate the proposed Boddington Gold Mine Lakes from Thirty-Four Mile Brook and the Hedges Lake should remain, in the event that hydrologic performance is not as predicted and all three lakes cannot be maintained to acceptable criteria. CALM stated that it would be preferable to have one good lake than three poor ones.

In addition, CALM stated that the issue of surface stabilisation cannot be overemphasised. Erosion could significantly enhance phosphate mobilisation into the lake system. Accordingly, vegetation establishment techniques on steep slopes and the ability to prevent significant soil erosion would have to be well demonstrated. CALM stated that the use of a low solubility form of phosphate fertiliser may be appropriate.

Views of the Department of Minerals and Energy

In its letter of 22 November 1994, to the Department of Environmental Protection, the Department of Minerals and Energy (DME) indicated support for the concept of rehabilitation of the mined areas to a state compatible with recreational use, recognising that this will allow Worsley Alumina to rehabilitate waste dumps *in situ* and not require complete backfilling of voids.

DME has indicated it would be recommending to the Minister for Mines that lease conditions be modified so as to bind the operator to the proposed land use concept and to ensure rehabilitation is completed to appropriate standards acceptable to the State.

Views of other submitters

Public submissions indicated the following concerns:

- that the design of the lakes did not appear suitable for wildlife—they are too deep and steeply sided which will allow substantial waves to occur and waterbirds do not like deep, rough water;
- waterbirds require a range of depths, wetlands with sloping edges and extensive littoral areas are attractive and provide opportunities for feeding for a range of waterbirds;
- the area should be returned to native vegetation and the landforms should harmonise with the natural landscape;
- the waste heaps should be contoured and restored so that they blend in with the undisturbed landscape; and
- vegetation should be selected to provide wildlife habitat and to restore the landscape after mining.

Evaluation

The primary beneficial use of Thirty-Four Mile Brook is now water-based recreation (see 4.1 above). Previous rehabilitation strategies which were intended to maintain potable water standards, consistent with environmental conditions and commitments, have now been shown to be unlikely to be successful. They have been replaced by a rehabilitation strategy which has evolved from a cooperative catchment-based approach to rehabilitation between the Boddington Gold Mine and the adjacent Hedges Mine.

While the EPA broadly accepts the rehabilitation strategy proposed by Worsley Alumina for the Boddington Gold Mine, it recognises that significant elements of the rehabilitation strategy, particularly the development of lakes in the mine pits, are based upon hydrological and other

studies which have proved difficult because of the sheer complexity of the hydrogeological conditions in the area.

In responding to submissions, Worsley Alumina (1994d), has indicated that:

- the hydrology of the proposed Boddington Gold Mine lakes has been thoroughly reviewed in consultation with officers from the Water Authority to determine probable long-term performance;
- a conservative modelling approach has been used and all available data (eg: streamflow, rainfall, aquifer transmissivity) has been incorporated to produce estimates of water quality and surface level ranges;
- this information has been compiled into a technical report, *Surface Hydrology and Water Balance of the Proposed BGM/Hedges Lake System* (Worsley Alumina Pty Ltd, 1994c) which has recently been submitted to relevant government agencies; and
- the hydrology review indicated that the combination of groundwater from the bedrock aquifer and surface flow from the catchment area will provide sufficiently stable lakes of acceptable [salinity] quality.

Although the principles influencing the hydrogeology of the Boddington Gold Mine lakes have become apparent, much of the work to date must be regarded as indicative of what may be expected. More detailed studies of the groundwater hydrology of the area should be undertaken to confirm short term and long term interactions between the proposed lakes and the groundwater system. Final lake water balance, based on stream flow in Thirty-Four Mile Brook, groundwater flow and runoff from surrounding areas is required. Final detailed rehabilitation designs for the lakes, including options for isolating lakes in the event that hydrologic performance is not as predicted, have not been provided. Therefore, while the EPA accepts the principle of incorporating lakes in the mine pits as a final landform feature, it is considered that on-going refinement of the rehabilitation strategy will be necessary. The EPA considers that the following recommendation is therefore appropriate.

Recommendation 1

At least 12 months prior to decommissioning the mine pits, the proponent should prepare and subsequently implement an Environmental Management Programme for the inclusion of lakes as final landform features within the mine pit areas. The Environmental Management Programme shall include, but not be limited to, the following:

(1) lake design, including:

- **the proposed connection to Thirty-Four Mile Brook;**
- **the partial return of mine waste as backfill to mine pits where required for the necessary creation of shallow water areas or islands for wildlife use;**
- **inflow and outflow options for the management of water quality and quantity in the lakes and Thirty-Four Mile Brook, including options for isolating the lakes; and**
- **slopes and proposed vegetation types including wetland plant species;**

(2) target minimum, maximum and optimum water levels in the lakes based on stream flow in Thirty-Four Mile Brook, groundwater flow and runoff from surrounding areas;

(3) water quality criteria to ensure the maintenance of appropriate water quality in the lakes and Thirty-Four Mile Brook;

(4) predicted groundwater and surface water hydrological responses and impacts on long term salinity in the lakes and Thirty-Four Mile Brook; and

(5) **the development of a comprehensive monitoring, management and reporting programme.**

The fulfilment of these provisions should meet the requirements of the Department of Environmental Protection on advice of the Water Authority of Western Australia, the Department of Minerals and Energy and the Department of Conservation and Land Management.

The Environmental Protection Authority notes that a large amount of information exists concerning wetland management, including construction of artificial wetlands. The proponent should ensure that the most recent information is obtained to assist in the preparation of the Environmental Management Programme required by recommendation 1.

In addition to waste stockpiles, mine pits and residue disposal areas, other project areas requiring rehabilitation include the following:

- water supply reservoir D1;
- water supply reservoir D4;
- Hotham River pump station and pipeline;
- haul roads outside the pit area;
- contractors' camp;
- metallurgical treatment plant;
- office complex and workshop areas;
- communications tower;
- 132kV power transmission line; and
- residue pipeline corridors.

The EPA notes that a number of the proponent's commitments, in particular commitments 19, 20, 27, 29 and 30 (Appendix 3), include rehabilitation, monitoring and reporting requirements. The EPA supports Worsley Alumina's high level of commitment toward rehabilitation of the Boddington Gold Mine site. The EPA also notes DME's intention to recommend to the Minister for Mines that lease conditions be modified so as to bind the operator to the proposed land use concept and to ensure rehabilitation is completed to appropriate standards acceptable to the State. Accordingly, the EPA considers that the following recommendation is appropriate.

Recommendation 2

The proponent should rehabilitate the Boddington Gold Mine site and environs and remove associated infrastructure, to meet the requirements of the Department of Environmental Protection and the State Mining Engineer with advice from other agencies, as appropriate.

4.3 Rehabilitation of residue disposal areas

Technical information

Salinity classes

The Western Australian Water Resources Council (1991), has defined salinity as the measure of the total soluble (or dissolved) salt (mineral constituents) in water. Water resources are classified on the basis of salinity in terms of milligrams per litre Total Soluble Salts (mg/l TSS) and the following salinity classes have been identified (Western Australian Water Resources Council, 1991):

- Fresh - less than 500 mg/l TSS;
- Marginal - 500-1000 mg/l TSS;
- Brackish - 1000-3000 mg/l TSS;
- Saline - Greater than 3000 mg/l TSS; and
- Potable - Fresh and marginal water, generally considered suitable for human and stock consumption.

Heavy metals

The content of heavy metals, such as arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc, in wastewater discharges and receiving waters has historically been regulated at the Boddington Gold Mine through EPA licence conditions (Worsley Alumina Pty Ltd, 1994d).

Worsley Alumina (1994d), monitors metal levels in both the Hotham River and Thirty-Four Mile Brook through direct water sampling, and "biomonitoring" using the fresh water mussel *Westralunio carteri*. Worsley Alumina (1994d), has indicated that:

- biomonitoring of Thirty-Four Mile Brook has shown four metals, namely, manganese, molybdenum, arsenic and cadmium to be elevated in comparison to a control catchment;
- elevated manganese is probably derived from the Hotham River water which is pumped to the Boddington Gold Mine for process requirements;
- molybdenum, arsenic and cadmium are elements which are naturally elevated in the greenstone rocks which host the gold deposit but have always been well within statutory criteria for potable water;
- the Boddington Gold Mine gold refining process itself does not introduce any exotic metals; and
- biomonitoring has demonstrated that some metals (eg: copper, mercury, and zinc) actually decreased over control values.

Worsley Alumina (1994d), suggested that data from monitoring programmes at Boddington Gold Mine have demonstrated that most of these metals pose no environmental problem at the minesite.

Residue management

The proponent intends to manage the discharge of water from the residue disposal areas to minimise its impact and has identified three consecutive stages associated with water management (Figure 3).

Process residue from the Boddington Gold Mine operation is currently stored in two engineered residue disposal areas in the head waters of Thirty-Four Mile Brook. The residue is a finely ground mixture of clay and rock which has been slurried with saline water from the Hotham River. When residue deposition stops, residue salinities are projected to be approximately 10,000 mg/l in the surface layers of the residue disposal areas (Worsley Alumina Pty Ltd 1994a). Metals, other than gold, from the ore are deposited with the process residue.

