WMC (Olympic Dam Corporation) Pty Ltd

OLYMPIC DAM EXPANSION PROJECT

ENVIRONMENTAL IMPACT STATEMENT

S U P P L E M E N T

KINHILL

OLYMPIC DAM EXPANSION PROJECT

supplement

WMC (Olympic Dam Corporation) Pty Ltd

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ENVIRONMENTAL IMPACT STATEMENT

S U P P L E M E N T

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October 1997

SUPPLEMENT
ISBN 0 94939792X

Limitations Statement

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INTRODUCTION

CHAPTER 1

INTRODUCTION

The Environmental Impact Statement (EIS) for the Olympic Dam Expansion Project was released for public comment on 14 May 1997 and was on display until 11 July 1997. The deadline for the receipt of public submissions for consideration in this Supplement was stated in the public notice to be 11 July 1997; however, the Minister for Housing and Urban Development, in concurrence with WMC, agreed to receive comments until 25 July 1997 following some requests for additional time.

Thirty-nine public submissions were received, as well as thirteen submissions from State Government agencies and three submissions from Commonwealth Government agencies. This document is a Supplement to the EIS, and responds where necessary to the comments made in those submissions.

This Supplement, together with the EIS and all submissions received, will be assessed by the relevant South Australian and Commonwealth government agencies. A copy of this Supplement is also to be sent to members of the public who made submissions in regard to the EIS.

1.1 STRUCTURE OF THE SUPPLEMENT

Because some comment was received on most chapters of the EIS, it was decided that, for simplicity, the order of subject matter presented in this Supplement should follow (as much as possible) the order of the EIS.

A large number of responses received are devoted in whole, or in part, to a range of issues that are explicitly outside the guidelines for the preparation of the EIS which WMC was directed to address (see Appendix B of the EIS). A response is not provided to these and other matters that are beyond WMC's capacity or responsibility to respond to (Section 1.5 of this Supplement).

A number of respondents also discuss the past and current environmental performance at Olympic Dam. A response to these comments is presented in Section 2.1 of this Supplement.

A number of appendices are provided with this Supplement. Appendices A, B and C summarise the points raised in public and government agency submissions. Appendix D lists corrections to the EIS. The purpose of this appendix is to note editorial corrections to the text, to add further clarification or amplification to points made in the text (as a result of the review of submissions), and to correct statements of fact or passages where the information provided may have been misinterpreted by the reader. Where a more detailed response or clarification is required, this is provided in Chapters 2 to 15 of this Supplement.

Appendices E, F and G provide supporting information for the Supplement in the form of a glossary of technical terms used, and lists of abbreviations used and references cited. Appendix H provides additional information on the ODEX1 hydrogeological model.

1.2 SOUTH AUSTRALIAN/COMMONWEALTH ASSESSMENT PROCESSES

The complete environmental impact assessment procedure is described in Section 1.3.2 of the EIS. Following publication of this Supplement, the State Government Department of Housing and Urban Development will assess the EIS, and the public and government department submissions together with the Supplement, and publish the results in an assessment report. These documents will be considered by the State Government ministers to determine whether the Expansion Project will be allowed to proceed and, if so, under what conditions.

The assessment process to be employed by the Commonwealth Government is outlined in Paragraphs 8, 9 and 10 of the Administrative Procedures of the *Environment Protection (Impact of Proposals) Act 1974* (Cwlth). Following the submission of this Supplement, a period of forty-two days is allotted to Environment Australia in which to consider the final documents and provide advice and recommendations to the Minister for the Environment (Commonwealth).

1.3 COMMENTS ON THE EIS

A total of fifty-five submissions were received in response to the EIS: thirty-nine from the general public, thirteen from State Government agencies, and three from Federal Government agencies. Very few of the submissions are concerned with single issues, and most cover several areas of the EIS content.

Areas of primary interest and/or concern, reflected by the number of submissions and comments, are as follows:

- water management (Chapter 4), particularly the past and predicted impacts of water abstraction from the Great Artesian Basin, the validity of the ODEX1 model and impacts on mound springs (sixteen submissions);
- tailings management (Chapter 8), particularly current and proposed management and past and predicted impacts (nineteen submissions);
- radiation (Chapter 10), particularly exposure limits and the calculation methodology for dose estimates (seventeen submissions);
- social issues (Chapter 12), particularly matters in relation to town management.

Other frequently raised issues include the nature and objectives of the project; the existing operations and the basis for the proposed expansion; local public consultation; Aboriginal heritage and consultation; the biological environment, particularly the mound springs; air quality, particularly fugitive dust; economic impacts and the validity of predictions; and rehabilitation and monitoring processes.

A significant number of public submissions relate to Roxby Downs township and community issues that fall outside the scope of the EIS, and these are discussed in Section 1.5.

1.4 THE PROCESS USED IN SUMMARISING SUBMISSIONS

The number and length of comments received on the EIS for the proposed Olympic Dam Expansion Project—many of which are to similar effect—have made it inappropriate to include them in full. Therefore, a summary of each of the fifty-five submissions has been prepared. The thirty-nine public submissions are summarised in Appendix A, the thirteen

South Australian Government agency submissions in Appendix B and the three Commonwealth Government agency submissions in Appendix C.

The aim in summarising the submissions has been to convey, in a concise format, the concerns raised in each submission and to identify those sections of the EIS that most closely relate to these concerns. Each submission was therefore analysed and condensed into a series of comments, with each comment representing a separate issue. The appropriate reference to the relevant EIS section was then noted beside each comment. Where a particular comment relates to more than one section of the EIS, separate references for each section have been given.

The priority has been to reflect, as accurately and concisely as possible, the concerns raised in each submission rather than to convey the varied tones and language used. Such inclusions would not only have lengthened the summaries dramatically but could also have led to the perception of unintended bias. Given individual differences in expression, no assumptions were drawn regarding the depth of concern of the author on the basis of the tone of the submission. The length of each submission is also not necessarily reflected in the summarised comments. This is because some authors state their views briefly, raising a number of issues in a relatively short submission. In such cases the summary of the submission may be almost as long as the submission itself. On the other hand, some authors have developed detailed arguments related to a particular issue. All responses contained in the supplement are based on the full submissions, not summaries.

The comment numbers do not always follow the order of the content of the submission. This reflects the fact that some submissions are repetitive or return to an issue previously dealt with.

Two detailed submissions (P9 and P26) are largely identical but were submitted under different names. Although each is treated as a separate submission, the submission text has been summarised only once.

In many cases, information provided in the EIS is considered to adequately address the issue raised in the submission with information in the Supplement clarifying or expanding on the issue. This is of particular relevance to the discussion on radiation (Chapter 10 of the EIS) regarding general issues and implications of radiation and consequent health effects. The relevant sections of this chapter of the EIS should also be referred to in this circumstance to gain a complete response.

1.5 ISSUES OUTSIDE THE SCOPE OF THE SUPPLEMENT

As noted in Section 1.3, many public submissions raise issues that are outside the guidelines and not within the proponent's capacity to respond. The guidelines note (Appendix B, EIS):

> The scope of the assessment will not include broader issues relating to the use of exported uranium in the nuclear fuel cycle. Issues related to the use of exported uranium in the nuclear fuel cycle are beyond the control of the proponent and it would be impractical for WMC to address these issues in the EIS. Issues relating to the use of exported uranium will be considered separately within the overall Commonwealth assessment of the proposal.

Thus, the views relating to exported uranium, which are stated in one form or another in a number of the public submissions, have not been responded to by WMC in this Supplement, but will be considered within the overall Commonwealth assessment of the proposal.

Comment is also not provided on other issues raised in the submissions that are not the responsibility nor within the control of WMC. These issues include:

- the adequacy of the environmental impact assessment process as specified under State and Commonwealth government legislation;

- the consultation process conducted by the State and Commonwealth governments;
- the perceived adequacy, or otherwise, of regulation of the existing operations by government;
- the administration of the Municipality of Roxby Downs, where specific issues are not the responsibility of WMC;
- comments of a personal nature, or made in relation to individuals, or that would require release of confidential information such as medical records.

In addition, some submissions express personal opinions and beliefs about various aspects of the existing operations or the proposed Expansion Project. As it is beyond the scope of this Supplement to debate the validity of personally held opinions, a response has only been provided in cases where the opinions expressed appear to be based upon errors of fact or lack of clarity in the EIS.

CHAPTER 2

PROJECT OVERVIEW AND EXISTING OPERATIONS

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PROJECT OVERVIEW AND EXISTING OPERATIONS

Chapter 1 of the Expansion Project EIS provides background to the Expansion Project and the development at Olympic Dam. It discusses the regulatory framework for the ongoing operations and the assessment process for future development. It also discusses the use and markets for Olympic Dam's principal products, copper and uranium, and the consequences of not proceeding with the Expansion Project.

Chapter 2 of the EIS describes the existing operations and facilities, as well as environmental and occupational health and safety management systems currently in use at Olympic Dam.

This chapter of the Supplement provides responses, where required, to comments pertaining to Chapters 1 and 2 of the EIS. The responses are grouped, and relate to:

- **existing operations;**
- **the Olympic Dam and Stuart Shelf Indenture and its relationship to environmental approvals, confidentiality and royalties;**
- **release of the Environment Management Programme Annual Report;**
- **long-term modelling projections for operation of the borefields;**
- **staging of the Expansion Project;**
- **WMC Board commitment;**
- **economic and employment projections made in the 1983 EIS;**
- **consequences of not proceeding with the Expansion Project;**
- **environmental care.**

2.1 EXISTING OPERATIONS

Comments on the existing operations were received in a number of submissions, relating to the following issues:

- tailings management practices
- dust suppression
- size of the orebody and future development, and effects of mineral extraction
- nature of pulverised fuel ash and source of dune sand used for mine backfill
- WMC obligations under the *Environment Protection Act 1993* (SA)
- predictions made in the 1983 EIS.

These issues are discussed further below. Comments relating to Aboriginal culture and relationships and the existing operations are discussed in Chapter 6 of this Supplement.

Issues relating to the perceived adequacy, or otherwise, of regulation of the operations by government are not commented upon, as these are matters for response by government.

Tailings and management practices

Submission P3 states that the tailings management practices described in Section 2.4 of the Expansion Project EIS are inconsistent with actual management practices carried out for most of the period described.

The purpose of Section 2.4 of the EIS is to provide a description of existing management practices. A description of previous practices and subsequent modifications to the operation of the tailings retention system is provided in Chapter 8 of the EIS and in the 1995 environmental review (WMC—Olympic Dam Corporation 1995a).

Dust suppression

Submission P21 suggests greater use of sealed roads rather than reliance on dust suppression using saline water, while Submission P10 recommends that the current practice be discontinued to avoid surface contamination by salt and radionuclides.

Wetting and sealing are both seen as an effective means of dust control. Cost is a consideration in the selection of dust control measures for a particular road. The cost of sealing needs to be weighed against the cost of watering, taking account also of the maintenance cost of sealed roads versus unsealed roads, for usage by heavy mine vehicles. It should be noted that sealing those roads used principally by heavy mine haulage vehicles does not necessarily eliminate the need for suppression of dust by watering.

Dust suppression using saline water occurs in operational areas that have been largely cleared of vegetation. Drainage is towards claypans, which are naturally saline. The mine water also contains extremely low levels of dissolved radionuclides, hence the use of this water for dust suppression does not provide a significant risk as implied in Submission P10.

Orebody and mineral extraction

A number of queries are raised in Submission P36 in relation to the size of the orebody, the extent of development, the geophysical effects on the region and the effects of earthquakes on the development. Most of these queries have been based upon information given in the Summary to the Expansion Project EIS. The data required for a response are contained within the EIS as described below.

Ore reserves at Olympic Dam are provided in Table 1.1 of the EIS. The extent of the orebody that is expected to be mined, in terms of the inferred resource limits, is shown in Figure 3.4 of the EIS. The Olympic Dam deposit is large; its known extent, as shown in Figure 3.4 of the EIS, is an area about 4 km long by between 0.5 km and 2 km wide at its widest point. However, copper, uranium, gold and silver extraction removes only a small proportion of the minerals in the ore. Therefore, on a regional basis, the gravity and magnetic anomalies of the area should not be altered as a consequence of the mining activities.

All structures at Olympic Dam are designed to withstand seismic loadings applicable to the region in accordance with current Australian standards.

Mine backfill

Submission P36 also enquires about pulverised fuel ash, and asks for more information on the usage of dune sand.

Pulverised fuel ash (also known as fly ash) is a residue product of the burning of coal, generally for electricity production. It is a common additive in concrete as a part substitute for cement. At the present time it is provided from the Northern Power Station at Port Augusta.

Dune sand used for mine backfill is currently sourced from surplus material generated by activities on site. Current (1996) usage of about 120,000 t/a is required for times when sufficient deslimed mill tailings are not available. Development planning for the Expansion Project is based upon the increased use of deslimed mill tailings for backfill, sufficient to remove the need to use dune sand for this purpose. The achievable utilisation figure of tailings in backfill is approximately 20%, as described in Section 3.3.9 of the Expansion Project EIS.

Submission P1 questions why further treatment of the tailings, by melting to form a granular material suitable for use as mine backfill, was not undertaken. Such treatment would require significant energy input as well as further development to prove the feasibility of the process. It therefore has not been considered for use at Olympic Dam.

The Environment Protection Act 1993

Submission G8 suggests that the EIS should contain a more detailed description of WMC's obligations under the *Environment Protection Act 1993* (SA).

Section 2.4.2 of the Expansion Project EIS provides reference to the licence issued by the South Australian Environment Protection Authority (EPA) for Olympic Dam, which is a publicly available document, and discusses WMC's obligations and exemptions granted in the licence. Members of the public wishing to see the full licence may do so at the EPA offices, in accordance with the provisions of the Environment Protection Act.

Conditions included in the EPA licence for Olympic Dam require WMC to:

- monitor effluents and emissions
- report incidents that have the potential to cause pollution
- report planned process changes that would alter effluents and emissions
- report process parameters on a quarterly basis
- have an environmental improvement programme.

Environmental care

Submission P36 requests that the $3.2 million annual expenditure (Table 1.3 of the Expansion Project EIS) on environmental care be itemised. This expenditure is composed of the salaries and direct costs associated with the environmental and radiation protection activities of Olympic Dam's Radiation, Environment, Safety and Quality Department. Direct costs include travel, consumables and training.

The environmental care expenditure given in Table 1.3 of the EIS does not include the following:

- capital expenditure on projects to improve environmental management;
- installation of monitoring equipment;
- running of pollution control equipment;
- rehabilitation.

2.2 THE OLYMPIC DAM AND STUART SHELF INDENTURE

The legal framework setting out the relationship between the South Australian Government (the State) and the Joint Venturers for project development and operation was established by the State Parliament through the *Roxby Downs (Indenture Ratification) Act 1982* and updated by the *Roxby Downs (Indenture Ratification) (Amendment of Indenture) Amendment Act 1996*. These Acts ratified and amended the Olympic Dam and Stuart Shelf Indenture, hereafter referred to as the Indenture.

The original Indenture provided for the development of an operation recovering up to 150,000 t/a of copper and associated products. The Amendment provides for the increase of this limit to 350,000 t/a of copper and associated products.

A number of submissions raise the following issues regarding the Indenture:

- the relationship to environmental approvals
- confidentiality provisions
- royalty payments.

These issues are discussed further below.

Environmental approvals

Several submissions express the view that the amendment of the Indenture in 1996 by the South Australian Government pre-empted the environmental approval for the Expansion Project.

This view is not correct, as the Indenture specifically requires environmental approval prior to development. In establishing the relationship between WMC and the State, the Indenture also provides the basis for some of the aspects of the project description contained in the EIS.

The environmental approvals required by the Expansion Project are described in Section 1.3 of the Expansion Project EIS, and in the Guidelines (Appendix B of the EIS), and are not repeated in this Supplement. Questions regarding the implications for the State Government under the Indenture should the Commonwealth Government not grant the necessary export licences are a matter for government.

Confidentiality provisions

Several submissions criticise the confidentiality provisions of the Indenture, expressing concern that they could be used to restrict publicly available information regarding environmental management at Olympic Dam. Such criticisms need to be tempered by an examination of the environmental management reports that have been made available to the public to date, which include:

- the 1983 EIS, comprising a Draft EIS (Kinhill – Stearns Roger 1982) and the Supplement (Kinhill Stearns 1983), together with the State assessment report (Department of Environment and Planning 1983) and the Commonwealth Government assessment report (Department of Home Affairs and Environment 1983);
- Olympic Dam Operations survey and assessment report—supplementary environmental studies: Borefield B development (Kinhill Engineers 1995), together with the State assessment report (Department of Housing and Urban Development 1995);
- Environmental Review (WMC—Olympic Dam Corporation, 1995a), together with the State assessment report (Department of Housing and Urban Development 1996);

- Environmental Management Programme annual reports (made available to the public annually since 1991);
- Environmental Management Programme 1993 (WMC—Olympic Dam Operations 1993) and Environmental Management and Monitoring Plan 1996 (WMC—Olympic Dam Corporation, Copper Uranium Division 1996);
- Occupational and environmental radiation dose reviews (made available to the public annually since 1991);
- Environmental and Radiation Management Programme annual reports (made available to the public since 1991);
- Many publications by WMC personnel in scientific journals and at conferences, including those listed in Table 15.4 of the EIS;
- Environment progress reports (published annually since 1994–95 for the entire WMC operations);
- Codes of practice for the construction of Borefield B Stage 1 (WMC—Olympic Dam Corporation 1995b), the Davenport to Olympic Dam 275 kV powerline (WMC—Olympic Dam Corporation 1997a), the Olympic Dam Expansion Project (WMC—Olympic Dam Corporation 1997b) and Borefield B Stage 2 (WMC—Olympic Dam Corporation 1997c);
- the Expansion Project EIS.

In addition to the above, there continues to be provision for consultation with the Commonwealth Government through the Olympic Dam Environment Consultative Committee, comprising representatives from the State and Commonwealth governments and WMC. As mentioned in the Expansion Project EIS, the State and Commonwealth governments and WMC are currently discussing new terms of reference and procedures for meetings of this committee, and also a broader based Community Consultative Forum including representatives of stakeholder groups.

Royalties

A number of submissions question the sufficiency of the royalties payable to the State Government under the Indenture.

The royalties as specified in the Indenture currently provide a surcharge effective to year 2005 of 1% over the standard royalty of 2.5%, as specified in the Mining Act for other mines in the State.

As noted in Section 1.1.2 of the Expansion Project EIS, royalties paid to date by WMC have already exceeded the Government's capital investment in infrastructure support provided during the initial establishment of the project. Given that future royalty income will be received without much further capital expenditure by Government, the initial expenditure by Government would appear to be an excellent investment by any normal measure. The Expansion Project would further improve the return to Government.

Some submissions also suggest that the costs for the provision of government services at Roxby Downs should be attributed to the Olympic Dam Project. However, residents of Roxby Downs, as taxpayers, are entitled to the same level of government services as any other Australian citizen, and these would still need to be provided if they were employed by other industries elsewhere. It should be noted also that WMC contributes annually 50% of the budget shortfall for the Municipality; in 1995–96 the budget shortfall was $651,000, and WMC's contribution was $325,500.

2.3 ENVIRONMENTAL MANAGEMENT PROGRAMME

Submission P37 questions why the Environmental Management Programme Annual Report 01/03/96–29/02/97 had not been made available by WMC to the public during the period of public responses.

The period in question represents the first year of operation under the Environmental Monitoring and Management Plan (EMMP) published in 1996. As a consequence, the previous timing of the annual report under the former Environmental Management Programme no longer applies. The EMMP annual report now includes environmental radiation monitoring results, which require three months for stabilisation for analysis purposes. In future, EMMP annual reports should be available in about August each year for the year ending the previous February. The Expansion Project EIS was based upon the most recent environmental information up to March 1997.

2.4 MODELLING PROJECTIONS FOR THE BOREFIELDS

A number of submissions raise the issue of the public release of modelling projections over a fifty-year period, compared with the twenty-year planning period adopted for the Expansion Project EIS. Some of these submissions assert that the failure of government to release the results of these modelling projections represents a fundamental perversion of due process, although the reasons for this are not presented.

WMC has not undertaken modelling over a fifty-year period. As noted in the EIS, the WMC planning period of the operation of the borefields is twenty years. The modelling undertaken in the Borefield B approval process was based on predicted drawdown over a twenty-year period (Kinhill Engineers 1995), and the Designated Area for Borefield B is based on the 5 m drawdown contours from the modelling undertaken at that time.

Results of the most recent modelling presented in the EIS, utilising an updated model for the Great Artesian Basin (ODEX1) and revised water usage estimates, demonstrate that the limits of the Special Water Licence could be reached by the end of the twenty-year planning period, assuming no change in the model and in abstraction rates and confirmation in field monitoring. Over this twenty-year planning period the ODEX1 model would be updated, and additional water conservation measures would be expected to be adopted. The EIS foreshadows future arrangements that may be required, which could include a further borefield deeper into the Great Artesian Basin. In response to some submissions, further information on ODEX1 is provided in Appendix H.

Therefore, WMC considers that it would be misleading to present modelling results beyond a twenty-year planning period, which could not be based upon the above information, but rather on speculation of future monitoring results and abstraction arrangements. Further information on modelling projections and water use minimisation strategies is provided in Sections 4.1 and 4.4 of this Supplement.

2.5 STAGING

A number of submissions criticise the staging presented in the Expansion Project EIS and, in particular, the adoption of the existing operations to define the baseline conditions rather than the previously approved production rate of 150,000 t/a copper.

The EIS adopts a baseline of Olympic Dam operations as at December 1996. The environmental assessment in the EIS describes the potential impacts, both positive and negative, of the Expansion Project against this baseline reference. It is disagreed that the previously approved production rate of 150,000 t/a copper should be used as a reference.

Although this was a potential alternative approach to the EIS, it was considered that using the December 1996 baseline was more realistic than using an approved production rate that had not yet been reached. The approach adopted is in accordance with the accepted principles of environmental impact assessment.

2.6 WMC BOARD COMMITMENT

A number of submissions are critical of the reliance on a conceptual design for the second phase expansion from 200,000 t/a to 350,000 t/a copper and of approvals being sought for this phase of the Expansion Project prior to WMC Board commitment. The latter issue is irrelevant to the assessment process, while the level of detail presented in the EIS for the second phase expansion is consistent with industry standards in terms of the level of detail provided for environmental impact assessment. Assessment of the Expansion Project to 350,000 t/a copper production as described in the EIS is considered important as it allows WMC to plan for future development of the project.

2.7 THE 1983 EIS

A number of submissions are critical of economic and employment projections presented in the 1983 EIS and, by analogy, are critical of similar projections in the Expansion Project EIS.

The projections made in the 1983 EIS were the best available at the time and did not have the benefit of experience with an operating plant. In addition, advances in technology have resulted in workforce efficiencies in both the mine and plant that, together with economic conditions and competitive market-place forces, have resulted in fewer people being employed than predicted in the 1983 EIS. The Expansion Project EIS is based on detailed workforce projections presented in Tables 12.4 to 12.6 in the EIS, which are the best available data at this time.

2.8 CONSEQUENCES OF NOT PROCEEDING WITH THE PROJECT

Submission P3 states that the EIS should include both the negative and positive economic effects that are avoided if the project does not proceed. It also states that the EIS does not present any negative effects associated with the project.

Reference to Chapter 13 of the Expansion Project EIS shows that there would be net positive economic effects associated with both stages of the Expansion Project. Hence, the discussion in Section 1.5 of the EIS is consistent with the overall findings of the EIS. A discussion on the predicted minor negative economic effects of the Expansion Project on certain sections of the Australian economy is contained in Chapter 13 of the EIS.

Submission P3 states that the EIS does not mention the health benefits if the project does not proceed. On the basis of information currently available, no increase in the collective dose of the workforce and public is predicted, hence no adverse health effects would be avoided by not proceeding with the Expansion Project.

CHAPTER 3

PROJECT DESCRIPTION

CHAPTER 3

PROJECT DESCRIPTION

Chapter 3 of the Expansion Project EIS describes the proposed project and provides the basis for quantification of the environmental impacts described in the remainder of the EIS. The chapter also discusses realistic alternatives to mining methods, metallurgical processes, tailings and liquor management, and power generation.

This chapter of the Supplement provides a response to comments received on the project description relating to:

- **clarification of specific issues**
- **alternatives for elements of the project**
- **use of imported concentrates or ores.**

3.1 CLARIFICATION OF SPECIFIC ISSUES

Specific issues are raised with respect to storage of mine seepage water underground, economic viability of the project and operation of the quarry.

Mine water storage

Submission P1 questions whether three days' underground storage of mine water is sufficient, as power failures of longer duration could occur. The reliability of power supply to Olympic Dam would be improved as a result of commissioning the 275 kV transmission line currently under construction. This new transmission line would operate in parallel to the existing 132 kV transmission line to the site, making a prolonged power failure, as suggested, unlikely.

However, should a prolonged power failure occur, mine dewatering could also be effected using standby generating capacity on site. The three days of underground water storage would be adequate for the implementation of any necessary measures in such a situation.

Economic viability

Submission P22 questions whether the Expansion Project is economically viable given the:

- current slump in gold prices;
- current trend against nuclear power, resulting in uranium demand and price dropping in the future.

Gold forms only a small proportion of the revenue at Olympic Dam and the viability of the project is not sensitive to gold prices.

WMC undertakes extensive market research prior to committing to major capital projects such as the Expansion Project. WMC does not share the view that demand for uranium will drop in future, and this is supported by estimates by the Uranium Institute, which are discussed in Section 1.4.3 of the EIS. As noted in that section, as at September 1996 a total

of 436 reactors were in operation worldwide, and another thirty-two were under construction. It is also noted that WMC's market research is not reliant on one source, such as the Uranium Institute, and that project viability assessment incorporates extensive use of sensitivity analyses for the prices of the products.

Backfill quarry

Submission P36 suggests that more information is needed for assessment of use of the dolomite quarry.

As described in Section 3.3.9 of the EIS, the mining operation relies upon mined-out stopes being backfilled with either development mullock or cemented aggregate fill. The latter is required in stopes adjacent to future mining areas. Aggregate, cement, pulverised fuel ash (a partial cement substitute, described further in Section 2.1 of this Supplement) and deslimed mill tailings are accurately proportioned to provide cemented aggregate fill with sufficient strength requirements.

Aggregate is sourced from the dolomite quarry operated on the site, and the quarry is an essential component of the mining operations. At a nominal production rate of 9 Mt/a of ore from the main mine, the required quantity of rock from the backfill quarry for use in the cemented aggregate fill as backfill would be approximately 4.5 Mt/a. The extent of the quarry operations is shown in Figure 3.7 of the EIS. The major impact of the quarry is in relation to vegetation clearance. The estimated area of land disturbance is 227 ha, as listed in Table 7.4 of the EIS. It should be noted that the maximum use of mullock and deslimed mill tailings reduces the dolomite demand.

Special Mining Lease boundary

Submission P36 states that plans and details of extensions to the Special Mining Lease need to be included in the EIS for assessment. At the present time, there are no plans to extend the Special Mining Lease. However, should this option be considered in the future, the appropriate procedures as required by the Indenture would be followed.

3.2 ALTERNATIVES

Questions are raised regarding the alternatives to the following elements of the project:

- uranium production and export
- water supply
- rail transport
- use of the mine as a waste repository
- value adding on site.

Additional information in response to these questions is provided below.

Uranium production and export

Submission P37 requests an assessment of the option of not exporting uranium from Olympic Dam. In addition, the submission states that this assessment of the Olympic Dam mine, in the event that the Commonwealth Government withholds or withdraws uranium export approvals, should include design, economic and environmental aspects.

The option of developing the Olympic Dam mine without the production of uranium was examined in the 1983 EIS, with the conclusion that it would not be economically viable to

develop the deposit by extracting only copper and precious metals from the ore. The relative values of copper, uranium, gold and silver have changed since 1983; however, the conclusion reached then is still valid today.

Without Commonwealth Government export approvals, WMC would be denied its market for uranium. The sales of uranium oxide comprise about 25% of the annual value of production from Olympic Dam. Accordingly, the existing or expanded project would not be economically viable without approval to sell the uranium oxide concentrate.

Water supply

Submission P4 comments that the Expansion Project EIS provides no discussion on alternative strategies for process and potable water supply.

The issue of alternative water supplies was addressed as part of the 1983 EIS, and existing approvals are expected to be sufficient to meet the Expansion Project needs over a twenty-year planning period. Strategies for abstraction of water beyond this period are discussed in Section 4.1 of this Supplement.

Rail transport

Submissions P21 and P27 suggest that consideration be given for a rail link between Pimba and Olympic Dam. Such a link remains a future option subject to economic and technical review.

Waste repository

Submission P29 raises the issue of a national radioactive waste repository. The submission suggests that Olympic Dam would be the best location for such a facility. WMC has not approached either the Federal or State governments on this issue.

Value adding on site

Submission P21 requests comment on value adding on site, producing copper products other than copper cathode sheets. Such value adding is not being considered as it does not constitute normal business activities undertaken by WMC. Such activities are unlikely to be economic in a remote location such as Olympic Dam.

3.3 IMPORTATION OF ORES AND CONCENTRATES

Questions are raised regarding the proposal for the importation of ores and concentrates, specifically:

- whether uranium ores would be imported;
- what would be the energy and water requirements and wastes produced from processing of copper concentrate.

Uranium ores

Submission P33 states that the terms of the Indenture as amended would allow South Australia to become the uranium processing centre for Australia.

The production of uranium oxide at Olympic Dam, other than from ores and concentrates derived from Olympic Dam, is in fact not permitted by the Indenture without the specific approval of the Minister.

Importation of copper concentrates

Submission P36 correctly notes that, for the 285,000 t/a copper production case, the additional energy, water and waste disposal requirements associated with the importation and processing of copper concentrates are not specifically provided in the EIS.

The energy and water requirements at a production rate of 285,000 t/a copper, using imported concentrates for production of 85,000 t/a of this copper, would be within the range of the corresponding values for 200,000 t/a and 350,000 t/a ex-mine copper production presented in the EIS. The waste disposal requirements would be essentially unchanged from the 200,000 t/a copper case, as the imported copper concentrates would generate little tailings material.

The processing of concentrates on site would require less power, water and waste disposal than if the ore had been fully mined and processed on site, because the mining of ore and part of the processing would have been undertaken elsewhere.

Table 3.1 provides specific values for the above parameters, on the basis of 85,000 t/a copper production from concentrates.

Table 3.1 Energy, water and waste disposal requirements at 285,000 t/a copper production

Parameter	Quantity
Energy use	7,857,684 GJ/a
Water use[1]	36.2 ML/d
Solid waste to tailings system	6.6 Mt/a

1 *Includes Roxby Downs.*

CHAPTER 4

WATER MANAGEMENT

CHAPTER 4

WATER MANAGEMENT

Sixteen public and four government submissions make ninety comments on various matters relating to water management issues in the Expansion Project EIS. These comments are primarily concerned with the matter of the long-term availability of water from the Great Artesian Basin, the effects of drawdown on the mound springs of the basin, the accuracy of modelling predictions for the life of the project and beyond (including the details of the ODEX1 computer model used), and the cost of water. One or two submissions also raise a number of quite specific issues.

Section 4.1 of this chapter deals with the related issues of:

- **water availability and predicted project impacts thereon**
- **Borefield B modelling and strategies for the period beyond twenty years**
- **compliance with Special Water Licence No. 2**
- **the validity of ODEX1 modelling.**

The question of impacts on the mound springs, including their flora and fauna, is addressed in Section 4.2, and the cost of water from the Great Artesian Basin is the subject of Section 4.3. Water use minimisation strategies are the subject of Section 4.4, whilst a number of miscellaneous matters, including the cone of depression resulting from mine dewatering, aquifer re-injection at Bopeechee Bore, impacts on pastoral bores, and the need for a comprehensive management strategy for the entire Great Artesian Basin are grouped together in Section 4.5.

4.1 IMPACT OF WATER ABSTRACTION FROM THE GREAT ARTESIAN BASIN

The impact of water abstraction on the Great Artesian Basin is a major issue raised in public and government submissions on water management, and this is addressed in this section under the topics generally raised in those submissions. These topics include availability of Great Artesian Basin water and the perceived effects of project-related water abstraction; timing and strategies for the development of additional borefields for copper production beyond 200,000 t/a; compliance with Special Water Licence conditions; and details of the groundwater model ODEX1, which was developed for the project's water requirements.

Availability of water from the Great Artesian Basin

The question of availability of water from the Great Artesian Basin is raised in a number of submissions. In all instances, these submissions address concerns that water abstraction for the existing Olympic Dam project and the proposed expansion (as well as consumption by other users such as pastoralists and oil producers) would have a long-term deleterious impact on the Great Artesian Basin's total water availability.

Most of these submissions reveal an apparent misunderstanding of the size and nature of the Great Artesian Basin aquifers, which are described in Section 4.2.1 of the EIS. For example,

one submission expresses concern that, as the quoted flow velocity through the basin is of the order of 1–5 m/a, the predictions for flow recovery in bores and springs quoted in Table 7.19 of the EIS are 'optimistic'. It needs to be understood that the aquifer is up to 750 m thick in the north of South Australia, and that the volumetric flow rates (as opposed to velocity) are very large.

The estimated total storage volume of the basin is of the order of 8,700 million ML (Sibenaler 1996) and, at the maximum projected consumption rates for the project, the daily consumption of 42 ML would result in an average annual consumption of 0.015 million ML, which is approximately 0.0002% of the total storage of the Great Artesian Basin. More importantly, the recharge of the basin is estimated to be not less than 2,600 ML/d, meaning that project-related consumption would be about 1.6% of this annual inflow.

Submission P4 draws attention to the figures quoted in Section 4.2.1 of the EIS regarding the recharge–discharge rates for the South Australian portion of the Great Artesian Basin; in particular, the claim that the Great Artesian Basin 'is in hydrogeologic equilibrium'. It should be noted that hydrogeologic equilibrium, or steady-state recharge-discharge, is not a fundamental assumption of the EIS or the supporting hydrogeologic reports.

Large-scale water balances calculated by the leading investigators quoted in the EIS show that the largest component of the estimated 425 ML/d inflow–discharge for the South Australian portion of the Great Artesian Basin is vertical leakage at 190 ML/d, and it is from this that much of the project's water abstraction is expected to come. Other major discharges are flowing bores (132 ML/d) and mound springs (66 ML/d). The projected maximum daily water consumption of 42 ML/d would be some 9.9% of the total inflow–discharge for the South Australian portion of the basin, compared with 1.6% of the total inflow. The Great Artesian Basin is a confined (or pressure) aquifer, and the major impact of the abstracted water will be a loss of pressure in some bores and springs, as modelled in ODEX1.

When abstraction ceases, as will be the case in some Borefield A bores, the pre-abstraction pressures of any affected bores and springs will gradually be restored over time. This is discussed in detail in Section 4.5 of the EIS. In the case of Borefield A, the recovery noted following the reduction of water abstraction since November 1996 has been very rapid.

The output of the 425 ML/d flow into South Australia occurs by several means, the most significant of which is the upward vertical leakage, as noted above. Water escapes through the porous sandstone and shale close to the surface and eventually evaporates. The fact that the volume of water abstraction is not the key issue is recognised in Olympic Dam's special water licences, which regulate WMC's access to Great Artesian Basin water by constraining the allowable pressure reduction at nominated locations (as shown in Figure 4.12 in the EIS), rather than by a volumetric allocation. The relationship between pressure reduction and volume is discussed later in this section.

Further demand for water from the Great Artesian Basin can be met by the use of strategically placed bores that 'harvest' water that would have normally been lost by vertical leakage to surface evaporation. A reduction in aquifer pressure due to the operation of these bores is required in order to reduce the rate of vertical leakage, thus making it available for 'harvesting'. Obviously, in order to protect environmental flows and access to water of existing users, future reductions in aquifer pressure need to be maintained within acceptable limits.

The development of the existing WMC borefields is a good example of the strategic placement of bores to 'harvest' vertical leakage. These borefields were located with the aid of numerical modelling, which was used to assess the impacts of potential borefield configurations on mound spring flows and existing users. Furthermore, as described above, the special water licences for these borefields incorporate agreed limits on aquifer pressure

drawdown, rather than volumetric constraints. In this manner the concept of harvesting vertical leakage by acceptable reductions in aquifer pressure is incorporated into regulation of the borefields.

Future borefields required by WMC or any other user would need to take into account the predicted aquifer pressure reductions from the existing WMC borefields, as well as existing pastoral bores. Hence, as foreshadowed in the EIS, any future borefields, if required, would probably need to be located deeper into the Great Artesian Basin.

Strategies for water abstraction beyond twenty years

A number of submissions raise questions concerning the strategy for obtaining additional water resources beyond 2016 (twenty years from the commencement of operation of Borefield B). This matter is responded to in Section 2.4 of this Supplement. One submission queries why approval for expansion to 350,000 t/a is being sought when it is not yet possible to model water abstraction for this production rate.

WMC is confident that the South Australian portion of the Great Artesian Basin has sufficient sustainable reserves for the long-term needs of production to 350,000 t/a copper. In Section 4.5.5 of the EIS it is stated that, as was the case in 1983 when insufficient data existed to model abstraction from Borefield B, WMC accepts that it may be necessary at the appropriate time to seek a similar approval for an additional borefield. Indeed, such a development may not be required at all, should future improved practices to minimise water use, further control by the authorities of free-flowing bores, or updated modelling demonstrate that an additional borefield is not necessary.

None of these possibilities can be fully evaluated at this time. The hydrogeologic information gained over the next few years of abstraction from Borefield B will enable refinements to be made to ODEX1 that will greatly enhance the level of understanding of the aquifer parameters and behaviour such that more reliable predictions to twenty years and beyond can be made. WMC is obligated under the terms of the special water licences to meet drawdown limits specified at the boundaries of the Designated Areas. It should be noted that these limits are the key management parameters; modelling is used as a predictive management tool only.

It should be noted also that the initiation of a new overall management strategy for the Great Artesian Basin, which is strongly supported by WMC, may have a considerable influence on the option finally chosen. This strategy is being developed by the Great Artesian Basin Consultative Council, which comprises South Australian, Queensland, New South Wales, Northern Territory and Commonwealth government departmental representatives and key stakeholders.

Compliance with Special Water Licence conditions

A number of submissions raise questions concerning Special Water Licence conditions, with Submission G9 noting that the issues concerning Borefield B were the subject of a previous assessment process (involving public input) that culminated in the issuing of the Special Water Licence for Borefield B. Submission G13 notes that the author 'would expect the option of a third borefield would be adopted rather than renegotiation of the Special Water Licence conditions'.

The matter of a possible third borefield has been discussed above. It should also be noted that the primary aim of any negotiation with the Department of Mines and Energy (MESA) in relation to Special Water Licence conditions must be to protect the environment and the interests of other Great Artesian Basin users. The Indenture agreement between the (then) Joint Venturers and the South Australian Government makes it clear that variations to the special water licences are possible, as indicated in Section 4.2.5 of the EIS.

The current agreed limits in the Special Water Licence for Borefield B were set at drawdown predictions derived by modelling the operation of the borefields at a total abstraction rate of 42 ML/d over a period of twenty years. Importantly, the current agreed limits allows a margin over and above the limits required to protect the environment and other users. Should future monitoring show that, despite the implementation of water use minimisation strategies, the agreed drawdown limits are being approached, the options available to WMC to ensure water supplies for the project are to:

- renegotiate the agreed drawdown limits, taking into consideration updated monitoring data and hydrogeologic modelling, the need to protect environmentally significant mound springs and the rights of other users;
- adjust the configuration of abstraction away from areas of higher drawdown;
- implement reinjection strategies to maintain aquifer pressure at strategic locations and, if necessary, mound spring flows;
- bring forward the investigation and development of another borefield deeper into the Great Artesian Basin, as foreshadowed in the Expansion Project EIS;
- explore any other water sources that may have become viable.

Submission P3 queries what is being done to verify that WMC 'is operating within the requirements of Special Water Licence No. 2 conditions at Borefield A'. The periodic reporting requirements in respect of impacts of water abstraction generally are set out in Section 15.1.3 of the EIS, where it can be seen that quarterly hydrogeological data are provided by WMC to the State authorities, and that summary results are made public in the annual Environmental Management and Monitoring Plan (EMMP) reports. An annual Water Report is also submitted to State authorities. Furthermore, Tables 15.7 and 15.8 of the EIS set out the obligations accepted by WMC with regard to drawdown of potentiometric heads at bores, springs and the Designated Area boundaries.

One respondent (Submission P36) queried the divergence from the original drawdown limit of 2 m for the boundary of the Designated Area for Borefield A. The figure of 2 m was set as an appropriate initial value in May 1986. Following extensive monitoring and assessment of potential abstraction rates and drawdown values, the Minister of Mineral Resources approved revision of the drawdown at Jackboot Bore to a maximum of 5 m, and the drawdown between bores GAB8 and HH2 to a maximum of 4 m.

Another respondent (Submission P32) also considers that the EIS process is compromised because the approvals for water abstraction from Borefield B were obtained prior to approval of the Expansion Project. It is difficult to see how this could be so; the EIS makes it very clear that up to 200,000 t/a copper production could be achieved within the constraints of the existing special water licences, and that any conceivable new borefield development would be subject to further public assessment in due course, as occurred for Borefield B.

The ODEX1 model and MESA predictions

In its response to the Expansion Project EIS, MESA states that the numerical model ODEX1 is conceptually sound and 'the best technical approach available for estimating potential (groundwater) drawdowns over the Designated Area during the period of simulation from 1996 to 2016'. However, the Department of Environment and Natural Resources (DENR) submission expresses the view that there must be 'a degree of scepticism until such time as actual flow data is available'.

It is accepted that, while a sound technical basis has been established for estimating future drawdowns, these must be verified by actual operation. The Expansion Project EIS maintains that improved knowledge and forecasting ability will naturally follow the period of actual

flow data collection now in progress. Table 4.4 of the EIS shows that the predictions of spring flow discharge made in 1984 have proven to be remarkably good, even though knowledge of the aquifer properties was limited at that time. As ODEX1 represents a considerable advance on earlier models, there are very good reasons to be confident as to the accuracy of its simulations.

It should be noted that future impacts on the Great Artesian Basin and the mound springs are not dependent on the accuracy of the ODEX1 model. Actual data will demonstrate the real impacts of abstraction. In this regard, the model is purely a predictive management tool and, although useful for planning purposes, it has no statutory status. The special water licences contain agreed limits on actual drawdown of aquifer pressure and are not reliant on model predictions.

A number of submissions also address matters related to the ODEX1 model as discussed below.

The full details of the model ODEX1 were not included in the Expansion Project EIS owing to the complexity and technical nature of the information. However, as some respondents believe that information on ODEX1 should be available, it is included as Appendix H to this Supplement.

Uncertainty about the model bounds is raised in some of the submissions. The geographic limits of the Great Artesian Basin are clear from Section 4.2.1 of the EIS. The bounds of the model are also discussed further in Sections 4.5.1 and 4.5.5 of the EIS and in Appendix H of this Supplement.

One submission (P36) also states that the EIS should show maps of the Great Artesian Basin below (south of) Borefield B. It is not clear as to why this is requested, as Figures 4.9 and 4.11 of the EIS both extend beyond the limits of Borefield B and well beyond any measurable influence of borefield abstraction. The same submission also requests a display of 'aquifers, their individual recharge and discharge points and recharge–discharge rates'. This level of detail is unnecessary for the purpose of assessment of impacts.

Submission P34 raises the issue of transient aquifer parameters and whether these would influence the ODEX1 model predictions. However, there is no evidence of the phenomenon of transient parameters at Borefield A, where the relative increase of aquifer stress has been greater than will be the case at Borefield B. Similarly, there is no such evidence at pastoral bores, where sediment discharge is much greater due to the absence of screens. In any event, formation damage in the vicinity of production bores will have no environmental impact.

Predictive validity (confidence limits), as raised in Submission P34, is qualitatively assessed through analysis of the sensitivity of the model predictions to realistic variations of model parameters. The results of sensitivity assessment were presented in the Borefield B report by Kinhill Engineers (1995).

Submission P34 makes three incorrect statements. These are that ODEX1 does not incorporate flow across the North-East Fault (which it does), that the quantity of vertical leakage was not determined from field measurements, and that the EIS assumes that reducing flow of vertical leakage would have no impact on other hydrogeological processes. Field determination of leakage rates was undertaken by Woods (1990), the results of which were used to constrain the numerical model. Reduced vertical leakage is a consequence of reduced aquifer pressure, consequently it is a component of the overall hydrogeological processes within the Great Artesian Basin that were considered in the EIS.

Submission P34 states that effects known to alter spring flow, such as barometric pressure, evaporation rates and others, are not included in the model. This statement is correct; however, the modelling was undertaken to predict changes in spring flow resulting from

operation of the borefields. The processes mentioned would continue to influence spring flows irrespective of the borefields, hence the effects can be considered separately.

Submission P34 also refers to a detailed review by Keane (1997) that, according to the submission, shows that the South Australian portion of the Great Artesian Basin is not in equilibrium. Keane's review (an undergraduate thesis) cannot be sourced and therefore cannot be substantiated. Work by Hillier (1996) suggests that the Great Artesian Basin is approaching steady state.

One submission notes that an earlier higher figure of 35 ML/d was quoted by Berry and Armstrong (WMC 1995) for the extraction of Great Artesian Basin water by Santos for its Moomba oil and gas fields. The earlier environmental assessment work done for Borefield B (Kinhill Engineers 1995) indicated a figure of 'the order of 35 ML/d'. The approximation was not part of the quantitative assessment. The later ODEX1 model report uses a reasonably accurate summary of oilfield abstraction as part of the model input, which gives a peak abstraction rate of 26 ML/d.

4.2 IMPACTS ON MOUND SPRINGS AND VALIDITY OF EARLIER ESTIMATES

The issue of actual and predicted impacts of groundwater abstraction on the mound springs of the Great Artesian Basin is addressed in a number of submissions, mostly with the underlying theme that 'hydrological modelling is still an imprecise science', and that 1984 predictions had been shown to be unreliable, with particular reference to Table 4.4 in the Expansion Project EIS. However, it is observed in Submission F1 from the Commonwealth Government that WMC should be commended on its monitoring and research of the mound springs and also on its commitment to continue this work.

There appears to be some misunderstanding of both the nature and accuracy of hydrogeological simulation and what constitutes a 'reasonable' estimate of drawdown or flow reduction. Hydrological modelling is not an imprecise science, and great strides have been made in the nearly forty years since the first mathematical models of the hydrological cycle were developed.

Any lack of precision results from a lack of hard data on which to base the models, not on a lack of understanding of the hydrological processes involved. In this context, the 1983–84 work that led to the predictions in Table 4.4 of the EIS was based on the limited hard data available. Despite this, the accuracy of most of those predictions has been proven by the outcomes, as Table 4.4 of the EIS shows.

This issue is also raised in one public submission, which considers that there had been no attempt to quantitatively analyse the results from previous modelling. This is not the case; the results of this analysis were reported extensively by Kinhill Engineers (1995) and are also shown in Table 4.4 of the EIS.

The database has grown with the more than fifteen years of research and monitoring conducted by WMC, and better estimates will continue to be made as the production and observation bores of Borefield B produce data that will be used to refine aquifer parameters and re-estimate drawdown effects at spring groups.

Damage to mound springs flora and fauna

The issue of damage to mound springs flora and fauna from Borefield A is addressed in Section 7.4 of the Expansion Project EIS and in Section 7.4 of this Supplement. A key part of the strategy inherent in the development of Borefield B is the opportunity it provides to reduce abstraction from Borefield A, with a concomitant recovery of some of the springs

affected by that abstraction. In this context, a number of the submissions argue that abstraction from Borefield A should cease immediately as:

- this is the only way to guarantee the integrity of the most seriously affected springs
- the springs are a significant tourist attraction.

However, it should be noted that those springs most affected by abstraction since the first withdrawals would not be generally regarded as 'tourist attractions' owing to their inaccessibility and relatively obscure locations. In addition, the springs affected by drawdown from Borefield A generally lack the aesthetic qualities associated with tourist attractions.

One submission considers that many mound springs show reduced levels of moisture and degradation of surrounding vegetation. This is acknowledged in the EIS (Section 7.4.11) in respect of those spring groups predicted in the 1983 EIS to have significant flow reductions, and a complete list of affected springs is included in Table 7.18 of the Expansion Project EIS. It should, however, be noted that in some springs where little or no flow reduction has occurred—such as Old Woman, Old Finniss and Wangianna springs—there has still been a decline in endemic fauna during the period of observation. This demonstrates the difficulty in unambiguously ascribing changes in faunal species abundance to project-related water abstraction from the Great Artesian Basin. A further factor affecting some mound springs is that removal or exclusion of cattle has allowed an increase in vegetation. This has resulted in increased evapotranspiration, capping of vents and damming of water flows by plant rhizomes, which has affected monitored spring flows.

More importantly, the proposed changes in the balance of abstraction between Borefields A and B would result in very much reduced use of Borefield A. This reduced use would see a consequent reduction in stress on the more abundant and important affected springs, with expected pronounced beneficial effects (Table 7.19, Expansion Project EIS).

WMC will continue to monitor mound spring flows as described in the EMMP. Should this monitoring indicate any significant variations with predicted flows, WMC in consultation with the regulatory authorities would investigate the cause of the variation and if necessary implement contingency measures, possibly involving one or some of the following options:

- modification of the relative abstraction rates for the two borefields and from individual bores;
- implementation of reinjection strategies to maintain aquifer pressure at strategic locations;
- development of another borefield further into the Great Artesian Basin.

Ongoing studies into the minimisation of water use at Olympic Dam would also continue.

4.3 COST OF THE GREAT ARTESIAN BASIN WATER TO WMC

The issue of the cost of Great Artesian Basin water to WMC is raised in a number of submissions, where views expressed include:

- 'WMC has free access to water.';
- 'Olympic Dam Operations should pay for the use of groundwater.';
- 'Water cost comparisons do not investigate relationships between subsidy rates and conservation incentives.';
- 'Water costs should give an analysis of full public costs.';

- 'Will WMC pay the full price for additional water they use?';
- 'Pastoralists in the region are charged for their use of artesian water.';
- 'If WMC were charged for water at the same rate as Roxby Downs residents, this would amount to $4.34 million per year at current rates of water use.';
- '. . . objects to WMC obtaining up to 42 ML/d of free water.'.

All of these submissions are based upon the same assumption: that everyone in Australia is charged for the water they use. This is not the case; consumers Australia-wide are in fact charged (where charging occurs at all) for their contribution to the cost of headworks and reticulation; that is, for the costs of providing a water service to their homes, businesses and similar. This is clearly stated in the EIS in Section 4.1.3. That this is often done on a consumption (or pay-as-you-use) basis does not alter the fact that what is being paid for is the cost of providing the service, not the water itself. There are also many places in Australia (including Leigh Creek in South Australia and a number of Queensland coal towns, for example) where not even the reticulation charge is levied on consumers.

WMC has provided and paid for the headworks and piping systems that are used to abstract water from the Great Artesian Basin, and a number of pastoralists are also beneficiaries of this supply system. Subsidy rates do not apply to the operation of the system, which was also constructed without any public cost. WMC investment to date on water supply infrastructure for the Olympic Dam Project is approximately $100 million.

It is also not the case that pastoralists are charged for the use of artesian water. They pay only the $30 application fee to the South Australian Government to construct a bore. Many of the older pastoral bores were drilled by government as stock route bores.

4.4 WATER USE MINIMISATION STRATEGIES

Five submissions address the question of the water use minimisation strategies currently practised or planned by WMC. Each of these discusses, in one form or another, the failure to use 'grey' water and to encourage the reuse of treated sewage effluent for watering of lawns and gardens at Roxby Downs, or to provide dual water reticulation systems for the town.

These matters are addressed in the EIS in Sections 3.8.3, 3.12, 4.1, 4.3, 4.4 and 4.7, where the following is stated:

- 'The upgraded [sewage collection and treatment] facilities would make provision for the reuse of this [treated sewage] water, either for landscape watering or for process water.' (Section 3.8.3);
- 'The sewage collected from the Roxby Downs township is given primary treatment followed by further treatment in lagoons, and is then used for irrigation of the golf course, ovals and other grassed recreational areas. The demand for treated effluent for this purpose currently exceeds the quantities available, a situation that is expected to continue after the Expansion Project.' (Section 3.8.3);
- 'Alternative means of obtaining water savings would be investigated further in the detailed design stage. The main measure proposed is the adoption of high solids density thickeners in the hydrometallurgical plant . . . Other potential measures for water savings would also be investigated further.' (Section 3.12);
- 'Potable water is produced in the desalination plant using reverse osmosis technology.' (Section 4.1.2);

- '[There are] separate potable and process water systems. Potable water is supplied to the mine, metallurgical plant and central services areas for use in ablution and other employee facilities and in processing where desalinated water is required.' (Section 4.1);
- 'The predicted site water balance is shown in Figure 4.10 . . . A site water use of 30.8 ML/d equates to a rate of 1.24 kL/t of ore milled, a reduction of approximately 21% from the 1995–96 rate of site water use of 1.50 kL/t of ore milled.' (Section 4.3);
- 'The current water supply strategy therefore assumes that sufficient water treatment and recycling facilities would be provided in future to enable the water use at a copper production rate of 350,000 t/a to be accommodated within the infrastructure capacity of 42 ML/d.' (Section 4.4);
- 'Previous experience at the site has indicated that regional rainfall is insufficient in quantity and too erratic to warrant permanent facilities for collection of stormwater to augment water supplies. However, as is current practice, temporary pumping facilities would be used following large rainfall events to recover stormwater for use as process water.' (Section 4.7).

All of the above statements make it clear that water conservation and reuse strategies have had a high priority at the mine and process plant as well as at Roxby Downs township in the past, and will be the focus of further attention in the future. Sewage effluent water is used for reticulation to parks and gardens, and this has been the practice for some time. Roxby Downs residents have subsidised domestic water to enable costs to consumers to be kept comparable to those in Adelaide, which, while high in comparison with other Australian capital city standards, reflect the higher cost of the service in the country's driest capital city.

Results of dust monitoring show that uranium levels in dust are at background levels beyond a distance of approximately 5 km from Olympic Dam. As Roxby Downs is over 13 km from Olympic Dam, uranium dust is not an issue for rainwater tank water quality. However, as noted above, regional rainfall is insufficient and too erratic to warrant expenditure during home construction on gutters and rainwater tanks to augment supplies at Roxby Downs. However, individual home owners may install these should they wish to do so.

In regard to the suggestion of a dual water supply to reticulate 'grey water', Roxby Downs has an excess demand over available supply for treated effluent water, for use for watering of recreation areas. Thus all available 'grey water' is being utilised.

Submission P3 states that the statement in the EIS that 'Figure 4.6 also demonstrates the effectiveness of water minimisation practices after 1993' should be deleted. However, the claim is entirely consistent with the data shown in Figure 4.6, which shows the effectiveness of specific programmes targeted at water minimisation in Roxby Downs from 1993 onwards.

The major potential additional water savings to be effected are in the area of process water strategies. As Section 4.1 of the EIS shows, there have already been considerable achievements here and further improvements are planned. The water use per tonne of ore milled will have reduced from 2.10 kL/t in 1989–90 to an expected 1.24 kL/t for 200,000 t/a copper production. This will correspond to a reduction of 41%.

To maintain the water consumption for 350,000 t/a within the infrastructure capacity of 42 ML/d would require a further reduction in water consumption of 35%. This assumes that the mine and process plant will use 38 ML/d and Roxby Downs and Olympic Dam Village will use 4 ML/d in 2010.

WMC is currently considering other measures that could reduce water consumption in the design of the 200,000 t/a copper facility. Further water consumption measures would continue to be investigated, including process changes, use of air cooling instead of water

cooling systems, and the treatment and recycling of tailings liquors, for the 350,000 t/a copper facility.

Submission P1 raises the specific issue of the use of heat from the process plant to treat the saline groundwater to recover water suitable for process use. Such options would be considered in future for economic and technical merit, although it is noted that the high grade waste heat from the process plant is currently used to generate project steam requirements, and that saline groundwater supplies are limited.

4.5 OTHER ISSUES

A number of other issues are raised by respondents in regard to water management. These issues are discussed below.

Cone of depression from mine dewatering

The issue of the cone of depression is raised in Submissions P3 and G9, though the latter was satisfied 'that the impacts on the groundwater system at Olympic Dam will be localised within the general region of the mine, and that the measures proposed to manage these impacts are considered to be acceptable'. This issue is the subject of Section 4.6.4 of the EIS.

Submission P3, queries the location of the cone of depression for the Arcoona Quartzite, shown in Figure 4.22 of the EIS, and asks why this cone of depression is centred on the mine water disposal pond rather than the mine area.

The location of the centre of the cone of depression is influenced by the location of the underground workings and the associated raise bores. Both of these intercept groundwater that is collected and managed as described in the EIS. Initially, the centre of the cone of depression was near the Whenan Shaft, within the mine area, but it has progressively migrated to the west-north-west in conjunction with mine development in this direction.

Figure 4.22 has been redrawn (Supplement Figure 4.1) based on a greater density of groundwater monitoring data in order to improve the accuracy of the location of the cone of depression. The contours of groundwater levels show that the flow of groundwater in the Arcoona Quartzite is towards the centre of the cone of depression. Slight 'mounding' has also occurred around the southern end of the tailings retention system, which has drawn in the 40–50 m AHD water level contours from the south-west. This produces an asymmetry in the cone of groundwater depression in the Arcoona Quartzite, with a steepening in the hydraulic gradient in the aquifer between the eastern side of the tailings retention system and the area of mine workings where mine drainage is occurring. Figure 4.1 also shows that groundwater in the aquifer below the tailings retention system should migrate towards the underground workings, the same conclusion derived from Figure 4.22 in the EIS.

Accurate measurement of the mine water inflow rate is difficult, and not required for the operation of the mine. However, WMC has estimated flow rates into raise bores to total about 696 kL/d. The predicted increase in mine inflow from 3.2 ML/d to 7.3 ML/d, also queried by Submission P3, is to be expected, given the expansion of underground workings that is an integral part of the current proposal.

Infrastructure associated with bores GAB30–32

Submission P29 refers to the infrastructure associated with the now unused bores GAB30–32, considering it unsightly and likely to offend tourists who visit the area.

It is proposed that this infrastructure be removed; however, the bores themselves would remain.

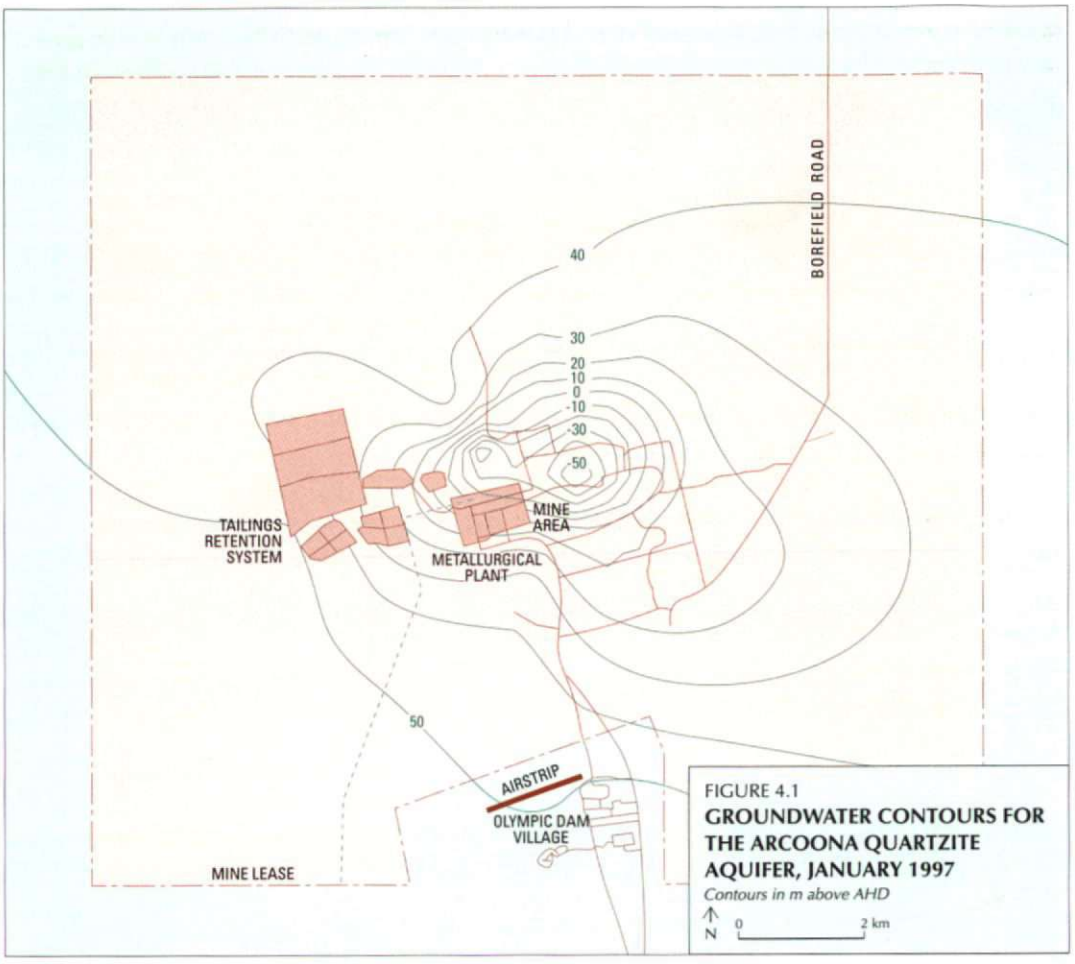


FIGURE 4.1
GROUNDWATER CONTOURS FOR THE ARCOONA QUARTZITE AQUIFER, JANUARY 1997
Contours in m above AHD

Aquifer reinjection at Bopeechee Spring

Submission P34 expresses disappointment with the description of the aquifer reinjection programme as discussed in Section 4.2.7 of the EIS, which reported both the positive and less satisfactory aspects of this mitigation programme. It would not be helpful to try to assess the value of this programme by reference to the water levels existing prior to the commencement of Borefield A, as it is the actual improvement resulting from the injection that is being assessed. Overall, the results described below are positive in relation to the overall drawdown and demonstrate the effectiveness of the programme.

Abstraction from Borefield A peaked at a monthly average of in excess of 16 ML/d in early 1996. Rates have since declined to around 6 ML/d following the commissioning of Borefield B in November 1996 and system test work from September 1996. In early 1995, it was recognised that the increasing demand from Borefield A may jeopardise continued natural discharge from nearby Bopeechee Spring before Borefield B could be brought on-line.

Abstraction was commenced from Borefield A in 1983. With hindsight, a trend of declining artesian pressure and flow rate in the Bopeechee Spring area has been evident since 1988, however this trend was masked by a high degree of short-term variability. In early 1994 the flow rate from the monitored spring vent had dropped as low as 0.15 L/s from typical rates of 0.6 L/s in 1988. It was predicted that in early 1996, the seasonal low in spring flow would coincide with a historical peak in abstraction. It was therefore decided to implement a proposal for artificially maintaining local aquifer pressure to sustain the discharge from the springs.

By 1995, the operation of Borefield A had significantly diminished the north–south pressure gradient in the north-eastern sub-basin (refer to Figure 4.2 of the Expansion Project EIS for this location), and hence the driving force behind the discharge at Bopeechee Spring. In addition, a pre-existing pressure gradient across the north-west fault zone from the borefield sub-basin to the north-eastern sub-basin had been reversed.

At this time, aquifer pressure at the southern end of the north-eastern sub-basin was a complex function of flow reversal across the north-west fault zone towards the centre of the original Borefield A bores (GAB6, 12, 14, 15, 16 and 18) and reduction in flow south into the north-eastern sub-basin owing to the regional effects of the above bores plus the more direct effect of bores GAB30, GAB31, and GAB32.

The aquifer reinjection programme made use of the natural partitioning of the borefield sub-basin and north-eastern sub-basin by the north-west fault zone and existing production and monitoring bores. Groundwater from bore GAB6 in the borefield sub-basin was pumped via a specially constructed low-pressure pipeline across the north-west fault zone to monitoring bore GAB20 and injected into the aquifer, which occurs at a depth of 120 m at this site.

Reinjection was commenced in late October 1995 at a rate of 200 kL/d (Figure 4.2 of this Supplement). Reinjection resulted in a rapid pressure rise, averaging 2–3 kPa at monitor bores GAB8 and HH2, as shown in Figure 4.2. The reinjection rate was maintained at about 200 kL/d for most of the period November 1995 to April 1996.

Monitoring results showed that during the 1995–96 summer the average pressure at GAB8 and HH2 was about 1 kPa higher than in the months preceding reinjection. This is despite a rise in abstraction to 14–16 ML/d from Borefield A during this period, a preceding trend of declining pressure (3 kPa/a) and a major decline in pressure in the borefield sub-basin.

The monitored flow rate from Bopeechee Spring continued to show a short-term decline but also appeared to show a reversal of the long-term declining trend at the time reinjection was commenced.

Reinjection was halted briefly in mid-1996 while engineering works were carried out to upgrade the system to a rate of 450 kL/d. During this period, aquifer pressure at monitor bores GAB8 and HH2 dropped to the lowest recorded level. At the higher injection rate, pressure rapidly recovered to its highest level since 1994.

The positive effects of reinjection can be distinguished from those resulting in reduced abstraction from Borefield A (and the virtual cessation of abstraction from GAB30, GAB31 and GAB32) from mid-September 1996. It is expected that over the long term, aquifer pressure recovery resulting from reduced abstraction from Borefield A will exceed the effects of reinjection and make the latter system redundant.

Flow from Gosse Bore

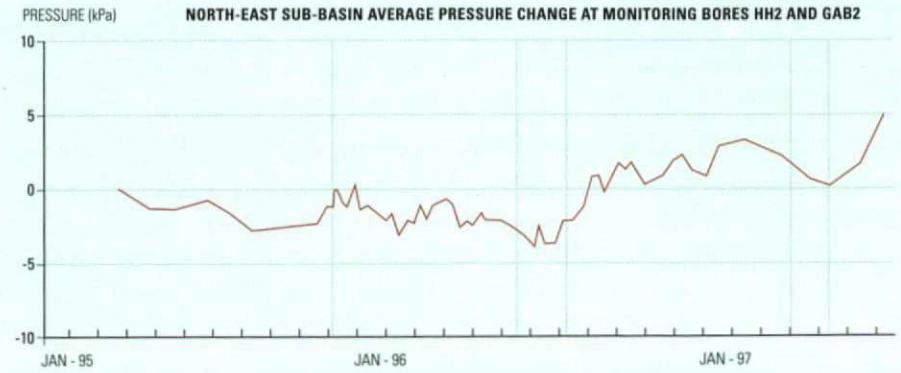
The matter of the uncontrolled flow from Gosse Bore is referred to in Submission P36. This bore has been capped by MESA.

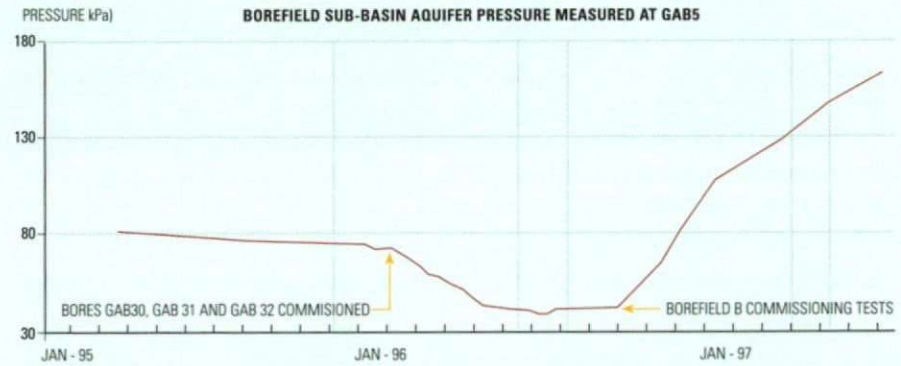
Annual sale of water to Andamooka

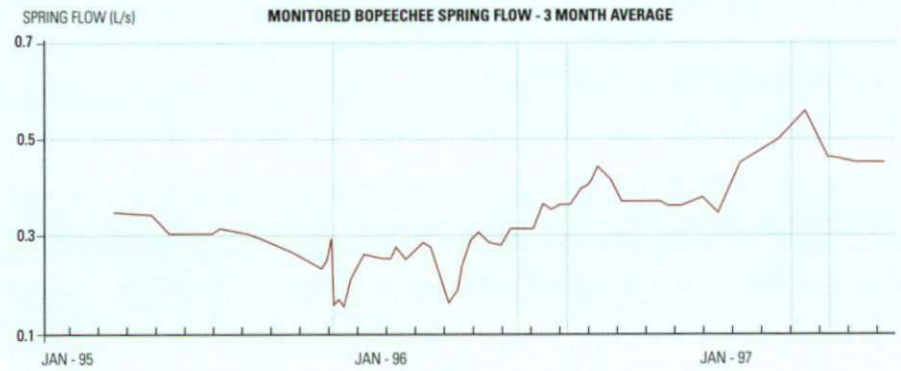
Submission P36 queries the volume of the annual supply of water by WMC to Andamooka. Water is supplied to Andamooka by a contractor using a water truck. Overall, the quantities are small, being in the order of 4,700 kL/a.

Impacts on mound spring flows and wildlife due to drawdown

One submission (P34) disagrees with the EIS conclusions that flows at the mound springs would not be significantly affected by Borefield B, referring to the graphs in Chapter 4 to support this view. However, close inspection of the graphs referred to shows that the







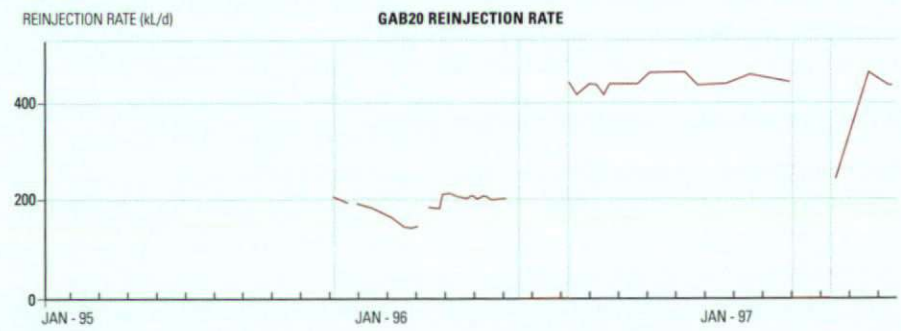


FIGURE 4.2
RESULTS OF AQUIFER REINJECTION PROGRAMME AT BOPEECHEE SPRING

vertical scales of the graphs are exaggerated for clarity and that the predicted reductions in flows are indeed not significant.

Submission P38 considers that the EIS did not address the detrimental effect of the increased use of water from the Great Artesian Basin on the wildlife that depend on this water source for survival. This topic is the subject of extensive discussion in Section 7.4.11 of the EIS.

Submission G4 suggests that remedial action should be taken at an earlier stage than was the case in Borefield A if monitoring detects damage at Borefield B springs. This need is acknowledged, and it should be noted that the hydrological and ecological database will be a considerable advance on that existing in 1983, enabling prompt remedial action to be taken in response to changes in condition of the mound springs.

Alternatives—desalination of Spencer Gulf waters and local groundwaters

Submission G4 proposes that WMC should consider the desalination and piping to Olympic Dam of water from Spencer Gulf. This option has been investigated. The option considered construction of a power station at Port Augusta, and using the waste heat to desalinate seawater. Overall, the desalination of seawater (at a salinity of around 35,000–42,000 mg/L at Port Augusta) to potable quality (less than 500 mg/L salinity) is very energy intensive and needs to be compared with the approximately 2,000 mg/L change demanded of Great Artesian Basin water to achieve potable quality. A further issue is the potential environmental impact of the disposal of large quantities of highly concentrated brine.

One submission questions why local groundwaters are not desalinated and used in preference to water from the Great Artesian Basin. Local groundwater is of similar salinity to seawater and therefore its treatment poses similar economic and energy use constraints to those described above. In addition, local groundwater is available only in limited supply, and is used for mine drilling and dust suppression.

Need for a comprehensive Great Artesian Basin management strategy

Both the Commonwealth and South Australian government submissions refer to the need for a comprehensive management strategy for the Great Artesian Basin. In particular, the response by MESA made the very valid point that 'Given the scale and potential longevity of groundwater extraction by this project, it is essential that a comprehensive management strategy be developed for the basin as a whole. The recent formation of the Great Artesian Basin Consultative Council is a significant milestone in this regard'.

WMC also regards the formation of the council as a very positive move, and considers that the need for evaluating effects of other developments, both existing and planned, upon the Great Artesian Basin, also should be considered.

Impacts on pastoral bores and compensation

The issue of impacts on pastoral bores and of compensation is the subject of Section 4.5.4 of the EIS, where predicted impacts on pastoral bores are tabulated (Table 4.8). It is also stated unequivocally in that section that 'The Indenture provides that pastoralists shall continue to have the right to use groundwater for the proper development and management of the existing use of the lands occupied by them. These rights can only be restricted or terminated by the State if WMC makes alternative supplies available or agrees on an appropriate level of compensation. WMC is in negotiation with pastoralists to formalise arrangements in written agreements'.

Independent assessment of impacts of groundwater abstraction

Submission P3 argues that there is a need for an independent assessment of the impacts of project-related groundwater abstraction on mound springs and other users of the GAB water. It should be noted, in this context, that MESA's submission drew attention to the fact that

MESA 'is developing a numerical model for the South Australian portion of the basin to assess the long-term impacts of Borefield B and other groundwater extraction to guide management strategies in this State'.

Together with the previously mentioned Great Artesian Basin Consultative Council, this should ensure that all developments are carefully and independently managed to ensure that the long-term use of the Great Artesian Basin is achieved without deleterious effects.

Water quality data

Submission P3 expresses the opinion that there is a lack of quantitative information on water quality in the EIS, and that it should include data on the analysis of all water associated with the project. The approach adopted in the EIS was to present water quality data only when they were required to support environmental impact assessment. The EIS is not considered the appropriate forum to present data *per se*, as extensive water quality data are reported in the EMMP annual reports.

Water use estimates

Submission P34 notes that no information (or references) are provided in the EIS to allow evaluation of the assumptions used in calculations of water usage, while Submission P3 notes that no estimate of uncertainty is provided. The water balance provided in Section 4.3 of the EIS for expansion to 200,000 t/a of copper is based upon extensive and detailed calculations that take into account:

- vendor data for process equipment
- knowledge of process conditions
- water quality and opportunity for recycling of process water streams.

Presentation of these calculations in an EIS is impracticable. The data in Table 4.7 are referred to as approximate as ongoing investigations continue to produce minor reductions in estimates of water consumption.

Submission P34 also states that there is no mention in the EIS of a discrepancy between the process water requirements per tonne of ore milled for the various stages of expansion. However, Section 4.4 of the EIS states:

> Planning for the possible future expansion to a copper production rate of 350,000 t/a is not sufficiently advanced at present to allow water balances to be calculated. However, this planning recognises that the further development of water treatment and recycling facilities at Olympic Dam may be an economic alternative to upgrading infrastructure to Borefield A and B or establishing another borefield. The current water supply strategy therefore assumes that sufficient water treatment and recycling facilities would be provided in future to enable the water use at a copper production rate of 350,000 t/a to be accommodated within the infrastructure capacity of 42 ML/d.

MESA bore rehabilitation programme

Submission P34 notes that the EIS argues that MESA's ongoing bore rehabilitation programme (and similar programmes in other States) will result in further water savings. However, most of these bores are outside the influence of the borefields and will not positively affect WMC's future plans. The beneficial effects of the bore rehabilitation programme in partially restoring aquifer pressures in the Great Artesian Basin are not used in the EIS as justification for operation of the borefields for the Olympic Dam Expansion Project. In addition, regional increases in aquifer pressure resulting from the bore rehabilitation programme must have some benefit, albeit small, at the Olympic Dam borefields, even though the rehabilitated

bores lie outside the drawdown curves predicted by the ODEX1 model. It is also noted that the ODEX1 model predictions do not assume any further increases in aquifer pressure in the Great Artesian Basin as a result of the rehabilitation programmes.

Lake Eyre North hydrology

The ODEX1 model predictions presented in the EIS show a reduction in Great Artesian Basin aquifer pressure underneath Lake Eyre North. Submission P34 states that the EIS provides no information on the effects on the hydrology of Lake Eyre North resulting from the operation of the borefields. However, there is no hydrologic connection between the Great Artesian Basin aquifer and Lake Eyre North.

Cost–benefit analysis

Submission P3 states that a cost–benefit analysis of rates of drawdown greater than those used in the EIS should be provided. It is noted that the special water licences provide restrictions to agreed limits on aquifer pressure and do not consider rates of drawdown to be relevant to managing water abstraction or impacts on the environment. The consequence of greater rates of drawdown would be to require implementation of the contingency measures outlined in Section 4.1 of this Supplement at an earlier date than the twenty-year planning horizon used in the EIS. In these circumstances, the cost would be borne by WMC, as it was for the development of the existing water supply infrastructure. Hence a cost–benefit analysis is meaningless in this situation.