The aims of the residue disposal area rehabilitation programme will be to improve drainage and to leach surplus salt from the upper levels of the residue in the early years of rehabilitation to support a self sustaining vegetation system. The proponent indicated, with rainfall input over time, runoff water from the residue disposal areas would improve, and was expected to approach pre-mining quality. Prior to mining, Thirty-Four Mile Brook was a fresh water stream (Worsley Alumina Pty Ltd, 1994c). However, in the short-term, flushing of the newly rehabilitated surface of the residue disposal areas with rainfall may result in poor runoff water quality, due to the salts, metals, and cyanide complexes present in the residue. Studies to characterise the quality of the runoff from the residue disposal areas are on-going (Worsley Alumina Pty Ltd, 1994d). Worsley Alumina propose a three-stage process to manage this runoff.

Stage 1

It is likely that the most saline runoff from the residue disposal areas will occur in the initial years after rehabilitation, while revegetation is becoming established (Worsley Alumina Pty Ltd, 1994d). Therefore, in the first stage, the proponent plans to collect salty run-off and seepage from the residue disposal areas in a second water supply reservoir, the D1 Dam, during the period of salt removal, and to pipe water from there to the already salty Hotham River (Figure 3). Worsley Alumina (1994a) proposes that water which is diverted from D1 Dam to the Hotham River via an existing pipeline system, would be controlled so as to cause no greater than 10 per cent increase in the salinity of the Hotham River at any time.

Kinhill (1990), quoted in the proponent's response to submissions (Worsley Alumina Pty Ltd, 1994d), indicates that the long-term weighted average stream salinity in the Hotham River is 3400 mg/l TSS, ranging from 1000 mg/l TSS in winter to more than 6000 mg/l TSS in summer. This places the Hotham River in the brackish to saline range. Worsley Alumina (1994d) considers, that in view of the degraded nature of the Hotham River, and the extreme annual variations in salinity, a 10 per cent increase in salinity is insubstantial and represents a "worst case scenario". The proponent considers that it is likely that the discharge from the D1 Dam will typically be less saline than the Hotham River and will in fact dilute it. This is because rain will flush and mix with saline water in the residue disposal areas before flowing to the D1 dam where it will be further diluted by mixing with catchment runoff before being released to the Hotham River (Worsley Alumina Pty Ltd, 1994d).

Worsley Alumina propose that heavy metal discharges would be within criteria for agricultural water usage during Stage 1, which is considered by the proponent to be consistent with the present quality and usage of the Hotham River.

Stage 2

Worsley Alumina (1994a) suggested that as the salt content of the upper levels of the residue decreased and vegetation was established, the salinity of runoff and seepage which is collected in the D1 Dam would also reduce.

Worsley Alumina (1994a) indicated that when salinity decreased to 3000 mg/l TSS, controlled discharge into Thirty-Four Mile Brook would start (Figure 3). This represents the second stage of the water management programme. The 3000 mg/l TSS level is considered by the Water Authority as the upper limit of "brackish" water, and is consistent with the primary beneficial catchment use of "recreation" as defined by the State (Worsley Alumina Pty Ltd, 1994d). The proponent expects that the salinity of run-off from the residue disposal areas would steadily decline and stabilise at levels well below 3000 mg/l TSS in the long term (Worsley Alumina Pty Ltd, 1994d).

Prior to mining, maximum and minimum salinity levels in the upper catchment of Thirty-Four Mile Brook were below 500 mg/l TSS, which is considered fresh water. Since mining and residue disposal operations have commenced, yearly salinity levels in Thirty-Four Mile Brook have ranged from less than 500 mg/l TSS in periods of high stream flow to 5000 mg/l TSS in low flow periods (R Williams, Worsley Alumina Pty Ltd, *pers. comm.*). Salinity levels of less than 5000 mg/l are considered an acceptable impact limit under current water pollution control licence conditions (licence number 4594), for the project.

The proponent considers discharge of water at 3000 mg/l TSS into Thirty-Four Mile Brook is unlikely to have a significant effect on its ecological function. Long term water qualities [salinity] in the proposed lake system upstream of Lake B are predicted to be comparable to existing levels (Worsley Alumina Pty Ltd, 1994d). However, the additional evaporative loss and groundwater mixing in Lake B, [compared with Lake G and the Hedges lake], may cause the water to become brackish at this point. The discharge from Lake B could affect approximately 1.2km of riparian vegetation (ie: 10 per cent of the length of the forested portion of Thirty-Four Mile Brook) (Worsley Alumina Pty Ltd, 1994d).

Worsley Alumina (1994a) indicated that outflow from Lake B should be of suitable quality for direct release to Thirty-Four Mile Brook. Therefore, if the water is brackish, Worsley Alumina has recognised it may be necessary to pipe overflow from Lake B to a point further downstream on Thirty-Four Mile Brook, where naturally brackish groundwater discharges into the stream .

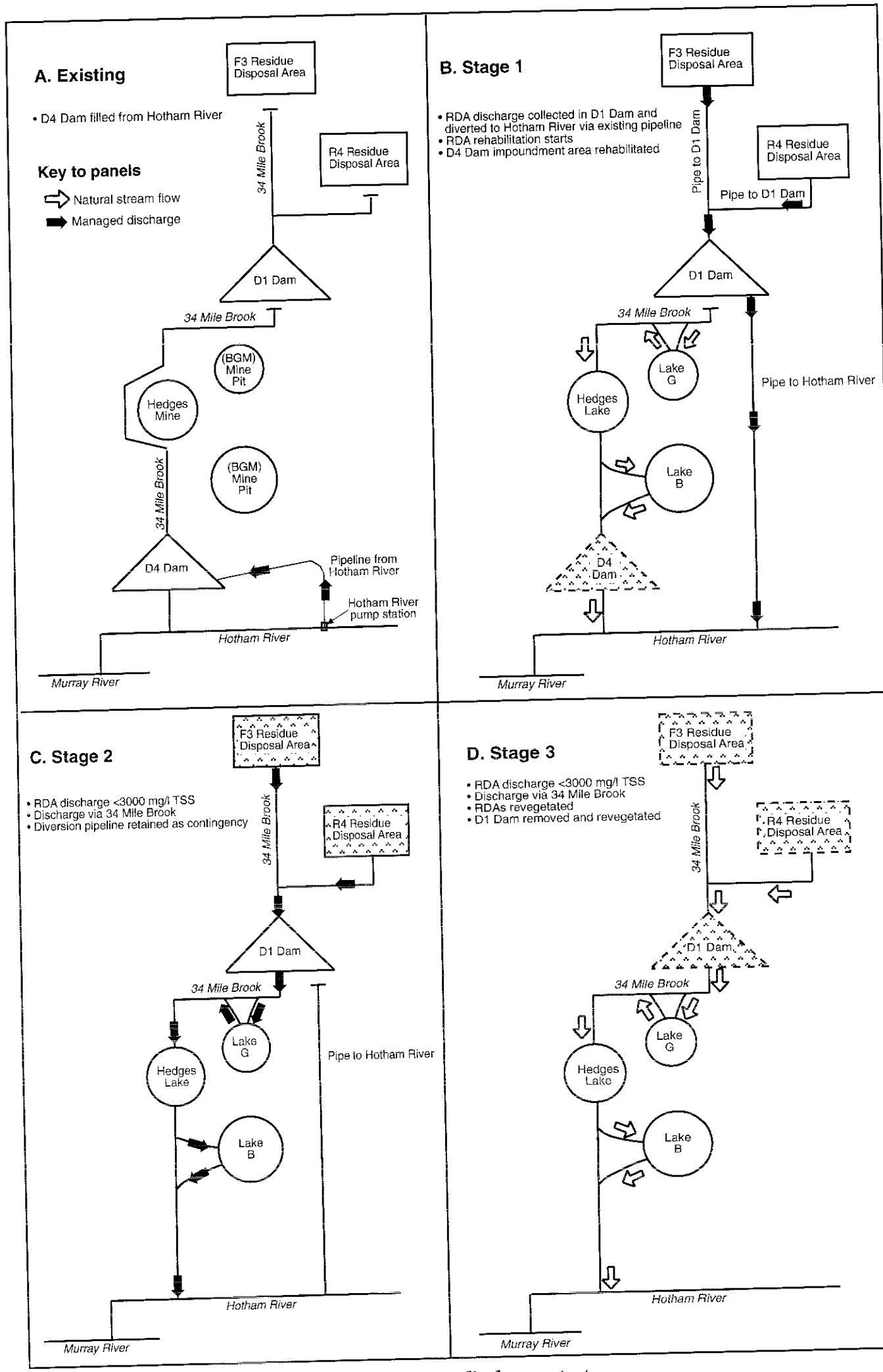

Figure 3. Residue disposal areas — staged water discharge strategy.

Worsley Alumina propose that heavy metal discharges would be within potable water criteria during Stage 2, which is considered by the proponent to be consistent with the potential recreational usage of the downstream lakes and is more stringent than required by existing licence conditions.

Stage 3

Worsley Alumina (1994a) stated that once monitoring has demonstrated, to the satisfaction of the State, that the runoff water quality has stabilised or is continuing to improve beyond the criteria for release to Thirty-Four Mile Brook, the D1 Dam would be decommissioned and rehabilitated and subsequent runoff from the residue disposal areas would flow unimpeded down Thirty-Four Mile Brook (Figure 3). This represents the third stage of the water management programme.