CHAPTER 5

LAND USE

CHAPTER 5

LAND USE

Chapter 5 of the Expansion Project EIS describes the present land use of the region surrounding the Olympic Dam operations. The chapter reviews the impact predictions of the 1983 EIS to determine their current applicability, and current regional development trends are investigated to identify and predict additional impacts. The following sections provide responses to comments regarding:

- **the Municipal Lease**
- **tourism and management opportunities**
- **off-road driving.**

5.1 STATUTORY CONTEXT OF THE MUNICIPAL LEASE

Submission P23 expresses a concern that at no stage in the Expansion Project EIS is the legal status of the Municipal Lease defined. In addition, the submission contends that the EIS does not clarify which environmental legislation applies and can be enforced.

As stated in Clause 23 of the Indenture, the Municipality has all the powers vested in municipalities by the Local Government Act, but subject to the limitations specified in Section 12(3) of the Indenture Ratification Act. All relevant environmental and other Acts applicable to the State of South Australia are also applicable to the Municipality of Roxby Downs and can be enforced within the Municipality's jurisdiction.

Submissions P6 and P21 enquire about approvals given by the Municipality to remove trees that were protected by WMC during town development. Submission P21 questions the legality of this, and P6 states that the granting of approvals to remove trees is against the spirit and intent of the Municipality's Supplementary Development Plan and the 1983 EIS.

In response, Clause 21 of the Indenture requires WMC to provide housing and infrastructure for personnel it employs on the Olympic Dam Project. Under this same clause, WMC is responsible for town planning, except for the design and landscaping of buildings to be owned or occupied by the State or the Municipality. In addition, in accordance with Clauses 21 and 24, WMC makes land available to third parties at development cost.

As part of these responsibilities, WMC has endeavoured to ensure that the town design and construction are sympathetic to areas of environmental and heritage significance, and that these areas are protected during development. This includes the identification of significant trees to be retained during construction. After development, the ongoing responsibility for these matters rests with the Municipality.

WMC does have occupation licences over the land not converted to other titles within the Municipal Lease. The occupation licences reserve the remaining land within the Municipal Lease for 'town development purposes' under the control of the Town Administrator. Management of the area of the occupation licences is therefore the responsibility of the Town Administrator. Further discussion on management of the Municipality is provided in Section 12.9.

5.2 TOURISM MANAGEMENT AND OPPORTUNITIES

Submissions P27, P29, P34 and G13 raise issues related to the impacts of increasing numbers of tourists to the Roxby Downs township and the wider region, and to opportunities to provide educational facilities for tourists.

Submission G13 reiterates the need for WMC and government to consider the management of impacts associated with increased tourist and visitor numbers to the sensitive sites within the wider region around Olympic Dam. The Olympic Dam Expansion Project is expected to draw additional visitors to the region; however, this is likely to occur during a period of general and unrelated tourism growth throughout the arid zone of north-eastern South Australia.

In recognition of this secondary project impact, WMC is prepared to discuss with government the investigation and implementation of management options to prevent or mitigate tourism impacts on sensitive sites.

Submissions P27 and P29 are concerned with the perceived need for, and advantages of, an Olympic Dam visitor interpretive centre developed as a joint South Australian Government and WMC initiative. The concept is currently under WMC review.

Submission P34 expresses concern at the projected increase in the number of tourists visiting the Woomera Prohibited Area Weapons Facility and questions the benefits of increased tourism on land near a major weapons testing range and defence facility. Since Woomera's use for testing and defence purposes is now minimal, access to the Woomera township is unrestricted, although restrictions still apply to access to much of the Prohibited Area. Tourism is actively encouraged to compensate for the effects of the decreased population on the town's local economy.

The previous function of the township has changed, and the town is now being used primarily as a residential base for Nurrungar personnel. The Nurrungar facility is expected to close in the near future. Other potential uses of the Woomera facilities are being actively pursued, and some weapons and rocket testing work still occurs. Given the current function of the township, tourism could not be seen as a conflicting pursuit, or one that poses threats to either visitor safety or the township function.

5.3 OFF-ROAD DRIVING

Specific issues are raised with respect to the environmental degradation and nuisance impacts of off-road driving, predominantly within the Municipal Lease area.

Submission G13 expresses a concern regarding the use of station tracks by recreational vehicles, vandalism and the disruption of livestock. This submission reiterates the concerns expressed by the pastoral industry during the Draft EIS (Kinhill – Stearns Roger 1982) and further considered in Section 5.5 of the Expansion Project EIS.

Submissions P6, P16, P21, P23 and P27 are concerned with the increase in off-road driving and damage in the Municipal Lease. This is a matter for the Municipality to consider (Section 5.1).

WMC is currently considering the development of a land management plan for the Special Mining Lease and the surrounding pastoral leases held by WMC. This plan could identify areas suitable for off-road driving, camping and picnicking which might reduce the incidence of off-road driving and degradation in environmentally sensitive areas in the region.

CHAPTER 6

ABORIGINAL CULTURE AND RELATIONSHIPS

CHAPTER 6

ABORIGINAL CULTURE AND RELATIONSHIPS

Chapter 6 of the Expansion Project EIS deals with Aboriginal culture and relationships.

Aboriginal issues have been raised principally in six submissions. No submissions were received from any person claiming to be Aboriginal or to represent an Aboriginal group. The issues raised are discussed below under the topics of issues relating to consultation, and issues relating to heritage sites.

6.1 ISSUES RELATING TO CONSULTATION

Submissions G3, P3, P22, P36, P37 and P39 raise issues related to consultation with Aboriginal groups. The main areas of concern are obligations and processes, the adequacy and extent of consultation, possible favourable treatment, Aboriginal dissatisfaction and conflict with the Expansion Project, and anthropology and territorial boundaries.

Obligations and processes

Submission G3 enquires about WMC's obligations regarding Aboriginal and community consultation on the progress of the expansion. Submission P3 also comments on obligations in regard to consultation, and states that WMC has refused to accept the rights of the Kokotha people to retain confidentiality of sacred sites.

The South Australian Aboriginal heritage legislation requires the identification and protection of sites. This entails conduct of Aboriginal heritage assessment surveys and field inspections by independent consultants, in consultation with Aboriginal informants nominated by those Aboriginal groups claiming custodial responsibility. WMC has investigated some 800 sites in the Special Mining Lease, Municipal Lease and the region.

When ground disturbing works are planned, a check is made of previous heritage assessment surveys and field inspections. If the area has not been previously surveyed, independent archaeologists and ethnographers are contracted to conduct surveys. The relevant Aboriginal people are contacted by the consultants and invited to assist in the survey. A report, written by the consultants, is provided to the Aboriginal informants, and the consultants complete site report cards, in consultation with the Aboriginal informants. The site cards are in accordance with the guidelines issued by the Department of State Aboriginal Affairs. A general report notifying the areas cleared for work, or areas to be avoided, is then prepared. When requested by the Aboriginal informants to do so, WMC maintains the confidentiality of this information.

Since early 1995, WMC has been formulating policies in regard to land access agreements, indigenous business enterprise strategies, community development plans and heritage management plans. WMC continues to consult with a number of local Aboriginal communities on these matters. Community consultation issues are also discussed in Section 12.3 of this Supplement.

Submission P3 states that the EIS should specify which processes WMC has instigated to ensure all Aboriginal concerns are addressed. These processes are discussed in the EIS and other public documents, but are also described again below. The submission also states that WMC and the Kokotha people have disagreed regarding the confidentiality of sacred sites. WMC complies with all legislative requirements relating to the confidentiality of heritage information.

It is company procedure to advise all staff of WMC of the importance of culture to Aboriginal people and of the sanctions that apply in relation to the disturbance of sites.

The appointment of a Community Relations Officer with responsibility for addressing Aboriginal matters within the company, the protection of sites and acting as a focus for members of the Aboriginal community has been implemented as one strategy for addressing Aboriginal issues. This officer is working with Aboriginal groups to ensure that effective processes for recording information provided during consultation are developed.

Adequacy and extent of consultation

Submission P3 enquires about the extent of the consultation for the project, and states that the Arabunna and Kokotha communities are concerned about the extent of consultation. It was also stated that a list should be provided of the Aboriginal groups and individuals consulted. Submission P22 states that consultation has been selective. Submission G3 enquires about the effectiveness of the consultation on the Borefield B project.

The following Aboriginal groups have been involved in consultation relating to the Special Mining Lease and Municipal Lease, borefields and service corridors:

- the Kokotha People's Committee, in relation to the initial development of Olympic Dam and in relation to the 275 kV powerline from Port Augusta to Olympic Dam;
- the Andamooka Land Council, in relation to the Special Mining Lease, the Municipal Lease and the 275 kV powerline corridor from Lake Windabout to Olympic Dam;
- the Barngala Aboriginal Consultative Committee, in relation to the 275 kV powerline from Port Augusta to Olympic Dam;
- the Nukunu Heritage Committee, in relation to the 275 kV powerline from Port Augusta to Olympic Dam;
- the Kuyani Association, in relation to the initial development of Olympic Dam and, more recently, the 275 kV powerline from Port Augusta to Olympic Dam;
- the Dieri Mitha Council Inc., in relation to Borefields A and B;
- the Marree Arabunna People's Committee in relation to Borefields A and B.

Consultation in relation to Borefield B included the following groups:

- the Antakarinya community, Coober Pedy
- the Dieri Mitha Council Inc., Marree
- the Marree Arabunna People's Committee, Marree
- the Marree Progress Association, Marree
- pastoral lessees directly and indirectly affected
- the Marree Aboriginal School Council
- various pastoral lands and soils boards.

The above consultative work was undertaken by WMC personnel and the following consultants:

- Kinhill Engineers Pty Ltd
- Anthropos - Australis Pty Ltd (G. Jackson and N. Green)
- D. Martin
- A. Lance
- C. Waite
- R. Callen
- R. Lucas
- A. Ginn
- L. Hercus
- P. Hughes.

Consultation with Aboriginal groups was fully reported in the supplementary environmental studies survey and assessment for the Borefield B development (Kinhill Engineers 1995), and continued until October 1996, two months after completion of the construction of the borefield and pipeline. Consultation is still proceeding with landowners in the vicinity of Borefield B in relation to possible effects on their water and power supply systems. This has involved complete audits of their current systems and future plans, computer modelling of drawdown effects and examination of possible strategies to ensure continued availability of water supply to pastoralists.

Submissions P3 and P22 state that WMC has consistently avoided serious consultation with the spokesperson and elders identified by the Aboriginal communities in the Far North of South Australia. Submissions P3, P22 and P36 question the extent of consultation with the Arabunna people.

As required under legislation and in accordance with the company's Indigenous Peoples Policy, WMC is committed to establishing and maintaining communication with Aboriginal groups in relation to any matters that may be of concern to them. A copy of the Indigenous Peoples Policy is included in Appendix A of the EIS. WMC has thus been in consultation with the elders of all groups with an interest in the project.

This consultation has included the Arabunna people. In October 1996, during the preparation of the EIS, the EIS Project Manager and WMC personnel met with the Aboriginal and pastoral communities in Marree to consult with them about the proposed Expansion Project. This consultation included R. Dodd of the Marree Arabunna People's Committee. Previous work with the Arabunna people has included a heritage survey in the Lake Eyre South region and heritage clearances for Borefield B monitoring bores.

Favourable treatment

Submissions P3 and P22 suggest that WMC seems to have helped set up and resource only the Aboriginal groups who are favourable to its activities, and that WMC recognises only the views of the Aboriginal groups who support its activities.

WMC has not set up Aboriginal groups. The claim that WMC consults only with Aboriginal groups that support the project is refuted. The consultation with Aboriginal groups has been extensive, as discussed in Sections 6.2, 6.3 and 6.4 of the EIS, and as further listed above.

Aboriginal dissatisfaction and conflict with the Expansion Project

Submission P37 claims that many in the Aboriginal community have voiced their disapproval of the Olympic Dam project and of the expansion.

However, no submissions were received from any person claiming either to be Aboriginal or to represent an Aboriginal group. Some have expressed concern for the protection of heritage sites and the mound springs as mythical sites. As indicated in Chapter 6 of the EIS, much work by employees of the company has been done to ensure the protection of heritage sites and to record the traditions of Aboriginal people in the region.

Submission P3 states that, in the 1983 EIS, the anthropological report prepared by the Kokotha People's Committee was not included despite being presented three months prior to publication. It also states that there was disagreement between WMC and the Kokotha People's Committee, and the EIS should explain what the problems were and if, and how, they were resolved.

In 1981 the Kokotha people, through the Kokotha People's Committee, undertook independent field inspections of the project area in conjunction with a consultant anthropologist. On the basis of this work, the Kokotha people advised in December 1981 that there was fresh evidence that sites of significance could exist in the area. However, by the time the 1983 EIS was produced, no information on such sites had been provided to the proponent.

From a subsequent ethnographic survey, the Kokotha People's Committee reported in 1983 eighteen sites in and adjacent to the project area. The Draft EIS was published in October 1982, and the Supplement in April 1983. The Supplement noted attempts to come to a satisfactory arrangement with the Kokotha People's Committee in relation to the discussion of sites of significance to it. At the time of publication of the 1983 Supplement, the report had not been completed, and the company acknowledged that submissions from the Kokotha people on sites of significance were still to be received.

Submission P3 also states that WMC consultation processes with Aboriginal people have been poor and inconsistent; that flawed consultation processes have exacerbated tensions within Aboriginal communities; and that the EIS should indicate what disagreements exist between WMC and Aboriginal people, explain the problems, outline any existing and/or potential dispute resolution measures, and review activities of WMC that have exacerbated conflicts between Aboriginal people in the region. Other comments (Submissions P22, P36 and P39) are that Aboriginal leaders have expressed frustration towards WMC, that WMC attempts to 'divide and rule' and pressures Aboriginal communities, and that WMC uses the consultation process as evidence that it has met its obligations towards Aboriginal stakeholders.

WMC's consultation processes are extensive. This has proven time consuming, and may in itself attract negative responses and accusations of bias. WMC has been pro-active in consultation with seven Aboriginal groups in relation to the ongoing development of Olympic Dam. The internal conflicts that exist within some sections of the Aboriginal community have a bearing on how such consultation can be conducted.

The company refutes any suggestion that it has been responsible for any conflict within Aboriginal communities. WMC's Indigenous Peoples Policy is designed to ensure Aboriginal concerns are addressed in the undertaking of its activities.

Anthropology and territorial boundaries

Submission P3 expresses concern about anthropological work undertaken by WMC, and states that anthropologists working for WMC have drawn up territorial boundaries which appear to favour the Aboriginal groups who support the company.

The company's Group Geographer, Dr Stephen Davis, undertook extensive research and consultation with Aboriginal people, prior to his employment in the company, regarding territorial boundaries with which he updated the work of many researchers before him (Davis and Prescott 1992). WMC has also engaged consultant anthropologists and other specialists with a range of expertise, and will continue to do so.

In the two extant consultation agreements between the company and Aboriginal groups in the Olympic Dam region, the boundaries delineated in those agreements were set by the Aboriginal groups, not WMC staff.

6.2 ISSUES RELATING TO HERITAGE SITES

Submissions P3 and P39 raise issues related to Aboriginal heritage sites. These issues include protection by legislation, damage to sites and access to sites.

Protection by legislation

Submission P3 states that the *Roxby Downs (Indenture Ratification) Act 1982* overrides the Aboriginal heritage legislation, and that only sites identified in the Expansion Project EIS are offered any protection.

The Indenture Ratification Act overrides State Aboriginal heritage legislation only in the event of an inconsistency between the two. In practice, all sites identified during heritage assessment surveys and field inspections are protected in accordance with State Aboriginal heritage legislation. Where the approval of the relevant Aboriginal group has been given, sites have been registered as required by the Aboriginal heritage legislation.

As noted in Section 6.1, the legislation requires the identification and protection of sites. WMC has investigated and protects a large number of the identified sites at Olympic Dam and in the region. As also noted above, some 800 sites in the Special Mining Lease, the Municipal Lease and the wider region have been identified.

Damage to sites

Submissions P3 and P39 state that the Kokotha and Arabunna communities have raised concerns about damage done to their sacred sites. It is also claimed that so far numerous sites have been destroyed, including a site desecrated during construction of the main mining shaft.

WMC refutes the claim that numerous sites have been disturbed. As noted above, so far some 800 sites have been identified and measures are taken to protect sites. In regard to the site mentioned near the main shaft, work on the Whenan Shaft was commenced in 1980, during the exploration and feasibility stage at Olympic Dam. As the company had been advised by the relevant government department at the time that no sites of significance existed in the Olympic Dam area, no further heritage investigation occurred until the preparation of the report by Hagen and Martin (1983). This report identified eighteen sites on the Special Mining Lease. Of these, one was at the site of the Whenan Shaft.

Submission P3 also refers to sites of significance to the Arabunna being damaged by the construction of pipelines, and requests a comprehensive description of the measures WMC will execute to ensure action is taken to protect Aboriginal sites and accommodate Aboriginal wishes and concerns.

The Borefield B construction programme involved extensive consultation with the Aboriginal people. This resulted in a major change to the overall pipeline route, and in a number of minor alignment changes to avoid archaeological sites. During construction, sites were

protected by temporary fencing and signage, as described in Section 6.3.2 of the EIS. These measures were discussed and agreed with the Department of State Aboriginal Affairs.

Access to sites

Submissions P3 and P39 enquire about the lease arrangements that prohibit the Kokotha people having access to sacred sites, except in the presence of company personnel.

In response to this query it needs to be noted that:

- the Special Mining Lease provides freehold title to WMC;
- access to the Special Mining Lease, and the mine and plant areas in particular, is restricted for security and safety reasons. No visitor is permitted to wander over the Special Mining Lease at will, unless accompanied by a person authorised by WMC;
- Aboriginal people have been given access to areas of the Special Mining Lease for cultural purposes, but must be accompanied by an authorised person, usually a staff member of the company, or an authorised consultant archaeologist or ethnographer with experience of the site.

CHAPTER 7

BIOLOGICAL ENVIRONMENT

CHAPTER 7

BIOLOGICAL ENVIRONMENT

Chapter 7 of the Expansion Project EIS deals with the biological environment of the Project Area. This chapter of the Supplement responds to issues raised in submissions referring to that chapter. Responses are provided according to the structure of the original chapter; that is:

- **Section 7.1—ecologically sustainable development and biological diversity**
- **Section 7.2—flora**
- **Section 7.3—fauna**
- **Section 7.4—mound springs.**

7.1 ECOLOGICALLY SUSTAINABLE DEVELOPMENT AND BIOLOGICAL DIVERSITY

Submission P3 indicates that ecologically sustainable development (ESD) is not given a sufficiently prominent role in the Expansion Project EIS. The concept of ESD introduced in the biological environment (Chapter 7 of the EIS) is a foundation of WMC's environmental management programmes. ESD is an integral part of WMC's Environment Policy, which is reproduced in Appendix A of the EIS.

Submission P3 also indicates that the EIS section on biological environment impacts is insufficient; however, comments from both Commonwealth and State government agencies express the opposite view.

Submission P39 suggests that a full account should be provided of microscopic creatures for which there is no reference in the EIS. Section 7.3.8 of the EIS describes the work that has been done in this area. While no assessment of microinvertebrate faunal composition and abundance has been undertaken, ants have been monitored in some detail as an indicator of microinvertebrate activity. It is considered that the survey, assessment and monitoring of vascular plants, terrestrial and aquatic microinvertebrates and vertebrates being undertaken are sufficient to provide environmental data that permit informed conclusions to be made about ecology and indications of environmental change.

7.2 FLORA

Submissions G4 and G13 note support for the detail and accuracy of information regarding the biological environment provided in the Expansion Project EIS, and the continuing and proposed monitoring and management programmes and actions developed by the proponent. This support is acknowledged.

Submission G4 suggests that permanent destocking of the Roxby Downs, Parakylia South and Purple Downs pastoral leases could occur. WMC has worked closely with the Pastoral Management Branch of the Department of Environment and Natural Resources (DENR) to ensure that its stock management practices are appropriate, and will continue to do so. It is

for this reason that some of the pastoral leases are presently destocked. While these leases may be restocked at the appropriate time, regional environmental management options will be kept under review by WMC. WMC remains committed to the sustainable management of its pastoral leases.

The submission's suggestion that the whole of the Project Area should be fenced with rabbit-proof fencing is not considered practical, since much of the Project Area is not of major conservation value, and total control of rabbits in such a large area would not be practicable. However, options for the control of feral animals will continue to be reviewed, based on the data obtained in future from the Roxby Downs Ecosystem Restoration and Research Project, an initiative of WMC, DENR and The University of Adelaide.

The aim of the project is to fence a 13 km^2 area of land at the northern edge of the mining lease with a rabbit-proof and predator-proof fence, to remove rabbits (and later foxes and cats) inside the fence and, in the longer term, to introduce populations of locally extinct and threatened Australian fauna from other areas of Australia. WMC has contributed $180,000 to the project, with smaller financial contributions from other groups. Additional funding is being sought from the National Heritage Trust Fund. As part of its Environmental Management and Monitoring Plan (EMMP), WMC is committed to providing resources for controlling proclaimed animal species (WMC—Olympic Dam Corporation 1996).

Monitoring of the Ecosystem Restoration and Research Project will be undertaken. The data derived from monitoring vegetation regeneration as well as native and introduced flora and fauna will be used to develop a more effective natural environment management programme in the Project Area and the region. These data may be important for further development of the Project Area EMMP.

Submission G4 further suggests that, following decommissioning, all of the pastoral leases could be transferred to the Crown for conservation purposes. The possibility of the State acquiring WMC's pastoral leases on decommissioning is a future option that could be pursued at that time.

Submission P11 is concerned with vegetation clearance within the Project Area. As noted in Section 7.2.6 of the Expansion Project EIS, land surface development and vegetation clearance would be kept to the minimum necessary, and disturbed areas rehabilitated promptly. Section 7.2.6 of the EIS provides information about the vegetation communities to be cleared.

Submission P11 also notes that rehabilitation of some areas will not be possible, since these areas will be sites of permanent infrastructure. This is agreed, and the EIS information should be qualified by the words 'where practicable'.

The loss of monitoring (3.7%) and rehabilitation control sites (less than 1%) due to the expansion (mentioned in Submission P11) cannot be avoided. Over 270 vegetation monitoring sites and twenty rehabilitation control sites per vegetation association are established in the Project Area. As noted by WMC—Olympic Dam Operations (1995), some monitoring and control sites have been disturbed in the past. This disturbance resulted in a review of the monitoring sites and in a decision to increase the sample size to twenty rehabilitation control sites in the 1996 EMMP, to allow for potential inadvertent damage to some sites.

Submission P11 suggests that the area measurement (in hectares) of the Project Area, Special Mining Lease and the Municipal Lease should be provided in order to place the preamble to Chapter 7 of the EIS in context.

The Project Area comprises the Special Mining Lease (17,974 ha) and the Municipal Lease (11,040 ha) and therefore comprises a total area of 29,014 ha. These data are available in Table 7.4 of the EIS.

Submission P11 also states that the use of percentages of an arbitrary area is an inappropriate criterion for assessing vegetation clearance. This comment is agreed with; however, the EIS does not use the percentage values quoted as a criterion for assessing vegetation clearance, but to provide some basis for assessing the extent of clearance.

7.3 FAUNA

Submission P11 refers to the information presented in Section 7.3.4 of the Expansion Project EIS concerning the use of the word 'benefit' in relation to increased populations of the same bird species.

The EIS is not claiming that the increase in the population of some bird species is a benefit of the project. Rather, it is noting the predicted and current data about bird numbers. As required by the EIS Guidelines, it is assessing the impacts that have occurred and were predicted to occur.

The potential ecological effects of artificially enhancing species populations in the Project Area are understood by WMC environmental staff and are considered before any changes are made in the Project Area.

Submission P11 suggests that some statements in the EIS and the Summary document trivialise the effects of habitat clearance. There is no intention to trivialise or sanitise the effects of the expansion on some animals and their habitats. However, the important issue is that all such species are regionally common and the critical issue—the effect of the expansion on the presence of species—is likely to be minimal.

Submission P26 suggests that the EIS commitment related to fencing of evaporation ponds should be amended to allow for the establishment of similar fencing or a suitable alternative barrier. This is agreed.

Submission F1 requests additional information about the incidence of migratory bird species (protected under the JAMBA and CAMBA international agreements) in and adjacent to the Project Area. Table 7.1 provides a synthesis of observations about the abundance and frequency of presence of these protected species.

All of the species listed in Table 7.1 have a low to very low abundance in and adjacent to the Project Area. This abundance varies from one since 1983 (e.g. oriental cuckoo: first South Australian record in 1995, Read 1995; and Latham's snipe: one sighting recorded in the 1996 EMP) to less than five every few years (e.g. eastern curlew and glossy ibis) to less than ten (e.g. most of the other species listed in Table 7.1). In general, the frequency of presence varies from annual (i.e. a regular seasonal visitor) to occasional (i.e. every few years).

As noted in Section 7.3.3 of the Expansion Project EIS, the Project Area and region do not provide high quality or essential habitat for any of the bird species listed in Table 7.1. This clearly distinguishes the Project Area and region from other areas in northern South Australia that do provide significant, high-quality habitats for many migratory bird species. These areas include Lake Eyre, Lake Torrens (very occasionally), the Arcoona Lakes following above-average rainfall and run-off, and some bore drains.

Submission F1 requests additional information about the species composition of the ninety-two bird fatalities from the tailings retention system in 1995, plus a copy of relevant information. Grebes, ducks and silver gulls constituted the majority of the fatalities. With the exception of an occasional greenshank, caspian tern and sandpiper, there is no record of any bird species listed under the CAMBA and JAMBA international agreements or of regional conservation significance being present at the tailings retention system ponds. None of the species listed in Table 7.1 has been recorded as a fatality since monitoring commenced.

Table 7.1 Migratory bird abundance and frequency of presence data

Species	Abundance	Frequency of presence
Latham's snipe	Very low	One sighting only
Eastern curlew	Very low	Occasional seasonal
Great egret	Very low	Occasional
Cattle egret	Very low	Occasional
Glossy ibis	Very low	Occasional
Grey plover	Low	Occasional seasonal
Black-tailed godwit	Very low	Seasonal
Marsh sandpiper	Low	Seasonal
Common sandpiper	Low	Seasonal
Greenshank	Low	Resident to annual
Ruddy turnstone	Very low	Seasonal
Red-necked stint	Very low	Seasonal
Sharp-tailed sandpiper	Low	Seasonal
Curlew sandpiper	Low	Seasonal
Caspian tern	Very low	Occasional
Oriental cuckoo	Very low	One bird recorded (Read 1995)
Fork-tailed swift	Low	Occasional
Rainbow bee-eater	Common in summer	Seasonal

Data on bird usage at the tailings retention system are reported publicly in the EMMP annual reports. A copy of the relevant data from the WMC Olympic Dam Corporation 1996 EMP has been provided to the respondent. The bird fatalities for the tailings retention system for the year March 1996 to February 1997 reduced to thirty-two, comprising grebes, swans, ducks, silver gulls and other unidentified species. No wading bird species have been recorded on or adjacent to the tailings retention system to date during 1997. It should be noted that the issue of cyanide-related bird deaths at tailings dams is not a major problem at Olympic Dam, as cyanide is neutralised before release to the tailings retention system.

Submission P31 questions the use of 'bird scarers' on the tailings retention system. WMC's environmental management commitments seek to minimise the project's impact on all bird species. Consequently, the development and use of bird deterrents is part of the EMMP for the Project Area's tailings retention system ponds. Information on bird deterrent systems in use at Olympic Dam is discussed in Section 7.3.4 of the EIS, and further information is to be published in the near future (J. Read, WMC, pers. comm., 1997).

A number of submissions question the lack of cat control measures in Roxby Downs. Under the *Animal and Plant Control (Agricultural Protection and Other Purposes) Act 1986* (SA), the domestic cat (*Felis catus*) is a proclaimed species (Class 4) throughout South Australia. Under Section 44 of this Act, it is an offence to release a cat or permit a cat to be released in South Australia. However, cats may be kept as domestic pets. The *Dog and Cat Management Act 1995* also allows for a range of cat management actions.

Control of cats within the municipality of Roxby Downs is vested with the Town Administrator and not WMC. A Roxby Downs cat control policy and programme could include the following items:

- establishment of a WMC-endorsed preferred position about people not bringing cats into the township, including development of an ongoing local publicity programme and possible inclusion of the introduction of a local by-law relating to cat control;
- compulsory identification and registration of all domestic cats in the township, including payment of a registration fee for each cat;

- desexing of all cats, with the exception of pedigree cats used in a captive breeding programme. These individuals would also be registered;
- establishment of a night curfew for all cats;
- enforcement and auditing of the control measures for cats;
- provision of a low-cost, humane cat disposal option for those no longer wishing to keep their cat;
- establishment of sufficient resources to enforce a Roxby Downs cat control policy and programme.

It should be noted that there is considerable local research, documentation and support for establishing domestic cat control in Roxby Downs. The establishment of a local by-law to control and manage cats has occurred elsewhere in Australia and South Australia, and could be considered by the Town Administrator and the proposed Roxby Downs Town Board (Section 12.9 of this Supplement).

WMC clearly recognises the ecological damage caused by feral and domestic cats. It would endorse the establishment of a township cat control policy and programme that is complementary to the WMC's Special Mining Lease Cat Control Policy and to actions undertaken under the EMMP.

Information additional to the Expansion Project EIS

Section 7.3.5 of the EIS indicates that WMC had commissioned a study to assess the taxonomy and, hence, the biological and conservation significance of distinctive forms of the skink species *Lerista bougainvillii* and *L. dorsalis*. The Evolutionary Biology Unit of the South Australian Museum has completed this study and a summary of its findings is provided below.

The technique of allozyme electrophoresis was used to assess the genetic and taxonomic affinities of distinctive northern forms of the skinks *L. bougainvillii* and *L. dorsalis*. Individuals collected from across the range of each species were examined for allozyme variation at thirty-eight locations. The data were used to assess the levels of genetic divergence between regions within each species, and the results interpreted in the light of the extent of genetic divergence between related species of *Lerista*.

The northern forms of *L. bougainvillii* and *L. dorsalis* are not sufficiently distinctive genetically to warrant a change in their taxonomic status based on these data alone. Instead, a general picture emerges of two species that contain local populations that are genetically distinct from their nearest neighbours. These populations occur in the northern and/or north-eastern parts of their range. The allozyme data suggest that little or no gene flow is occurring between these distinct populations. Under such conditions, local adaptation and/or genetic drift may lead to the evolution of unique forms, be they morphological, behavioural, ecological or physiological. Often these distinct forms warrant subspecific status, in recognition of their biological uniqueness. Based on the available information, neither form of the species warrants a change in its taxonomic status.

7.4 MOUND SPRINGS

Submission F1 commends WMC's ongoing monitoring and research of the mound springs and suggests that WMC formalise its commitment as part of an environmental management plan for the mound springs that could be developed by the South Australian Government.

WMC would support a proposal by the South Australian Government to develop an environmental management plan for the mound springs, and has expressed its support

previously through the Far North Consultative Committee of DENR. The company would be pleased to contribute its technical expertise to help develop such a plan.

Submission P1 notes that, owing to the slow rate of water flow, rates given in Table 7.18 of the EIS for the re-establishment of flows at Beatrice, Venable and Priscilla springs are optimistic. While this comment is noted, and is addressed in Section 4.1 of this Supplement, the site of each of these mound springs will be monitored as part of the EMMP in order to assess the predictive model and its accuracy in relation to flow from these sites. It should be noted that Beatrice is not extinct.

Submission P11 asserts that Section 7.4.11 of the Expansion Project EIS is subjective and unscientific; it also suggests that fifty-year modelling has been undertaken and that this information should be made available. The EIS notes that there has been an overall downward trend in populations of all invertebrate fauna considered in the Mound Spring Invertebrate Fauna Monitoring Programme (MSFMP), including those at springs that are clearly beyond the drawdown effects of water extraction (WMC—Olympic Dam Operations 1996). Detailed, precise quantification of MSFMP data is not currently practicable owing to the exceptionally wide range of factors influencing fauna populations, as stated in Section 7.4.11 of the EIS.

It is hoped that the additional monitoring and research being undertaken by WMC and others will provide more definitive information on the biology and ecology of fauna, including confidence limits of data. However, there is extremely limited knowledge of the populations of invertebrates in mound spring groups other than those considered by WMC.

WMC has not undertaken fifty-year modelling. As noted in Section 2.4 of this Supplement, the WMC planning period for the operation of the borefields is twenty years. Twenty-year modelling was used as the basis for the Borefield B approval process (Kinhill Engineers 1995), and the Designated Area for Borefield B is based on the 5 m drawdown contours from the modelling undertaken at that time. During the twenty-year planning time-frame the ODEX1 model would be updated, and additional water conservation measures would be expected to be implemented. The planning period allows ample time for consideration of updated data and potential future water supply options.

Submission P36 notes that many mounds have shown reduced moisture levels and degradation of vegetation. It further notes that the 1983 EIS considered transpiration as not having a significant effect on water flow. Submission P38 notes that the Expansion Project EIS does not address the detrimental effect of use of Great Artesian Basin water on water dependent wildlife.

Some mound springs do have reduced water flow, and the reasons for this are discussed in Section 7.4 of the EIS (Sections 7.4.7 and 7.4.11). Degradation of vegetation at some mound springs is due to damage by cattle and horses.

Kinhill Stearns (1984) and Kinhill Engineers (1995) note that transpiration can be a significant water loss pathway for some mound springs. In particular, this is apparent where *Phragmites* and, more rarely, *Typha* (both of which have significantly higher transpiration rates than other mound springs plant species) replace *Cyperus* and other species. *Phragmites* probably represents a climax vegetation community on many undisturbed mound springs.

Developing a control programme for *Phragmites* and *Typha* may be a practical solution; however, a regional mound springs assessment and management plan should be established before any such control programme is developed. This is a matter for government. WMC would participate in such a programme for mound springs on its pastoral leases.

Submission P11 requests more information about 'the principle of sacrificing degraded areas rather than addressing their possible restoration'.

Kinhill Engineers (1995) provides a detailed review of the flora and fauna of the Wangianna, Welcome, Davenport and Hergott spring groups. There is no suggestion that these are 'sacrificial springs'. As stated in Section 7.4.13 of the EIS, the predicted impacts on these springs are minimal owing to the lack of or low frequency of plant and animal species of particular conservation significance and the relatively small reduction in flow predicted. The need for restoration of mound springs in the region is a matter for the State Government to consider.

Comments in Submission P34 are developed around the theme of use of borefields water and the predictive effects on the biological environment of the mound springs.

The predicted biological impacts of operating the borefields are, after careful consideration of all available data, considered to be acceptable in that the risk to all mound springs of particular conservation significance is minimised.

Submission P34 notes that mound springs are an important tourist attraction, and extraction of water from Borefield A should stop in order to minimise further significant impact.

WMC notes that relatively few of the mound springs are visited by tourists to the region. However, large numbers of tourists could cause major ecological damage to some springs, and such damage has already been observed. Development of a regional mound springs management plan by the South Australian Government, as suggested in Submission F1, should be a high priority for the region.

Submission G13 notes that reductions in flow rates from mound springs, even minor flow reductions, can have a major deleterious impact on invertebrate fauna. This fact is acknowledged in the invertebrate fauna monitoring programme. However, as noted in the EIS, all significant invertebrate fauna species continue to be present in the monitored mound springs.

Submission G13 also notes that the current monitoring programme may miss the significance of some changes in the populations of some invertebrates. It should be noted that the current monitoring programme has been developed in consultation with the State Government. Since 1995, species have been individually identified as far as possible, as noted in Section K3.2 of the EIS. Species that are very difficult to identify, such as some hydrobiid snail species, are identified by an acknowledged expert, Dr W. Ponder. As additional, new and useful data and applicable techniques/methods become available, the monitoring programmes would be revised to take account of this new information.

WMC's mound springs monitoring programme is based on the best available knowledge and data and targets those springs that may be affected by WMC's activities. WMC presently is estimated to consume approximately 6.4% of the total water discharged from bores and mound springs in the South Australian portion of the Great Artesian Basin (Section 4.2.1 of the EIS), excluding vertical leakage. Including vertical leakage, WMC's present shared total discharge is 3.5%. WMC's mound springs monitoring programme can be seen as an adjunct to an overall State Government programme.

Development of a formal, regular DENR and WMC review process (e.g. a twice yearly meeting) would allow for additional, more direct DENR input into future monitoring projects and programmes, and this is proposed to be implemented in response to comments in Submission G13.

Responses to submissions on water management at the borefields is also relevant to environmental management of the mound springs. Water management at the borefields is discussed in responses to submissions on this topic in Section 4.2 of this Supplement.

CHAPTER 8

TAILINGS MANAGEMENT

CHAPTER 8

TAILINGS MANAGEMENT

A number of submissions raise issues regarding tailings management at Olympic Dam. Some of those submissions request clarification of information presented in the EIS, while others express opinions regarding the relative merits of the two tailings storage options being considered. Issues relating to rehabilitation of the tailings storage facility are commented upon in many submissions, as are the performance of the existing facilities, the construction of the new facilities and the future control of seepage.

This chapter addresses the comments made in relation to tailings management. It also provides an update on pilot trials conducted on the central thickened discharge option for tailings storage, and on research programmes on the development of a final rehabilitation strategy.

8.1 CLARIFICATION OF EIS INFORMATION

This section provides clarification of information presented in the EIS as well as additional information or data requested in the submissions.

Structure of the EIS

The EIS presents two tailings storage options for the expansion of the tailings retention system (TRS):

- the existing paddock method, described in Section 8.5 of the EIS
- the central thickened discharge (CTD) method, described in Section 8.6 of the EIS.

Subsequent sections of the EIS (8.7 to 8.10) address issues of relevance to both methods of tailings storage facility (TSF) expansion. This document structure appears to have been misunderstood by some respondents who raised the issue of dusting from the CTD surface following rehabilitation. While the final rehabilitation method has not as yet been developed (see Section 8.5 of this Supplement), the approaches described in Section 8.10 of the EIS would, following further development, rehabilitation trials and detailed design, be sufficient to prevent erosion and dusting of tailings from the CTD surface.

Terminology

Submission G9 raises an inconsistency in terminology in reference to 'decant liquor ponds' and 'reclaim ponds'. This inconsistency is noted, with the correct terminology being:

- decant liquor ponds apply to the paddock method
- reclaim liquor ponds apply to the CTD method.

Lining of decant and reclaim liquor ponds

Submission G9 requests clarification of the proposed lining systems for the decant and reclaim liquor ponds. The proposed lining system for both decant liquor ponds (paddock method) and reclaim liquor ponds (CTD method) is compacted clay.

Lining of CTD drains

Submission G9 seeks clarification on whether the clay-sized fraction of tailings or tailings *per se* are involved in the option to line the CTD drains. The submission also expresses concern that clay-sized tailings would not provide an adequate seal to drains.

The option as presented in the EIS is based on the use of complete tailings.

Evaporation pond liquor

Submission P3 considers an analysis of the liquid in the evaporation ponds should have been provided in the EIS.

In effect, this analysis was provided in Table 8.5 of the EIS, which gives a typical analysis of the tailings supernatant, the liquid that is decanted to the evaporation ponds from the TSF. In the evaporation ponds, the concentration of the dissolved salts is allowed to concentrate until the liquor reaches a maximum specific gravity of 1.2, and this is controlled as described in the EIS.

Data variability

Submissions P3 and P10 raise the issue of data variability and accuracy of measurement methods, particularly in relation to measurement of radium grades and radon release rates. The EIS recognises that the 'charcoal can' method previously used at the site for measuring radon release rates produces results which are difficult to reproduce both in time and in space. At the time, however, the charcoal can method was recommended and approved by government. The accumulator drum method is currently used to conduct these measurements.

Methods of measurement used at Olympic Dam are based on standard methods and are incorporated into the Environmental Management and Monitoring Plan (EMMP). Changes in these methods, which may arise due to changes in monitoring technology or programmes, are implemented following consultation with the appropriate regulatory authorities.

Permanent markers

One submission (P3) questions what is meant by 'permanent markers' in relation to rehabilitation of the TSF. The design of such markers still needs to be developed, but it is likely to consist of large stones affixed with durable (for example, bronze) plaques inscribed with a warning message.

Current position regarding tailings management strategy

The EIS presents two options for the further expansion of the TSF:

- continued use of the existing paddock method;
- adoption of the CTD method involving further thickening of the tailings slurry and deposition to form a profile resembling a series of intersecting flat cones.

WMC recognises that there are advantages and disadvantages associated with both systems, and this is reflected in the preferences expressed in a number of submissions. Accordingly, the assessment of both methods presented in the EIS is awaited by WMC so that this information can be incorporated into future decisions on expansion of the TRS. The existing approval for production up to 150,000 t/a of copper assumes a TRS based on use of the paddock method.

Since the publication of the EIS, the design concept of the TSF has progressed. For expansion to 200,000 t/a of copper, the design concept now comprises the construction of

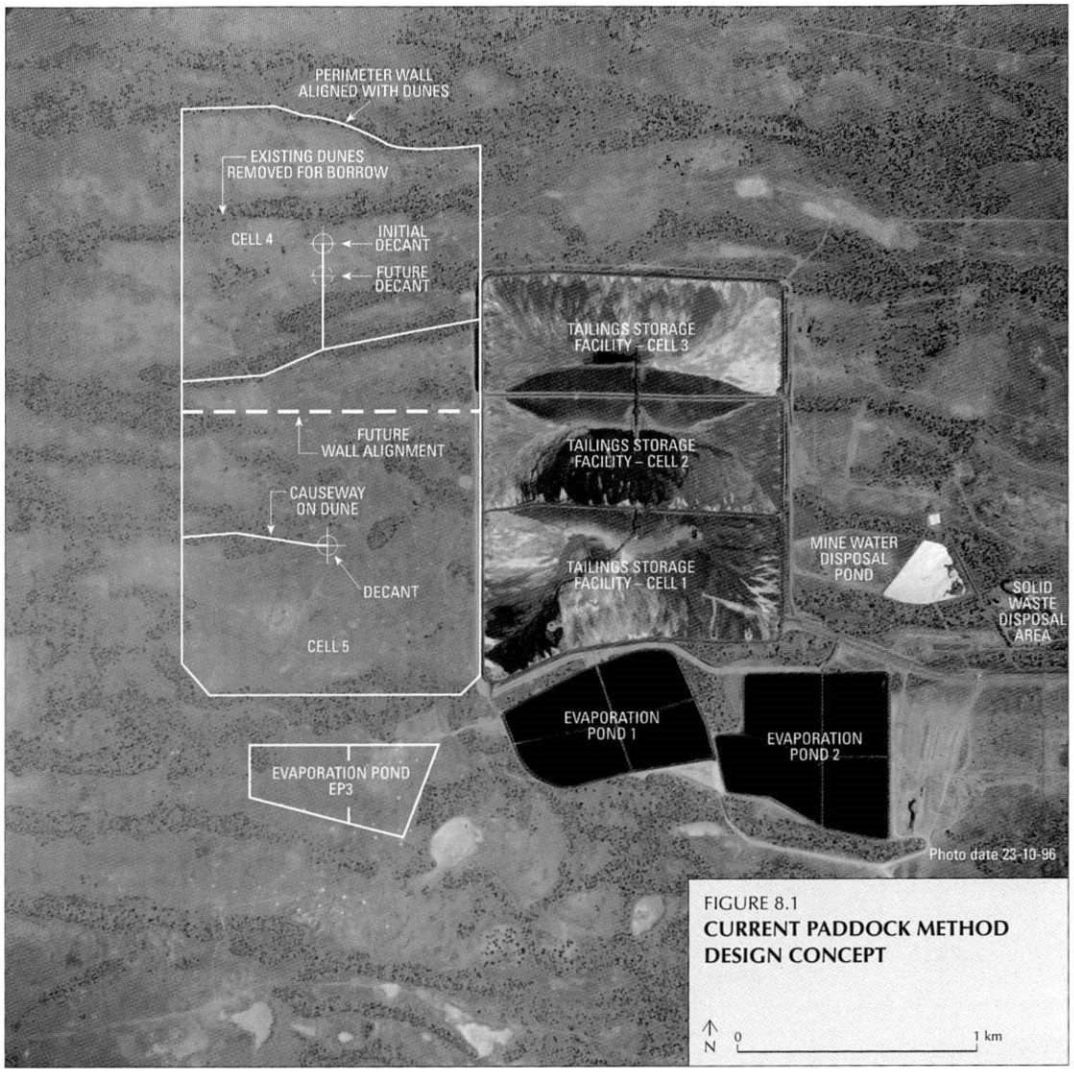


FIGURE 8.1
CURRENT PADDOCK METHOD DESIGN CONCEPT

two paddock cells (Cells 4 and 5) of total area 340 ha, as shown in Figure 8.1, followed by possible conversion to a CTD system within five years. The construction of the two paddock cells would increase the total paddock cell area to 530 ha, compared with the 390 ha area described in the EIS which was based upon the minimum area required to remove all free liquor from the tailings surface. As well as making provision for possible future conversion to a CTD system, the additional area to be provided allows evaporation pond requirements to be limited, as indicated in Section 8.6 of this Supplement.

Approval process

A number of submissions request information regarding the approval process for expansion of the TRS following assessment of the EIS. In particular, some submissions raise the problems associated with design changes following assessment of the 1983 EIS and question the approval mechanisms that would be used to prevent a recurrence of these problems.

Initially, the expectation is that at least one of the TRS expansion options presented in concept form in the EIS would be approved, subject to conditions. The approval process requirements that follow are specified in the Indenture and involve assessment by State Government authorities of a detailed submission prepared by WMC seeking approval to construct the facility. These submissions would be supported by preliminary engineering calculations, descriptions of construction methods and monitoring programmes.

The TRS expansions to be subsequently submitted for 'approval to construct' may differ in detail from the concepts presented in the EIS due to:

- the need to incorporate conditions attached to the EIS approvals;
- further developments that improve the operational or environmental performance of the system.

The latter point is considered important, particularly if the system is to maintain consistency with best practice technology. Government also retains the option to require further public consultation should the preliminary design be considered to differ significantly from that presented in the EIS.

Some submissions assert that design changes implemented following the 1983 EIS imply a reduced intent on the part of WMC in regard to observing the provisions of this Expansion Project EIS. Such assertions are unfounded and therefore do not require a response other than to state that this EIS accurately reflects WMC's intentions and commitments for the Expansion Project based upon current knowledge. WMC made a public statement in February 1994 on seepage from the TRS, and the issue has been acknowledged many times in public forums, as have been the changes to improve the performance of the TRS. There are now no known problems with the operation and monitoring of the existing TRS, and WMC intends to maintain or improve the current level of performance for future expansion.

CTD stormwater ponds

Submission G3 questions why stormwater ponds are required for the CTD method of tailings storage. The stormwater ponds are required because the CTD profile, a number of intersecting flat cones, sheds rainfall run-off to its perimeter. Stormwater ponds are therefore provided at the CTD perimeter to collect the stormwater run-off for either recycling for reuse in the process or evaporation, depending on its quality.

8.2 EXISTING FACILITIES

This section addresses issues raised in relation to the existing TRS facilities.

Environment, Resources and Development Committee (Parliament of South Australia) Inquiry

The seepage of water from the TRS was the subject of an inquiry by the Environment, Resources and Development Committee of the Parliament of South Australia. The inquiry was conducted in 1995, and the findings and recommendations were contained in a report dated April 1996 (South Australian Parliament 1996). The seepage incident and corrective action were also described in the Environmental Review public consultation process (WMC—Olympic Dam Corporation 1995).

Submission P3 considers that the EIS does not provide adequate responses to many of the recommendations made by the committee.

Section 8.1.6 of the EIS contains discussion regarding the inquiry, focusing on the findings and recommendations of relevance to the Expansion Project, and provides responses on implications for the Expansion Project. The EIS notes that the committee made a number of other findings regarding the design, operation and monitoring of the original TRS. These were not discussed further in the EIS because they had been addressed by changes made to the operation of the original TRS as described in the 1995 Environmental Review. In addition, the committee's report is publicly available.

Submission P11 raises questions relating to the uncertainty of the cause of the seepage and the adequacy of monitoring in the TRS. However, the causes of the seepage were considered at length by the Parliamentary committee, based on extensive investigations by WMC. The causes were subsequently addressed by modifications made by WMC to the operation of the TRS in 1994–95, at a cost exceeding $20 million. The seepage was initially identified by the initial WMC monitoring system, which has been upgraded further in consultation with the regulatory authorities. WMC does not agree that the monitoring system is in any way deficient or inadequate.

Submission P29 questions why acidic liquor is not stored underground, thereby avoiding expensive evaporation ponds. No studies have been conducted into this option as it is considered inconsistent with public expectations that the liquor be contained in the TRS.

Seepage

Submission P11 raises a number of questions regarding the effectiveness of the modifications to the TSF, querying whether the modifications fulfilled the objective of ensuring minimum seepage from this facility. Some of these questions request data relating to the floor preparation of the existing TSF. The Environment, Resources and Development Committee reported on the issue of floor preparation for the existing TSF when publishing the results of its inquiry in 1996 (South Australian Parliament 1996).

The meaning of the term 'minimum seepage' is also queried. In the context of the existing TSF, this term refers to the minimum quantity of seepage that could be achieved by operational changes. This meaning differs slightly for new facilities (Section 8.6 of this Supplement) because of the constraints imposed by the existing facilities.

The modifications to the existing TSF are expected to continue reducing any seepage in absolute terms, hence the use of the term 'becoming effective' in the EIS. The data required to support the above statements are provided in the EIS, specifically in Figure 4.21, which shows a reduction in groundwater levels in the Andamooka Limestone aquifer immediately below the TSF. Such a reduction in levels over this period could only have been achieved by a significant reduction in seepage from the TSF.

Submission P11 also questions why the EIS did not provide data to support the field results described in Section 8.1.5 (p. 8-6) of the EIS. The data from the field investigations were used to confirm the results of laboratory investigations (shown in Figure 8.3 of the EIS), which provided quantitative data of greater value for assessment purposes.

8.3 CONSTRUCTION ISSUES

This section provides responses to comments relating to the construction of the TRS facilities required for the Expansion Project.

Location of facilities

Submission G6 expresses the opinion that the Special Mining Lease boundary is not a convincing 'constraint' to the siting of TRS facilities (Table 8.2 of the EIS). WMC agrees with this opinion regarding the siting of the TSF in the long term, as envisaged in Section 5.5.2 of the EIS. However, extension of the boundary would constitute a change in land use and could be associated with delays in the short term, given the current uncertainty that exists with regard to land title in Australia. Hence the location of the boundary needs to be taken into consideration as its relocation may impose timing restrictions on the expansion of the TRS required for the Expansion Project.

Construction materials and standards

A number of submissions express the opinion that the EIS should contain greater detail regarding construction of the TRS, specifically the suitability of construction materials and construction standards. WMC considers that the level of detail supplied in the EIS is sufficient to allow environmental assessment of the proposals. The level of detail is also consistent with the information available at the time of preparing the EIS. As described in Section 8.1 of this Supplement, detailed design of the TRS facilities associated with the Expansion Project would be undertaken after the environmental assessment process, thereby enabling any conditions associated with environmental approvals to be incorporated into the design. This is the normal procedure for resource development projects.

Prior to construction, a detailed submission based upon preliminary designs would be made to the South Australian Government requesting approval to construct the TRS facilities.

All WMC design preparation and the South Australian Government review would be undertaken by qualified geotechnical engineers experienced in the design of tailings storage facilities. As described in Section 3.11 of the EIS, current Australian Standards would be used for design and construction of the Expansion Project, thereby defining an acceptable construction standard.

It is noted that the area proposed for expansion of the TRS has been subject to preliminary geotechnical investigations to define the source and suitability of construction materials for the expansion of the TRS. The results of the investigations are summarised in Section 8.4 of the EIS. Although preliminary, these investigations were extensive. When combined with construction experience from the existing TRS facilities, the findings provide a high level of confidence that the results described in the EIS will be achieved. The results of the stability analyses presented in the EIS are a good example of this. These calculations were undertaken with design loadings applied in accordance with the latest issue of Australian Standard AS 1170.4, *Minimum design loads on structures, Part 4: Earthquake loads* (Standards Australia 1993), using standard stability analysis techniques.

The suitability of the clay to be used to contain the tailings liquor, which is of an acidic nature, was also assessed as part of the geotechnical investigations. These results, including chemical stability as well as suitability to achieve low permeability using normal construction techniques, are also summarised in Section 8.4 of the EIS.

One submission, P10, considers that alternative tailings storage strategies must be specified in the event that tailings do not achieve sufficient strength to hold later tailings lifts. As a result of tailings test work and experience with the current TRS, WMC considers upstream construction to be a low risk method in the context envisaged in the submission.

Floor preparation

Two issues are raised in the submissions regarding floor preparation:

- source and suitability of the low permeability floor liner
- identification and effects of near surface karst features (dolines).

As described in Section 8.5.4 of the EIS, a low permeability clay liner would be placed over areas where the floor level would be either in or close to sand or limestone, and would have a minimum thickness of 0.3 m. The source of the clay liner would be identified during the preliminary design stage. However, it is expected to consist of swale material (soil cover type AL1 in Table 8.7 of the EIS) sourced from within the TRS expansion area. Laboratory testing on compacted samples of this material has indicated low permeability of about 5×10^{-8} m/s. Further discussion on seepage minimisation is provided in Section 8.6 of this Supplement.

Submission G9 correctly states that the methods outlined in the EIS to identify near surface karst features do not provide a guarantee that these methods will be totally effective. These limitations of the currently available methods are recognised in the EIS (Section 8.5.4) which also describes the contingency plan to be used should such features appear during tailings deposition.

Embankment construction

Submission G9 provides comments on possible design details for the embankments. These comments will be considered during the detailed design of the TRS expansion facilities and do not require further comment in this Supplement.

8.4 CENTRAL THICKENED DISCHARGE OPTION

The CTD option of tailings storage receives considerable comment in the submissions received. Most of these comments express opinions regarding the perceived advantages and disadvantages of the application of this system at Olympic Dam. All comments will be taken into consideration during assessment of the alternative systems and, if appropriate, during detailed design of the facilities.

A detailed discussion of the CTD option, including the results of pilot trials, follows.

That the CTD has the potential to result in greater radon emanation and dusting than the paddock system, due to the greater surface area and lower initial moisture content of the tailings, is recognised in the EIS. However, natural ventilation should continue to disperse and dilute radon and radon decay products to very low levels within quite short distances from the TSF. Dust monitoring of the existing TSF has shown that this facility is not a major emission source, mainly due to the particle size characteristics of the tailings and because the tailings form a crust upon drying. These characteristics would also apply to the CTD, hence additional dust generation would also be minimal.

Submission G6 notes that, unlike the paddock system, there does not appear to be a mechanism by which liquor or tailings can be directed to a section of the CTD that becomes excessively dry. It is noted the CTD does not offer the same flexibility to tailings deposition as the paddock method, which has spigots evenly distributed around the perimeter. However, CTD systems operate efficiently elsewhere, producing reasonably uniform cone profiles that reflect uniform tailings distribution. In addition, the CTD system presented in the EIS has multiple outlet structures, thereby allowing some control to the location of tailings deposition.

Pilot trials

A series of pilot trials have been carried out at Olympic Dam operations for the purpose of providing information on the characteristics of thickened tailings and the deposition and drying behaviour of these tailings over a range of solids concentrations.

The trials involved the deposition of thickened tailings into four small cells constructed for the purpose within Cell 1 of the existing TSF at Olympic Dam. Deposition at a medium scale was carried out on Cell 2 of the existing TSF to assist with scaling up the small-scale trials to expanded production rates.

The results, which are briefly summarised below, have confirmed the validity of the concept ideas for a CTD system of disposal at Olympic Dam and have provided the data needed for the design of such a system. A full description of the pilot trial results, which are highly technical in nature, will be provided to the State Government in support of any design submissions for a CTD system.

Rheological comment

In the pilot trials, normal plant tailings were thickened to a solids concentration of 45–60% in the pilot thickener for deposition into the trial cells. The upper target slurry solids concentration of 60% could be consistently attained in the thickener without difficulty.

Rheological test work carried out on site in parallel with the pilot trials indicated that the tailings could be thickened to a solids concentration appropriate for the CTD method and pumped to a nominated point of disposal using centrifugal pumps. The slurry solids concentration would likely be in the range of 55–60% solids.

Changes in the viscosity of the slurry feed to the pilot thickener were noted during the trials, attributed to mineralogical changes in the feed, flocculent addition and removal of sands by the sand plant operation. These fluctuations can be accommodated in the management of a CTD system.

The rheological test work has supplemented the data necessary for the design of the thickener, pumps and pipework that will be required for the CTD system.

Beach profiles

The small-scale trial beaches generally developed average slope profiles ranging from 4.5% to 8.5% for tailings densities in the range of 55–60% solids concentration.

At a solids concentration of 45%, the small-scale beach profiles ranged between 2.5% and 4% compared with an average beach profile of 1.5–2% for the medium-scale trial.

The average beach slopes at the various solids concentrations and flow rates were modelled using a beach prediction model developed from pilot trials and existing beaches at various operations. The results indicate that a beach slope of approximately 2.5% can be achieved for a deposition solids concentration of between 55% and 60%. Observations confirm that particle segregation after deposition of the tailings is suppressed at these levels of solids concentrations.

A check of liquefaction potential of the tailings was carried out using *in situ* shear strength test results. This check indicated that liquefaction potential is low.

Drying characteristics

An important element of the trials was evaluation of the supernatant liquor release from the deposited tailings, and the subsequent drying characteristics of the beaches over time.

The results indicated that, irrespective of the solids concentration at which the tailings were discharged into the cells, supernatant liquor release from the tailings ceased within twenty-four to forty-eight hours after deposition, and by that time the tailings had invariably attained solids concentrations on the trial beaches in excess of 60%. The rapid increase in solids concentration was even more apparent on the upper reaches of the existing beaches for tailings deposited at low solids concentrations, although bleed near the decant pond continued for a further two days.

If the tailings are discharged to the storage at a solids concentration approaching 60%, the quantity of supernatant released after deposition would be limited.

Determinations of *in situ* densities carried out on existing beaches confirm the likely average tailings density to be approximately 1.7 t/m^3. After three months of drying, samples collected on the lower and middle sections of the beach of TSF Cell 1 indicated a degree of saturation in the range 95–98%.

Tailings deposited on to the existing beach of TSF Cell 2 showed a rapid fall in moisture content to 31% within two days of cessation of deposition. Thereafter, the moisture content declined gradually to 22% over a further ten-day period.

Permeability and rate of advance of liquor

A test work programme was carried out off site to supplement the data obtained from the pilot trials. The programme included determining of permeabilities under varying conditions and evaluating the likely rate of advance of liquor in either tailings or sandy clay under conditions of low pressure.

The test work indicated that the likely rate of advance of liquor would be around 100 mm in seven days in tailings under a variable pressure head to 250 mm, and around 100 mm in ten days in the swale material under an average pressure head of 90 mm. The results support the concept that seepage is unlikely to occur under intermittent wetting conditions.

Liquor management

An advantage of the CTD option is that most of the free water is removed by thickening the tailings prior to discharge. Submission G9 suggests that there would be little water available from the thickened tailings for release down slope, resulting in very little discharge of liquor to the base and probably little segregation of the tailings on the beach. This suggested behaviour was confirmed by the small-scale field trials discussed above.

Submission G9 also questions whether the drains would be necessary. During normal operation, some supernatant liquor release is expected and therefore drains would be provided.

The reclaim and stormwater ponds would be lined with clay, which is considered sufficient to meet the overall objective of minimising seepage from the facility. Whereas the existing evaporation ponds have a composite lining of synthetic membrane and clay, enabling them to permanently hold liquor several metres in depth, the reclaim and stormwater ponds are required to hold liquor less frequently and to a lesser depth.

Submissions G6 and G9 raise concerns regarding the efficiency of the drainage collection system. Specifically, these concerns relate to drain spacing and gradients of the drains and possible blocking by tailings. These comments are noted and will be taken into consideration during assessment of the alternative systems and, if appropriate, during detailed design of the facilities. At the present time a herringbone drainage design is envisaged to ensure that drainage is maintained as the tailings advance over the floor of the cell. These drains would be open and therefore not prone to blocking.

Submission G9 also raises concerns about lack of data on evaporation rates from the CTD beaches and evaporation pond requirements. However, it is noted in Section 8.6 of the EIS that detailed water balance calculations to determine evaporation pond requirements for the CTD option would be dependent upon parameters such as evaporation rates being measured from field trials.

It is also noted that progressive rehabilitation of the CTD cells is not planned, and the full area would be available for evaporation of liquor, together with the existing TSF if needed, throughout the life of the CTD system.

Further development of the CTD concept

Further development of the CTD concept, undertaken as part of the pilot trials, has highlighted the potential to make better use of the existing topography during the early stages of deposition.

Tailings deposition would occur along embankments situated over existing sand dunes. Further deposition would form an elongated cone parallel to the dunes. An embankment would be provided around the entire perimeter by incorporating sand dunes where possible and using selected fill material obtained from within the facility as necessary. The number and type of deposition points would be arranged to suit the topography and facilitate the collection of any tailings liquor or stormwater run-off.

8.5 REHABILITATION

A large number of comments were received on the issue of rehabilitation of the TSF. It is noted correctly that, although the broad concepts for rehabilitation are well understood and are documented in the Expansion Project EIS, the detailed rehabilitation planning is at a preliminary level. This is due in part to the long lead time available for long-term rehabilitation trials and design planning. The first major rehabilitation works at Olympic Dam are not expected to commence until approximately 2016, allowing a long period for rehabilitation trials and consultation with Government in the detailed design planning stage. The following section addresses particular comments raised about rehabilitation matters.

Responsibility for long-term tailings management

A number of the submissions question who would be responsible for the long-term management of the rehabilitated TRS. In this context, 'long term' was generally described as a function of the half-lives of the radionuclides contained in the tailings.

The Code of Practice on the Management of Radioactive Wastes from the Mining and Milling of Radioactive Ores 1982 requires that ultimately it will be a State Government responsibility to manage the rehabilitated TRS over the long term. The mechanism for the State Government assuming this responsibility is covered by this code, requiring the mining company to rehabilitate the tailings to a standard acceptable to the regulatory authority (the State Government) prior to the regulatory authority accepting the responsibility.

It is noted that the tailings at Olympic Dam contain a host of minerals, the extraction of which is not currently economically viable. Future changes in mineral extraction technologies combined with depletion of the most easily exploited mineral reserves elsewhere may result in reprocessing of the tailings becoming economically viable. Under these circumstances the State Government would be in a position to derive further mineral royalties from the Olympic Dam deposit.

Research programme

Section 8.10 of the EIS describes concepts currently being considered for rehabilitation of the TSF. The development of these concepts into detailed rehabilitation plans will involve:

- a research programme to determine design parameters applicable to surface cover at Olympic Dam;
- further geotechnical investigations to determine cover materials available;
- detailed design taking into consideration data from the above studies and the requirements of Codes of Practice and Australian Standards as they apply at that time.

The existing TSF has now developed to a stage where site-based research programmes can commence. There are two types of programme:

- Capping programme: Trials into the effects of different capping layers on radon emanation have commenced. These trials, covering an area of approximately one hectare on Cell 3

of the existing TSF, will be completed by early 1998. Radon emanation measurements for these trials are being conducted using the accumulator drum method.

- TSF wall programme: A mostly qualitative programme is about to commence on rehabilitation trials for the TSF walls. The trials will be over a term of about twenty years, utilising a portion of the east wall of the TSF that is not expected to be disturbed in the future.

  Different sections of the wall will be modified in order to trial the effects of erosion control and revegetation success of:

  – various outer embankment slopes;

  – combinations of substrates (cover materials) and seeding techniques;

  – various vegetation species indigenous to the area;

  – erosion controls consisting of various rock armour types and terracing.

Design parameters

Section 8.10 of the EIS discusses the factors that will be taken into consideration when developing design criteria for rehabilitation of the TSF. An important consideration in developing these criteria is the future land use of the region. The EIS postulates that in the foreseeable future it is probable that pastoralism would remain the major land use and that the region would remain sparsely populated.

Some submissions question what effect possible future climate change would have on land use in the region. This aspect is not examined in the EIS due to the preliminary nature of climate change predictions. However, climate change predictions are expected to be further developed over the life of the Olympic Dam mine. The approach being adopted by WMC in progressively developing design criteria, taking into consideration the results of field trials and other studies, should enable future climate change predictions to be utilised.

Submission P3 argues that radon release rates from the tailings should be compared to background release rates for the area. Radon emanation criteria, including return to background levels, do not apply in Australia. Instead, limits are placed on exposures received by people, emphasising the importance of future land use in establishing design criteria.

However, measured radon release rates at Olympic Dam, which are indicative for the soil types found in the TRS expansion area, are provided in Table 8.1 below. It is noted that the soil type in the TRS expansion area is predominantly swale.

Table 8.1 Typical radon emanation rates from terrain types at Olympic Dam

Soil types	Typical radon emanation rate ($Bq/m^2.s$)
Sand dune	0.0095 ± 0.0021
Swale	0.063 ± 0.007

The structural integrity of the rehabilitated TSF was also questioned in some submissions. The EIS notes that the Australian codes of practice on the containment of tailings, and codes in the United States and Canada, now call for a design life of 200 years and a structural life of 1,000 years.

The Guidelines to the Code of Practice on the Management of Radioactive Wastes from the Mining and Milling of Radioactive Ores 1982 provide the following elaboration on the meaning of these criteria:

> 'Design life' is the period for which the structure is expected, by the designer, to perform fully in accordance with the objectives of the design, such as rates of releases of contaminants, taking into account the known parameters and influences. The design life is a prediction of the useful life of the structure. A structure, once in service, will usually retain integrity of the materials and components used to build the structure for a period considerably longer than the design life. Such a structure will show signs of deterioration but will be capable of performing the functions of the design to a reduced extent. The 'structural life' is therefore the actual measurement of the useful life of the structure in performance. The structural life may be extended by renovation and maintenance of the structure. In the context of this guideline the objective in the engineering of a waste management structure should be to attain a design life of at least 200 years (institutional controls such as record keeping, monitoring and land-use restrictions should operate as an adjunct to design criteria during this time) and a structural life of a substantially longer period, of the order of 200 to 1,000 years, taking into account estimates of geomorphic and climatic influences so as to minimise rates of contaminant release caused by denudation, seepage, and exhalation.

One submission, P34, raises issues regarding the completeness of the seismological record in the region. The seismological records were recently reviewed as part of a revision to the Australian Standard AS 1170.4, *Minimum design loads on structures, Part 4: Earthquake loads* (Standards Australia 1993). Further revisions to this standard are expected over the life of the Olympic Dam mine as the seismological record is extended.

Rehabilitation of the CTD system

Submission G6 raises a number of perceived disadvantages relating to rehabilitation of the CTD system by comparison with the paddock system. Specifically the submission raises the following issues:

- The CTD system would need a larger volume of cover material than the paddock system. The sourcing of the cover material, together with the larger area occupied by the CTD itself, would result in an increased area of land disturbance.
- The CTD system has greater potential for surface erosion than the paddock system and, if erosion penetrates the cover, tailings could be dispersed into the environment.

The detailed rehabilitation planning at Olympic Dam is at a preliminary level; however, the following comments are provided based upon current knowledge and general principles.

The CTD system requires more land than the paddock system for any volume of tailings stored. This fact is evident from the information presented in the EIS. However, what may not be evident are the relative volumes of cover material required for each system, particularly if the successive perimeter embankment raises of the paddock system (EIS Figure 8.5) are taken into consideration. These raises may in future be constructed of tailings, but if this is not the case then other materials would need to be sourced, considerably increasing the overall cover volume of the paddock system.

The tailings storage concepts presented in the EIS for a production rate of 200,000 t/a of copper can be used as an example to illustrate the above discussion. If the paddock system perimeter raises are not constructed of tailings, but of material suitable for use as cover, then the cover material volumes for both systems would be virtually identical if a final minimum cover thickness of 1.5 m were adopted for both systems. Adoption of a thinner minimum cover thickness would result in the CTD system requiring a lesser volume of cover material. Therefore, until the final cover designs are completed, it is not possible to categorically assume that the CTD system would require a greater volume of cover material and that cover material requirements are a necessary disadvantage of this system.

The other issue raised in Submission G6 requires consideration of erosion of the cover material. The submission recognises the greater erosion potential of the CTD tailings surfaces due to the larger stormwater catchment areas and the slightly steeper tailings surfaces. It also recognises that, owing to its internal drainage system, the paddock method is less likely to result in dispersion of tailings in the event of erosion penetrating the cover layer.

WMC is confident that, following assessment of long-term rehabilitation trials, cover designs can be engineered for both tailings storage methods that would prevent erosion penetration of the cover layer. Therefore, the secondary protection provided by the internal drainage system of the paddock method may not be a significant advantage. The greater erosion potential of the CTD system would, however, require a greater level of erosion control, particularly in the valleys where the CTD cones intersect. This factor is a disadvantage of the CTD method, which will be taken into consideration during future decisions on expansion of the TRS.

Other factors that would also be considered include the advantages offered by the CTD method, which are:

- elimination of rehabilitation issues associated with the paddock method perimeter walls, including erosion control and stability;
- reduced potential for long-term seepage through the tailings due to rainfall run-off being shed from the CTD surface.

Sources of rehabilitation materials

Submission P29 questions the source of the materials for the rehabilitation of the final tailings retention system.

The sources of rehabilitation materials have not been identified at the present time as the final rehabilitation design is subject to a research programme, as described above. Part of this programme will involve further investigations to determine the cover materials available. However, it is expected that rehabilitation materials would be sourced from the following:

- any surplus soil resulting from profiling of the TRS floors and stockpiled adjacent to the perimeter embankments;
- any surplus soil resulting from development of the surface quarry and stockpiled for future use;
- local dune sand and swale material from borrow areas identified from future investigations;
- rock sourced from the surface quarry;
- waste rock (mullock) sourced from the underground mine.

8.6 HYDROLOGY

Hydrology issues associated with tailings management include seepage from the tailings storage facilities, run-off from design storm events and evaporation pond requirements. Comments on these issues are discussed in this section.

Seepage minimisation

A number of submissions raise questions regarding the use of the term 'minimise' with regard to seepage control and the suitability of the naturally occurring clay and limestone barriers to contain tailings liquors.

As outlined in the EIS, the design of the tailings storage facilities and evaporation ponds has been based on the requirement to ensure minimal practical seepage from the TRS. Features of the alternative paddock and CTD designs for achieving this include:

- containment of acidic plant and tailings liquor in synthetically lined ponds;
- provision of sufficient tailings storage area to ensure effective drying of tailings between deposition cycles;
- construction of a low permeability liner and drained area around the decant structure of each tailings storage cell (paddock design);
- shaping of the floor of each tailings storage cell to minimise ponding of supernatant tailings liquor during initial filling (paddock design);
- provision of a low permeability clay liner over the floor of each tailings storage cell to minimise infiltration of supernatant tailings liquor and rainfall run-off (paddock design);
- additional dewatering prior to discharge (CTD design);
- the use of sloped floors and lined trenches to direct water into decant areas (CTD design).

Wherever possible, the low permeability clay liner for the paddock method would consist of natural clayey soils prepared (if necessary) to form a low permeability soil layer.

Once the tailings beaches are fully established, the cycle of subaerial deposition, removal of decant liquor and drying, combined with the low rate of tailings rise, would theoretically result in no seepage from the tailings beaches. However, the term 'minimise' recognises that seepage control may not be absolute. Before the beaches become fully effective, for example, greater reliance will be placed on floor preparation and temporary decant facilities to remove liquor and thereby control seepage. The quantity of seepage at these times cannot be quantified due to the transient nature of the process. However, it should be effectively controlled to low values owing to the combined effects of:

- the low permeability floor layer
- the low hydraulic heads due to the operation of the temporary decants
- the removal of liquor due to natural drying.

Extensive profiling of the floor of the paddock option, as described in the EIS, is not now envisaged. Instead, strategically located drains would be provided to collect liquor and direct it to either temporary decants located in naturally occurring drainage points or the central decant. These drains will be unlined where the natural soils are of low permeability or lined with clayey material where the natural soils are of high permeability. The intent of the floor profiling, as described in the EIS, would therefore be fulfilled by the new system which would also effectively prevent supernatant liquor from ponding on the TSF floor.

The supernatant liquor would be collected and pumped to the evaporation ponds to minimise the ponding of tailings liquor on the floor of the facility. A gravity decant system, draining directly to the evaporation ponds, would be installed once the tailings level had risen sufficiently to provide the necessary fall for the decant to operate under gravity. This system would be similar in concept to that now installed in Cells 1, 2 and 3. Liquor collected in the underdrainage system around the decant structures would also be pumped to the evaporation ponds.

One submission, P10, recommends that fabricated impermeable membranes be used as part of the floor preparation in order to eliminate reliance upon the floor treatment outlined in the EIS. However, as discussed above, floor treatment is only one component of the seepage control measures to be used at Olympic Dam, and it decreases in importance as the

operation of the tailings retention cells progresses. WMC does not support the use of synthetic liners in this situation as it would have no apparent benefit to the environment.

Submission P10 also suggests that a carbonate-bearing slurry could be sprayed on each tailings layer to provide *in situ* neutralisation capacity. This issue has been previously investigated by WMC as part of pilot plant trials undertaken prior to initial plant construction. These trials showed that neutralisation of the tailings resulted in a significantly increased volume of tailings (due to the addition of carbonate-bearing material) and that the tailings did not form a competent crust upon drying, thereby increasing potential problems with dusting. These disadvantages were considered to outweigh any possible advantages achieved from neutralising the tailings.

Design storm events

The paddock method is inherently able to store rainfall run-off resulting from a 1-in-500-year event, and the CTD method would be designed to store rainfall from a 1-in-100-year event. The CTD would also be designed to discharge to the surrounding drainage system any run-off from a 1-in-500 year event that could not be stored by the stormwater ponds. A number of submissions suggested that the CTD should be designed to contain rainfall run-off from a 1-in-500 year event. However, this would be inconsistent with accepted current Australian mining industry practice and is considered unnecessary as the overall design caters for a 1-in-500 year event.

With regard to stormwater management for the CTD system the EIS states:

> The stormwater ponds at a copper production rate of 200,000 t/a would have an operational storage volume of approximately 950 ML, equivalent to the run-off from a 1-in-100-year average return interval, seventy-two hour storm from the CTD area. For 350,000 t/a copper production the stormwater storage volume would be approximately 1,630 ML. Spillways would discharge to the surrounding drainage system any run-off from a 1-in-500-year rainfall event that could not be stored by the stormwater ponds. For such rare occurrences, the run-off would be significantly diluted by rainwater by a factor of about 50. Any contaminants would then be further diluted by regional run-off from the extreme event.

Submission G6 requests further justification of the term 'significantly diluted' used in the EIS, noting that it did not appear to consider that rainwater would dissolve evaporites and other soluble components of the tailings surface layers.

The dilution factor of about 50 was calculated on the basis that all tailings liquor would mix with rainfall during a seventy-two-hour 1-in-500-year rainfall event and that the plant would remain operational during this time. Shorter duration events, such as the twelve-hour duration event, would result in a considerably higher dilution factor of about 300. The calculations do not need to consider the evaporites and other soluble components because these would dissolve in the initial stormwater run-off, which would be stored in the stormwater ponds. In this regard, stormwater ponds would operate in a similar manner to 'first flush' pollution control systems commonly found in urban stormwater systems.

Evaporation pond requirements

A number of submissions query the evaporation pond requirements for the second expansion phase of the project from 200,000 t/a to 350,000 t/a of copper. As noted in the EIS, current planning assumes that no extra evaporation ponds would be required for this phase owing to the additional water recycling to be carried out on site. Current planning provides 20 ha for Evaporation Pond 3, and disposal of surplus liquor through evaporation on the tailings beaches. However, this situation would be evaluated during the detailed design of the second expansion phase, and if additional evaporation ponds are required, they would be constructed to the same standard as the existing ponds.

8.7 OTHER ISSUES

The following provides responses to specific issues not addressed in the previous sections.

Industry best practice

Submission P3 criticises tailings management at Olympic Dam as not conforming with industry best practice and notes that the storage cells should be lined with appropriate clay and synthetic liners in such a way as to meet specific criteria. The tailings storage systems described in the EIS are consistent with the techniques described in Best Practice Environmental Management in Mining—Tailings Containment (Environment Protection Agency 1995). The issue of synthetic liners for the TSF is also discussed in Section 8.6 of this Supplement.

Cone of depression

Submission P3 raises a number of issues regarding the movement of seepage from the TRS and the cone of groundwater depression resulting from dewatering of the underground mine. The submission correctly notes that the centre of the cone of groundwater depression is too close to the TRS and should be further to the east. This error is corrected in Chapter 4 of this Supplement.

Notwithstanding the above, the TRS does lie within the cone of groundwater depression, and any seepage that reaches the groundwater table will therefore be contained within this localised system for some considerable time after mining ceases. Reactions between the tailings liquor and the local limestone referred to in Submission P3 would not be sufficient to direct seepage outside of the cone of depression, which extends well outside the TRS.

Furthermore, the infiltration of groundwater into the mine would increase in future as a consequence of increased underground development, which would in turn increase the cone of groundwater depression and result in the centre of the cone migrating to the north-west over the centre of future mining operations. There is no connection between the rate of in-flow of groundwater into the mine and seepage from the TRS.