Existing policy framework

The Australian and New Zealand Environment and Conservation Council (ANZECC), has developed the *Australian Water Quality Guidelines for Fresh and Marine Waters* (ANZECC 1992). The guidelines are derived from a vast body of scientific information and management experience on the water quality required to sustain the range of environmental values that Australian waters may support (EPA, 1993).

The EPA's draft report, *Western Australian Water Quality Guidelines for Marine and Fresh Waters* (EPA, 1993), is based on the Australian Guidelines and modified to suit local West Australian conditions. In 1993, the EPA stated that: "The *Western Australian Water Quality Guidelines for Marine and Fresh Waters* provides the most up to date and comprehensive set of guidelines available for the range of aquatic environments found in Western Australia and, as such, should be regarded as the primary reference for dealing with water quality issues in this State." (EPA, 1993)

Guidelines required to protect aquatic ecosystems are often the most stringent, and generally ensure that other related environmental values, such as edible fish and shellfish, and wildlife are also protected (EPA, 1993). The discharge criteria for heavy metals proposed by Worsley Alumina for the Hotham River are consistent with the ANZECC water quality guidelines and the draft EPA water quality guidelines (EPA, 1993) for agricultural water use, specifically for livestock watering.

The discharge criteria for heavy metals proposed by Worsley Alumina for Thirty-Four Mile Brook are consistent with the ANZECC water quality guidelines and the draft EPA water quality guidelines (EPA, 1993) for 'raw water for drinking water supply'.

Table 1 in Appendix 4 of this report indicates the relevant criteria for the metals historically regulated at the Boddington Gold Mine through EPA licence conditions. Ultimately, revised licence conditions on the discharge criteria will be set under Part V of the Environmental Protection Act.

Comments from submissions

Views of the Water Authority of Western Australia

The Water Authority in its letter of 17 October 1994, has indicated that, overall, the requirements for rehabilitation of the mine site are satisfactory. However, the Water Authority has indicated its preference for the water quality discharge criteria to Thirty-Four Mile Brook to be consistent with guidelines prepared by a joint committee of the National Health and Medical Research Council and the Agricultural and Resource Management Council of Australia and New Zealand, outlined in their 1994 draft report *Australian Drinking Water Guidelines* (NHMRC, 1994) The criteria preferred by the Water Authority are included in Table 2 in Appendix 4 of this report.

The Water Authority has also indicated that the section of Hotham River adjacent to Boddington Gold Mine is listed in the Perth-Bunbury Draft Regional Plan as a significant river for

ecosystem maintenance (Western Australian Water Resources Council, 1991). However, the Water Authority does not have enough information to confirm if the water quality criteria for agricultural use proposed by Worsley Alumina are acceptable for maintaining the ecosystem of this water body. This indicates that the Water Authority considers that water quality should meet the standards required for ecosystem maintenance.

Views of the Department of Conservation and Land Management

The Department of Conservation and Land Management has also raised questions regarding the rationale behind the proposed discharge criteria for the Hotham River and the impacts on ecosystems downstream.

Evaluation

Salinity - Hotham River and Thirty-Four Mile Brook

The EPA acknowledges that the Water Authority has designated water-based recreation as the primary beneficial use for the Thirty-Four Mile Brook and that the secondary objective should require the streamflow at the former D4 Dam site to be the lowest practical salinity.

In view of the above, it is unlikely that Thirty-Four Mile Brook can be used as a potable water supply by the Water Authority of Western Australia. However, it is possible it could be considered as a supplementary source for dilution with a fresher source if needed. Accordingly, the comments of the Water Authority regarding the proposed discharge criteria on the salinity levels in Thirty-Four Mile Brook and the Hotham River are considered important by the EPA. In its letter of 17 October 1994, to the EPA, the Water Authority did not identify any specific concerns with the residue disposal area rehabilitation strategy in regard to discharge criteria affecting the salinity levels of the Hotham River or Thirty-Four Mile Brook. The EPA notes from Table 2 in section 3 of this report and advice from the Department of Environmental Protection, that the Water Authority has been involved in extensive and on-going negotiations with the proponent regarding salinity levels and other aspects of the rehabilitation strategy.

The effect of salinity on fauna such as fish, crustacea, invertebrates, reptiles and mammals is unclear. Researchers state generally that as salinity increases, the variety of life that can tolerate it diminishes (Western Australian Water Resources Council, 1992).

The EPA understands that for Stage 1 of the water management programme, discharge of water from the residue disposal areas will be routed via the D1 Dam, prior to controlled discharge to the Hotham River. While discharges from the residue disposal areas contain elevated levels of salt and other contaminants, it will be necessary to pipe these flows from the residue disposal areas to D1 Dam, rather than using the watercourse. Due to dilution effects in D1 Dam, discharges from that point are likely to be less saline than the Hotham River. Accordingly, it is considered that the salinity of the discharge water is unlikely to affect the existing environment of the Hotham River to a significant degree.

In regard to Thirty-Four Mile Brook, the EPA recognises that the watercourse has been subject to considerable alteration and disturbance (section 4.1) and that since mining operations commenced, the existing biota found in the watercourse have been influenced by salinity levels which currently range from less than 500 mg/l to 5000 mg/l.

In addition, the EPA understands from the proponent that:

- the rate of discharge will be controlled to minimise salinity increase in the brook; and
- facilities to divert saline water to the Hotham River will be retained until monitoring has satisfied the State that residue area runoff water quality has stabilised or is continuing to decline below the 3000 mg/l TSS criterion proposed for release to the brook.

In view of the above, and the proponent's commitments, in particular commitments 21, 23, 24, 25 and 29 (see Appendix 3), the EPA considers that the discharge of water associated with Stage 2 of the water management programme, in accordance with the proposed salinity criterion, is unlikely to affect the existing environment of Thirty-Four Mile Brook to a significant degree.

Heavy metals - Hotham River

The Water Authority and the Department of Conservation and Land Management have raised concerns regarding the water quality discharge criteria for heavy metals to both the Hotham River and Thirty-Four Mile Brook. The Western Australian Water Resources Council (1992) indicates that the cumulative behaviour of heavy metals and some pesticides is one of the major concerns about their use. "They can accumulate in the liver, gills and pancreas of aquatic organisms and cause both acute and chronic effects, including lesions, reduced fertility and general environmental stress. Heavy metals can be concentrated in their surroundings. These concentrated heavy metals and persistent pesticides can be passed up the food chain to predators, including humans. Also, some aquatic plants are directly affected by heavy metals."(Western Australian Water Resources Council, 1992)

The discharge criteria proposed by Worsley Alumina for the Hotham River are derived from the ANZECC (1992) report and reflected in EPA Bulletin 711 (EPA, 1993) (see Appendix 5). However, the criteria proposed are water quality guidelines established for livestock watering, which do not take account of environmental factors. Previous studies undertaken by Streamtec Ecological Consultants (1990) for Worsley Alumina and Hedges Gold, have indicated that:

- the fauna from the Hotham River include high proportions of salt tolerant Crustacea (Ostracoda, Amphipoda and Decapoda);
- insects form only a relatively minor proportion of the fauna in contrast to typical streams and rivers;
- the density of benthic invertebrate fauna in the Hotham River system is considerably higher than those recorded for forest streams in Western Australia;
- the fish fauna associated with the area are represented by five species including, the Native Minnow (*Galaxias occidentalis*), the Blue-Spot Goby (*Pseudogobius olorum*), the Nightfish (*Bostockia porosa*), the introduced Red-Fin Perch (*Perca fluviatilis*) and Mosquitofish (*Gambusia affinis*); and
- the current level of heavy metals in the Hotham River is low, with the exception of iron and manganese.

The EPA also notes that the section of Hotham River adjacent to Boddington Gold Mine is listed in the Perth-Bunbury Draft Regional Plan, (Western Australian Water Resources Council, 1991), as a significant river for ecosystem maintenance. Havel (1989), quoted in the report by Streamtec Ecological Consultants (1990), suggests that the regional significance of the Hotham River is its position as a tributary to the Murray River upstream of the Lane Poole Reserve, the largest conservation reserve in the Northern Jarrah Forest.

Based on the above, the EPA has adopted a precautionary approach in relation to the proposed discharge from the residue disposal areas to the Hotham River and considers that water quality discharge criteria for heavy metals should be based on environmental criteria. Worsley Alumina (1994d), has indicated that setting of overly-stringent criteria could significantly delay the point at which water from the upper catchment can be made available to help sustain the lakes and ensure their viability. Therefore, in recommending this approach it is recognised that the timing of elements of the rehabilitation strategy, particularly the development of lakes, may be affected. The EPA considers that, if the proponent wishes to have the criteria for heavy metal discharges relaxed, it is incumbent on the proponent to demonstrate that the existing environmental values of the river will not be compromised.

Recommendation 3

The quality of discharge water from the residue disposal areas and the D1 Dam to the Hotham River should, in the case of inorganic toxicants, conform with the guidelines for protection of aquatic ecosystems in Table 2.2 of Environmental Protection Authority Bulletin 711 (EPA, 1993).

Table 2.2 of Environmental Protection Authority Bulletin 711 is included as Appendix 5 in this report.