It is noted that the local groundwater is currently unsuitable for potable uses and its other beneficial uses would not be restricted as a consequence of seepage of tailings liquors.

Central ponds

Submission P3 questions the use of the term 'central pond' with reference to Figure 8.2 of the EIS. Examination of the figure in conjunction with Figure 3.7 of the EIS shows that the decant towers are located approximately centrally in the cells, and that the ponds are only in contact with internal cell division walls. The use of the term 'central' is therefore considered appropriate in this circumstance.

Storage of tailings in the mine

Submission P34 suggests that Olympic Dam should dispose of tailings in the worked-out area of the mine. Unfortunately this option is incompatible with underground mining, owing to the strength requirements of mine fill. A portion of tailings will continue to be returned to the mine, and this portion would increase following modifications to be implemented as part of the Expansion Project, as described in the EIS (Sections 3.3.9 and 8.2.1).

Nature of tailings

The process used to recover minerals at Olympic Dam would remain unchanged following the Expansion Project, hence the chemical composition of the tailings and the associated

liquor would also remain unchanged. A greater proportion of the coarse (sand) fraction would be removed for return to the mine as described in the EIS (Section 8.2.1). No significant alterations in the physical properties of the tailings are expected from this change, as coarse material for backfill purposes is only removed from part of the overall tailings stream and thus there is a significant portion of the coarse fraction that would remain with the tailings in the TSF.

CHAPTER 9

AIR QUALITY AND NOISE

CHAPTER 9

AIR QUALITY AND NOISE

Three submissions raise issues regarding air quality and noise at Olympic Dam. One of these, P36, questions the suitability of air quality regulations generally, and is not addressed in this Supplement. This is a matter for response by government. The following discusses the issues raised in the other two submissions.

9.1 SMELTING TECHNOLOGY

Submission G3 questions how Olympic Dam will maintain sulphur dioxide (SO_2) levels within the requirements of the South Australian Environment Protection Authority (EPA) if the Expansion Project utilises existing smelting technology.

This is possible because the Expansion Project will utilise improved gas collection and scrubbing systems as described in detail in Section 3.5 of the Expansion Project EIS.

The results of air quality modelling undertaken, presented in Section 9.3 of the EIS, show a significant reduction in ground level concentrations of SO_2 following the Expansion Project. Furthermore, all such predictions for the Expansion Project show compliance with current, and expected future, requirements of the EPA.

9.2 CONSTRUCTION PHASE

Submission G8 suggests the EIS should mention additional controls or measures for minimising occupational exposure of personnel during construction of the Expansion Project. Controls have been developed specifically for the construction phase of the Expansion Project as construction personnel would be working at heights where they may be exposed to emissions from existing stacks. These controls include:

- employment of an occupational hygienist to oversee air quality issues pertinent to the Expansion Project during construction. This officer attends production meetings for the existing plant in order to communicate production information to the Expansion Project workforce;
- installation of a scrubber at the existing acid plant to scrub the acid plant tail gas and, in an emergency, the acid plant bypass gas (to be operational in October 1997);
- installation of burners in the existing anode furnace stacks to increase the buoyancy of the gases during the oxidation cycle (operational September 1997);
- implementation of a control alarm system for alerting operators to unplanned SO_2 emissions from the existing smelter;
- establishment of a stand-alone alarm system covering construction activities near to the existing smelter. The base station alarm system is equipped with a progressive display that indicates monitored SO_2 levels;

- distribution of personal respirators to all construction personnel, who are required to have them in their possession at all times;
- provision of safe houses throughout the Expansion Project work area;
- monitoring wind direction at the existing smelter control room;
- installation of a wind direction indicator at the acid storage tank alongside the existing acid plant.

9.3 MODELLING PREDICTIONS

Submission G8 raises issues with regard to Case 3 (285,000 t/a copper production) and presentation of data (Table 9.8 of the EIS).

285,000 t/a copper production

The 285,000 t/a case applies to the situation of processing imported concentrates and ores (85,000 t/a) together with the 200,000 t/a copper production plant established following the Expansion Project. The 85,000 t/a component would utilise the existing smelter with modifications to reduce atmospheric emissions of SO_2.

No decision has been made to proceed with the treatment of imported concentrates or ores, hence the timing for this stage is unknown.

Data presentation

Submission G8 suggests that the distance from the source (smelter/acid plant) should be shown in Table 9.8 for the predicted SO_2 values. An estimation of the location of the highest values could be obtained from Figures 9.3, 9.4 and 9.5 in the EIS, while the model results, as suggested, are presented in Table 9.1 below.

Table 9.1 Distance to highest predicted values for sulphur dioxide concentrations (m)[1]

Sulphur dioxide concentration	Case 1 Existing 85,000 t/a	Case 2 200,000 t/a	Case 3 285,000 t/a	Case 4 350,000 t/a
10 minute	770	870	1,070	770
1 hour	770	870	1,070	770
Annual	700	520	520	640

1 Distance from location of 200,000 t/a main smelter stack.

9.4 OTHER ISSUES

Submission G8 raises two issues relating to:

- clarification of SO_2 emissions during the blister copper filling stage
- sampling protocols
- 1993 data.

Blister copper filling

Section 3.5.3 of the EIS describes the gas handling arrangements to be implemented for the anode furnaces during filling of these furnaces with blister copper. The acid plant is

designed to handle oxidation gases, and includes the capability to accept gases during filling, although this is subject to overall available gas handling capacity. Overall emissions estimates and impacts are provided in Chapter 9 of the EIS.

Sampling protocols

Submission G8 raises possible incompatibilities between air quality monitoring undertaken at Olympic Dam with normal protocols. In some cases, the monitoring undertaken is in excess of the normal protocols in order to obtain sufficient dust samples to undertake radiometric analyses. In other cases, the monitoring undertaken is restricted by the availability of power supplies.

The air quality sampling protocols at Olympic Dam are approved and are regularly reviewed in conjunction with the EPA. This review process will continue as part of future revisions to the Environmental Management and Monitoring Plan.

1993 data

Submission G8 asks if the brief periods of high SO_2 concentrations shown in the 1993 data presented in Appendix L of the EIS can be correlated to meteorological conditions. Some modelling work on this was attempted; however, the high levels are mainly associated with smelter upset conditions, and the effect of meteorological conditions is thus secondary.

CHAPTER 10

RADIATION

CHAPTER 10

RADIATION

Several submissions contain queries on aspects of radiation. The major issues raised are:

- **the long-term containment of tailings material**
- **the assessment of radiation doses, and their associated risk.**

Queries relating to the long-term containment of tailings are addressed in Chapter 8 of this Supplement. Queries regarding the exposure of employees and members of the public to radiation arising from activities at Olympic Dam are addressed in this chapter.

Questions raised in submissions are addressed individually, except where the same question is raised in several submissions. In these cases, cross-references are provided that direct the reader to the response. Any errors contained in the EIS have been corrected here and are also listed in Appendix D.

10.1 ISSUES RAISED BY THE SOUTH AUSTRALIAN HEALTH COMMISSION

This section addresses radiation issues raised in Submission G6 by the South Australian Health Commission (SAHC).

Smelter dust bleed

The SAHC has sought clarification of the arrangement by which dust is bled from the waste heat boiler and the electrostatic precipitator on the smelter.

The dust bleed system proposed for the new smelter will be of flexible design to enable variable proportions of waste heat boiler and electrostatic precipitator dust to be returned or bled from the system. It is expected that the dust bleed would come preferentially from the electrostatic precipitator, thereby minimising recycling of polonium-210 (^{210}Po), and consequently reducing the potential radiation exposure in the smelter complex.

Radiation safety management

The SAHC points out that the exact number of people required to implement a radiation management plan for the expanded facilities will only be determined when such a plan is submitted for approval. Thus the statement that no extra people will be needed is premature.

As part of the approval process established under the Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores 1987 (AGPS 1987), a radiation management plan would be submitted to the appropriate authorities prior to the commissioning of the expanded facilities. This plan would detail the monitoring methods, frequency of measurement and data analyses that will be undertaken. The plan would include an organisation chart detailing the number of radiation safety personnel, reporting relationships, responsibilities and authority levels.

The detailed analyses described in the EIS have shown that there is a substantial number of employees exposed to no more than 2 mSv/a, and that there is a small number of employees exposed to individual doses of 5–10 mSv/a. WMC contends that radiation safety resources should be preferentially directed at the higher end of the radiation dose spectrum. This position has support in both the International Commission on Radiological Protection (ICRP) philosophy, the International Atomic Energy Agency (IAEA) Safety Series and the Australian codes of practice.

To this end, a submission will be made to the appropriate authorities to reallocate existing radiation safety resources and to place greater emphasis on the measurement and reduction of higher radiation exposures, while at the same time conducting a more detailed (albeit lower frequency) audit programme of measurements at the lower end of the exposure spectrum. Where possible, automatic, continuous monitors and in-plant control systems will be utilised to record ambient radiation levels. The use of these techniques will supplement the human resources in the radiation safety group and thereby enable it to concentrate on dose reduction programmes.

10.2 ISSUES RAISED BY THE FRIENDS OF THE EARTH—FITZROY

This section addresses radiation issues raised in Submission P3 by the Friends of the Earth—Fitzroy.

Individual radiation doses

Submission P3 requested that individual radiation doses be given, in addition to the work category average doses shown in the EIS.

Figures 10.1A, 10.1B, 10.1C and 10.1D of this Supplement show the distribution of individual radiation doses for personnel working underground. The dose distribution for personnel working above ground is shown in the EIS (Figure 10.15).

Radionuclide composition of ventilation air

Submission P3 requested that the radionuclide composition of ventilation air be stated.

It was stated in the EIS that ventilation air drawn into the mine is '. . . relatively free of radon decay products'. This is because no air, wherever it comes from, is totally free of radon decay products; when compared to ambient underground air, the intake air is relatively free of radon decay products.

Air is drawn into the mine from the surface. Ambient radon decay product measurements made at sites close to the intakes have consistently shown low concentrations that are only marginally above natural levels.

Dose conversion factors

Submission P3 asks that the question of the appropriate inhalation dose conversion factor for radon decay products be addressed, noting that different conversion factors to those used at Olympic Dam are recommended by Leigh (1997) in his research paper to the Senate Select Committee on Uranium Mining and Milling in Australia.

WMC uses the most recent recommendations of the ICRP, as required by the Indenture and approved by the SAHC. Leigh cites exactly the same sources as the ICRP and reaches a different conclusion for dose conversion factors than the ICRP recommended values. Moreover, in his calculations regarding the exposure to dose conversion for the Olympic

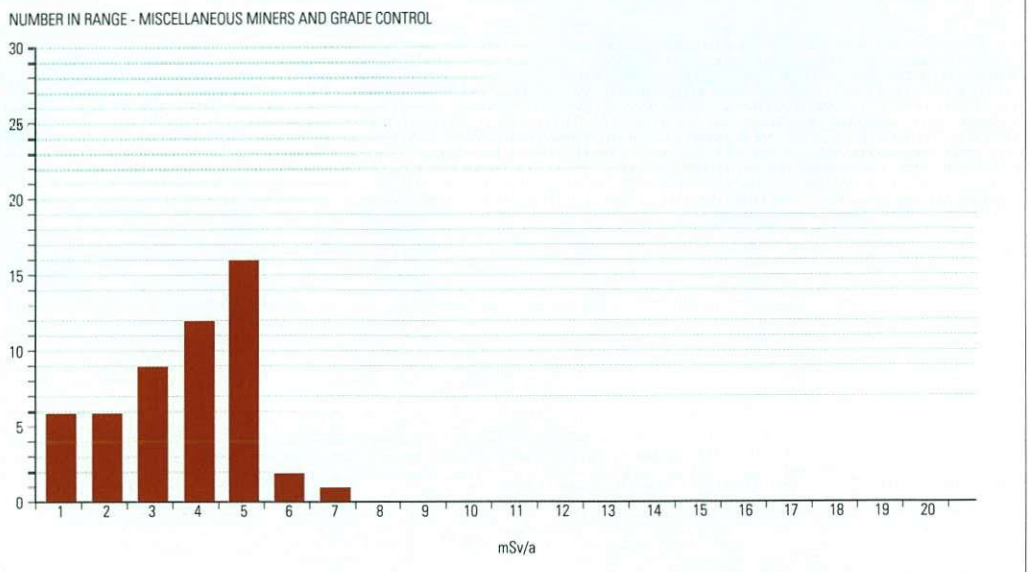


FIGURE 10.1A
DISTRIBUTION OF INDIVIDUAL RADIATION DOSES FOR UNDERGROUND PERSONNEL (MISCELLANEOUS MINERS AND GRADE CONTROL)

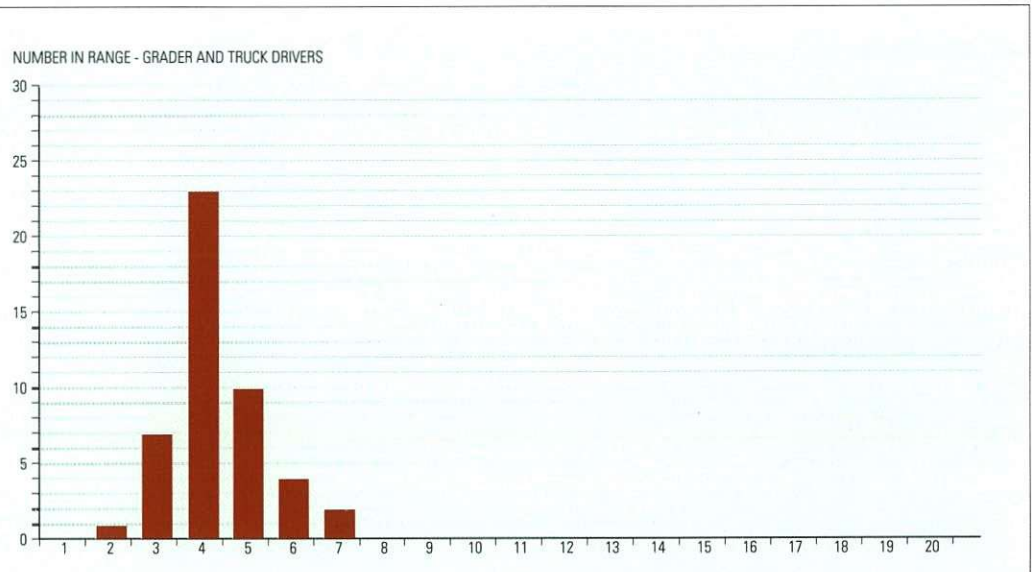


FIGURE 10.1B
DISTRIBUTION OF INDIVIDUAL RADIATION DOSES FOR UNDERGROUND PERSONNEL (GRADER AND TRUCK DRIVERS)

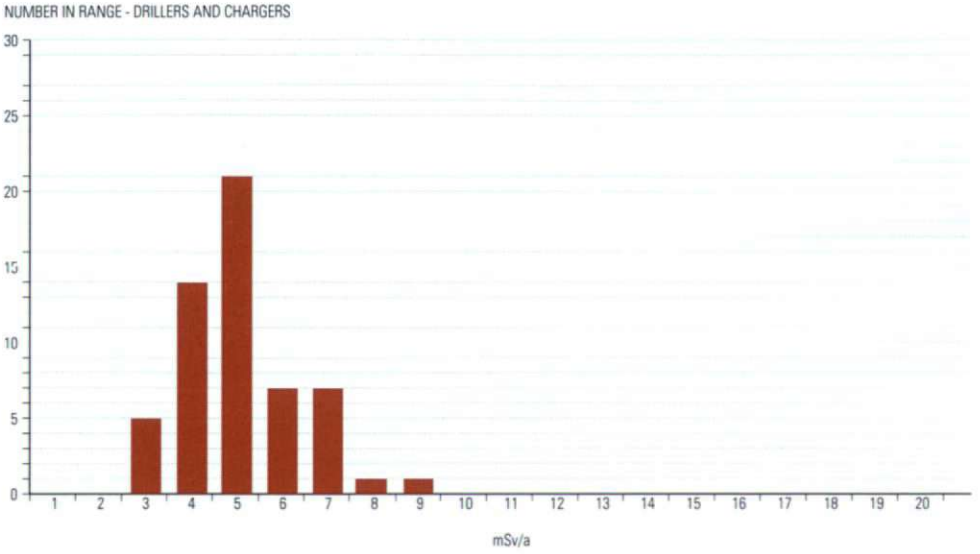


FIGURE 10.1C
DISTRIBUTION OF INDIVIDUAL RADIATION DOSES FOR UNDERGROUND PERSONNEL (DRILLERS AND CHARGERS)

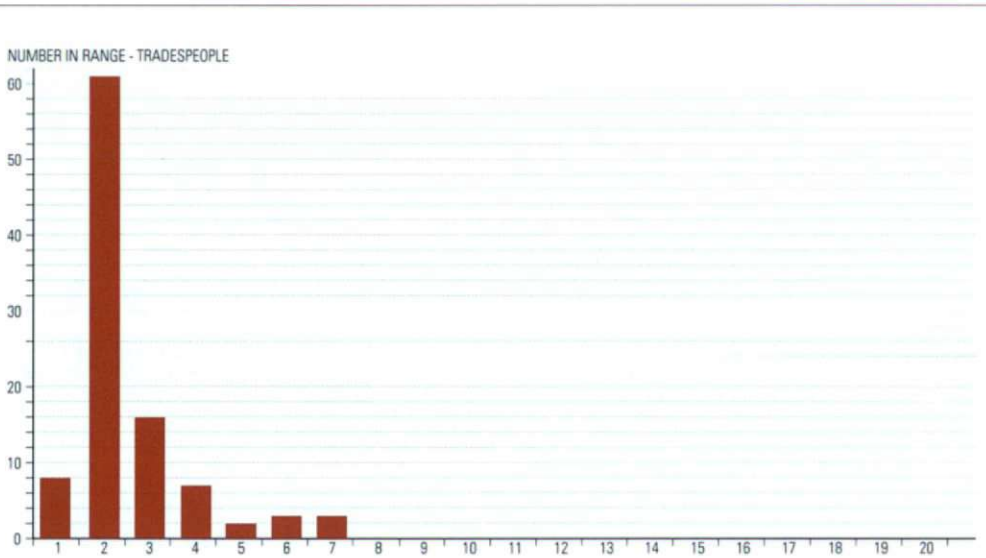


FIGURE 10.1D
DISTRIBUTION OF INDIVIDUAL RADIATION DOSES FOR UNDERGROUND PERSONNEL (TRADESPEOPLE)

Dam and Ranger mines, Leigh has taken the sum of the exposures from radon decay products and inhalation of dust, and multiplied this by a dose conversion factor that applies to radon decay products alone. The dose conversion factors for radon decay products and for dust cannot be used interchangeably.

Dose reductions in the smelter and calciner

Submission P3 asks whether or not radiation doses will be reduced with the introduction of a new smelter and calciner.

The EIS discusses engineering design optimisations that would be implemented in the new smelter and calciner and estimates the potential reduction in doses that would result in these new facilities.

Dose axis on Figure 10.16

Submission P3 correctly notes that the first point on the annual dose axis in Figure 10.16 of the EIS is in error, and should read 0.05 mSv, not 0.5 mSv.

Risk estimates

Submission P3 asks that risk estimates should be given, using the best available data.

The EIS discusses the likely change in annual radiation doses in an expanded operation, and comes to the conclusion that individual doses will not change significantly in the mine. This is because no major changes are planned for the method of ventilation (although the system will expand), and no individual is likely to work longer hours than they currently do. The increase in the workforce for an expansion to 350,000 t/a copper is likely to increase the number of people receiving an average annual dose of 5 mSv from 141 to 250, that is, by a factor of 1.77.

The attributable risk of fatal cancers in excess of normal rates for exposure to 5 mSv effective dose equivalent, annually from age eighteen to sixty-five years, is 0.95% (ICRP 1991). If the employees that receive an individual annual dose of 5 mSv were to work at this exposure for an entire working life of forty-eight years, the excess number of cancers that could be expected would be 1.3 for the existing workforce and 2.3 following expansion to 350,000 t/a copper production. The tissue weighting factor for the lung is 0.12, and thus the number of excess fatal lung cancers would be 0.16 for the existing workforce and 0.3 following expansion to 350,000 t/a copper production.

The fact that the mine life is likely to be longer than forty-eight years is irrelevant to the annual average dose received by an employee. Thus, for the number of excess fatal cancers to increase by a factor of approximately 100, as is stated in the submission, the total number of employees would have to increase by a factor of 100, which clearly would not be the case, or the mine life would have to increase by a factor of 100.

Food consumption in the area

Submission P3 asks that the statement that native plants and animals are not consumed be substantiated.

It is noted that the comments made in the EIS are in the context of the pathway analysis as shown in Figure 10.20 of the EIS. WMC controls access to the Special Mining Lease as well as owning the surrounding pastoral leases, and is able to substantiate the comments made in the EIS by local observation. Nevertheless, as discussed in Section 10.3 of the EIS, WMC does investigate all potential pathways, with the results of these investigations showing that the radionuclide concentrations in fauna do not show significant differences with pre-

operational levels and that radionuclide concentrations in vegetation cannot be detected beyond approximately 5 km from the site.

Uranium concentration in deposited dust

Submission P3 seeks information regarding the method of data reduction used in the analysis of dust deposition measurements.

Figure 10.22 of the EIS shows the concentration of uranium in dust that has deposited in the collectors. The data shown are a summary of measurements taken annually at fifteen sites, with eight composite samples per site (each composite is composed of four subsamples), measured over a period of five years (a total of 2,400 individual samples). Figure 10.23 of the EIS shows a time series of the dust fallout rate at seven of these sites. The summary statistics are given below in Table 10.1.

Table 10.1 Summary of uranium concentrations in deposited dust

Site	Distance from site (km)	Dust deposition rate ($\mu g/m^2/d$)		Uranium concentration (mBq/g)	
		Average	Standard deviation	Average	Standard deviation
3	0.1	221	99	57	17
4	2.6	614	182	28	9
5	3.0	427	99	50	9
11	4.2	209	96	4	1
14	4.2	297	182	10	8
6	4.8	445	139	56	43
7	5.0	928	417	16	8
9	6.2	177	85	1	0
2	7.0	102	30	2	1
8	8.2	406	137	3	1
10	12.6	305	106	2	1
12	15.2	341	132	2	1
1	16.6	424	290	2	1
13	20.8	41	106	2	1
15	25.4	41	8	1	0

Pre-operational levels

Submission P3 asks that dust deposition information shown in the EIS be compared to pre-mining levels.

No comparable programme of dust fallout measurements was undertaken prior to the commissioning of the mine and plant. Measurements made in the pre-operational period used high volume air samplers that produced measurements of the concentration of dust in ambient air, not the dust deposition rate.

At the time of the 1983 EIS, the standard air quality dust measurement method generally used in Australia for health assessment was the USEPA high volume sampler method, which is now also an Australian standard. Although dust fallout was commonly monitored in Australia at the time, it was (and is) regarded as an air quality indicator for amenity purposes, and not health.

Site 15 is the southern boundary site and, as such, is at the boundary of the Special Mining Lease, downwind of the mining and processing operations for the prevailing winds (see annual wind rose data in Figure 9.2 of the EIS). The dust deposition rate at this site is 41 $\mu g/m^2/d$, and the concentration of uranium in this dust is 1 mBq/g. These may be regarded as background levels for the Olympic Dam area.

Annual dust deposition rates (Figure 10.23)

Submission P3 contends that the statement in the EIS that 'annual changes in dust deposition rates do not appear to be a result of operational factors', regarding Figure 10.23, is invalid.

The units of measurement shown in Figure 10.23 of the EIS should be $mg/m^2/d$ and not mg/m^2.

The annual production rate of the mine is shown in Figure 10.30 of the EIS. It can be seen that the increase has been a smooth line with a positive slope. None of the lines in Figure 10.23 of the EIS increase with a smooth positive slope, thus the statement regarding the causal link between dust deposition and operations is valid. Moreover, the data show that there are very large seasonal and other factors that are not explained by project activities. This is not an uncommon outcome for dust deposition studies.

Dust concentrations (Figure 10.24)

Submission P3 asks that apparent inconsistencies regarding the effects of operations on dust concentrations be addressed.

The information in Figure 10.24 is incorrect and has been revised as shown in Figure 10.2 of this Supplement. The units for dust and uranium are concentrations in air. In response to a request in Submission P19 (Section 10.4 of this Supplement), information on polonium and lead has also been included. The results shown in Figure 10.2 of this Supplement support the EIS conclusions that the mine operations are undetectable beyond a distance of approximately 5 km.

Error bars on data in Table 10.6

Submission P3 asks that error bars be shown for the data on member of the public radiation doses.

Figure 10.3 of this Supplement shows the measure of uncertainty associated with the average annual effective dose equivalent to people living full time in Olympic Dam Village and Roxby Downs.

Inconsistencies

Submission P3 asks that data shown in Figure 10.30 and Table 10.6 be checked.

The units of measurement shown on the left-hand Y-axis in Figure 10.30 of the EIS are a factor of 10 too high. The range should read 0.000 to 0.035 mSv/a. The correct values are shown in Table 10.6 of the EIS.

Correlation with production rate

Submission P3 states that the claim that radiation doses to members of the public are not correlated with the production rate should be deleted.

There are several confounding factors when assessing the correlation between radiation doses to members of the public and the production rate, including the difference in annual wind and stability classes, together with rainfall, and the difficulty of separating a small signal from a large noise and somewhat variable background level. However, no other more

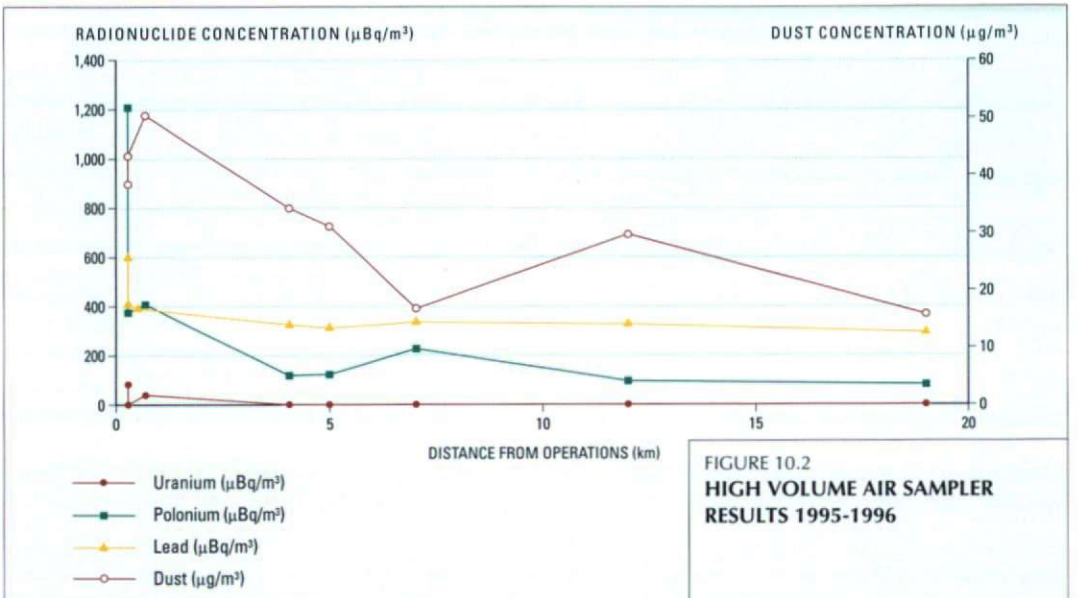


FIGURE 10.2
HIGH VOLUME AIR SAMPLER RESULTS 1995-1996

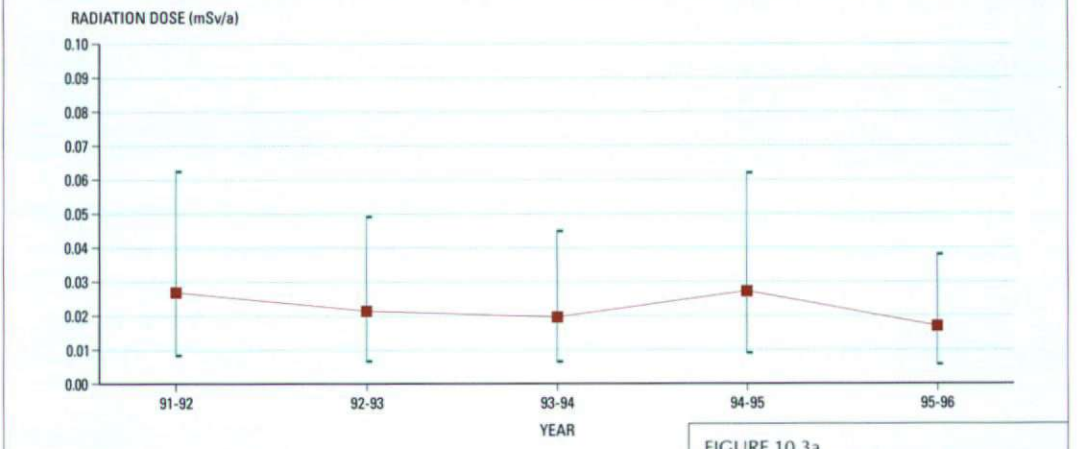


FIGURE 10.3a
ERROR BAR ON MEMBER OF THE PUBLIC DOSE ASSESSMENTS– OLYMPIC DAM VILLAGE

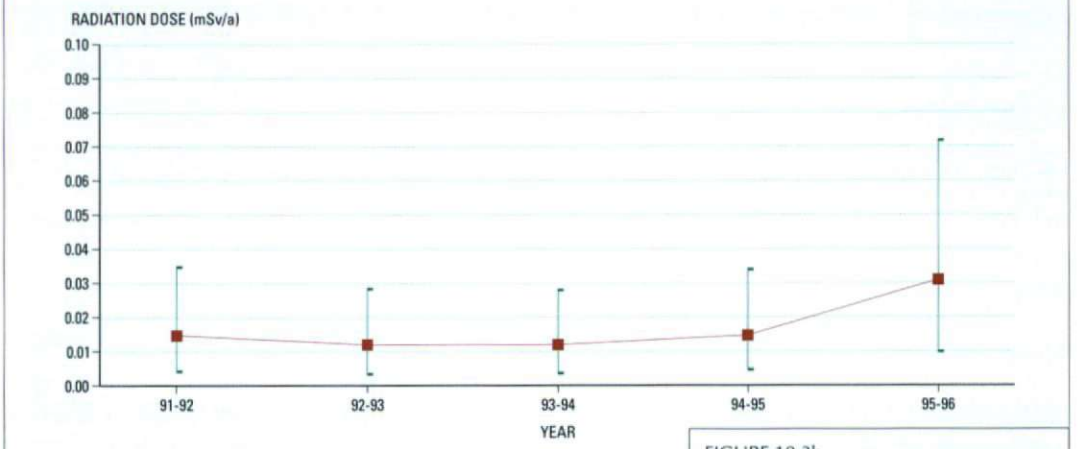


FIGURE 10.3b
ERROR BAR ON MEMBER OF THE PUBLIC DOSE ASSESSMENTS– ROXBY DOWNS

powerful methods of assessing radiation doses at Olympic Dam Village and Roxby Downs present themselves. Radon decay product concentrations in air are measured continuously and data are recorded every ten minutes. Dust is collected by high volume air samplers continuously, and filters are changed every week. The resulting data do not show a strong correlation with production rate, and the assessed annual radiation doses remain very small fractions of the annual dose limit of 1 mSv.

Year of background measurements

Submission P3 asks that the year and method of determination of background and pre-operational uranium concentration be stated.

Uranium concentrations in surface waters have been measured since 1981. The pre-operational baselines shown in Figures 10.32 and 10.33 of the EIS are average uranium concentrations from all samples in the years 1981 to 1987.

Differences in uranium concentrations in surface waters

Submission P3 asks that differences in the time at which peaks occurred in the concentration of uranium in the waters of Axehead and Olympic dams be discussed.

Time series graphs of uranium concentration in water are shown in Figures 10.32 and 10.33 of the EIS. There is no substantial difference between the times at which the uranium concentrations peak. Concentrations of uranium in both dams are elevated between months 30 and 45.

The difficulties associated with detecting low concentrations of uranium in muddy waters more than account for the variations shown in the graphs. Importantly, the data do not show any increase over time in uranium concentration in either Olympic Dam or Axehead Dam.

Uncertainties in Figures 10.34 and 10.35

Submission P3 asks that measures of uncertainty in data be given for Figures 10.34 and 10.35 of the EIS.

The standard deviation in the uranium concentration measurements for a single vegetation type (e.g. saltbush or hopbush) at a single site and on the same sampling date is ± 50%. The uncertainty in the analytical measurement is dependent on the absolute concentration (higher concentrations are associated with lower uncertainties, principally because of the improved radioactive decay counting statistics). At low concentrations (approximately 5 mBq/g), the standard deviation among duplicates of the same sample is ± 85%. At higher concentrations the standard deviation is ± 40%.

Dispersion as a radiation management tool

Submission P3 suggests that dilution and dispersion is not an appropriate tool for radiation protection purposes.

Dilution can be an appropriate technique for certain operations, such as using ventilation air in the mine. For example, exhausting air with low contaminant levels from the mine is preferable to allowing radiation levels to accumulate in these areas.

Definition of designated employee

Submission P3 suggests that the annual dose at which a person becomes 'designated' should be changed from 5 mSv to 1 mSv.

The definition of a designated employee is Australian; it has no directly comparable ICRP definition. The Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores 1987 requires a greater degree of detail in the determination of the doses to designated employees. WMC conducts dose assessment procedures for all employees, no matter how small the anticipated dose. Thus, in practice, WMC goes beyond the requirements of the code as far as designated employees are concerned.

Indenture

Submission P3 asks that comment be given on all aspects of the Indenture that impinge on environmental requirements and radiation protection.

Contrary to the assertion that the Indenture prohibits the imposition of more restrictive regulation of radiation and environmental requirements, the Indenture specifically states that WMC is obliged to adopt the most recent recommendations of national and international bodies. Thus, Olympic Dam operates on national and international recommendations that are as recent as 1997.

Number of people who work on radiation safety

Submission P3 requests information on the number of people who work on radiation safety-related tasks.

The number of people who work full time on occupational radiation safety is thirteen. In addition, there are two ventilation engineers working in the underground mine, who provide data to the radiation safety personnel.

There are four full-time employees working on radiation in the environment and two part-time employees.

Risk estimates of low level ionising radiation

A reproduction of a paper about risk estimates of low-level ionising radiation written by Professor Wolfgang Kohnlein of the University of Munster, Germany, is contained in an appendix to Submission P3.

The paper does not address the EIS, but rather is a discussion on the subject of the numerical value of the risk associated with low-level ionising radiation.

Table 1 of the paper is meaningless if the information provided in the cited reports is not also included. For example, Kohnlein quotes a range of values for cancer deaths from the UNSCEAR 1988 report of 5.4 to 12.4. What is not stated is that the original text gives values of 4.0 to 5.0 for the additive risk projection model, and 7.0 to 11.0 for the multiplicative risk projection model. The lower value for each model is based on age-specific coefficients of probability, whereas the higher value for each model is based on constant (age averaged) coefficients of probability.

Similarly, risk projection models are based either on acute exposure to low linear energy transfer (LET) radiations, or on chronic exposure to low LET radiation. The values will be different for the two exposure situations. Specific risk factors are also given for high LET radiation (such as alpha particles).

The basis of the currently recommended ICRP fatal cancer risk estimate is the multiplicative risk projection model, averaged over either a working population of adults, or the entire population, including children. Comparisons of risk estimates provided in the literature can only be made if the basis upon which they are founded is the same.

No worker in Australia receives an annual radiation dose of 20 mSv, which is the annual limit. Kohnlein may not be aware of the legislative imperative in Australia that all doses

must be as low as reasonably achievable, social and economic factors being taken into account (the ALARA principle), regardless of the value of the annual limit of exposure.

Surprisingly, the paper does not discuss the numerous epidemiological studies on populations of uranium miners, but rather discusses only the findings of studies on the survivors of Hiroshima and Nagasaki. The paper is even less applicable to the Olympic Dam situation when one considers that Professor Kohnlein dismisses the power of the Hiroshima and Nagasaki studies by stating that the exposed population in Japan was not a healthy one, whereas of course, the population of miners at Olympic Dam is healthy.

All the risk values in Table 1 of the paper are compatible with the values canvassed by the ICRP (1991) in Publication 60, except Professor Kohnlein's value, for which there is no reference.

Chronic low dose radioactive exposure

The appendix to Submission P3 contains another paper by Professor Kohnlein, titled 'Chronic low-dose radioactive exposure: false alarm or public health hazard?'. Again, the paper does not specifically address issues concerning the EIS.

The paper presents arguments to support the no-threshold linear hypothesis, which is discussed in Section 10.2.4 of the EIS. This hypothesis is exactly the basis upon which the ICRP derives its risk projections, and is the same as that used in the EIS.

The effects of alpha particles on chromosomal alterations

The third paper of Professor Kohnlein contained in the appendix to Submission P3 also does not address the EIS.

The paper titled 'The effects of alpha particles on chromosomal alterations' is a discussion on the relative biological effectiveness of alpha particles (relative to low linear energy transfer radiations such as gamma rays). The conclusion reached is that the papers cited should be taken into account when interpreting epidemiological studies. This is a matter for national and international bodies charged with reviewing epidemiological studies.

Comments on the Olympic Dam Expansion Project environmental impact statement

The final paper by Professor Kohnlein contained in the appendix to Submission P3 is titled 'Comments on the Olympic Dam Expansion Project environmental impact statement'.

The paper considers that the risk estimates derived from the Japanese atomic bomb survivor studies are inappropriate when uranium miners are the population of concern. The paper then goes on to argue that studies conducted on other nuclear workers, such as workers at the Hanford and Oak Ridge nuclear research facilities and British nuclear workers (working in power reactors, fuel fabrication plants and spent fuel reprocessing sites) are more appropriate.

This argument fails to recognise that there are many excellent studies on uranium miners, which are a more appropriate group with which to compare Olympic Dam employees. It should be noted also that epidemiological studies conducted on Hanford dockyard workers, Oak Ridge nuclear workers and British nuclear workers were considered by the ICRP in reaching its recommendations, as were 208 other reports, many of which summarise smaller studies, and many of which were reports on uranium miners.

In 1995 (i.e. after the publication dates of the papers cited by Kohnlein), the National Health and Medical Research Council (NHMRC) together with the National Occupational Health and Safety Commission (NOHSC, also called 'Worksafe Australia') published their

recommendations for limiting exposure to ionising radiation and the national standard for limiting occupational exposure to ionising radiation. The recommendations were developed in a tripartite climate and were released for public comment prior to adoption; thus they are the most recent in Australia. The Expansion Project EIS is based on these recommendations.

10.3 ISSUES RAISED BY PETER SCHNELBOGL AND THE BIG SCRUB ENVIRONMENT CENTRE INC.

Two submissions were received that are sufficiently similar to allow consideration as one submission in this Supplement. The first submission was from Mr Schnelbogl (Submission P9) and the second was received from The Big Scrub Environment Centre Inc. (Submission P26). There are some differences between the two submissions, but in general, they canvass similar issues. Perhaps the most significant difference between the submissions is that, in one, a prediction of 180 million deaths occurring as a result of the Olympic Dam mine is made and, in the other, 90 million deaths (later qualified by stating that the death toll could be between 35 million and 2.2 billion). There is no explanation for the widely different predictions.

In both submissions, hereafter referred to only as Submission P9, no consideration is given to the probability of events occurring or the probability factors associated with exposure equations for inhalation and ingestion. The premise of Submission P9 appears to be that, at some time in the far future, it can be assumed that the tailings will completely erode away, and be distributed in the environment, in forms conducive to uptake by humans. The submission goes as far as assuming that in the distant future there would either be millions of people living on the tailings of Roxby Downs or that the tailings would be distributed to between ten and fifty billion adults worldwide (note that the current world population is some 6.3 billion). By any objective measure, both assumptions would have to be considered as extremely remote possibilities.

If probability is ignored in each stage of a multi-compartment exposure model, any number of eventual deaths could be speculated, including the millions derived in the submission. However, only when potential harm is multiplied by probability of exposure to that harm can the true risk be derived. The fact that the Olympic Dam tailings are radioactive and that radiation can cause cancer is not disputed—the Expansion Project EIS contains data to this effect, and uses information from the scientific literature to convert exposure to dose (using exposure probability factors).

The following addresses specific issues raised in Submission P9.

Alpha radiation and fine milling

Submission P9 contends that by milling, or grinding, the ore to a small particle size, the particles become small enough to enter the food chain, and therefore can deliver a dose by ingestion, and become airborne, thus delivering a dose by the inhalation pathway.

The weighting factor for alpha radiation is twenty (alpha radiation is twenty times more biologically effective than gamma radiation), not the '. . . several million times more bio-effective' quoted in the submission. It appears that the author has confused 'bio-effective' with 'bio-available' and potential dose with actual dose, where the probability of exposure (or availability) has been omitted from the equation.

The tailings and their share of the uranium decay chain

Submission P9 describes the uranium decay series and comments on dose limits from uranium.

The 'permissible dose limit for uranium tailings dust' for members of the public is 1 mSv, which is the same dose limit for exposure to any form of radiation. It is no lower or higher for uranium tailings dust.

The lost knowledge

Submission P9 contends that humans will forget the presence of the tailings pile, and will eventually work, grow food and live on top of the tailings.

Contrary to the submission's statements, children (and tourists) have not been swimming in the tailings dam of the abandoned government-owned mine at Rum Jungle in the Northern Territory. The only swimming hole is a mined-out open cut, from which uranium has been removed. The water in the man-made lake is of potable quality.

Tailings versus toxic chemical waste

Submission P9 argues that radioactive tailings are more toxic, and will remain more toxic, than other toxic chemicals.

The argument put forward by the submission that radionuclides are somehow more toxic and enduring than other chemical toxins is difficult to comprehend when one considers that, in a manner analogous to the biodegradation that occurs for many chemical toxins, radionuclides decay.

The quantities

Submission P9 uses the production rate and predicts the eventual quantity of tailings that will be produced. This quantity is then used to predict the surface area covered by tailings to a number of depths.

For a production rate of 350,000 t/a of copper, and a production period of fifty years, the diameter of the tailings storage area would be approximately 6 km. Just as the sand dunes in the immediate vicinity of the tailings facilities at Olympic Dam have remained in place for more than 40,000 years (Bowler et al. 1976), there is no reason to suppose that the tailings will migrate to an area the size of Tasmania and cover it to a depth of 2 mm, let alone Victoria (1 mm) or the Australian Capital Territory (6 cm).

Leakage into groundwater

Submission P9 states that tailings liquor has been pouring into the groundwater underlying the tailings dams.

This issue is discussed in Section 4.6 of the EIS, with the information available indicating an alternative view to that expressed in the submission. Monitoring of the evaporation ponds and detailed water balance calculations show that these ponds do not leak and there is no reason to speculate that the composite HDPE clay liner would lose integrity in the future. In addition, the attenuation of metals and radionuclides by the soils that underlie the tailings storage areas is demonstrated by the geotechnical investigations conducted by drilling cores through the tailings and into the substrates.

Speculation regarding the future of the water regime in the area (new springs and the appearance of surface expressions of groundwater) does not take into account the fact that the age of the water in the aquifer indicates the geological stability of the existing regime can be measured in millennia. The risks associated with climate change due to the enhanced greenhouse effect far outweigh the risks associated with the radioactivity in tailings, and the greatest contributor to the enhanced greenhouse effect is the use of fossil fuels.

Structural life expectancy

Submission P9 states that the structural integrity of the Olympic Dam tailings dam walls is unlikely to prevent incremental wall increases from sinking into the tailings material. Sinking would then lead to breaches, with consequential rapid and large-scale erosion of the very fine tailings material. As a consequence, the submission speculates that the structure of the tailings facilities at Olympic Dam will have difficulty surviving one hundred years.

Operating experience with the existing tailings storage facility has confirmed laboratory testing that the tailings do attain sufficient strength upon drying to allow the safe raising of the perimeter walls using the upstream construction method. The failure mechanisms suggested in the submission are therefore speculative. Furthermore, WMC operates its facilities within the constraints of the regulatory regime, and its proposals for the long-term disposal of tailings are subject to regulatory approval prior to implementation.

Erosion of the tailings

Submission P9 contends that erosion of the tailings will lead to the exposure of 50 billion people to more than 1 mSv/a.

The submission relies heavily on an erosion rate estimated in a paper developed for the Nuclear Energy Agency (NEA) of the OECD (1984). The submission quotes an initial erosion rate of 0.5 mm/a. What the submission does not report is that the OECD/NEA paper goes on to say that this erosion leads to a collective dose of 0.1 person-sievert per year, or 1 mSv to each of 100 people, not the 1 mSv to each of the 50 billion people assumed in the submission.

Furthermore, the submission seems to ignore any mitigating effect of the surface cover that would be provided to the tailings during rehabilitation. Such covers would be designed to prevent erosion by wind and water. This issue is discussed further in Section 8.5 of this Supplement.

Comparison of the storage options for tailings

Submission P9 discusses the relative merits of alternative tailings disposal methods used in various parts of the world.

Disposal options at individual sites must of necessity take into account local conditions. Thus, for underground mining operations, disposal into mined-out open cuts is not an option. Below-grade disposal options are not available at sites where there are no below-grade pits, or where the construction of below-grade disposal sites would cause more environmental degradation than above-grade disposal sites. The cement stabilised disposal option is used to the extent possible at Olympic Dam, as described in Section 3.3 of the EIS and Section 3.1 of this Supplement. The synthetic material Synroc®, suggested by the submission, has never been postulated as a practical tailings disposal option.

The 'critical group'

Submission P9 makes various statements regarding the definition of a critical group, and factors that influence its selection.

The ICRP concept of a critical group differs significantly from that used in the submission. A critical group is not one that receives 1 mSv/a or more. It is the group that receives the highest exposure resulting from an identified operation, regardless of the magnitude of that exposure.

Account needs to be taken of the probability of a group that meets the homogeneity requirements living in the vicinity of rehabilitated tailings disposal sites. If the land in the

immediate vicinity cannot support a group of a few tens of people, then one must look further afield for land that will.

Prior to the establishment of Roxby Downs, the area surrounding Olympic Dam could not support the existence of more than a few scattered families. Without the mining operation and the current reliance of local residents on imported fuel, water and food, the area would be expected ultimately to revert to pre-mining population densities.

There is no justification for speculating that a significant number of people would choose to live on or near a man-made plateau, 30 m high, in the middle of an arid zone, with no access to fresh water. No crops are grown in the area, and there is no information to support the contention that crops could or would be grown there in the future.

Given reasonable choice, people tend to live in areas where water and food are readily available. Since neither of these commodities was locally available prior to the establishment of Roxby Downs, and neither would be available when Roxby Downs ceases to service the mining operation, it is likely that people will gravitate to more congenial surroundings. Such surroundings exist, but not in the immediate vicinity of the tailings storage sites. Therefore, it is extremely unlikely that in the distant future the critical group could conceivably involve millions of people as stated in the submission.

The contribution of the various aspects and pathways of radiation

Alpha radiation–inhalation of tailings particles

Submission P9 states that people in the critical group, as defined, will inhale between 30 g and 150 g of tailings dust per year.

In the unlikely scenario that human lungs could function with such high dust levels and that all dust breathed is of inhalable size, inhalation of 30–150 g per year of tailings (let alone any other type of dust normally found in air) would require an ambient dust concentration of 14 mg/m^3. This compares with the average of all high volume sampling results of 32 $\mu g/m^3$ (Section 9.4.3 of the EIS). The required ambient dust level of 14 mg/m^3 is more than 400 times the current dust levels at Olympic Dam, clearly demonstrating that the assumptions in the submission are well outside bounds supported by available data.

Alpha radiation–ingestion of tailings particles

Submission P9 contends that people in the critical group, as defined, would receive a dose of at least 500 mSv/a (and more likely several thousand mSv/a) from the ingestion of food contaminated by tailings.

The EIS discusses the probable pathways of exposure (Section 10.3). Ingestion is considered, and the probability of ingestion is considered to be either minimal or non-existent. It is extremely unlikely that a group of people will '. . . work, grow food and live near the tailings deposits'.

A member of the critical group as defined in the submission would have to consume the unlikely amount of 30 kg of tailings per year in order to receive an annual dose of 500 mSv.

Inhalation of radon gas

Submission P9 bases the calculation of exposure to radon decay products on an estimate of radon emanation rates and meteorological conditions conducive to dispersion. It estimates that a person in the critical group would receive 3 mSv/a from the inhalation of radon decay products, but then goes on to use a value of 170 mSv/a, without any justification being given for the 57-fold increase.

The radon emanation rate calculated from theoretical considerations (and confirmed by measurements taken on trial tailings disposal areas) was shown in the 1983 EIS to be 0.6 $Bq/m^2/s$.

Measurements of radon emanating from the current tailings surfaces at Olympic Dam indicate a geometric mean release rate of 0.65 $Bq/m^2/s$, with an arithmetic average of 1.27 $Bq/m^2/s$. The Australian Radiation Laboratory (ARL) (1982) suggests 1 $Bq/m^2/s$ per becquerel of radium per gram in tailings as being 'a reasonably conservative number to use in preliminary impact assessments of both ore bodies and tailings . . . As there are obviously factors which can result in significantly modified surface emanation rates (moisture content and non-uniformity of activity in ore or tailings) it is obviously important to obtain measured values for accurate assessment purposes'. Since many hundreds of measurements of release rates and radium grades have been made at Olympic Dam, it seems reasonable to use these data and not the conservative, first approximation derived by ARL and used in the submission.

Submission P9 uses the predicted radium concentration (from the 1983 EIS), combines it with ARL's conservative release rate, applies a factor for moisture content and calculates a total release rate (for 6 km^2) of 4.5 x 10^7 Bq/s. Using the measured values, this number becomes 5.4 x 10^5, or 9% of the number derived by the submission's author.

In regard to the submission's calculations of meteorological processes, inversions influence the mixing height but are not the main mechanism for restricting dispersion. Atmospheric stability in both the vertical and horizontal dimensions is the cause for mixing and therefore dispersion. Table L.4 of the Expansion Project EIS shows the frequency distribution of six stability categories. The category that leads to the least atmospheric mixing and dispersion (and therefore the highest concentration of radon decay products in local air) is category F. This occurs at Olympic Dam 6.7% of the time.

Appendix L also shows the number of hours for which various mixing heights occur. Mixing heights less than 250 m occur during approximately 8% of night-time hours in a year, which is equivalent to 350 hours, not the 3,723 hours used by Submission P9.

For the concentration of radon and its decay products to reach a maximum, category F dispersion conditions and the lowest mixing height conditions would have to coincide. This is not always the case. However, if it was always the case, the resulting radiation dose from the inhalation of radon decay products, taking account of the above factors, would be approximately 0.02 mSv/a, not 2 mSv/a as calculated by the submission.

Given that the submission's calculated radiation dose under the most stable conditions is more than 100 times greater than the actual dose, it is likely that the extra 1 mSv said to be received during the remainder of the year is also grossly exaggerated. At all other times of the year both the mixing conditions and the lateral and vertical wind speeds are such that not only is the concentration of radon in air above the tailings lower but also the decay products of radon are dispersed over much greater areas than the 15 km^2 assumed by the submission.

External radiation–beta radiation

Submission P9 contends that exposure to beta radiation from the tailings will contribute significantly to the dose to members of the critical group.

It is highly improbable that people would choose to live on bare tailings surfaces for an extended period. Nevertheless, if they did, the radiation dose due to beta emissions from the tailings can be calculated.

The paper by Reif et al. (1993), to which Submission P9 refers, is an account of the calibration of a beta ray detector system, not an assessment of beta dose *per se*. There is

evidence in the submission of a confusion between 'dose equivalent to the skin' and 'effective dose equivalent'. The annual limit of exposure is expressed in terms of the effective dose equivalent, which is the sum of individual dose equivalents to exposed organs and tissues. Thus the skin exposure is modified by the tissue weighting factor (0.01) to produce the effective dose equivalent. If the effective dose to the skin was 0.024 mSv/h, the effective dose equivalent would be 0.24 μSv/h. This assumes that the entire skin surface is exposed at a distance of 1 cm, which is a physiological impossibility, without burial.

For a person who never left a bare tailings surface and who slept on no more than a blanket at night, and who furthermore did not wear shoes during the day, the annual effective dose equivalent from beta radiation arising from the tailings would be approximately 4 μSv/a. This contrasts with the figure of 600 μSv/a derived in the submission, and ignores the improbability of someone willing and able to live the lifestyle assumed.

External radiation–gamma radiation

Submission P9 contends that a person living, working and sleeping on tailings would receive an annual dose from gamma radiation of 130 mSv. The submission refers to a technical report of ARL (1980). The ARL report also explains the effect of build-up (resulting from internal scattering of gamma rays in the source) and attenuation (arising from internal absorption in the source). Exposure rate factors appropriate to infinitely thick sources are not appropriate to thin sources, and direct proportionality between exposure rate and source thickness does not hold.

Based on theory in the ARL report, a person spending an entire year on top of a bare disposal area would accumulate a gamma radiation dose of 32 mSv. A person spending an entire year on thinly spread tailings, mixed in the top few centimetres of surface soils, would accumulate a gamma radiation dose of 0.03 mSv. The EIS contains measurement data showing the gamma exposure rate above the existing tailings disposal area (Figures 10.9 and 10.11), and these dose rates include a cosmic component not taken into account here. Combining the measured dose rate with 8,760 hours of occupation, the annual gamma radiation dose would be 5.56 mSv. If the lack of build-up and internal absorption are taken into account for thin sources, the annual dose would be considerably less.

The difference between the theoretically derived dose and the measured dose is accounted for by differences between using assumptions (for such factors as the density of the source, the specific gamma ray constants, and gamma ray energy abundances) and measurements.

Residual uranium content

Submission P9 states that gamma radiation from residual uranium remaining in the tailings may add significantly to the future death toll. Extraction of 95% of the uranium from the ore would leave the specific uranium activity of the tailings at 0.335 Bq/g ^{238}U. The gamma radiation dose for full-time occupation (8,760 h/a) would be 0.00125 mSv as a result of the residual uranium alone.

The pre-mining background gamma radiation dose in the area of Olympic Dam (Kinhill – Stearns Roger 1982) was 0.52 mSv/a. The increment in gamma dose resulting from the residual uranium, in the long term, would be 0.24%, using the submission's uranium extraction rate and full-time occupation on uncovered tailings. In practice the actual uranium extraction figure at Olympic Dam is 70%, and, using this figure, the increment would be approximately 0.18%.

The combined radiation exposure

Submission P9 states that the combined radiation exposure to the critical group would be 840 mSv/a, and gives a distribution in time of the dose.

As demonstrated in the above discussion, dose estimates are grossly overestimated for each exposure pathway in the submission, hence the combined radiation exposure would also represent a gross overestimate. An indication of the magnitude of this overestimate can be attained by considering the 'combined' dose (*sic*) arising from the operation of the mine and processing plant, to the current and transient critical group (people who live in the Olympic Dam Village), as shown in the Expansion Project EIS (Table 10.6) to be 0.016 mSv/a. This dose is composed of exposure to radon decay products (primarily from the mine exhaust vents) and dust (mainly arising from stockpiles). Following mine closure and rehabilitation, the mine exhaust vents would cease to be operational, the ore stockpiles would have been processed and the tailings retention system capped and rehabilitated. Hence future doses would be substantially less than the current levels.

Estimates of the future death toll

Submission P9 reaches the conclusion that the future death toll from the disposal of Olympic Dam tailings will be between 90 million and 2.2 billion people.

As demonstrated above, this conclusion is based on estimates of combined radiation exposures to the critical group as high as 840 mSv/a, which were derived with no account taken of the low probabilities associated with contributing events. In another comparison, the United Nations Scientific Committee on the Effects of Atomic Radiation (1988) considered the long-term dose to an individual exposed to radiation from the nuclear fuel cycle, from mining to high-level waste disposal. It was calculated to be 0.025 mSv/a or approximately 1% of the current annual individual dose from background radiation. The integration period was one million years and the population was taken to be ten thousand million (10 billion) people. The dose was calculated for all current and future projected nuclear power plants, associated fuel fabrication plants, low and high level waste disposal facilities, and the mines that would be needed to supply the fuel.

Rehabilitation, reclamation, compensation and mine closure

Submission P9 asserts that many millions of dollars are being paid in lung cancer compensation cases overseas, and that studies on chromosomal aberrations in Namibian uranium miners show dose effect relationships 'far beyond the known increase in birth defects and still births'.

The question of compensation in cancer cases is a matter for the courts. WMC's efforts in radiation protection are directed at minimising exposure to radiation and thus reducing the likelihood of cancer occurring.

Nowhere in the paper to which the submission refers is there evidence presented on increases in birth defects and still births.

Role of the International Commission on Radiological Protection

Submission P9 is critical of the ICRP, but it does not present any facts to support its assertions. The ICRP is not a 'regulatory body'. The recommendations of the ICRP are just that, recommendations. Nothing the ICRP recommends has legal force unless it is adopted into law by a regulatory authority. The fact that ICRP recommendations are so widely adopted by national governments the world over would indicate that the body has reasonable credibility among a wide cross-section of governments.

Far from being forced by critical scientists and statistical evidence into lowering the dose limit, the ICRP funds numerous task groups on all aspects of radiation research. In addition to its task groups, the ICRP considers the work of all studies on the effects of radiation in reaching its recommendations.

The ICRP works closely with its sister body, the International Commission on Radiation Units and Measurements (ICRU), and has official relationships with the World Health Organisation (WHO) and the International Atomic Energy Agency (IAEA). It also has important relationships with the International Labour Organisation (ILO) and other United Nations bodies, including the United Nations Scientific Committee on the Effect of Atomic Radiation (UNSCEAR) and the United Nations Environment Programme (UNEP), as well as the Commission of European Communities, the Nuclear Energy Agency of the Organisation for Economic Cooperation and Development (OECD/NEA), the International Standards Organisation (ISO), the International Electrotechnical Commission (IEC), and the International Radiation Protection Association (IRPA). It takes account of progress reported by major national organisations.

ICRP Publication 26 contained general recommendations regarding dose limits, and was published in 1977. This was amended and extended by a statement in 1978, and further clarified and extended by statements in 1980, 1983, 1984, 1985 and 1987. In 1990 the ICRP issued its revised recommendations. There have followed a further thirteen publications covering many specialised topics in great detail. The ICRP cannot be said to be tardy in responding to scientific advances.

The mining industry in Australia has never 'frowned at' the ICRP recommended dose limits. Indeed, all mining companies have unilaterally adopted new recommendations in advance of their official adoption by regulatory bodies. Thus while the Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores 1987 contains an annual dose limit of 50 mSv, mining companies in Australia have operated with a self-imposed limit of 20 mSv/a since the publication in 1990 of the ICRP's new recommendations.

The ICRP's recommended dose conversion factors are derived from biological, physiological, radiological and epidemiological evidence. They are used to calculate the dose resulting from ingestion, inhalation and direct external exposure paths. It is not at all surprising that some factors will change over time, as research refines the models used, and as epidemiological evidence advances. Some factors will increase, others will decrease.

Supervision

Submission P9 contends that the supervision of uranium mines is neither adequate nor independent.

Supervision and regulation of radiation protection at Olympic Dam is vested in the South Australian Government. The SAHC administers the relevant Act and Regulations (Tables 1.5 and 1.6 of the EIS). As is the case generally for monitoring of potential hazards in all industries, the primary requirement for assuring both workplace safety and environmental protection rests with the operator, who must conduct the appropriate monitoring.

In carrying out its responsibilities, the SAHC conducts regular, independent monitoring at Olympic Dam. Using its own equipment, the SAHC conducts 'side by side' measurements, using measurement devices owned and operated by the SAHC placed alongside measurement devices owned and operated by WMC. Results are compared by the SAHC and a report written. In the years since Olympic Dam was commissioned, the SAHC exposure data and the WMC exposure data correlate extremely well.

Exposure audits are accompanied by independent calibration (some units are calibrated by ARL and some by the SAHC). Finally, dose assessment protocols are independently audited.

All data are legally required to be made available to the regulatory authorities.

The Australian Nuclear Science and Technology Organisation has no role in the regulation of uranium mines.

Nuclear industry and society

Submission P9 contends that the nuclear industry, aided and abetted by governments and criminal scientists, should be tried in an international trial similar to the Nuremberg trials that followed World War II, for exposing people to radiation.

It is axiomatic that uranium mining (and the use of uranium in the nuclear fuel cycle) will expose people to radiation. The Expansion Project EIS makes this clear. Exposure to radiation is recognised as having an associated risk. This risk is calculated for current operations and for radiation arising from rehabilitated facilities.

The submission contends that only a projected death probability of zero is acceptable for the nuclear industry. Using the same logic, no industrial activity that leads to a single death would be acceptable. There should also be no mining of any mineral, no building or transport, no electricity generation and no agricultural or primary production.

Clearly zero deaths, while desirable, is unachievable for virtually any human activity, whether industrial, primary production or recreational. By all objective criteria, the risk associated with electricity generation by nuclear reactors is lower than many currently accepted industrial activities. This conclusion was reached in numerous studies, including those sponsored by the United States Academy of Sciences, the American Medical Association, the United Kingdom Health and Safety Executive, the Norwegian Ministry of Oil and Energy, the Union of Concerned Scientists and Ralph Nader.

Seepage of the mine water disposal pond

Submission P9 states that the water in the mine water disposal pond is possibly the most dangerous waste liquid on the site.

Uranium in orebodies is highly insoluble in groundwater. If it was not, orebodies would not exist. In addition, mine water can only deliver a radiation dose if consumed. A person would have to consume 1,058 L of the mine water at Olympic Dam in order to reach an annual dose of 1 mSv. Note that this is the 50 year integral of the dose, not the actual dose delivered in one year.

The probability of a person drinking 1,058 L/a of this highly saline water is remote.

Insufficient information given

Submission P9 asks for information regarding measurement principles and techniques, and contends that 'contamination' of the Olympic Dam area by activities at Maralinga should be investigated. Other issues on which the submission seeks further information are addressed here.

Radiation measurements

Monitoring and measurements made for both occupational health and environmental purposes are the subject of approval by the authorities. All equipment is calibrated annually using standards that are themselves calibrated.

The three main occupational health measurements made are:

- long-lived alpha activity concentration in air
- gamma exposure
- radon decay product concentration in air.

Long-lived alpha activity concentration in air is measured by passing ambient air through a filter for a known time period (eight hours for occupational monitoring, one week for

environmental monitoring) and a known flow rate. The filter is placed in an alpha particle detector and counted for a period that minimises the statistical uncertainty inherent in random radioactive decay. Once calculated, the result is expressed in units of $\alpha d/s/m^3$ where $\alpha d/s$ is alpha disintegrations per second.

Gamma exposure is measured either by attaching a thermoluminescent dosimeter to a person's body for a measurement period of between one and three months, or by measuring the gamma exposure rate using an energy compensated and calibrated scintillation detector. The dosimeters are supplied under a commercial arrangement by ARL, which also analyses the integrated gamma exposure to the dosimeter. The results from both measurement techniques are expressed either as an integrated gamma dose (mSv, for a known period), or as a gamma dose rate (mSv/h).

Radon decay product concentration in air is measured by two techniques. 'Spot' measurements are made using portable equipment comprising an air sampler and an alpha particle detector. The sampling and measurement periods are dictated by the protocol developed by Borak (1987). Continuous radon decay product monitors are also used. These instruments contain an air sampler, an alpha detector and computer-controlled data analysis and data storage electronics.

Other measurements made are:

- surface contamination (fixed by alpha/beta scintillation detector, and non-fixed by wipe test);
- particle size (activity median aerodynamic diameter, using multi-stage inertial separation devices);
- radon concentration in air (Lucas cell);
- radon emanation (accumulator drum technique).

Biological samples (fauna and vegetation), water samples, soil samples and process stream samples are analysed in an environmental laboratory by radiochemical techniques that vary according to the radionuclide of interest. All techniques follow published methods and a quality control programme that includes duplicates and blanks is used.

The monitoring programmes currently undertaken at Olympic Dam are described in the Environmental Management and Monitoring Plan (EMMP) (WMC—Olympic Dam Corporation 1996).

Maralinga

Maralinga is the subject of a current clean-up, largely designed on the recommendations of the Royal Commission into British Tests in Australia (AGPS 1985). It has also been the subject of several radiological assessments. The ultimate aim of the clean-up is to ensure that, when the lands are returned to the Aboriginal owners, the critical group will not be subjected to radiation doses that are deemed unacceptable.

The EIS and this Supplement have detailed the likely radiation doses arising in the long term from operations at Olympic Dam. The radiation doses both at the site and in the vicinity of the site will be less than 1% of the current annual limit of 1 mSv/a for members of the public.

Radiation doses arising from the Olympic Dam site, in the area of Maralinga, will be orders of magnitude less than those in the immediate vicinity of Olympic Dam. There is no basis for asserting that either the radiation from Maralinga (once it has been rehabilitated) or Olympic Dam will together produce doses that could exceed the limit for members of the public.

Atmospheric contamination

Submission P9 asserts that wind and weather are not the 'causative factors' in dictating the concentration of radionuclides in air. However, they are.

Measurements of wind speed and direction are taken at an automatic meteorological station every five minutes and averaged over thirty minute intervals (producing data files with 210,000 entries per year). Radon decay product concentrations are measured continuously at eight sites (producing data files with 420,000 entries per year). Dust in air is measured at eight sites and the filters are analysed for a number of radionuclides in addition to total dust mass (producing data files with 2,500 entries per year). The data presented in the Expansion Project EIS summarise more than five years of data collection, and involved the analysis of more than 3,800,000 records for atmospheric constituents and dispersion alone. It was not possible nor is it necessary to include these data in an appendix.

Radioactive contamination of food

This issue is addressed in Section 10.2 of this Supplement.

Design of drums

Yellowcake is not packed into drums. Yellowcake is the name given to ammonium diuranate which is bright yellow. Ammonium diuranate is calcined, a process that converts it to a mixture of uranium oxides, principally U_3O_8, which is dark green in colour. The drums used to pack the uranium oxide for export are constructed from steel and lined with a plastic-based paint. The external surfaces are painted with corrosion resistant paint. The lids, which have a sealing ring, are secured in place by steel bands that are bolted together. These drums are packed into steel shipping containers which are locked and sealed.

Reporting of environmental incidents

All environmental incidents of relevance to the prediction of impacts arising from the expansion are described in the Expansion Project EIS. In particular, a summary of the incident involving the seepage of tailings liquor and mine water into the underlying aquifer was provided in Section 8.1.

Provision of contour maps

Appendix H of the Expansion Project EIS contains a detailed description of the landform and terrain. It was judged that these parameters were more important to the discussion of likely impacts of the Expansion Project than mere contour mapping. The Expansion Project will not affect contours.

Editing of aerial photographs

Aerial photographs reproduced in the Expansion Project EIS have indeed been edited. The process of mosaicking numerous individual photographs includes the following steps:

- morphing to remove pitch and yaw effects from aircraft attitude;
- poly-vector morphing to remove lens vignetting and lens aberrations;
- size correction for differences in aircraft altitude between photo runs;
- spectral normalisation of red, green and blue values to account for reflectance differences between runs;
- cropping to allow edge-to-edge matching of adjacent photographs.

The photographs shown in the Expansion Project EIS have received no other editing and no information was deleted.

Composition of various process streams and solids

In the Expansion Project EIS, process flow charts are provided in Figures 2.5, 2.16, 3.10, 3.11, 3.12, 3.13, 3.14, 3.15 and 3.16. Chemicals used in the process are shown in Table 3.3. Process descriptions are given in Chapters 2 and 3. Effluents and emissions are given. A radionuclide balance is shown in Figure 10.7.

The constituents of solid and liquid process streams are determined as part of the process control, at intervals dictated by the need to keep the efficiency of extraction at a maximum. Samples are analysed on site in a laboratory that is accredited to ISO 9000, and is registered for chemical determinations by the National Association of Testing Authorities.

Waste rock

Economic considerations dictate that waste rock extraction be kept to the minimum required to establish underground access to mineralised zones. Thus, there is a low quantity of waste rock (usually called mullock) produced at Olympic Dam. Mullock is used in the backfill plant, where it is combined with the sand fraction of the tailings to produce cemented aggregate fill. This material is used to fill mined-out sections of stopes to provide ground stability for the extraction of adjacent areas (Section 3.1 of this Supplement, and Section 3.3.9 of EIS).

Such is the overall shortage of mullock that a quarry is necessary to provide construction rock. Thus there are no waste rock piles at Olympic Dam.

Contradictory information

Submission P9 asks that the following apparent contradictions be explained.

Radionuclide concentrations in tailings liquor

The difference in radionuclide concentrations in tailings liquor between the 1983 EIS and the Expansion Project EIS, mentioned in Submission P9, is due to the original EIS being based on theory, prediction and laboratory-scale investigations, whereas the current EIS is based on more than fourteen years of data collected from an operating mine and processing plant. Table 7.2 of the 1983 EIS (Kinhill – Stearns Roger 1982) shows values of chemical constituents for tailings slurry. Table 8.5 of the Expansion Project EIS shows values of chemical constituents for supernatant liquor in the evaporation ponds. The two tables cannot be directly compared because the concentration of any element in the liquor of the evaporation ponds will be greater than that in the slurry lines, due to evaporation.

Ore grade

The 1983 EIS shows estimates of the likely average ore grade (0.06% U_3O_8). These estimates were, of necessity, derived from geological interpretations and geostatistics based upon data available to that time. Following extensive drilling work, the average ore grade of Olympic Dam's proved and probable reserves remains at 0.6 kg/t of U_3O_8 (0.06%). Leigh (1997) quotes a value of 0.15% U_3O_8 but provides no reference for the value quoted.

Submission P9 seems to have mistaken a grade expressed as 0.87 kg/t as equivalent to a grade of 0.87%. The value 0.87 kg/t denotes a grade of 0.087%.

Like every other orebody, grades vary from place to place. Thus the grade of ore mined in each year may vary from the long-term mean grade.

Radionuclides in fauna

Possible explanations for the differences (both positive and negative) between pre- and post-operational mean concentrations of radionuclides in fauna samples include:

- differences in the availability and radionuclide content of fodder and food between the years of pre- and post-operational measurements;
- differences in the radiochemical techniques between pre- and post-operational measurements (the minimum detectable level for radionuclides is now considerably lower than it was for pre-operational techniques);
- destocking of areas close to the Olympic Dam operations following fencing of the leases (this affects only steer and sheep samples);
- differences in the availability of rainwater for drinking (there have been several years of high rainfall during the years of operation).

Loss of life expectancy

Submission P9 contends that the number of years 'lost' due to radiation exposure is irrelevant.

Everyone will die, the only question is when they will die. Almost everyone would argue that it is preferable to die at age seventy-five rather than at age twenty-five. Consideration of the age at death as well as the number of deaths is therefore entirely justifiable. Death as a point of risk comparison is meaningless, since ultimately everyone will die.

The role of Kinhill

Submission P9 accuses Kinhill (the consultants to WMC who prepared the Expansion Project EIS) of compounding the 'crimes' perpetrated by the ICRP.

The choice and role of a consulting organisation to compile the EIS is irrelevant to the environmental impact assessment process and purely a matter for the proponent. To argue or imply otherwise shows a misunderstanding of this process as it applies in Australia. Proponents can prepare their own EIS, resources and time permitting, and many proponents exercise this option. Checks and balances in the process are provided by the setting of guidelines, public review of the EIS and assessment by regulatory authorities.

10.4 ISSUES RAISED BY THE AUSTRALASIAN RADIATION PROTECTION SOCIETY

This section addresses issues raised in Submission P19 by the Australasian Radiation Protection Society.

Detail of ALARA

Submission P19 seeks information on the 'as low as reasonably achievable' (ALARA) programme as it applies to Olympic Dam.

The EIS contains a description of two aspects of the ALARA programme for the expansion: the optimisation of design in the smelter and calciner complexes, and the identification of areas or processes that are amenable to further exposure reductions (see Section 10.2.3 of the EIS).

Current initiatives in regard to ALARA will be the subject of submissions to the regulatory authorities.

Current initiatives include:

- a proposal to reallocate resources in proportion to the assessed dose, so that greater efforts can be made to truncate the tail of the dose histogram (Figure 10.4 of this Supplement);
- a research project on methods for using existing distributed plant control systems to monitor and report on exceptions to normal operating envelopes, especially for emission control devices such as bag filters and venturi scrubbers, thus providing real-time information for immediate response;
- a pilot study on the use of remotely controlled mining machinery, to remove operators from underground environments and place them in remote, air-conditioned, control cabins;
- a study into the use of networked radon decay product monitors in the underground mine, to provide real time information on gross air flow movements. This programme is unlikely to be of value in the determination of radiation doses, but it would provide a mechanism for alerting ventilation engineers to changes in atmospheric conditions caused by ventilation failures;
- investigations into alternative uranium packing methods to allow remote sampling and lid sealing.

Research into tailings rehabilitation

Submission P19 seeks information on the programme of research into rehabilitation of the tailings.

WMC has developed a conceptual rehabilitation plan, and this is presented in Section 8.10 of the EIS. A more detailed programme of research is currently under way and is described further in Section 8.5 of this Supplement.

Dose conversion factors

Submission P19 makes the point that sources of information on the derivation of dose conversion factors should be given.

Inhalation dose conversion factors for long-lived radionuclides of the uranium series are traceable to the ICRP lung model, described in ICRP Publication 66 (1994a) and modified by the biokinetic models presented in ICRP Publication 68 (1994b). Silk et al.(1995) and others have reviewed the recommendations of the ICRP and derived inhalation dose conversion factors for insoluble uranium ore, insoluble thorium ore and uranium mill tailings. The Western Australian Department of Minerals and Energy has examined both the ICRP and the British National Radiological Protection Board recommendations and has adopted inhalation dose conversion factors into WA regulations. The dose conversion factors used in the Expansion Project EIS are modified by the specific nature of the radionuclides in various process streams, and by such factors as the activity median aerodynamic diameter of the dust. The Lung Dose Evaluation Program (LUDEP) has not been used because the biokinetic models used by LUDEP follow earlier ICRP recommendations, principally ICRP Publication 30 (1979). LUDEP has not been issued in a form compatible with ICRP Publication 68 (1994b).

Dispersion model source terms

Submission P19 contends that information on the magnitude of emissions from the site should be given, since it believes that these source terms are necessary for predicting future radiological impacts.

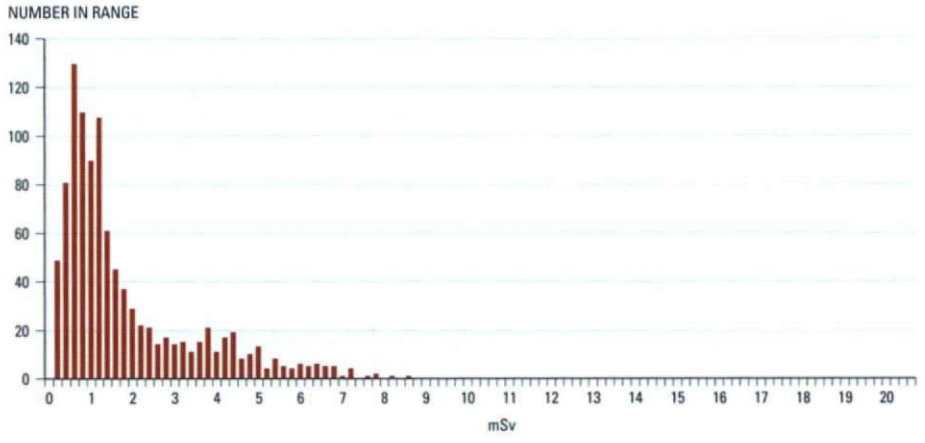


FIGURE 10.4
HISTOGRAM OF ANNUAL ASSESSED DOSES

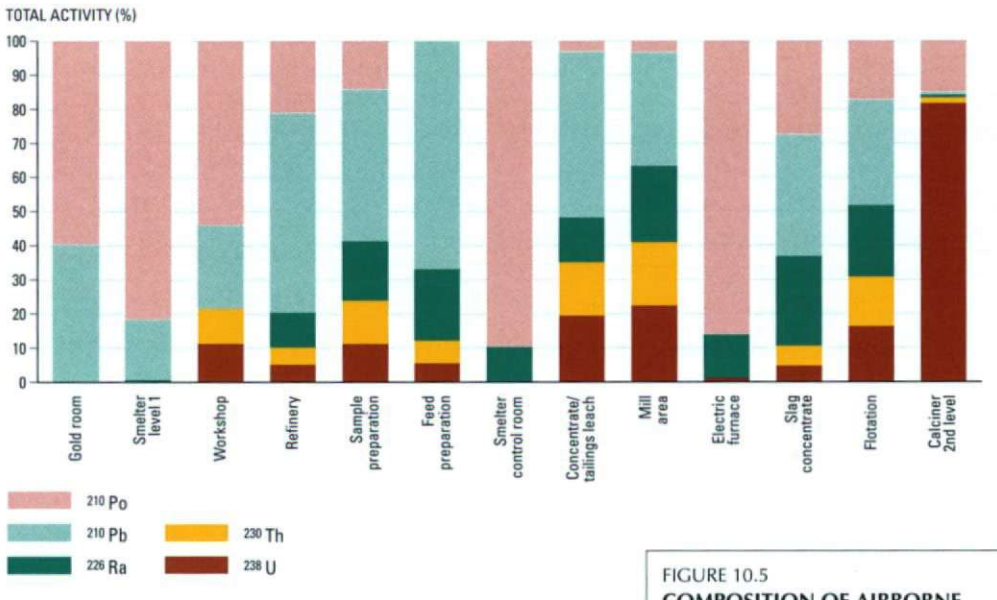


FIGURE 10.5
COMPOSITION OF AIRBORNE RADIONUCLIDES IN AREAS OF THE PROCESSING PLANT

The approach taken in the Expansion Project EIS to estimating future effects of the expansion was to take existing measurement data and examine them for cause and effect. Thus the assessment was more direct than would have been the case had source terms been estimated and this information used as input to dispersion and distribution models. In order to model dispersion, many assumptions are required and the receptor site dose estimates therefore have a greater degree of uncertainty associated with them than direct measurements made at the receptor locations.