Heavy metals—Thirty-Four Mile Brook

The Boddington Gold Mine is a "prescribed premises" as defined by the Environmental Protection Act 1986, and is therefore subject to operating licence conditions. Under the existing licence for Boddington Gold Mine, the nature and composition of any surface waters such as surface seeps, streams, springs, wetlands or brooks potentially affected by the residue disposal areas, shall in the case of metals, conform to recommended quality criteria for livestock as given in the Australian Water Resources Council technical paper No. 77 titled "Australian Water Quality Criteria for Heavy Metals". This condition essentially applies to unplanned discharges or small leaks. It is noted that the existing water pollution control licence conditions and criteria therein are based upon a containment strategy which seeks to prevent discharge of wastes from the residue disposal areas.

However, the proponent's proposed new rehabilitation strategy incorporates the intentional, staged release of large volumes of discharge water from the residue disposal areas. The Water Authority has recommended discharge criteria to Thirty-Four Mile Brook which are more stringent than the criteria proposed by Worsley Alumina and the criteria required by existing licence conditions. It is anticipated that the licence conditions will need to be changed at the appropriate time to reflect the water pollution control requirements arising from the staged discharge component inherent in the new rehabilitation strategy.

The EPA considers that defining water-based recreation as the primary beneficial use for Thirty-Four Mile Brook should not imply that the existing environmental values of the watercourse have been diminished or should be abandoned.

Worsley Alumina (1994d), has indicated that the recreational use of Thirty-Four Mile Brook will be focussed primarily on the proposed lakes. It is considered that passive, water based recreation (unpowered boating), may not be inconsistent with the maintenance of environmental values.

The EPA considers that while the local environmental value of Thirty-Four Mile Brook should be maintained, the environmental values of the brook are unlikely to be regionally significant. In arriving at this conclusion, the EPA has recognised that the watercourse within the mining areas and downstream has been subject to disturbance associated with diversion around mining areas, the placement of structures such as weirs and storage dams and to farmland clearing downstream of the D4 Dam. Only about 1.2km of the brook remains largely undisturbed. For this reason the EPA believes that the watercourse could be utilised as part of a properly managed residue disposal area water management programme provided that the primary and secondary beneficial uses and the existing environmental functions are maintained.

Although the residue disposal area discharge criteria proposed by Worsley Alumina for Thirty-Four Mile Brook conform with 'raw water for drinking water supply' guidelines, they do not necessarily take account of environmental factors. While localised deterioration of an aquatic ecosystem, due to degradation of water quality, may be reversible, in general the recovery of the abused system to its former state is far more costly than prevention of the abuse. (EPA, 1987b)

Based on the above, the EPA has adopted a precautionary approach in relation to the proposed discharge from the residue disposal areas to the Thirty-Four Mile Brook and believes that water quality discharge criteria for heavy metals should be based on environmental criteria.

Recommendation 4

The quality of discharge water from the residue disposal areas and D1 Dam to the Thirty-Four Mile Brook, should, in the case of inorganic toxicants, conform with the guidelines for protection of aquatic ecosystems in Table 2.2 of Environmental Protection Authority Bulletin 711 (1993).

Table 2.2 of Environmental Protection Authority Bulletin 711 is included as Appendix 5 in this report.

The conditions and criteria for discharge from the residue disposal areas to both the Hotham River and Thirty-Four Mile Brook may require a works approval under Part V of the Environmental Protection Act and should take account of the recommendations in this report.

4.4 Assessment of existing environmental conditions and commitments

The Boddington Gold Mine is currently subject to environmental conditions and commitments set as a result of environmental impact assessment of the proposals listed in Table 3.

Table 3. Summary of proposals assessed for the Boddington Gold Mine

Proposal	EPA Bulletin No.	EPA Assessment No.	Date of Minister for the Environment's Statement	EPA Statement No.
Boddington Gold Mine (BGM) Proposal	219	not applicable	assessment pre-dates the Environmental Protection Act 1986	not applicable
BGM Enhancement of Facilities	313	156	15 Feb 1988	19
BGM Projects Expansion of Facilities Stage 2	361	182	8 Dec 1988	49
BGM, Mining and Processing of Supergene/Basement Ores	408	238-A	22 Nov 1989	85
BGM, Mining and Processing of Supergene/Basement Ores (Sec 46)	430	238-B	8 June 1990	100
BGM, Development of Eastern Anomalies	661	700	21 Jan 1993	299

Objective

The objective of reviewing existing conditions and commitments is to achieve one environmental statement and one list of proponent commitments that provides for adequate protection of the environment and for efficient and effective environmental auditing of compliance criteria. It is also considered that this objective will assist the public, the proponent and relevant agencies to more easily identify environmental requirements associated with the Boddington Gold Mine.

4.4.1 Changes to environmental conditions

The EPA has taken this opportunity to review, revise and consolidate existing environmental conditions. Recommended changes are made in this section, and these are summarised in Table 4. Table 4 should be examined in conjunction with Table 3 above, and the original environmental conditions in Appendices 1(a) to 1(e). The recommended draft environmental conditions arising from the proposed new rehabilitation strategy and the review of previous environmental conditions appears in Section 7 of this report.

Table 4. Summary and evaluation of changes to environmental conditions set by the Minister for the Environment

State-ment No.	Original Condition No.	Issue	Evaluation	New Condition number
19	1	Adhere to proposal	This is a standard condition - now updated.	1-1
	2	Water supply— pumping must not reduce river flow below 342 kl/hr	Carried over and modified to conform with current style.	3-1, 3-2
	3	Water supply	This condition has been met to the satisfaction of the Minister for Water Resources. Letter received by Worsley Alumina, 27 April 1989.	deleted
	4	The minimum flow rate to be reviewed	This condition has been met to the satisfaction of the Water Authority of WA, 6/8/90 and the EPA, 5/10/90.	deleted
	5	Minimum water flow rate to be modified following review	This condition has been met to the satisfaction of the Water Authority of WA, 6/8/90 and the EPA, 5/10/90.	deleted
49	1	Adhere to proposal	This is a standard condition - now updated.	1-1
	2	Adhere to original commitments	This is a standard condition - now updated.	1-1
	3	Construction of new water storage reservoir and modifications to residue storage area.	This condition has been met. Proponent design reports of April and May 1989. Construction and modifications completed to the satisfaction of the DEP.	deleted
	4	Water supply	This condition has been met to the satisfaction of the Minister for Water Resources. Letter received by Worsley Alumina, 27 April 1989.	deleted
85	1	Adhere to proposal	This is a standard condition - now updated	1-1
	2	Drainage from waste and ore stockpiles	This condition has been met to the satisfaction of the EPA, 16/8/90.	deleted
	3	Water supply	This condition requires that extraction of water is in accordance with relevant conditions in Statement 19. Condition 2-1 of Statement 19 has been carried over, the remaining conditions have been met.	3-1, 3-2
	4	Rehabilitation of the site to maintain water quality in Thirty-Mile Brook for public water supply	This condition is inconsistent with the proposed new rehabilitation strategy. Detailed evaluation of this issue is provided in Section 4 of this report.	deleted
	5	Transfer of ownership	This is a standard condition - now updated.	8-1

Table 4. Summary and evaluation of changes to environmental conditions set by the Minister for the Environment (cont'd)

State-ment No.	Original Condition No.	Issue	Evaluation	New Condition number
100	1A	Adhere to proposal	This is a standard condition - now updated.	1-1
	1B	Adhere to commitments	This is a standard condition - now updated.	1-1
299	1-1	Adhere to commitments	This is a standard condition - now updated.	1-1
	2-1	Adhere to proposal	This is a standard condition - now updated.	1-1
	3-1	Decommissioning	This is a standard condition - now updated	7-1, 7-2
	3-2	Decommissioning	This is a standard condition - now updated	7-1, 7-2
	4-1	Transfer of ownership	This is a standard condition - now updated	8-1
	5-1	Time limit on approval	The development of the eastern anomalies project has substantially commenced.	deleted
	6-1	Compliance auditing	This is a standard condition - now updated	9-1, 9-2

4.4.2 Changes to proponent commitments

Worsley Alumina in consultation with the Department of Environmental Protection has taken this opportunity to review, revise and consolidate existing environmental commitments. Worsley Alumina has amalgamated all previous commitments for the Boddington Gold Mine and removed those which either duplicate existing statutory (especially licensing) requirements, or have already been met. Other commitments have been updated or amalgamated to avoid repetition. The current list of environmental commitments for Boddington Gold Mine approved as part of the Supergene/Basement extension in October 1989, is included in Appendix 1(c). The proposed new consolidated and updated list of environmental commitments is included as Appendix 3. Table 5 summarises the changes to the proponents environmental commitments.

Table 5. Summary and evaluation of changes to proponent's environmental commitments

Original proponent commitment No. (from Appendix 1(c))	Issue	Evaluation	New proponent commitment No.(see Appendix 3)
3	Forest hygiene (dieback) management.	Modified to enable on-going revision.	3
4	The operation will be licensed under the Environmental Protection Act, 1986.	Regulated through existing licences or other statutory mechanisms.	deleted
9	Rehabilitation in consultation with the State to maintain water quality in 34 Mile Brook.	This commitment is inconsistent with the proposed new rehabilitation strategy. Detailed evaluation provided below.	deleted
17 and 18	Mine site drainage.	Amalgamated into a single commitment.	14
20	Mine waste to be returned as backfill to mine pits.	Proposed new rehabilitation strategy inconsistent with this commitment. Detailed evaluation provided below.	deleted

Table 5. Summary and evaluation of changes to proponent's environmental commitments (cont'd).