Reporting relationships

Submission P19 seeks information on the reporting relationships in the Radiation, Environment, Safety and Quality Department.

The manager of this department reports to both the Process Plant Manager and the Mine Manager.

Ratio of airborne radionuclides in various areas of the plant

Submission P19 queries the data shown in Figure 10.8 of the EIS.

Figure 10.8 is reproduced here in its correct form and is Figure 10.5 of this Supplement.

Use of respiratory protection devices

Submission P19 correctly points out that the exposure of people who work in the uranium packing area to airborne dust appears to be quite low, and queries whether this is because a respiratory protection factor has been applied to the monitoring results.

Measurements of the exposure to radioactive dust are made inside full face AirStream® helmets for employees working in the uranium packing area. Thus no 'protection factor' is used in the calculation of dose for these employees.

Comparison of risks

Submission P19 states that there is some confusion regarding the comparison of radiation risks with the risks in safe industries.

The Expansion Project EIS (Section 10.2.4) makes the statement that the ICRP no longer uses comparisons with 'safe' industries, and bases its recommendations on its definition of tolerability.

Comparison of radiation induced cancer death rate and normal cancer death rate

Submission P19 makes the point that it is important to compare the risk associated with incremental radiation exposure to the 'normal' risk of death at each age.

Figure 10.6 of this Supplement shows the incremental death probability rate for given ages (as a percentage of the normal death probability rate at those ages) owing to a radiation dose of 1 mSv every year.

Distribution of radionuclides other than uranium in environmental samples

Submission P19 asks that information on other radionuclides (in addition to the uranium shown in Figure 10.24 of the Expansion Project EIS) be shown.

Figure 10.2 of this Supplement shows data for uranium, polonium and lead, measured on high volume air sampler filters, at various distances from the site.

Observations

Submission P19 makes the following two observations that are self-explanatory and that do not require further comment in this Supplement:

- The numbers quoted in Table 10.3 of the EIS are only the extrapolated probable occurrence of death in the defined population. The table gives the impression that this will be an actual number when it is only the probability, and having 0.04 deaths is a meaningless concept (a person is either dead or alive and there is no intermediate state).
- The probability of cancer death associated with radiation in Figure 10.19 of the EIS should be compared with the cancer risk from other causes and with the normal cancer risk of 250,000 per million. For example, the percentage of deaths from malignant tumours in Australia is 25% (Bourbeau 1993).

10.5 ISSUES RAISED BY SENATOR DEE MARGETTS

This section addresses radiation issues raised in Submission P32 by Senator Dee Margetts.

Reduction in radiation standards

Submission P32 states the belief that the Expansion Project EIS should have taken into account information given to the Senate Select Committee on Uranium Mining and Milling in regard to the downward trend in radiation dose limits.

It is a common misconception that radiation protection standards have been reduced at regular intervals and that, therefore, a projection can be made to future likely protection standards. That standards have changed over time is not questioned, but so have the bases upon which the standards rest. Comparing a skin tolerance dose from the 1930s with an effective dose equivalent from the 1970s is not a valid exercise, unless the earlier doses are first converted to the same basis or vice versa.

The first 'standard' was the tolerance dose (Kocher 1991), recommended in 1934. It was developed for x-ray workers and, if it is converted into an annual dose equivalent (the unit of comparison now used), it equals approximately 500 mSv/a. Strictly speaking, the tolerance dose was based on skin erythema, which is a non-stochastic effect, i.e. it has a threshold.

It is interesting to note that the tolerance dose was still applicable to non-stochastic protection of the skin in 1987, thus this standard survived for a period of fifty-three years.

In 1949 the National Council on Radiation Protection and Measurements (NCRP) made new recommendations on the maximum permissible external dose for workers. This dose limit, when converted into effective dose equivalent, is approximately equal to 150 mSv/a.

The reduction from 500 mSv/a to 150 mSv/a was prompted by four factors:

- a change from a standard based on a skin tolerance dose to one based on cancer induction;
- evidence of genetic effects in fruit flies;
- observed excess leukaemias in radiologists;
- the likelihood that nuclear workers would be exposed to high energy photons.

Thus the 1949 recommendation was based not on the prevention of non-stochastic effects, but on the prevention of stochastic effects (leukaemia and genetic effects), and cannot therefore be said to serve the same purpose.

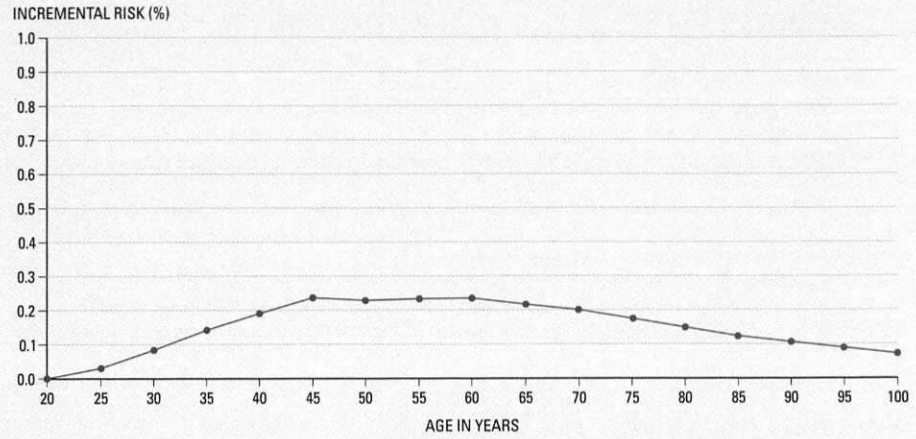


FIGURE 10.6
INCREMENTAL RISK DUE TO RADIATION – PERCENT ABOVE NORMAL DEATH RATE AT AN EXPOSURE RATE OF 1 mSv/a

In 1956 the National Academy of Sciences and the ICRP recommended a maximum permissible dose equivalent from whole-body radiation for workers of 50 mSv. The reduction (from 150 mSv to 50 mSv) was prompted by the conclusion that exposures should be limited primarily because of the increase in the genetically significant collective dose to the greatly increased number of people exposed in the nuclear weapons industry. The reduced annual dose was also presumed to lower the risk of leukaemia.

In 1957 a cumulative dose limit was recommended. This was, for a worker of age N, (50 x (N-18)) mSv and permitted the averaging of annual doses over a lifetime, since it was thought that the total dose was more significant than the dose rate.

In 1959 the ICRP recommended that the dose limit should apply to the sum of doses to individual tissues and organs of the body, from both internal irradiation and external irradiation. It was also during this period that discussions took place on setting dose limits at points where the associated risks could be compared to risks in other industries. However, the magnitude of the risks associated with radiation exposure was not sufficiently well known to allow direct comparison.

Following quantitative risk assessments, the ICRP reaffirmed its earlier recommendation that, for radiation protection purposes, the annual effective dose equivalent should be set at 50 mSv. However, the ICRP reinforced its recommendation that all doses should be kept as low as reasonably achievable, social and economic factors being taken into account. Studies of large groups of exposed radiation workers showed that the average dose to people working under the 50 mSv limit was 5 mSv, and that few workers approached annual doses of 50 mSv.

In 1987 the NCRP recommended a limit on the annual effective dose equivalent of 50 mSv and at the same time recommended a limit on the cumulative dose equivalent of (10 x N) mSv.

In 1990 the ICRP published its new recommendations, reducing the annual effective dose (a quantity similar to the previous quantity, effective dose equivalent) to 100 mSv in a period of five years, with no more than 50 mSv in any one year (i.e. an average of 20 mSv/a). The

new recommendation was based, in part, on a reassessment of the risk per unit exposure derived from both a reinterpretation of the Japanese atomic bomb data and the further years of follow-up in the epidemiological study of the Japanese survivors.

It should be noted that in the development of these standards, the purpose was to protect employees. The dose equivalents and the nominal risk factor are intended for use only for the purposes of radiation protection and are not intended for the purpose of estimating mortality risks to individuals or populations. This use of the nominal risk factor is widespread and accepted, usually without question, but may have, at best, a tenuous scientific basis.

In summary, the annual limit on effective dose has been reduced from 50 mSv/a to 20 mSv/a, and the time span covered by these two limits is forty-one years.

Even if the annual dose limit were to be reduced to 10 mSv, Olympic Dam would be in compliance. It should also be noted that the ability or otherwise of the operators of the proposed Jabiluka mine to comply with current or future dose limits is not relevant to the Olympic Dam EIS.

Dose calculation methodology

Submission P32 believes that operations at Olympic Dam should be re-examined in light of criticisms levelled by Leigh (1997), in his research paper to the Senate Select Committee on Uranium Mining and Milling, on the dose assessment methodologies used.

The dose calculation methodology used at Olympic Dam is identical to that used at the Ranger mine. The only difference between the two operations is that Olympic Dam is obliged by the Indenture to use the most recent recommendations of national and international scientific bodies, but this is not specifically required of the Ranger operation.

It should be noted that, under the Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores (AGPS 1987), the dose conversion factors (Schedule 4) should be used,

> . . . except that, with the approval of the appropriate authority, more appropriate data may be used when detailed knowledge of the physical characteristics of the relevant environmental parameters and the physiological characteristics of exposed individuals is available.

Similarly, Schedule 4, Part B, of the Code of Practice shows a table of dose conversion factors for mixtures of radionuclides. The list includes only ore dust, product dust (uranium oxide) and tailings dust. It does not include the many dusts with entirely different physical and radionuclide compositions that potentially exist at Olympic Dam, where dust and fume in the smelter complex are two of the more significant sources of dose. Thus Olympic Dam would have to compile its own list, even if the code had not been superseded by more recent recommendations.

ARL has not recommended a different dose calculation methodology. ARL argues that the inhalation dose conversion factor for radon decay products should be varied according to the proportion of unattached decay products, and the activity aerodynamic median diameter of the particles. These are factors that can be accommodated in a model of the respiratory tract that the ICRP has specifically recommended against, since the model predicts a greater number of lung cancers than have been observed in epidemiological studies of uranium miners (amongst other groups). Thus there is a mismatch between what is calculated by a mathematical model, and what is actually observed. Until this mismatch is resolved, the ICRP has recommended reliance on observation (epidemiology), not mathematics.

10.6 ISSUES RAISED BY THE AUSTRALIAN CONSERVATION FOUNDATION

This section addresses radiation issues raised in Submission P37 by the Australian Conservation Foundation.

Trends in dose limit reduction

Submission P37 contends that the Expansion Project EIS does not take into account the 'downward trend' in international standards on radiation exposure. This issue is also raised in Submission P32 (Section 10.5 of this Supplement).

In 1988–89 the annual effective dose limit was 50 mSv. Seventeen smelter employees received assessed doses of over 20 mSv and one smelter employee received a dose of 30 mSv. Eight mine employees received doses of over 20 mSv. No employee was exposed to a radiation dose in excess of the extant limit. In 1990 WMC adopted the current annual average dose limit of 20 mSv, in advance of national recommendations.

Between the years 1990 and 1996, no employee's radiation dose exceeded 20 mSv/a. The highest radiation dose received by an employee in 1996 was 8.4 mSv, which is below the current average annual limit of 20 mSv. The average dose to the 141 most exposed individuals at Olympic Dam is 5 mSv.

The reduction in individual and collective dose over the years following 1988 clearly demonstrates the effectiveness of WMC's ALARA programme. If the dose limit were to be reduced to 10 mSv per year, Olympic Dam would already comply.

Regardless of the value of the annual limit (averaged or not), Olympic Dam operates an active dose reduction programme in accordance with standard radiation protection principles, and will continue to do so even if the annual limit is reduced in the future.

Reduction of radiation exposures

Submission P37 contends that, because radiation doses have remained relatively constant for a number of years, the operators of Olympic Dam are not complying with the ALARA requirements of radiation protection.

Application of the ALARA principle does not mean a constantly reducing individual or collective dose. To the contrary, reduction to a level that is as low as reasonably achievable would ultimately result in a stabilisation of the doses, unless new technologies or procedures become available to permit further reductions.

Design improvements to reduce exposures and approvals

Submission P37 states that governments must require design improvements to reduce radiation exposures and that government approvals should be attained prior to implementation of any changes.

The Expansion Project EIS (Section 10.2) outlines the measures being taken in the design phase for the expansion. Prior to commissioning, all procedures, equipment and processes are subject to formal assessment by the regulatory authorities. Hazard and operability (HAZOP) analyses are currently being undertaken for all features of the expansion as part of WMC's design process.

Employees are not 'cycled' through tasks in order to reduce their individual exposures. This is an illegal practice and is not proposed by WMC.

Procedures to calculate radiation doses

Submission P37 includes quotes from Leigh's submission to the Senate Select Committee on Uranium Mining and Milling, in which he contends that the dose assessment procedures used at Olympic Dam differ from those in the Code, and have the effect of reducing the apparent exposure of people working at Olympic Dam (Leigh 1997). This issue is also raised in Submission P32 (Section 10.5 of this Supplement).

Contrary to the assertion by Leigh, doses are calculated in exactly the same way as the Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores (AGPS 1987) requires. There are two differences between the factors used by the Ranger mine and those used at Olympic Dam. These are that:

- Ranger uses ICRP 30 inhalation dose conversion factors and the Olympic Dam Expansion Project EIS uses ICRP 68 inhalation dose conversion factors and ICRP 66, the most recent physiological lung model;
- Ranger does not have a smelter, a refinery, an underground mine, or a copper concentration circuit, and thus does not need to calculate inhalation dose conversion factors for these areas.

Additionally, WMC goes to considerable lengths at Olympic Dam to assess both the radionuclide content of dusts collected on filters and the distribution of particle sizes of airborne dusts.

Submission P37 accuses WMC of using the most recent lung model of inhalation dose conversion factors in order to reduce the assessed doses. This accusation is not correct. There have been advances in the science of health physics in the past ten years (e.g. the epidemiology of cancer induction). It seems reasonable to make use of these advances, and indeed the Indenture requires WMC to do so.

Submission P37 calls for 'real' doses to be assessed. 'Real' doses can only be assessed by taking into account such factors as radionuclide composition and particle size as measured at Olympic Dam.

Choice of conversion factors and dose calculation procedures by WMC

Submission P37 implies that WMC chooses dose conversion factors and dose assessment procedures in order to reduce apparent radiation exposures.

WMC does not unilaterally adopt conversion factors or dose assessment procedures. The factors and the assessment procedures are only adopted after approval has been granted for their use. Thus it is not true to state that '. . . it is not sufficient for mining companies alone to determine how they record exposure to radiation'. It seems somewhat contradictory for the submission to, on the one hand, call for 'real' doses to be assessed and, on the other, to call for the adoption of 'conservative' procedures.

Submission P37 asks that the Supplement address '. . . the right of all workers at Olympic Dam, since its operation began, to know WMC's reasons for using the methods it does and the resultant extent of reduction in reported dose levels'.

All employees are required to attend an initial induction training session after being accepted for employment. This course covers all aspects of safety at Olympic Dam, including radiation safety. Measurement methods, dose assessment methods and reporting requirements are outlined.

'Tool-box' training sessions are conducted. These sessions provide an opportunity for employees and safety staff to discuss any issues of concern.

Annual safety training courses are provided for all employees. At these courses annual exposure results are discussed and explained, and safety topics are discussed in greater detail than at the initial induction.

Workplace safety committees are constituted and include delegates chosen by the employees to represent them in discussions with management and safety staff.

Submission P37 implies that dose assessment methods used by WMC reduce the exposure of employees. This is not the case. WMC uses methods designed to reflect as accurately as possible the actual exposure of employees. These methods are documented in publications of the ICRP and approved prior to their implementation by the SAHC, as is required by the Indenture.

10.7 ISSUES RAISED IN OTHER SUBMISSIONS

This section addresses radiation issues that have not been addressed in earlier sections of this Supplement.

Worker health monitoring

Submission P33 asserts that 'Not only is there no plan to monitor health, there is not even any intention to monitor radiation exposure for individual mineworkers'.

On the contrary, WMC undertakes medical surveillance of its employees, and the exposure of individual mine employees to radiation is monitored. Although the Expansion Project EIS contends that individual radiation exposures will not significantly change, this does not mean that they will therefore not be monitored.

Radiation exposures are converted to dose using approved methods, and the results are recorded in the SAHC computer system UWHIS (Uranium Workers Health Information System). Submission P36 notes that adherence to regulations cannot be readily assessed without release of comparative raw data such as readings from dosimeter badges. All of these data are subject to normal confidentiality provisions that apply to medical records and therefore cannot be made public.

Radiation safety practices

Submission P36 seeks information regarding the 'stringent radiation safety practices' initiated by WMC in 1988, and the practices that were in place prior to this.

Practices implemented by WMC have not changed in essence since the early days of exploration. The Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores 1987 was applied to all activities on site. There was no step change in 1988.

Radiation safety practices have been and remain the subject of formal approval by the relevant authorities. As the project has moved from exploration, through construction and commissioning to full operation, submissions have been made that reflect the activities being undertaken. Thus monitoring programmes have changed. For example, during exploration there was no process plant, and therefore no monitoring of process workers, although employees at the pilot plant were monitored. In 1988 the various programmes were integrated into a site-wide radiation management plan which reflected full production.

CHAPTER 11

PROJECT INFRASTRUCTURE AND TOWNSHIP DEVELOPMENT

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PROJECT INFRASTRUCTURE AND TOWNSHIP DEVELOPMENT

This chapter addresses issues raised regarding project infrastructure and township development, originally discussed in Chapter 11 of the Expansion Project EIS.

Issues addressed include those related to:

- **transportation (Section 11.1)**
- **solid waste disposal (Section 11.2)**
- **township water supply (Section 11.3)**
- **township development (Section 11.4)**
- **concept design (Section 11.5)**
- **the construction village (Section 11.6).**

Comments regarding the use of desalinated Great Artesian Basin water in preference to local saline groundwater are addressed in Chapter 4, Water Management.

11.1 TRANSPORTATION

Submissions G7, P3 and P21 question the implications of transporting large modules by road to Olympic Dam, particularly impacts on the roadside vegetation.

Recent investigations into the broader effects on existing vegetation of the movement of large objects by road from Port Augusta to the Special Mining Lease have indicated that while some limbs of trees require removal, no trunks of trees are affected. Other smaller shrub species requiring trimming are generally of the type that regenerate quite quickly, and these are unlikely to be greatly affected. The first wide load (14.5 m) was transported to Olympic Dam with very little damage to vegetation.

There are a number of unsealed roads servicing the borefields areas for which increased traffic volumes have not been provided in the Expansion Project EIS. While there will be some increased activity on the roads during the construction phase, post-construction traffic is expected to consist largely of fuel deliveries to the pump stations and inspection and/or maintenance vehicles. The maintenance vehicles are generally light trucks and small four-wheel drive units that place little additional stress on the roads, whereas the fuel delivery vehicles are mainly road trains. It is these larger vehicles that could have an impact on the road condition.

The actual routes taken by fuel road trains may vary depending on the impact of weather and road maintenance on road conditions at different times. Estimates of the additional fuel delivery traffic on the various roads are as follows:

- Borefield Road, which services Borefield A, currently has one road train per week delivering fuel. Additional deliveries of fuel along Borefield Road may occur to service

Borefield B, should fuel road trains travel via Roxby Downs rather than via Marree. This could amount to up to two deliveries per week for the 200,000 t/a copper expansion, plus one additional delivery for the 350,000 t/a expansion.

- Part of the Oodnadatta Track, which will service a new pump station in Borefield B, will carry two deliveries per week for the 200,000 t/a copper expansion, plus one additional delivery for the 350,000 t/a expansion.
- Muloorina Homestead Road, which also will service an upgraded pump station in Borefield B, will carry one road train delivery per week for the 200,000 t/a expansion, and one further delivery per week for the 350,000 t/a expansion.
- Birdsville Track cannot be used for fuel deliveries to the borefield pump stations without considerable upgrade of the Muloorina or Clayton Station tracks, or construction of a new road.

Maintenance of the above roads is undertaken by the Department of Transport.

It has been commented that a number of heavily trafficked roads within the area are not sealed and that this is causing a fugitive dust problem.

It is not cost-effective to seal all roads within the area, and unsealed roads with heavier traffic within the Special Mining Lease are watered to minimise dust problems. The maintenance of roads outside the Special Mining Lease is not a WMC responsibility; however, WMC does regularly use a watering truck on roads in the Olympic Dam Village.

Submissions P21 and P27 suggest that consideration be given for a rail link between Pimba and Olympic Dam.

Such an extension to the rail network is not part of the current expansion project. However, it remains a future option subject to economic and technical review.

11.2 SOLID WASTE DISPOSAL

Submission P23 questions the management responsibility for the two clean landfills to the north and south of the township. Both are controlled by the Municipality of Roxby Downs. A number of respondents (G8, P6, P7, P8, P21, P23, P27 and P29) also comment on the level of recycling that occurs within Roxby Downs at present, and whether more recycling could be done. Other comments included the condition, management and operation of the waste disposal landfill sites at Roxby Downs.

The recent additions to the main township landfill, including the netting cage and alternative trenching, have not, in their short time of operation, appeared to be fully successful in overcoming some of the problems of the landfill. Unrestricted access and no supervision of operation may be contributing to these issues.

Discussions between the Town Administrator, the State Government and WMC have resulted in the Town Administrator agreeing to consider WMC staff's proposals for improvements to the waste disposal areas and their operation, particularly regarding recycling.

11.3 TOWNSHIP WATER SUPPLY

The use of rainwater tanks as a way of reducing demand on Great Artesian Basin water has been questioned (P3, P7, P23).

Owing to the very low and irregular rainfall at Roxby Downs, houses are constructed without gutters. Notwithstanding the desirability of reducing demand on the existing water

supply, the percentage of water saving that rainwater tanks might provide would be very small, which makes their mandatory use unwarranted. However, individual home owners may install gutters and rainwater tanks if they wish. Other water saving techniques, such as reduced flow shower heads in the bathrooms of the dwellings, have also been suggested to be used in the expansion of the township. These measures are already incorporated into the new dwellings that WMC develops.

11.4 TOWNSHIP DEVELOPMENT

Submissions G3, P23, P25 and P36 comment that the planning for the expansion of the Roxby Downs township beyond the commitment for development is misuse of resources and an intrusion on the land.

It is considered appropriate to prepare plans for future expansion to allow for the most efficient use of resources, and to permit opportunity for the public to comment on the proposals. The plan developed as part of this process is able to be implemented in stages as demand occurs and, as such, will only occupy as much land as is required.

The arrangements for the development of housing in Roxby Downs and its availability to WMC and non-WMC staff have also been questioned.

Housing is developed by WMC under the terms of the *Roxby Downs (Indenture Ratification) Act 1982* (as amended), Clauses 21, 22 and 23. These clauses relate, in general terms, to requirements to provide such housing, accommodation, services and other works to meet the needs of persons who are employed by WMC (and their dependants). WMC is also to use its best endeavours to assist in the provision of the housing needs of other persons who provide services to the town and are ancillary to WMC employees.

Subject to overall financial and budget limitations, WMC develops additional land within the town for residential purposes related to demand. Roads and services are constructed in accordance with a township master plan, making land available for residential development.

People interested in either purchasing land or obtaining residential accommodation within Roxby Downs register their names with the town office. This enables WMC to assess demand for both land and houses. The registration process is open to anyone, whether WMC employees, members of the general public or developers. Land allocation occurs on a preferential basis, with WMC having first choice, potential owner-occupiers second choice, and others (investors) third choice of available allotments.

By way of example, in the most recent addition of 100 allotments, WMC is taking approximately fifteen allotments for its own staff, contractors (owner-occupiers) about twenty, and investors the remaining sixty to seventy allotments.

One submission, relating to the township development generally, calls for investigation into the use of solar hot water systems for the dwellings in the town, and more broadly in the mine and processing plant. Solar hot water systems have been investigated in some detail during township development design and have been found to be not cost-effective for residential accommodation. However, individual home owners may install solar hot water systems if they wish.

The issue of cat control is also raised as a general matter of township development, and this is addressed in Chapter 7 of this Supplement.

Tree removal

The legality of tree removal with respect to the Roxby Downs Development Plan has been questioned.

As discussed in Section 5.1, this is a responsibility of the Municipality. WMC encourages the retention of trees wherever practicable. A review of the relevant objectives and principles of development control from the Development Plan indicates that there are general clauses covering the conservation of trees. This is a matter of policy in the interpretation of the plan, and is a matter that could be addressed by the proposed new Roxby Downs Town Board.

Existing township

Submission P27 raises a number of suggestions for possible improvements to traffic management, parking and verge landscaping in the existing township development at Roxby Downs. These matters are seen as part of the responsibility of the Municipality.

11.5 CONCEPT DESIGN

Submissions P15 and P21 include comments related to the proposed concept design for the township expansion.

Residential allotments

It has been suggested that there could be some interest in larger allotments of 1–4 ha for alternative 'rural living' accommodation.

Allotments of this type were considered in the proposed concept design and requests for this, and other forms of accommodation, will be monitored by the town office through the registration process. Allotments of such size may provide lifestyle benefits for some people. However, the overall impact of township construction, including vegetation clearance, would be greater.

Open space

Development of neighbourhood parks with facilities for children and youth has been suggested as a priority issue.

Open space areas have been allocated within the proposed expansion, and design concepts have been prepared incorporating these ideas. Implementation would be subject to broader township budget and policy deliberations.

Pedestrian footpaths

The provision of footpaths on all roads has been a general public comment often raised at Roxby Downs.

Through the Australian Model Code for Residential Development (AMCORD), current practice in residential land developments is for the provision of footpaths as indicated in Table 11.5 in the Expansion Project EIS. All extensions to the township are to comply with this general level of provision, and would include a footpath on at least one side of all local access roads as part of the pedestrian network.

Stormwater management

Submission P27 notes that the EIS does not contain reference to stormwater harvesting as a freshwater source (for the southern township expansion) and questions whether a freshwater park/reserve/wetland could be established. The concept design for the southern expansion of the township uses a different stormwater management system to the existing township development, which uses piped collection systems and reuse for irrigation via the sewage

lagoons. The southern expansion would utilise naturally low-lying areas of vegetation to collect stormwater for local infiltration, thereby supplementing direct rainfall as a source of water for this vegetation. The rainfall of Roxby Downs is insufficient and too unreliable to further develop this concept to provide the freshwater features envisaged in the submission.

11.6 CONSTRUCTION VILLAGE

Concern is expressed in Submission P8 over the standard of accommodation in the construction village and rumours that a lower standard could encourage village residents to visit Roxby Downs more frequently.

Olympic Dam Village No. 1, which will cater for up to 900 personnel, is being constructed to a very high standard, including en-suite units. This high standard applies to both accommodation and support facilities, with a view to providing an attractive living and recreation environment for those involved in the expansion construction. The accommodation at Olympic Dam Village No. 2, which will cater for up to 300 personnel, is more basic, but still comfortable, and is intended for personnel staying for short-term periods of up to approximately four weeks.

CHAPTER 12

SOCIAL ENVIRONMENT

CHAPTER 12

SOCIAL ENVIRONMENT

Chapter 12 of the Expansion Project EIS deals with the social environment of the Project Area and Roxby Downs. The majority of submissions relating to Chapter 12 comment on workforce projections, community consultation and community services. This chapter of the Supplement responds to these and other issues raised in various submissions.

It should be noted that a number of comments referring to social environment issues fall outside the scope of the Expansion Project EIS, and should more properly be directed to the Roxby Downs Municipality, as indicated in the text.

12.1 WORKFORCE

Submissions P3, P17 and P39 include comments related to the accuracy and potential social impacts of local workforce projections.

Local workforce projections

Submissions P3 and P39 comment that, given the discrepancies between employment levels predicted in the 1983 EIS and those actually realised, the levels predicted in the Expansion Project EIS need greater examination.

The discrepancies in the predicted employment levels in the 1983 EIS arose through advances in technology that resulted in increased workforce efficiencies in both the mine and plant, so that fewer people were employed than originally predicted. Economic conditions and competitive marketplace forces also contributed to reduced workforce requirements. The forecasts made in the Expansion Project EIS are based on the best available information at this time, following nine years of operation of the mine and plant.

These submissions also state that the Expansion Project EIS makes no mention of the creation of less than 1,000 jobs rather than the promised 2,500, with only a weak reference to there being fewer jobs. In addition, it is considered that there is no distinction made between long-term and casual jobs, which is deceptive and cruel to job seekers.

Table 12.4 of the Expansion Project EIS projects an increase in the local workforce at Olympic Dam from 895 in 1996 to 1,076 in 1999–2000. The table does differentiate between contract and staff positions, noting however that award personnel have been offered staff positions over the past few months. Estimated indirect workforce figures (including during construction) are clearly stated in Tables 12.5 and 12.6 of the EIS.

Projected workforce to year 2000

Submission P3 considers that the inclusion of information pertinent to the 1983 EIS or expansion up to 150,000 t/a is not relevant to the current EIS, except as background information, and is therefore inappropriate to include in Chapter 12.

Given the potential for readers to confuse the currently approved level of operation with the actual present activities, it was considered appropriate to include this discussion in the

document. The Expansion Project EIS assesses the overall impacts from a December 1996 baseline, which is an appropriate reference basis, as discussed in Section 2.5 of this Supplement.

Construction and operational workforce (indirect)

Submission P3 also suggests that the examples used in Table 12.7 are too narrow. However, these assumptions are based on available studies of similar large-scale development projects in remote areas.

Social implications of workforce structure

Submission P17 considers that the provision of a regular bus service from the tavern to Olympic Dam Village No. 1 (ODV1) contradicted previous advice regarding separation of the workforce from the local community.

Section 12.3.4 of the Expansion Project EIS states that because a high standard of amenities—including accommodation, recreation and entertainment facilities—will be provided at Olympic Dam Village, the need for construction personnel to travel to Roxby Downs will be reduced. Some construction personnel may still wish to frequent the townships of Roxby Downs and Andamooka; however, they are expected to comply with a code of behaviour. The bus service operating from the tavern to ODV1 is provided by the tavern and is outside the control of WMC.

12.2 PROJECTED POPULATION CHARACTERISTICS

Submission P36 expresses concern that government provisions to establish Roxby Downs township were based on an estimated population of 9,000 people, and funds in excess of this were spent at that time.

While the current population is less than half that originally predicted, the Government established township facilities based on the original estimates. This involved developing the township layout with a capacity to expand to 9,000 people as needed. However, as detailed in Section 12.7 of the Expansion Project EIS, government services are only expanded to respond to the needs of the population as they exist at any time.

12.3 COMMUNITY CONSULTATION

A large number of submissions comment on the poor organisation of the consultation process regarding the Expansion Project EIS document. There was consultation with the Roxby Downs community before the publication of the EIS and while the EIS was open for public comment. The consultation process was advertised in State and local newspapers and discussed on the ABC radio network.

The nature of the obligations regarding Aboriginal and community consultation regarding the progress of the expansion is also questioned. Chapter 6 of the Expansion Project EIS indicates that all Aboriginal groups that have an interest in an area proposed for development are approached by WMC prior to any development taking place. In addition, in accordance with WMC's Indigenous Peoples' Policy, a Community Relations Officer has been appointed by WMC to ensure ongoing consultation with Aboriginal groups.

The effectiveness of consultation for the Borefield B project is also questioned. The Borefield B expansion was approved prior to the Expansion Project EIS and has been included for information only; it is not part of the EIS process. However, the Borefield B consultation process was extensive, and consultation with the Aboriginal people resulted in a

major change of the overall pipeline route and in a number of minor alignment changes to avoid archaeological sites.

Section 6.1 of this Supplement provides a full list of Aboriginal and other community groups consulted in relation to the Special Mining Lease and Municipal Lease, borefields and service corridors.

12.4 PROVISION OF ACCOMMODATION

Submission P21 suggests the need for further development of accommodation to alleviate the current shortfall and high cost, and improve the viability of community facilities.

Section 12.6.1 of the Expansion Project EIS notes that in response to the current demand, an additional 101 allotments have been developed in the eastern subdivision of Roxby Downs. WMC will construct forty-six houses and fifteen one-bedroom units on the allotments it retains. Four allotments within the current township are also being developed. In addition, a comprehensive programme has been put in place to house the projected increase in the permanent local workforce. The EIS also notes that, for a town of its size, Roxby Downs has a relatively high standard and range of community services.

Submission G3 questions what obligation WMC has to make housing sites available for non-WMC people, and what arrangement there is for the development of housing sites.

Section 12.6 of the EIS discusses the provision of accommodation. It notes that the Indenture stipulates that WMC is responsible for providing accommodation to meet the needs of Olympic Dam employees and their families, as well as assisting in provision of housing for those who provide services in the town.

This is also discussed in Sections 5.1 and 11.4 of this Supplement.

12.5 PROVISION OF COMMUNITY SERVICES

Submission P8 questions why the Expansion Project EIS concludes that an increase in population would have minimal impact on existing facilities.

As discussed in Section 12.7.1 of the EIS, this statement was made because an extensive range of facilities would be provided at Olympic Dam Village, making it unlikely that temporary construction personnel would place undue demand on existing community services located within the Roxby Downs township.

Child care and educational services

Submission P17 suggests that a local bus service in Roxby Downs would assist in getting children to school safely and on time.

This is not a WMC responsibility. The Roxby Downs township has been designed so that housing is generally within walking distance of the school. The provision of a school bus would be a matter for the State Government to consider, and the provision of community buses is usually the responsibility of the local government. Thus, this suggestion may be one for consideration by the Town Administrator or the proposed Roxby Downs Town Board, discussed in Section 12.9 of this Supplement.

In the submissions, it is considered that there is a high staff turnover and restricted secondary curriculum at the high school.

As detailed in Section 12.7.2 of the EIS, the school has encountered difficulties in attracting and retaining staff, but this has improved and there is now an average length of stay of

teachers of around three years. As indicated, this is a reasonably common problem for educational services located in rural and remote areas of Australia. WMC is aware of the difficulty created by the movement of many secondary students to boarding schools in Adelaide, and is working with the Roxby Downs Area School to address the issue.

WMC has recently given significant financial support for the provision of computers at the school.

Community health and medical services

Submission P21 expresses concern that the provision of hospital facilities at Roxby Downs is long overdue and questions whether the promised facility will have a maternity section. Currently, Roxby Downs residents must travel to maternity facilities in other centres.

The ten-bed acute health facility to be constructed by the State Government will provide low-risk obstetric care to allow the delivery of babies at the facility. Women requiring more extensive obstetric care will still need to travel to other areas. This situation is common in remote areas of Australia.

The lack of availability of a family doctor is also raised as an issue. Currently the medical centre has one part-time visiting and two resident general practitioners. The new health facility presently under construction is expected to improve the availability of family doctors in the town.

12.6 RECREATION AND CULTURAL FACILITIES

A number of submissions address issues related to recreation and cultural facilities, including the recreation centre, the library, outdoor areas, recreational facilities for young people and the outreach service.

Indoor and outdoor recreation facilities

There are a number of submissions suggesting that the existing recreation centre is overtaxed, and questioning whether there are any plans for expanding the indoor and outdoor recreation facilities.

Section 12.7.5 of the EIS suggests that demands for new sporting facilities may emerge with the increase in population at Roxby Downs. Further assessment of the future recreational and cultural needs of the Roxby Downs community will need to be undertaken by either the proposed community planning services group (Section 12.7.1 of the EIS) or the Town Administrator. Alternatively, it could be considered by the proposed Roxby Downs Town Board, discussed in Section 12.9 of this Supplement.

It is also suggested that there is need for shade in recreation areas, particularly over playgrounds and swimming pools. Again, this is an issue for the Municipality, and could be taken up by the Administrator or the proposed Roxby Downs Town Board.

Library services

Submissions P21 and P27 comment that the community library needs to be expanded and query why the mezzanine floor has not been constructed. In addition, the question of how the library is funded is raised, and whether there would be any impact on the funding with the establishment of full local government in Roxby Downs.

Section 12.7.5 of the EIS suggests that the mezzanine is likely to be constructed sometime in 1997 and that this should overcome some of the space problems currently being experienced by the library. It is noted, however, that the mezzanine has not yet been constructed.

Funding for the library comes from both the Municipality and the school, as it is a shared facility, and any impact from a change to full local government (presumably meaning an elected council) is outside the scope of the EIS.

Cultural and entertainment facilities

In submissions P8, P17, P21 and P27, comments are made that the town lacks recreational opportunities for young people, especially those who do not like sport.

Section 12.7.5 of the EIS notes that Roxby Downs has few entertainment facilities for people under eighteen, and that this is a common problem in remote areas throughout Australia. There is also acknowledgement in the EIS that further assessment is required to better understand the needs of the community. In addition, it is suggested that the poor acoustics of the auditorium reduce its usefulness and need urgent attention. This is not an EIS matter, and it is not appropriate for WMC to comment. These matters could be considered by the proposed community services planning group, the Town Administrator or the proposed Roxby Downs Town Board.

These submissions also comment that the outreach service planned for ODV1 and ODV2 has not eventuated, apparently owing to lack of funds. This is considered unsatisfactory treatment of the expansion workforce, whose limited leisure time may not be satisfied by the tavern or gymnasium.

A range of recreational activities has been catered for in the development of ODV1 and ODV2, and these are considered to be appropriate for the situation at the construction villages.

12.7 POLICING AND EMERGENCY SERVICES

Submission P8 comments that the outcome of the request made for additional police officers during construction is not known.

This proposal is currently with the Police Commissioner pending a decision. It is not a WMC responsibility.

12.8 RETAIL AND COMMERCIAL FACILITIES

Submission P21 expresses the view that the community would like to see open competition of retail facilities. In addition, it is suggested that more sealed and shaded parking areas need to be provided at the existing retail facilities.

The provision of appropriate car parking areas is a matter for the Municipality to address. A number of proposals for further commercial development, including an expansion of retail facilities, are under consideration. Any major extension of retail facilities will also involve additional car parking, and this would be considered in conjunction with any development application.