21	Marginal ore to be returned to mined-out pits.	Proposed new rehabilitation strategy inconsistent with this commitment. Detailed evaluation provided below.	deleted
Original proponent commitment No. (from Appendix 1(c))	Issue	Evaluation	New proponent commitment No.(see Appendix 3)
27	Water extracted from the Hotham River in accordance with Water Authority licence.	Regulated through existing licences or other statutory mechanisms.	deleted
28	Agreements with other water users to satisfaction of the Minister for Water Resources.	Commitment has been met. Letter from Minister for Water Resources to Worsley Alumina received, 27 April 1989.	deleted
29	After 2 winter flows in the Hotham River, a report to be submitted.	This commitment has been met to the satisfaction of the Water Authority of WA, 6/8/90 and the EPA, 5/10/90.	deleted
30	Water and residue management structures in accordance with terms of the Rights in Water and Irrigation Act.	Regulated through existing licences or other statutory mechanisms.	deleted
31	Acidic mine drainage to be reclaimed.	Commitment has been met to the satisfaction of the EPA, 16/8/90.	deleted
1*	Adherence to relevant policies, procedures and commitments contained in 1987 Environmental Management Programme (EMP).	This commitment has been made redundant by virtue of the new consolidated commitments list in Appendix 3 of this report.	deleted
2*	Adherence to conditions of Environmental Protection Act Licence No. 2322.	Regulated through existing licences or other statutory mechanisms.	deleted
3*	Include the Eastern Anomalies area in regional salinity impact re-assessment.	Commitment has been met to the satisfaction of the EPA, 17 February 1993.	deleted
4*	Salinity levels in water bodies and water courses in the event of dewatering.	Now included as part of consolidated commitment list and carried over.	28
5*	Continue to monitor surface and groundwater as part of regional programme.	Now included as part of consolidated commitment list and carried over.	29
6*	Develop rehabilitation strategies in consultation with the State.	Now included as part of consolidated commitment list and carried over.	30

* Note: Commitments from Boddington Gold Mine, Development of Eastern Anomalies (Appendix 1(c))

The new rehabilitation strategy proposed by Worsley Alumina and assessed in this report is inconsistent with three of the current commitments which Worsley Alumina now seeks to replace with several new ones. These specific changes are evaluated in more detail below.

Commitments to be removed (from Appendix 1(c))

Commitment 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."

Evaluation

Worsley Alumina (1994a) has indicated that connection of the proposed lakes to Thirty-Four Mile Brook will result in mixing of brackish groundwater with fresh to marginal surface water, leading to an overall increase in salinity in the brook and it is possible this water will not be of potable standard.

In view of the change in the primary beneficial use of Thirty-Four Mile Brook from public water supply to water based recreation, the EPA recognises that this commitment is no longer appropriate. However, the EPA believes that the secondary objective should require the stream flow at the D4 dam site to be the lowest practical salinity and that appropriate rehabilitation is required to be carried out in consultation with the State. The EPA considers that these issues have been addressed adequately by either environmental management commitments given by the proponent or by the EPA's recommendations in this report. Accordingly, the EPA concludes that former commitment 9 should be removed.

Commitment 20 and 21

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

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

Evaluation

The return of all mine waste to pits at project completion, as required by former commitments 20 and 21, is now inconsistent with the proposed mine pit rehabilitation strategy for the development of lakes. However, the EPA considers there may be a need for partial backfilling of mine pits in certain areas in order to create an adequate proportion of biologically useful shallow water within the final lakes. Waterbirds in particular require a range of depths. Wetlands with sloping edges and extensive littoral areas are attractive and provide opportunities for feeding for a wide range of waterbirds.

In responding to submissions, Worsley Alumina (1994d) has indicated that removal of commitment 20 will not prevent the utilisation of mine waste material where practicable for rehabilitation development.

In addition, Worsley Alumina (1994d), considers it is technically feasible to provide for significant areas of shallows to support vegetation, and sheltered zones in which waterbirds may take refuge through various means including:

- selective use of mine waste material to create shallows where appropriate;
- benching or shaping of cut surfaces; and
- arranging lake discharge so as to define an upper lake level which takes maximum advantage of the post-mining landform.

The EPA therefore considers that these issues have been addressed adequately by either environmental management commitments given by the proponent or by the EPA's recommendations in this report. Accordingly, the EPA concludes that former commitments 20 and 21 could be removed.

New commitments to be introduced (see Appendix 3)

As a consequence of the proposed rehabilitation strategy the following new commitments, have been proposed by the proponent:

Commitment 21
Prior to the commencement of rehabilitation BGM will develop detailed prescriptions for the residue areas which will be aimed at stabilising the residue surface, providing a sustainable vegetation system, and optimise [sic] *the quality of any future runoff from those areas.*

Commitment 22
As a temporary measure following decommissioning, D1 Dam will be used to capture and control saline runoff from the BGM Residue Disposal Areas, which will be diverted to the Hotham River. This diversion of water will not cause an increase of more than 10% in the salinity of Hotham River at any time. Other than salinity this discharge will not exceed statutory guidelines for water used for livestock watering.

Commitment 23
Unless authorised by the State, residue area runoff water which is released from D1 Dam into Thirty-Four Mile Brook will not exceed 3000 mg/l Total Dissolved Solids. This discharge will not exceed statutory guidelines for recreational waters.

Commitment 24
During the initial period of lake filling following rehabilitation, BGM will endeavour to manage water flows so as to minimise drought stress in riparian vegetation in Thirty-Four Mile Brook.

Commitment 25
When the quality of residue area runoff meets the criteria for discharge to Thirty-Four Mile Brook, BGM will continue to monitor and manage further runoff until sufficient data are available to demonstrate to the satisfaction of the State that (notwithstanding seasonal effects) the quality of this runoff has stabilised or is continuing to improve below those criteria. Final rehabilitation of D1 dam will not commence until this has been demonstrated.

Commitment 26
BGM will include in the final landform, lakes in the Pit G and Pit B areas, which will be linked to Thirty-Four Mile Brook. Detailed plans will be developed in consultation with and to the satisfaction of the State showing lake design, inflow and outflow structures, slopes, and proposed vegetation types, prior to final rehabilitation commencing. Measures to maximise the area of shallows in the lakes will be investigated and implemented where practicable. The design will include predicted hydrological responses and impacts on long-term salinity in 34 Mile Brook.

Commitment 27
Detailed rehabilitation prescriptions for the mining area will be developed with the primary objectives of stabilising surfaces, minimising erosion, minimising risks of saline groundwater seepage, and providing a sustainable vegetation system. Local provenance native species will be used where possible, although other species may be used where they provide advantages in meeting the primary objectives.

Evaluation

Worsley Alumina (1994a), considers that the proposed new commitments address the management of environmental impacts arising from the new rehabilitation strategy.

The commitments have been reviewed through the assessment process by the Department of Conservation and Land Management, the Water Authority of Western Australia, the Department of Minerals and Energy, the Department of Resources Development and the Department of Environmental Protection. The commitments have been modified as a result of the environmental assessment process and are generally considered acceptable to the EPA. Where

the commitments are at variance with the EPA's views the recommendations in this report take precedence.

Community expectations for the rehabilitation of mined lands have increased significantly over the last decade. It is recognised that for rehabilitation to be effective it must be integrated into the mining plans, not left to the conclusion of mining (EPA, 1991). The EPA is satisfied with the status of rehabilitation planning and implementation at the Boddington Gold Mine and supports the co-operative catchment based approach to rehabilitation between Boddington Gold Mine (Worsley Alumina Pty Ltd) and the Hedges Gold Mine (Hedges Gold Pty Ltd).

It is of paramount importance to the State that rehabilitation management does not impose short or long term costs on the community of Western Australia. This is particularly relevant when the success of the rehabilitation strategy cannot be evaluated in the short to medium term. Therefore, further work to ensure that the State will not be left with on-going liabilities is required. Attention to the long term integrity of rehabilitation works and the quality of all drainage waters with particular respect to salinity, heavy metals and acid forming materials will be required. Accordingly, the EPA makes the following recommendation.

Recommendation 5

At least 12 months prior to decommissioning, the proponent should prepare and subsequently implement a decommissioning and rehabilitation plan including development of a 'walk away' solution for the site, to the requirements of the Department of Environmental Protection and the State Mining Engineer.

A 'walk-away' solution means that the site shall either no longer require management at the time the proponent ceases mining operations, or if further management is deemed necessary, the proponent shall make adequate provision so that the required management is undertaken with no liability to the State.

This surety could be in the form of an environmental bond such as those routinely held against mining rehabilitation success by the Department of Minerals and Energy.

5. Discussion and synthesis

Worsley Alumina have proposed a new rehabilitation strategy for the Boddington Gold Mine which necessitates changes to environmental conditions and proponent commitments. The new rehabilitation strategy is based upon a catchment management approach and removes the obligation on Worsley Alumina to return the stockpiled waste to mine pits. In assessing the rehabilitation strategy, the EPA gave particular consideration to the following potential environmental effects:

(1) The status and beneficial use of Thirty-Four Mile Brook;

(2) Water quality discharge criteria from the residue disposal areas to the Hotham River and Thirty-Four Mile Brook;

(3) The development of lakes in the mine pits; and

(4) On-going rehabilitation and management of the site, including rehabilitation of the waste dumps, consistent with environmental conditions and proponent commitments.

The EPA has evaluated the impact of the rehabilitation strategy in relation to these issues and has also recommended that previous environmental conditions set on a number of other proposals for the Boddington Gold Mine be amalgamated and amended to reflect changes.

The EPA has evaluated the implications of the proposed change of proponent commitments and the proposed new rehabilitation strategy. A number of proponent commitments have been consolidated and updated to more easily identify environmental requirements associated with the Boddington Gold Mine. The replacement of three specific commitments (commitments 9, 20 and 21) with a number of new commitments (commitments 21, 22, 23, 24, 25, 26 and 27),

as discussed in Section 4.4.2 of this report is in response to the development of a proposed new rehabilitation strategy.

The EPA considers on the basis of this evaluation that its original objective of protecting the designated beneficial use of Thirty-Four Mile Brook will be acceptably achieved by the new rehabilitation strategy. The EPA has also considered the environmental value of the brook.

Following consideration of the environmental issues in Section 4 of this report and the proponent's response to them, the EPA has concluded that the modifications to the proponent commitments for the Boddington Gold Mine are acceptable, subject to the further recommendations in this report, and recommends that the environmental statement be amended accordingly.

6. Conclusions and recommendations

The EPA concludes that the modifications to the Boddington Gold Mine rehabilitation strategy are environmentally acceptable and recommends that it could proceed, subject to the recommendations in this report.

Recommendation 6

The proposal by Worsley Alumina Pty Ltd for the Boddington Gold Mine Rehabilitation Strategy and changes to environmental commitments is environmentally acceptable and could proceed subject to:

(1) the Environmental Protection Authority's recommendations in this assessment report (Recommended Environmental Conditions are listed in Section 7).

(2) compliance with the proponent's environmental management commitments (see Appendix 3).

(3) compliance with the Environmental Statements for the proposal of 15 February 1988, 8 December 1988, 22 November 1989, 8 June 1990 and 21 January 1993, being consolidated and updated to reflect changes to the proposal, as reported in Environmental Protection Authority Bulletin 766.

7. Recommended environmental conditions

The following recommended environmental conditions would amend the Minister for the Environment's previous Statements for the Enhancement of Facilities as reported in Environmental Protection Authority Bulletin 313, the Expansion of Facilities Stage 2 as reported in Environmental Protection Authority Bulletin 361, the Mining and Processing of Supergene/Basement ores as reported in Environmental Protection Authority Bulletins 408 and 430 and the Development of Eastern Anomalies as reported in Environmental Protection Authority Bulletin 661 (Appendices 1(a) to 1(e)), and apply additional conditions to reflect the recommendations in this report and ensure a continued review of the environmental performance and development.

STATEMENT TO AMEND CONDITIONS APPLYING TO PROPOSALS (PURSUANT TO THE PROVISIONS OF SECTION 46 OF THE ENVIRONMENTAL PROTECTION ACT 1986)

PROPOSALS / PROJECT:	BODDINGTON GOLD MINE (ASSESS. NOs.156, 182, 238-A, 238-B, 700)
CURRENT PROPONENT:	WORSLEY ALUMINA PTY LTD

CONDITIONS SET ON: 15 FEBRUARY 1988, 8 DECEMBER 1988, 22 NOVEMBER 1989, 21 JANUARY 1993

CONDITIONS AMENDED ON: 8 JUNE 1990

The implementation of these proposals is now subject to the following conditions which replace all previous conditions:

1 Proponent Commitments

The proponent has made a number of environmental management commitments in order to protect the environment.

1-1 In implementing the proposals, including the Enhancement of Facilities as reported in Environmental Protection Authority Bulletin 313, the Expansion of Facilities Stage 2 as reported in Environmental Protection Authority Bulletin 361, the Mining and Processing of Supergene/Basement ores as reported in Environmental Protection Authority Bulletins 408 and 430, and the Development of Eastern Anomalies as reported in Environmental Protection Authority Bulletin 661, the proponent shall fulfil the commitments made during the assessment in 1989 (summarised and published in Environmental Protection Authority Bulletin 408 as Appendix 2) and the revised commitments of November 1994 (published in Environmental Protection Authority Bulletin 766 as Appendix 3); provided that the commitments are not inconsistent with the conditions or procedures contained in this statement.

2 Implementation

Changes to the proposals which are not substantial may be carried out with the approval of the Minister for the Environment.

2-1 Subject to these conditions, the manner of detailed implementation of the proposals shall conform in substance with that set out in any designs, specifications, plans or other technical material submitted by the proponent to the Environmental Protection Authority with the proposals. Where, in the course of that detailed implementation, the proponent seeks to change those designs, specifications, plans or other technical material in any way that the Minister for the Environment determines on the advice of the Environmental Protection Authority, is not substantial, those changes may be effected.

3 Hotham River

Diversion of water from the Hotham River may have an adverse impact on the Hotham/Murray River system as well as on other downstream users.

3-1 The proponent shall only pump water from the Hotham River when the river flow is in excess of 342 kilolitres per hour as measured at Marradong River bridge gauging station.

3-2 When pumping from the Hotham River, the proponent shall not cause the remaining river flow to be reduced below the level of 342 kilolitres per hour as measured at Marradong River bridge gauging station.

Note 1: Water is 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.

4 Development of lakes in the mine pits

Detailed plans for the development and management of lakes are required.

4-1 At least 12 months prior to decommissioning the mine pits, the proponent shall prepare an Environmental Management Programme for the inclusion of lakes as final landform features within the mine pit areas, to the requirements of the Department of Environmental

Protection on advice of the Water Authority of Western Australia, the Department of Minerals and Energy and the Department of Conservation and Land Management.

The Environmental Management Programme shall include, but not be limited to, the following:

(1) Lake design, including:

(a) the proposed connection to Thirty-Four Mile Brook;

(b) the partial return of mine waste as backfill to mine pits where required for the necessary creation of shallow water areas or islands for wildlife use;

(c) inflow and outflow options for the management of water quality and quantity in the lakes and Thirty-Four Mile Brook, including options for isolating the lakes; and

(d) slopes and proposed vegetation types, including wetland plant species;

(2) target minimum, maximum and optimum water levels in the lakes based on, stream flow in Thirty-Four Mile Brook, groundwater flow and runoff from surrounding areas;

(3) water quality criteria to ensure the maintenance of appropriate water quality in the lakes and Thirty-Four Mile Brook;

(4) predicted groundwater and surface water hydrological responses and impacts on long term salinity in the lakes and in and Thirty-Four Mile Brook; and

(5) the development of a comprehensive monitoring, management and reporting programme.

4-2 The proponent shall implement the Environmental Management Programme required by condition 4-1 to the requirements of the Department of Environmental Protection on advice of the Water Authority of Western Australia, the Department of Minerals and Energy and the Department of Conservation and Land Management.

5 Rehabilitation

In addition to waste stockpiles, mine pits and residue disposal areas, other project areas will need to be properly rehabilitated.

5-1 The proponent shall rehabilitate the Boddington Gold Mine site and environs and remove associated infrastructure, to the requirements of the Department of Environmental Protection and the State Mining Engineer with advice from other agencies, as appropriate.

6 Discharge waters

Heavy metals can be concentrated in their surroundings.

6-1 The proponent shall ensure that waters discharged to the Hotham River from the residue disposal areas and the D1 Dam, in the case of inorganic toxicants, conform with the guidelines for protection of aquatic ecosystems presented in Table 2.2 of Environmental Protection Authority Bulletin 711, "Draft Western Australian Water Quality Guidelines For Fresh and Marine Waters".

6-2 The proponent shall ensure that waters discharged to the Thirty-Four Mile Brook, from the residue disposal areas and the D1 Dam, in the case of inorganic toxicants, conform with the guidelines for protection of aquatic ecosystems presented in Table 2.2 of Environmental Protection Authority Bulletin 711, "Draft Western Australian Water Quality Guidelines For Fresh and Marine Waters".

Note 2: The proponent should apply for a Works Approval for this part of the project under the provisions of Part V of the Environmental Protection Act.

7 Decommissioning

The satisfactory decommissioning of the project, removal of the plant and installations and rehabilitation of the site and its environs is the responsibility of the proponent.

7-1 At least twelve months prior to decommissioning, the proponent shall prepare a decommissioning and rehabilitation plan, including development of a 'walk away' solution for the site, to the requirements of the Department of Environmental Protection and the State Mining Engineer.

Note 3: A 'walk-away' solution means that the site shall either no longer require management at the time the proponent ceases mining operations, or if further management is deemed necessary, the proponent shall make adequate provision so that the required management is undertaken with no liability to the State. This could be in the form of an environmental bond such as those routinely held against mining rehabilitation success by the Department of Minerals and Energy.

7-2 The proponent shall implement the plan required by condition 7-1 to the requirements of the Department of Environmental Protection and the State Mining Engineer.

8 Proponent

These conditions legally apply to the nominated proponent.

8-1 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 for the Environment 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.

9 Compliance Auditing

In order to ensure that environmental conditions and commitments are met, an audit system is required.

9-1 The proponent, in consultation with the Department of Environmental Protection, shall prepare an Audit Programme, which includes requirements for the preparation of periodic Compliance Reports.

9-2 The proponent shall subsequently implement the Audit Programme required by condition 9-1.

Procedure

1 The Department of Environmental Protection is responsible for verifying compliance with the conditions contained in this statement, with the exception of conditions stating that the proponent shall meet the requirements of either the Minister for the Environment or any other public authority.

2 If the Department of Environmental Protection, other public authority or proponent is in dispute concerning compliance with the conditions contained in this statement, that dispute will be determined by the Minister for the Environment.

8. References

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Appendix 1

Environmental conditions for the Boddington Gold Mine

Appendix 1(a):	Boddington Gold Mine, Enhancement of Facilities
Appendix 1(b):	Boddington Gold Mine Projects, Expansion of Facilities Stage 2
Appendix 1(c):	Boddington Gold Mine, Mining and Processing of Supergene/Basement Ores
Appendix 1(d):	Boddington Gold Mine, Mining and Processing of Supergene/Basement Ores [Report under Section 46 of the Environmental Protection Act]
Appendix 1(e):	Boddington Gold Mine, Development of Eastern Anomalies

Appendix 1(a)

ASS # 150

Bull # 313

State # 019

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

7th Floor, May Holman Centre,

Phone (09) 325 4133

SUMMARY OF ENVIRONMENTAL COMMITMENTS

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 square brackets after these commitments:

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

- Topsoil from areas cleared for project activities will be salvaged for use in decommissioning and other rehabilitation programmes [EPA Recommendation 12].

- 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).

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

- 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).

- Alternative access from private land around the Water Supply Reservoir to State Forest to the west of the project area has been provided for local bush fire brigades and CALM.

- 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 Recommendations 1 and 2].

- 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). 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].

- 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].

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

- 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].

- 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].

- 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.

- 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.

- 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.

- 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].

- 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 is 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].

- 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.

- 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 [EPA Recommendation 4].

- 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.

- 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.

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

- 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.

- 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.

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

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

- Shallow mine pits will be contoured to slopes generally consistent with natural landforms [EPA Recommendation 13].

- 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 be made, detailed plans will be submitted to the State for approval [EPA Recommendations 15 and 16].

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

- 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].

- 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].

Appendix 1(b)

Bull # 361

State # 049

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

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

6 DEC 1988

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SUMMARY OF ENVIRONMENTAL COMMITMENTS

The EMP (Worsley Alumina Pty Ltd 1987a) documented a comprehensive set of environmental management commitments (Section 9) which have been adhered to in the design, construction and operation of the Boddington Gold Mine. None of the aspects of the proposed expansion to 6 Mt/a would affect the integrity of these commitments. The Joint Ventures restate their commitment to environmental management, in accordance with the April 1987 EMP, for the proposed 6Mt/a operation.

The following list is a summary of those major environmental commitments, as previously stated 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 square brackets after these commitments:

- clearing for project activities will be kept to a minimum, consistent with safe operating practices;

- topsoil from areas cleared for project activities will be salvaged for use in decommissioning and other rehabilitation programmes [EPA Recommendation 12];

- 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);

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

- 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);

- alternative access from private land around the Water Supply Reservoir to State Forest to the west of the project area has been provided for local bush fire brigades and CALM;

- 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];

- a quantified assessment of likely 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];

- 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 Ventures will drain the dam, allowing it to refill naturally [EPA Recommendation 11];

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

- 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];

- 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];

- 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 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.

- 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.

- 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.

- 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];

- 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 is 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];

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;

- caustic soda used in the Metallurgical Treatment Plant will have a mean mercury content of less than 100 ug/L, with a maximum of 1,000 ug/L [EPA Recommendation 4];

- 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;

- 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;

drainage will be installed in the mine pits with runoff either used for dust suppression, or drained via spilt traps to natural watercourses;

- 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;

- 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 longterm salinity and turbidity impact on Thirty-Four Mile Brook;

mine waste not used in road construction will be returned as back fill to mine pits during the life of the project;

- if it is decided not to process marginal ore, this material will be returned to mined-out pits;

- shallow mine pits will be contoured to slopes generally consistent with natural landforms [EPA Recommendation 13];

- deeper pits will be rehabilitated it, at the time of completion of mining 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];

- final rehabilitation will ensure that runoff will drain to natural watercourses or into the deeper pits;

- 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], and

- 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].

[31-1] [31-2]

Appendix 1(c)

Ass # 238-A

Bull # 408

State # 085

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

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

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 1(d)

Ass # 238-B

Bull # 430

State # 100

WESTERN AUSTRALIA

MINISTER FOR ENVIRONMENT

STATEMENT TO AMEND CONDITIONS APPLYING TO A PROPOSAL (PURSUANT TO THE PROVISIONS OF SECTION 46 OF THE ENVIRONMENTAL PROTECTION ACT 1986)

PROJECT	:	BODDINGTON GOLD MINE, MINING AND PROCESSING OF SUPERGENE/BASEMENT ORES
CONDITIONS SET	:	22 NOVEMBER 1989

Condition 1 has been amended to read as follows:

1A. In implementing the proposal (including the documented modifications of 1 March 1990) the proponent 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 Programme for the Boddington Gold Mine of April 1987. (A copy of commitments summarized and consolidated on 30 October 1989, is attached).

1B. Subject to the conditions in the Minister for the Environment's Statement of 22 November 1989, as modified by condition 1A, the manner of detailed implementation of the proposal shall conform in substance with that set out in any designs, specifications, plans or other technical material submitted by the proponent to the Environmental Protection Authority with the proposal. Where, in the course of that detailed implementation, the proponent seeks to change those designs, specifications, plans or other technical material in any way that the Minister for the Environment determines on the advice of the Environmental Protection Authority, is not substantial, those changes may be effected.

Bob Pearce, MLA
MINISTER FOR THE ENVIRONMENT

- 8 JUN 1990

Published on

- 8 JUN 1990

Ass # 700

Bull # 661

State # 299

WESTERN AUSTRALIA
MINISTER FOR THE ENVIRONMENT

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

BODDINGTON GOLD MINE, DEVELOPMENT OF EASTERN ANOMALIES (700)

WORSLEY ALUMINA PTY LTD

This proposal may be implemented subject to the following conditions:

1 **Proponent Commitments**
The proponent has made a number of environmental management commitments in order to protect the environment.

1-1 In implementing the proposal, the proponent shall fulfil the commitments (which are not inconsistent with the conditions or procedures contained in this statement) made in the Consultative Environmental Review. These commitments are consolidated in Environmental Protection Authority Bulletin 661 as Appendix 1. (A copy of the commitments is attached.)

2 **Implementation**
Changes to the proposal which are not substantial may be carried out with the approval of the Minister for the Environment.

2-1 Subject to these conditions, the manner of detailed implementation of the proposal shall conform in substance with that set out in any designs, specifications, plans or other technical material submitted by the proponent to the Environmental Protection Authority with the proposal. Where, in the course of that detailed implementation, the proponent seeks to change those designs, specifications, plans or other technical material in any way that the Minister for the Environment determines on the advice of the Environmental Protection Authority, is not substantial, those changes may be effected.

3 **Decommissioning**
The satisfactory decommissioning of the project, removal of the plant and installations and rehabilitation of the site and its environs is the responsibility of the proponent.

3-1 At least six months prior to decommissioning, the proponent shall prepare a decommissioning and rehabilitation plan to the requirements of the State Mining Engineer and the Environmental Protection Authority.

3-2 The proponent shall implement the plan required by condition 3-1 to the requirements of the State Mining Engineer and the Environmental Protection Authority.

4 **Proponent**
These conditions legally apply to the nominated proponent.

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21 JAN 1993

4-1 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 for the Environment 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.

5 Time Limit on Approval

The environmental approval for the proposal is limited.

5-1 If the proponent has not substantially commenced the project within five years of the date of this statement, then the approval to implement the proposal as granted in this statement shall lapse and be void. The Minister for the Environment shall determine any question as to whether the project has been substantially commenced. Any application to extend the period of five years referred to in this condition shall be made before the expiration of that period, to the Minister for the Environment by way of a request for a change in the condition under Section 46 of the Environmental Protection Act. (On expiration of the five year period, further consideration of the proposal can only occur following a new referral to the Environmental Protection Authority.)

6 Compliance Auditing

In order to ensure that environmental conditions and commitments are met, an audit system is required.

6-1 The proponent shall prepare periodic "Progress and Compliance Reports", to help verify the environmental performance of this project, in consultation with the Environmental Protection Authority. This can be achieved through existing reporting mechanisms.

Procedure

The Environmental Protection Authority is responsible for verifying compliance with the conditions contained in this statement, with the exception of conditions stating that the proponent shall meet the requirements of either the Minister for the Environment or any other government agency.

If the Environmental Protection Authority, other government agency or proponent is in dispute concerning compliance with the conditions contained in this statement, that dispute will be determined by the Minister for the Environment.

Jim McGinty, MLA
MINISTER FOR THE ENVIRONMENT

21 JAN 1993

PROPONENT'S COMMITMENTS

BODDINGTON GOLD MINE - DEVELOPMENT OF EASTERN ANOMALIES (700)

WORSLEY ALUMINA PTY LTD

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.

Appendix 2

List of organisations, agencies and individuals invited to comment on the proposal

List of organisations, agencies and individuals invited to comment on the proposal

State and local government agencies

Water Authority of Western Australia
Department of Conservation and Land Management
Department of Resources Development
Department of Minerals and Energy
Shire of Boddington

Members of the public

Conservation Council of WA
The Wetland Conservation Society
Waterbird Conservation Group
Royal Australian Ornithological Society
Hedges Gold Pty Ltd
Mr W Johnston (Worsley Timber Company)

Appendix 3

Proponent commitments

PROPONENT 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.

3. Environmentally - sensitive construction and operational practices, including stringent forest hygiene measures, will be employed throughout the project area.

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

5. 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.

6. 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.

7. 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 minimise adverse hydrological and hydrogeological effects.

8. 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.

9. 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.

10. 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.

11. 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.

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

13. 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 minimise leakage. The pond will have sufficient capacity to accommodate rainfall runoff from a one in one hundred year storm event.

14. Drainage will be installed around mine pits, haulroads, and stockpiles; water (other than acidic mine drainage) from these will either be used for dust suppression, or will drain via silt traps into natural watercourses.

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

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

17. 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 [sic] made, detailed plans will be submitted to the State for approval.

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

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

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

21. Prior to the commencement of rehabilitation BGM will develop detailed prescriptions for the residue areas which will be aimed at stabilising the residue surface, providing a sustainable vegetation system, and optimise [sic] the quality of any future runoff from those areas.

22. As a temporary measure following decommissioning, D1 Dam will be used to capture and control saline runoff from the BGM Residue Disposal Areas, which will be diverted to the Hotham River. This diversion of water will not cause an increase of more than 10% in the salinity of Hotham River at any time. Other than salinity this discharge will not exceed statutory guidelines for water used for livestock watering.

23. Unless authorised by the State, residue area runoff water which is released from D1 Dam into Thirty-Four Mile Brook will not exceed 3000 mg/l Total Dissolved Solids. This discharge will not exceed statutory guidelines for recreational waters.

24. During the initial period of lake filling following rehabilitation, BGM will endeavour to manage water flows so as to minimise drought stress in riparian vegetation in Thirty-Four Mile Brook.

25. When the quality of residue area runoff meets the criteria for discharge to Thirty-Four Mile Brook, BGM will continue to monitor and manage further runoff until sufficient data are available to demonstrate to the satisfaction of the State that (notwithstanding seasonal effects) the quality of this runoff has stabilised or is continuing to improve below those criteria. Final rehabilitation of D1 dam will not commence until this has been demonstrated.

26. BGM will include in the final landform lakes in the Pit G and Pit B areas, which will be linked to Thirty-Four Mile Brook. Detailed plans will be developed in consultation with and to the satisfaction of the State showing lake design, inflow and outflow structures, slopes, and proposed vegetation types, prior to final rehabilitation commencing. Measures to maximise the area of shallows in the lakes will be investigated and implemented where practicable. The design will include predicted hydrological responses and impacts on long-term salinity in 34 Mile Brook.

27. Detailed rehabilitation prescriptions for the mining area will be developed with the primary objectives of stabilising surfaces, minimising erosion, minimising risk of saline groundwater seepage, and providing a sustainable vegetation system. Local provenance native species will be used where possible, although other species may be used where they provide advantages in meeting the primary objectives.

28. In the event of mine dewatering being necessary, BGM will ensure that the salinities of water bodies and water courses receiving discharges do not exceed 5,000mg/l TDS as a result of those discharges; and will monitor and report impacts of such release on downstream vegetation, and adjust procedures as appropriate.

29. BGM will continue to monitor surface and groundwater in the area, as part of the regional programme established in the early 1980's, and report findings to the State.

30. BGM will develop rehabilitation strategies and prescriptions in consultation with the State, and monitor and report on the success of rehabilitation.

Appendix 4

Water quality criteria

Water quality criteria

The following metals have historically been regulated at Boddington Gold Mine by the State through Environmental Protection Authority licence conditions - arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc

Table 1: Water quality guidelines preferred by the proponent. The water quality criteria are derived from the ANZECC (1992) report and Environmental Protection Authority draft report Bulletin 711 (EPA, 1993).

	DESTINATION	
Parameter (mg/l)	**Hotham River** (Water quality guidelines for livestock watering)	**Thirty-Four Mile Brook** (water quality guidelines for raw waters for drinking purposes subjected to coarse screening)
Weak acid dissociable (WAD) cyanide	0.5	0.1
Arsenic	0.5	0.05
Cadmium	0.01	0.005
Chromium	1.0	0.05
Copper	0.5	1.0
Lead	0.1	0.05
Mercury	0.002	0.001
Nickel	1.0	0.1
Selenium	0.02	0.01
Zinc	20.0	5.0

Table 2: Water quality guidelines preferred by the Water Authority of Western Australia The water quality criteria are derived from the draft NHMRC (1994) report. (NB: underline emphasis added to indicate differences between Table 1 and 2)

	DESTINATION	
Parameter (mg/l)	**Hotham River**	**Thirty-Four Mile Brook**
Weak acid dissociable (WAD) cyanide	0.5	0.07
Arsenic	0.5	0.007
Cadmium	0.01	0.002
Chromium	1.0	0.05
Copper	0.5	1.5
Lead	0.1	0.01
Mercury	0.002	0.001
Nickel	1.0	0.02
Selenium	0.02	0.01
Zinc	20.0	3.0

Appendix 5

Table 2.2 of Environmental Protection Authority Bulletin 711

Table 2.2: Summary guidelines for protection of aquatic ecosystems

Indicator	Units	Fresh waters	Marine waters
Biological		It is premature to recommend specific values for these indicators. The need for biological evaluation is recognised, and these indicators are identified as important characteristics of ecosystem function (Section 2.2)	
Physico-chemical			
Colour & clarity		< 10% change in euphotic depth[1]	< 10% change in euphotic depth
Dissolved oxygen[2]	mg/L	> 6 (> 80–90% saturation)	> 6 (> 80–90% saturation)
Nutrients/nuisance growths		(Section 2.2)	(Section 2.2)
pH		6.5–9.0	< 0.2 pH unit change
Salinity	mg/L	< 1000 (about 1,500 mS/cm)	< 5% variation from background
Suspended particulate matter/turbidity		< 10% change seasonal mean concentration	< 10% change seasonal mean concentration
		(see also colour & clarity)	(see also colour & clarity)
Temperature[3]		< 2°C increase	< 2°C increase
Toxicants	all µg/L		
Inorganic toxicants			
Aluminium		< 5.0 (if pH < = 6.5) < 100.0 (if pH > 6.5)	NR
Ammonia		20.0–30.0 (Table 2.3)	NR
Antimony		30.0	500.0
Arsenic		50.0	50.0
Beryllium		4.0[4]	NR
Cadmium		0.2–2.0[5]	2.0
Chromium		10.0	50.0
Copper		2.0–5.0[5]	5.0
Cyanide		5.0	5.0
Fluoride		NR	2000.0*
Iron		1,000.0[6]	NR
Lead		1.0–5.0[5]	5.0
Mercury		0.1	0.1
Nickel		15.0–150.0[5]	15.0
Selenium		5.0	70.0
Silver		0.1	0.45*
Sulfide		2.0	2.0
Thallium		4.0	20.0
Tin (tributyltin)		0.008	0.002
Zinc		5.0–50.0[6]	20.0*
Organic toxicants			
Acrylonitrile		NR	NR
Benzidine		NR	NR
Dichlorobenzidine		NR	NR
Diphenylhydrazine		NR	NR
Surfactants		*0.05 times the ninety-six hour LC_{50} determined in the receiving water, on the most sensitive important species in the region.*	

Table 2.2 cont.: Summary guidelines for protection of aquatic ecosystems

Indicator	Units	Fresh waters	Marine waters
Halogenated aliphatic compounds			
Hexachlorobutadiene		0.1	0.3
Halogenated ethers		NR	NR
Hydrocarbons (total)**		NR	10.0*
Isophorone		NR	NR
Monocyclic aromatic compounds			
Benzene		300.0	1.0*
Chlorinated benzenes		(Table 2.4)	NR
Chlorinated phenols		(Table 2.5)	(Table 2.5)
Phenol		50.0	50.0
Toluene		300.0	NR
Nitrosamines		NR	NR
Pesticides			
Organochlorine		(Table 2.6)	(Table 2.6)
Organophosphate		(Table 2.6)	(Table 2.6)
Acrolein		0.2	0.2
Phthalate esters			
di-n-butylphthalate		4.0	NR
di(2-ethylhexyl)phthalate		0.6	NR
other phthalate esters		0.2	NR
Polyaromatic hydrocarbons			
Chlorinated naphthalenes		NR	NR
Polychlorinated biphenyls		0.001	0.001*
Polychlorinated dibenzo-*p*-dioxins		NR	NR
Polycyclic aromatic hydrocarbons		3.0	3.0

SPM: Suspended particulate matter; NR: no recommendation made at this time

Notes

1. For systems where depth is greater than 0.5 x euphotic depth (z_{eu}). For waters shallower than 0.5 z_{eu}, the maximum reduction in light at the sediment bed should not exceed 20%
2. Measured over at least one, but preferably several, diurnal cycles
3. Or use formula in Section 2.3.7 (ANZECC 1992); no data for temperature reductions
4. Higher values may be acceptable in hard waters
5. Depends upon hardness of water
6. Provided iron not present as Fe(II)

* Bulletin 103, DCE (1981)

** Interim guideline only