12.9 MUNICIPAL MANAGEMENT

A large number of submissions, including a petition with 412 signatures, comment on the current and future requirements for municipal management and on community involvement.

WMC is aware that Roxby Downs residents take pride in their community and wish to contribute in a positive manner to decisions about the administration of their town. WMC and the State Government have been discussing this matter for some time, taking into

account that the State and WMC share the cost of the annual municipal deficit, which was $651,000 in 1995–96 and is expected to be approximately $700,000 for 1996–97.

As noted in the EIS (Section 12.9.1), the administration of the town is currently undertaken by an administrator appointed by the State Government. The Town Administrator exercises the power and functions of a municipal council in relation to the operation of the town. Further information on the statutory context of the Municipal Lease is provided in Section 5.1 of this Supplement.

More recently, WMC and the State Government have had discussions regarding an improved arrangement for policy and budget decisions at Roxby Downs, in the form of a Roxby Downs Town Board, and a response from Government is pending.

The Town Board proposition

The Roxby Downs Town Board is proposed to have nine members, comprising four to be elected from residents of Roxby Downs (to represent the views of the community), two nominated by the South Australian Government, two nominated by WMC, and the Town Administrator. It is envisaged that the community representatives would be elected at a public meeting, with their term of appointment being two years and with a right to seek re-election.

It is proposed that the Town Board would have input to decisions about the development of the Municipality, be able to make comment on budgets and policy matters, and advise on the provision of community facilities. It is recognised that while the Town Administrator would take advice from the Board, the Administrator would retain ultimate responsibility for the decisions of the Municipality, in accordance with the *Local Government Act* (SA) and the *Roxby Downs (Indenture Ratification) Act 1982* (SA).

It is intended that the Town Board differ in its function and operation from the former Roxby Downs Advisory Committee. Representation of the State Government and WMC on the Board would ensure more direct and effective consultation with residents on issues of community interest and concern. It would be expected that initially the Board would meet quarterly, with published agendas and minutes of its meetings, which would also be open to the general public.

WMC has expressed the view to the State Government that this new structure is a positive step toward helping the community to prepare for ultimate self-government, with the Town Board having the capacity for greater input and influence over the development of the Roxby Downs township than the former Advisory Committee was able to achieve. The State Government has indicated its endorsement of this view.

If a fully elected Council were to be established for Roxby Downs on the current population base, it would have to immediately impose an approximate doubling of residential rates to properly discharge its responsibility to be self-funding. WMC takes the view that such increases would not be acceptable to the community and that WMC and the State Government should continue to share responsibility for meeting the annual deficit of the Municipality until it can become self-funding. This is unlikely to occur until the population reaches about 5,000 people, and it is proposed to review these interim arrangements for the administration of the Municipality at that time.

In the meantime, while WMC and the State Government continue to make financial contributions towards the ongoing operations of the Municipality, they believe it would be inappropriate to surrender total responsibility for financial decisions to a body that would not be accountable to WMC and the State.

Environmental management

There are also many comments regarding the perceived lack of environmental management by the Municipality.

These matters need to be addressed to the Municipality, not WMC. Policy issues on environmental management are matters that could be addressed by the proposed Roxby Downs Town Board with the assistance, if requested, of WMC environmental staff.

The state of the waste disposal depot was mentioned in a number of submissions and this has been addressed. As noted in Section 11.2, discussions between the Town Administrator, the State Government and WMC have resulted in the Town Administrator agreeing to consider the proposals suggested by WMC environmental staff for improvements to the waste disposal areas and their operation, particularly regarding recycling. These improvements are expected to be implemented during 1998.

Development Plan

A number of comments are made (Submissions P21, P16, P24) about the issue of caretaker occupation of light industrial blocks.

The Roxby Downs (Municipality) Development Plan, as contained in the South Australian *Development Act 1993*, contains a principle stating that 'no dwelling should be erected in the zone' and includes dwellings as a non-complying form of development. Should the community continue to call for changes to this part of the Development Plan, this may be another policy issue for the Town Administrator or the proposed Roxby Downs Town Board to consider.

Support for community groups

Comments are made regarding the perceived lack of support for community and sporting groups by the Municipality.

Again, this is a responsibility of the Municipality that the proposed Roxby Downs Town Board could consider.

CHAPTER 13

ECONOMIC IMPACTS

CHAPTER 13

ECONOMIC IMPACTS

Chapter 13 of the Expansion Project EIS reports the results of economic modelling, using a computable general equilibrium (CGE) model to estimate the impacts of expansion from the current (1996) production rate of 85,000 t/a of copper to 200,000 t/a, and then further expansion to 350,000 t/a. The impacts in terms of employment created, changes to gross state product (GSP), gross national product (GNP) and a number of other economic indicators are reported at the levels of the South Australian and Australian economies. For each expansion phase, impacts are estimated separately for a construction and operational phase. This chapter responds to comments received regarding Chapter 13 of the EIS.

13.1 ISSUES

Submission F3 provided extensive comment on a number of aspects of the economic modelling and assessment, including on the model used, assumptions and model results. Much of the response in this chapter is to Submission F3, and responses to other submissions are noted as appropriate in the text.

Other comments received on the information presented in Chapter 13 include the following:

- The expansion stages modelled are inappropriate (Submissions P3, P5, P11, P37). (This issue was discussed in Section 2.5 of this Supplement and is not further commented upon here.)
- The difference between projections in the 1983 EIS and current outcomes brings into question the usefulness of economic modelling for predicting outcomes of the expansion (Submissions P3, P11).
- The information in Chapter 13 related to impacts on the Northern Statistical Division is criticised (Submissions P3, P11).
- The treatment of government costs in the economic modelling is questioned (Submissions P3, P11).
- The calibration of the model for South Australia using data for Western Australia is questioned (Submissions P3 and F3).
- Negative impacts are not given emphasis (Submissions P3, P11).

These issues are discussed in turn below.

13.2 ECONOMIC MODELLING

The economic modelling framework

Submission F3 questioned the use of the CGE model. The GCE type model used in the EIS is widely used by government and non-government policy agencies in Australia. The Industry Commission uses CGE models extensively in its investigations or microeconomic reform

proposals. Economic modelling for the Expansion Project EIS was carried out by the South Australian Centre for Economic Studies, which is experienced in the application of economic models to policy issues.

Like all economic models, the CGE framework relies on assumptions about the real operation of the economy. Some of these assumptions simplify the portrayal of how the economy works, allowing the workings of the economy to be modelled within the limitations of economic theory and of the available data. The more complex the economic unit being modelled, the greater the necessity for simplifying assumptions to be adopted.

Judgement is therefore required in applying somewhat imperfect modelling tools to the operation of complex national and sub-national economies. In the Expansion Project EIS, the modellers have been careful to explain how the model works and to make their assumptions clear. They have endeavoured to report scenarios that show the range of possible economic outcomes of the proposed project, given uncertainties about data and the limitations of the governing model assumptions.

It is important to note therefore that the results of the modelling signify the expected direction and relative magnitude of the project's economic effects. No model will be capable of estimating the precise outcomes, particularly when the effects of time are taken into account.

Usefulness of economic modelling

Submissions P3 and P11 questioned the usefulness of economic modelling, citing the difference between the projections in the 1983 EIS and actual outcomes.

As discussed in Section 2.7 of this Supplement, the employment projections in the 1983 EIS were higher than the actual employment numbers that have eventuated at Olympic Dam to date. In response to Submissions P3 and P11, production levels at Olympic Dam are about one-half those envisaged in the 1983 EIS, which is a contributing factor to the actual direct and indirect employment being less than that predicted in the 1983 EIS.

As also noted in Section 2.7 of this Supplement, the projections made in the 1983 EIS were the best available at the time; however, those projections did not have the benefit of experience with an operating plant. In addition, advances in technology have resulted in workforce efficiencies in both the mine and the plant that, together with economic conditions and competitive workplace forces, have resulted in fewer people being employed than predicted in the 1983 EIS.

The modelling undertaken for the Expansion Project EIS shows that, provided the investment and production levels are as projected by WMC, the economic and employment impacts will be as predicted by the model. The CGE methodology used in the Expansion Project EIS is a more sophisticated approach than the input–output approach used in the 1983 EIS. Specifically, this approach is likely to estimate smaller, but more realistic, impacts because it is a more complete model of the economy.

13.3 IMPACTS ON THE NORTHERN STATISTICAL DIVISION

The CGE modelling produced results at a South Australian and Australian level. Detailed predictions of economic impacts were not disaggregated to the level of the Northern Statistical Division, in which Roxby Downs lies. The comments made in the Expansion Project EIS that most direct mining and processing employment would be located at Roxby Downs are reasonable. The Northern Statistical Division population has been declining in recent years and this trend is expected to continue. In response to Submissions P3 and P11,

the intention was not to claim that new employment associated with expansion would completely compensate for loss of employment in the region, but rather that it would be a compensating influence.

13.4 TREATMENT OF GOVERNMENT COSTS IN THE ECONOMIC MODELLING

Submissions P3 and P11 note that the economic analysis does not include costs to government departments of services that would be provided if the Expansion Project were to proceed. One specific cost—that of providing a $3.7 million medical facility at Roxby Downs—was included. This is the only capital investment commitment remaining for the South Australian Government under the Indenture.

Other government costs were not included, on the basis that:

- many government services are provided on a cost recovery basis;
- many government services would be supplied to a population anyway, whether in Roxby Downs or elsewhere;
- many services would be provided by WMC rather than government.

WMC payments and other taxes associated with the Olympic Dam Project are discussed in Section 1.1 of the Expansion Project EIS. Further information on royalties payable by WMC, and WMC's contribution to municipality costs, is provided in Sections 2.2 and 12.9 of this Supplement.

13.5 CALIBRATION OF THE MODEL

Submissions F3 and P3 question the information given in Chapter 13 that the CGE model used was calibrated based on economic changes observed in Western Australia following implementation of nine major projects. The CGE model used by the South Australian Centre for Economic Studies was calibrated to reflect observed relationships between gross mining product, GSP and employment in Western Australia in recent years. The approach is discussed in Appendix O of the Expansion Project EIS. The methodology has been documented in Wittwer and Bright (1996).

In any modelling, it is useful to track the responsiveness of the model against historical data. Western Australian data were seen as the most appropriate for this task because of the close linkage between growth in gross mining product and GSP associated with relatively rapid employment and population growth since the mid-1980s. This evidence resulted in parameters in the model being adjusted downwards, providing smaller employment multipliers than other multi-regional CGE models and econometric models that have been used previously in policy debate in Australia.

13.6 SENSITIVITY ANALYSIS USING DIFFERENT VALUES FOR IMPORTANT VARIABLES

Submission P3 suggests that Chapter 13 should have presented sensitivity analysis using different values for important variables. Sensitivity analysis was not undertaken on different investment and production levels, as the expansions modelled are the best estimates available from WMC. Sensitivity analysis was undertaken for the construction phase of the Expansion Project to 200,000 t/a copper production by modelling national employment, constrained and unconstrained. Submission F3 also raised issues associated with the

assumptions for constrained and unconstrained employment, given current employment conditions.

In modelling the predicted impacts of the Expansion Project, the choice was made to use constrained national employment in most scenarios modelled, and to drop this constraint in one scenario modelled only. This use of constrained national employment produces conservative estimates of employment generated when compared with an unconstrained option. In an economy with full employment, the constrained employment approach is the appropriate approach to model. It can be argued that in an economy with high unemployment, as is currently the case for the South Australian and national economies, it would be more appropriate to lift the constraint on national employment.

The approach of retaining the constraint on national employment for most scenarios was adopted because of the lack of evidence of sufficient skilled labour of the occupations required or mobility of labour to meet the unconstrained target. For the possible future expansion to 350,000 t/a copper production, the assumption of constrained national employment was used on the basis that, in the longer term, the economy may return to lower unemployment levels (that being the intention of most governments). The Expansion Project EIS states that the constrained estimate is at the lower end of possible estimates.

The employment effects in economic models tend to be a function of what is assumed about labour market behaviour. This is true for both CGE models and econometric models. The employment numbers given in the modelling give some idea of how both South Australia's and the national share of employment will change with the project, an important assumption, given that most labour market adjustment between regions in Australia occurs through interstate migration rather than a widening of unemployment rate differentials between regions. The closure used in the operational phases reflects the assumption of interstate migration as the avenue of adjustment, as indicated in the graphs at the end of Appendix O in the Expansion Project EIS.

The constrained and unconstrained employment scenarios reported in the EIS signify the range of possible outcomes of the project. It is appropriate that conservative and upper bound estimates of outcomes be reported, enabling readers to gauge the sensitivity of the model results to the judgements and assumptions adopted by the modellers.

13.7 SIZE OF THE EMPLOYMENT IMPACTS PREDICTED

Submission F3 questions the employment multipliers and proposes that the employment impacts predicted were too high, suggesting a structural problem in the model.

The model generates employment estimates based on investment, operating costs and revenues (including royalties) and their impacts, not on direct employment. The submission translates employment results into implied employment multipliers (calculated as total employment divided by direct employment). Based on this approach, the multipliers implied by the model results are shown in Table 13.1. These implied multipliers are somewhat misleading as they imply a direct link in the model between direct employment and total employment predicted, whereas the link in the model is between investment, operating costs and revenues, including royalties, and total employment predicted.

The implied multipliers resulting from the constrained national employment settings are not remarkable for most scenarios modelled. Multipliers of around 2 or larger are common for Australian industries. In this context, the higher implied multiplier at the State level arising from the unconstrained setting for the construction phase of the expansion to 200,000 t/a copper production is not remarkable. The impacts of the unconstrained setting at a national level have been clearly stated to be at the upper boundary of possibility, and therefore the implied multiplier at a national level of 4.2 should be interpreted in this context.

Table 13.1 Implied employment multipliers

Phase	Direct jobs (No.)	Total jobs (No.)	Implied multiplier
FIRST EXPANSION PHASE TO 200,000 T/A COPPER PRODUCTION			
Construction phase, constrained employment	1,300	1,750	1.3
Construction phase, unconstrained employment, State level	1,300	2,500	1.9
Construction phase, unconstrained employment, national level	1,300	5,500	4.2
Operational phase	191	1,100	5.8
SECOND EXPANSION PHASE TO 350,000 T/A COPPER PRODUCTION			
Construction phase	1,100	1,240	1.1
Operational phase	510	1,190	2.3

The implied multiplier of around 5.8 for the operational phase of the expansion to 200,000 t/a copper production is high. An explanation for this is that, in general, mining operations have high employment impacts owing to a number of effects. These effects include the reduction in public sector borrowing requirements brought about by the earning of royalties and other taxes, which releases government funds for spending in the economy or for tax cuts that allow private spending. These impacts of royalties are in addition to normal flow-on impacts of industry spending.

The employment generation predicted in this modelling exercise is influenced by the fact that the model has been calibrated to reflect performance in Western Australia in recent years, where a mining boom has coincided with growth in GSP and employment (Appendix O, Expansion Project EIS).

As stated above, the employment impacts generated in the model are based on investment and operating costs and revenues, including royalties. An expansion to 350,000 t/a copper production would have further economies of scale in investment compared with an expansion to 200,000 t/a copper production, as explained in Section O4 of the EIS. This is the explanation for the implied multiplier for the operational phase for the expansion to 350,000 t/a copper production being lower than that for expansion to 200,000 t/a copper production. There is no direct link in the model between the direct employment nominated by WMC and the total employment predicted by the model; the link is between operating costs and revenues, including royalties, and the employment predicted by the model.

The South Australian Centre for Economic Studies considers that there is no structural problem with the model and that the results are within reasonable bounds, given the data supplied and the assumptions made.

13.8 EMPHASIS ON NEGATIVE IMPACTS

It is claimed in Submissions P3 and P11 that negative impacts are not given emphasis. These include negative impacts on the balance of trade in the construction phases, when materials have to be imported, and negative impacts during the operational phases on some

other sectors of the economy owing to the effect on the exchange rate of increased mineral exports. Submission F3 also commented on the net effect of the construction phase on balance of trade.

The negative points are illustrated in tables and commented on in the text, to draw attention to impacts on different sectors or at some phases of the expansion. In the case of the balance of trade, it is predicted that it will take several years of exporting of product—up to eight-and-a-half years for the expansion to 200,000 t/a copper production—to offset the effect of the construction phase on the balance of trade. In all cases, however, the overall net impacts on GSP, GDP and balance of trade are positive. If overall net impacts had been negative, this would have been reported and given emphasis.

13.9 OTHER ISSUES

Submission P39 questions why details such as imported equipment and materials such as sulphur are not included in the balance of payments. It is incorrect to assume that these costs were not included in the economic modelling undertaken for the Expansion Project and described in Chapter 13 of the Expansion Project EIS. The effects of the Expansion Project on the balance of trade is described in Section 13.3 of the Expansion Project EIS.

Submission F3 states that tables in the EIS should provide magnitudes of absolute changes of economic variables as well as percentage changes.

Expressing changes in percentage terms allows their relative significance to be gauged. In addition to percentage changes, the EIS also provides overall effects expressed in dollar terms.

Submission F3 states that additional detailed information should be provided, including on matters such as employment, revenues, construction and operational costs, and profits.

Information is provided in the EIS on Olympic Dam's contribution to the State and national economies (Table 1.3), the projected value of production (Sections 1.4.1 and 1.5.3, and Table 1.7), employment estimates (Sections 1.5.3 and 13.3.4, and Table 12.4), construction costs (Sections 13.2.2 and O2) and export revenues (Sections 13.3.2 and 13.3.4). WMC is not prepared to present information that it regards as commercially confidential, or to potentially prejudice requirements of the Australian Securities Commission. Overall, it is considered that the EIS presents very detailed economic information that is more than adequate for the purpose of environmental impact assessment of the Expansion Project.

CHAPTER 14

REHABILITATION AND DECOMMISSIONING

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REHABILITATION AND DECOMMISSIONING

Chapter 14 of the Expansion Project EIS deals with the incorporation of progressive rehabilitation into operations at Olympic Dam, and provides a conceptual plan for rehabilitation and decommissioning of the project.

Submissions G6, G9, P3, P11, P26, P30 and P39 include comments relating to the proposed rehabilitation and decommissioning measures for the tailings retention system. These comments are considered in Section 8.5 of this Supplement.

Comment P3 notes that adequate financial arrangements must be made by WMC to ensure full rehabilitation in the Project Area.

WMC confirms that adequate resources would be available to complete all required rehabilitation measures. WMC has a monthly accounting provision for Olympic Dam for ultimate site rehabilitation, which ensures that adequate accumulated funds would be available for final rehabilitation. The overall WMC Group accumulated rehabilitation provision, as stated in the WMC 1996 Annual Report, was $119.2 million.

Submission P3 also suggests that the acidity of the tailings should not be presented as a constraint to rehabilitation. The pH of tailings is one of a number of factors that are known to influence the success of rehabilitation work. The natural state of the regional soils is alkaline, and local vegetation has adapted to living in alkaline conditions. Consequently, the acidity of the tailings may be a constraint to rehabilitation until sufficient trials data are available.

In addition, P3 recommends that the last three paragraphs in Section 14.3 of the Expansion Project EIS should be deleted since they have nothing to do with rehabilitation constraints.

This proposed deletion is not agreed to, since the content of these paragraphs provides necessary background information about the methods and techniques of past rehabilitation work that have been required to overcome some of the constraints to rehabilitation in the Project Area successfully.

CHAPTER 15

MANAGEMENT AND MONITORING — ENVIRONMENT AND WORKPLACE

CHAPTER 15

MANAGEMENT AND MONITORING — ENVIRONMENT AND WORKPLACE

Chapter 15 of the Expansion Project EIS summarises WMC's Environmental Management and Monitoring Plan (EMMP) and identifies the changes to the EMMP necessitated by the Expansion Project.

WMC staff and associated scientific research projects were listed, as was the environmental and workplace management framework for construction and expansion (comprising management systems, codes of practice and inductions). Relevant aspects of occupational health and safety, risk management and contingency planning, environmental safeguards and the Expansion Project's key environmental commitments are also presented in that chapter. This chapter provides responses to queries raised in relation to Chapter 15 of the EIS.

15.1 AUDITING PROCEDURES

Submission G3 seeks clarification of the external auditing process used by WMC. WMC currently has an agreement in place with the Commonwealth Government for the conduct of an annual independent audit of the EMMP process. The first of such audits has been undertaken by external consultants and, as of September 1997, WMC is awaiting the finalised audit findings.

15.2 ENVIRONMENTAL MONITORING REQUIREMENTS

Submission G13 is concerned with the need to improve the quality of mound springs monitoring and the dissemination and evaluation of results. In particular, the submission suggests that the time lag between data collection, analysis, and dissemination should be reduced. This issue is addressed in Section 7.4 of this Supplement.

Submission P19 is concerned that a disproportionate effort is being expended on the monitoring of radiation. This submission considers that radiation monitoring should not be conducted at an intensity that monopolises resources, and that limits resources available for more conventional occupational and public hazards. As indicated in Sections 15.5 and 15.6 of the Expansion Project EIS, considerable effort is also expended by WMC on the management of other hazards.

15.3 PUBLIC ACCOUNTABILITY

Submission P3 states that the Expansion Project EIS should address the issue of public accountability in regard to the potential impact of the Olympic Dam operations on the environmental, social and economic sectors; for example, effects on the Great Artesian Basin and mound springs. Public accountability is provided for by the presentation of monitoring and other data, including the annual report of the EMMP and the annual WMC Environmental Progress Reports. A more complete list of public reporting in relation to the Olympic Dam operations is provided in Section 2.2 of this Supplement.

Submission P3 also queries how WMC intends to implement the Environmental Resource Development Committee recommendation that the Roxby Downs operations be 'more open to public scrutiny'. It is considered that WMC's approach to the public release of data is consistent with the requirement of open public scrutiny and, as noted above, Section 2.2 of this document lists some of the environmental management reports that have been made available to the public to date. As also noted in Section 2.2, it is also proposed that a Community Consultative Forum be established, which would include representatives of stakeholder groups.

15.4 GREENHOUSE GAS EMISSIONS

Submission P3 states that the Expansion Project EIS should address the question of reducing greenhouse emissions through the use of renewable energy sources. As noted in Section 3.8.4 of the EIS, WMC has made a commitment to participate in the Commonwealth Government's Greenhouse Challenge programme. The company has set an initial target (as stated in the first Environmental Progress Report) for a 15% reduction in carbon dioxide emissions per tonne of ore processed, by mid-1998. As also noted in the EIS, the expansion from 85,000 t/a copper production to 200,000 t/a copper production will conform with this target.

15.5 SUMMARY OF ENVIRONMENTAL COMMITMENTS

The preceding chapters of this Supplement provide responses to issues raised in submissions received on the Expansion Project EIS. Table 15.1 provides a summary of commitments relating to environmental management made in the responses, which complement the commitments contained in Table 15.8 of the Expansion Project EIS.

Table 15.1 Summary of key commitments relating to environmental management

Relevant section in Supplement	Commitments
4.0	**Water management**
4.2	WMC will continue to monitor mound spring flows as described in the EMMP. Should this monitoring indicate any significant variations with predicted flows, WMC in consultation with the regulatory authorities would investigate the cause of the variation and, if necessary, implement contingency measures, possibly involving one or some of the following options: • modification of the relative abstraction rates for the two borefields and from individual bores; • implementation of reinjection strategies to maintain aquifer pressure at strategic locations; • development of another borefield further into the Great Artesian Basin. Ongoing studies into the minimisation of water use at Olympic Dam would also continue.
4.4	Water conservation and reuse strategies would continue to be investigated, including process changes, use of air cooling instead of water cooling systems, and the treatment and recycling of saline groundwater and tailings liquors.
4.4	The infrastructure associated with the now unused bores GAB 30–32 would be removed; however, the bores themselves would remain.

Relevant section in Supplement	Commitments
7.0	**Biological environment**
7.2	The rabbit-proof fencing of the whole of the Project Area is not warranted at present; however, options for the control of feral animals will continue to be reviewed, based upon the data obtained in future from the Roxby Downs Ecosystem Restoration and Research Project (ERRP).
7.2	Monitoring of the ERRP will be undertaken. The data derived from monitoring vegetation regeneration as well as native and introduced flora and fauna will be used to develop a more effective natural environment programme in the Project Area and the region.
7.2	As part of the EMMP, WMC is committed to providing resources for controlling proclaimed animal species.
7.3	WMC recognises the ecological damage caused by feral and domestic cats. It would endorse the establishment of a township cat control policy and programme that is complementary to the WMC Special Mining Lease Cat Control Policy and actions undertaken under the EMMP.
7.4	WMC would support a proposal for the South Australian Government to develop an environmental management plan for the mound springs. The company would be pleased to contribute its technical expertise to help develop such a plan.
7.4	The sites of Beatrice, Venable and Priscilla springs will be monitored as part of the EMMP in order to assess the predictive model and its accuracy in relation to re-establishment of flows from these sites.
7.4	WMC would develop a formal, regular review process (e.g. twice yearly meetings) with the Department of Environment and Natural Resources (DENR) to allow for additional direct DENR input into future monitoring projects and programmes.
8.0	**Tailings management**
8.3	All designs undertaken by WMC would be undertaken by qualified geotechnical engineers experienced in the design of tailings storage facilities.
8.3	Current Australian Standards would be used for design and construction of the Expansion Project.
8.6	Should additional evaporation ponds be required, they would be constructed to the same standard as the existing ponds.
10.0	**Radiation**
10.1	As part of the approvals process, a radiation management plan would be submitted to the appropriate authorities prior to the commissioning of the expanded facilities.
10.1	Where possible, automatic, continuous monitors and in-plant control systems will be used to record ambient radiation levels.
11.0	**Project infrastructure and township development**
11.5	All extensions to the township will comply with the current Australian Model Code for Residential Development (AMCORD), and will include a footpath on at least one side of local access roads as part of the pedestrian network.
15.0	**Management and monitoring—environment and workplace**
15.4	WMC will participate in the Commonwealth Greenhouse Challenge programme, and has set an initial target of 15% reduction in carbon dioxide emissions per tonne of ore produced, by mid-1998.

APPENDIX A

SUMMARY OF PUBLIC COMMENTS

APPENDIX A

SUMMARY OF PUBLIC COMMENTS

This appendix contains a summary of all the public submissions relating to the Expansion Project Environmental Impact Statement (EIS) that were received from the public by the Department of Housing and Urban Development on or before 25 July 1997. This was two weeks after the advertised period during which the EIS was available for public comment. Submissions received after this date were not considered.

The submissions were numbered in order of receipt, and each comment summarised. The summarised submissions were then placed in alphabetical order according to the name of the author.

The entry for each submission is divided into four columns in which the following information is provided:

- Column 1—the submission and comment number. The whole number is the number allocated to each submission by the Department of Housing and Urban Development in order of receipt, while the decimal component refers to the individual comments within each submission. For example, comment number 9.3 is the third comment made in Submission Number 9.
- Column 2—summaries of the comments made in each submission.
- Column 3—the number of the EIS section (or sections) that is considered to most closely relate to the comment made in the submission.
- Column 4—a reference to the section(s) in the Supplement where the response from the proponent to the comment may be found. A reference to Section 1.5 of this Supplement indicates that a response is not provided for the reasons outlined in that section.

To locate the relevant responses to their comments, authors of submissions should refer to the sections of the Supplement listed in column 4.

List of submission authors

ADUCHEM Pty Ltd (Dr G. Laurence) (P30)

Anon (name withheld) (P29)

Australian Conservation Foundation (P37)

Australasian Radiation Protection Society (P19)

Big Scrub Environment Centre Inc. (P26)

Blyth, J. (P28)

Bowen, Z. (P23)

Cichon, S. (P8)

Conservation Council of South Australia (P5)

Evans, Mrs P.A. (P27)

Fisher, W.A. (P33)

Friends of the Earth, Australia (P18)

Friends of the Earth, Australia (P3)

Geological Society of Australia (SA Division) (P10)

Harris, M. & S. (P12)

Lewis, Peter (P1)

McGovern, A.M. (P36)

Margetts, Dee—Senator for Western Australia, The Greens (WA) (P32)

Mineral Policy Institute (P34)

Moody, L. (P38)

Nature Conservation Society of South Australia Inc. (P11)

Oshlack, A. (P35)

Port Augusta Hospital Inc. (P14)

Ratepayers and Residents of Roxby Downs (P20)

Read, J. (P25)

Roxby Action Collective (P4)

Roxby Downs Health Advisory Committee (P17)

Roxby Downs Junior and Senior Basketball Association (P13)

Roxby Downs Municipal Council (P15)

Roxby Downs Tidy Towns Team (P6)

Royal Australian Institute of Architects, South Australian Chapter (P2)

Schnelbogl, P. (P9)

Spencer Gulf Environmental Alliance (P39)

Stone, P.J. & S.L. (P16)

Stop Uranium Mining, Sydney (P22)

Summers, S.K. (P31)

Trutwin, S. (P7)

Zeptner, M. (P24)

Zwar, J. (P21)

Table A1 Summary of public comments

No.	Summary	Reference in EIS	Reference in Supplement
P30	**ADUCHEM Pty Ltd (Dr G. Laurence)**		
P30.1	Normal operations of the expanded project will not make a significant impact on radiation doses to mine workers or Roxby Downs residents. There is some opportunity for radiation doses to be reduced by operational changes.	10	1.5
P30.2	The underground rail system is likely to reduce the dose received by ore haulage workers.	3.3	1.5
P30.3	The new copper smelter should result in a further reduction of doses to workers from dust and furnace fume, e.g. polonium-210.	3.5	1.5
P30.4	Past operations have resulted in a negligible increase in the dose over natural background at Roxby Downs.		1.5
P30.5	The estimated dose at the township is more than an order of magnitude below the current NHMRC recommended limit, and may be increased by less than this as a result of the new furnace operations.	10.3	1.5
P30.6	The impact of current operations on the radioactivity levels in the surrounding environment has been very low outside the mine and processing site. There is no reason to expect this to change with the expansion.	10.3	1.5
P30.7	The unexpected increase in the underground water level below the tailings retention system (TRS) illustrates the need to be able to apply appropriate remedies to unexpected problems. The central thickened discharge (CTD) tailings management system appears to be more difficult to control or modify than the present system.	4.6, 8.1	8.4
P30.8	Immediate hazards from the TRS are the emission of radon and the transport of radionuclides in surface dust. The CTD technique appears to be less satisfactory than the paddock	8.10	8.4

No.	Summary	Reference in EIS	Reference in Supplement
	system because of the increased surface area. The conical surface of the CTD system would approximately double the radon and dust hazard.		
P30.9	It is unwise to assume that the layer of consolidated tailings above the soil base can be dispensed with in the CTD system, and that the proposed drainage system will be adequate. (It is noted that extensive field trials of the CTD system are being undertaken.)	8.6	8.4
P30.10	The CTD system evaporation ponds would have a clay lining only. However, the EIS makes it clear that the increase in underground water level is largely due to seepage from ponds without a polymer lining.	8.6	8.4, 8.6
P30.11	The TRS must be able to handle rainfall loadings. With the CTD system rainfall will become part of the normal liquor drainage system. As the system is designed to handle less liquid, its capacity to handle rain loads must be considered.	8.6	8.6
P30.12	Maintenance of the CTD system is more complex than the paddock system. The discharge pipes run below the cones of tailings, and problems in dealing with corrosion or breakdown are exacerbated in an environment with significant radioactivity.	8.6	8.4
P30.13	The long-term stabilisation and rehabilitation of CTD systems may be more difficult and will need to be part of the field trials.	8.6	8.5
P30.14	While the field trials may provide answers to the previous comments, the current paddock system should be retained for the expansion until the results of the CTD field trials are evaluated.	8.6	8.1, 8.4
P30.15	The EIS provides a realistic assessment of the radiological impact of the Expansion Project. There do not appear to be any radiological grounds for limiting the operation to the current size.	10	1.5
P30.16	Approval of the CTD system is dependent on the field trials and should be considered as peripheral to approval for the expansion, for which the paddock system remains appropriate.	8.6	8.1, 8.4
P29	**Anon (name withheld)**		
P29.1	The infrastructure related to GAB30–32 is an eyesore and should be removed. The bores are no longer essential, and tourists attracted by the infrastructure are disturbing the local environment.	4.1	4.5
P29.2	Why isn't there more efficient use of town sewage water? The lagoons are often overflowing, even in summer when water is at a premium.	4.1, 11.6	4.4
P29.3	Why hasn't the Roxby Downs administration enforced reductions of unnecessary grassed areas (e.g. lawns)? Unused areas of lawn could be replaced with native groundcovers.	4.1	12.9

No.	Summary	Reference in EIS	Reference in Supplement
P29.4	Why isn't excess sewage water treated to the point where it can be used on town plantings? Has a realistic long-term costing been done of this option?	4.1	4.4
P29.5	What is being done about the potential use of grey water?	4.1	4.4
P29.6	Given that the operation hosted approximately 18,000 visitors in 1996 (pers. comm., ODC Community Affairs), why hasn't an appropriate visitor's centre been constructed as is the case for the Ranger Uranium Mine? Has this been discussed?	5.2	5.2
P29.7	When will the Government make a decision on which Aboriginal group is responsible for the Olympic Dam and borefield areas? Dealing equally with the many groups claiming ownership is ultimately unworkable for WMC.	6	6.1
P29.8	Given that an inquiry found that seepage has had no harmful effects, why not store acidic liquor underground via seepage, rather than in expensive evaporation ponds? Has there been a computer modelling study of the long-term fate of seepage to determine the impact and the possibility of developing this option?	8.1	8.2
P29.9	Where would the materials come from for rehabilitation of the final tailings retention system?	8, 14	8.5
P29.10	Does rehabilitation of the central thickened discharge (CTD) tailings management system involve covering the entire surface with material?	8, 14	8.5
P29.11	The Roxby landfill is a disgrace. There has been no serious attempt at recycling and the administration has not taken advantage of the offer of expertise from WMC.	11.5	11.2, 12.9
P29.12	Has the EPA enforced fines or reported the poor management of the landfill to the Minister for Mines and Energy?	11.5	11.2, 12.9
P29.13	Many recycling initiatives have worked through the efforts of WMC, community groups and individuals. Why doesn't the Roxby Downs Administration (RDA) support these groups?	11.5	11.2, 12.9
P29.14	What has the RDA achieved in the area of recycling?	11.5	11.2, 12.9
P29.15	All the concerns raised in the EIS are agreed with, particularly the lack of accountability of the municipality. The advisory committee was ineffective, with issues ultimately decided by the Administrator.	12.5	12.9
P29.16	Despite a public meeting voting to establish cat controls, and the majority of owners being willing, the RDA has not implemented a control programme.	7.3, 12.9	7.3
P29.17	Has the Federal Government approached the State Government and WMC on the issue of a national radioactive waste repository? Given geology and existing radiation protection measures and infrastructure, Roxby would be the best location. When will the committee deciding this issue make a decision?	13.3	3.2

No.	Summary	Reference in EIS	Reference in Supplement
P37	**Australian Conservation Foundation**		
P37.1	The EIS does not address longstanding concerns with the nuclear industry.	–	1.5
P37.2	The ODO Environment Management Report 1.3.96–29.2.97, due to be released in June 1997, was not made available to the public until the end of July. This has meant that current information on environmental impacts on which to base assessment of the EIS was not available during the public response period.	–	2.3
P37.3	If approvals are granted for expansion to 350,000 t/a, Roxby Downs will be responsible for 20% of the world's uranium production. All of this uranium becomes untenable nuclear waste around the world. The EIS should provide a life-cycle assessment of uranium mining, milling, transport, refinement and use in reactors, including risk assessment of operations, waste management of end products and decommissioning of reactors. These should be assessed as part of the cost and benefits attributable to the project.	–	1.5
P37.4	Many Aboriginal communities have rejected uranium mining. The EIS process has no credibility unless it addresses this concern.	2.5, 6	6.1
P37.5	An assessment of current operations and impacts is essential to assessment of the proposed expansion, but the most recent environmental information available to the public is only up to 1996. Government should explain why the information was not available.	–	2.3
P37.6	Documents not available to the public include a working document containing 'computer generated plots of drawdown and recovery predicted to result from fifty years of pumping' by MESA. ACF is aware that more recent work has been done on predicted impacts for the Great Artesian Basin (GAB) for a longer period than released in the Draft EIS. None of these longer-term projected impacts for Borefields A and B have been made public.	4.2	2.2, 2.4
P37.7	The rights and obligations relating to WMC's extraction of up to 40 ML/d for the next forty years were established prior to the Commonwealth-ordered EIS on the proposed expansion to 350,000 t/a, and at a time when the public was only aware of a proposed expansion to 150,000 t/a. This compromises the due decision-making role of the EIS process.	4	4.1
P37.8	The Commonwealth must order a full public release and assessment of all WMC and MESA modelling projections of impacts on the GAB and mound springs. The assessment must include the confidence limits of projections, as a chronology of increased production and water withdrawal with projected impacts, which is not provided in the EIS. The Commonwealth must require independent assessment of this modelling and the extrapolated impacts.	4.2	2.2, 2.4, 4.5

No.	Summary	Reference in EIS	Reference in Supplement
P37.9	In the public interest, and if required by the Commonwealth as a precondition to acceptance of the EIS, the South Australian Government and WMC should make full disclosure of all circumstances and content of information withheld from the public under the confidentiality provisions of the Indenture.	1.3	2.2
P37.10	The information presented by the EIS on the second stage expansion is wholly reliant on a conceptual design. The EIS fails to present the proposed operations and their projected impacts in substantive detail to enable public assessment.	3.4	2.6
P37.11	It is not acceptable to consider granting approval on the basis of a conceptual design a decade ahead of project implementation. No rights should be granted without full and comprehensive environmental and occupational health and safety information, which are not provided. The second stage expansion should be disallowed on these grounds.	3.4	2.6
P37.12	ACF is concerned regarding the lack of appropriate regulation of operations to date and proposed arrangements for regulation of the expansion. Roxby should be made legally subject to the Commonwealth's Office of the Supervising Scientist (OSS).	2.5	1.5
P37.13	The EIS fails to present any economic analysis of the proposed expansion stage one (from 150,000 t/a to 200,000 t/a). The information presented uses a false baseline of the current level of operations (85,000 t/a) projecting to 200,000 t/a. Information up to 150,000 t/a should be presented as background only, but has been used to misrepresent proposed benefits from stage one.	13	2.5
P37.14	Information on the proposed expansion from 200,000 t/a to 350,000 t/a is inadequate and largely speculative, particularly in regard to employment.	13	2.5
P37.15	The EIS should provide a comparison of the 1983 EIS economic/employment predictions and outcomes to date, including costs and returns to government.	13	2.7
P37.16	A long-term chronological balance of costs and returns for the proposed expansion, including impacts on the balance of payments, should be provided.	13	2.2
P37.17	The EIS must require assessment of the option of not exporting uranium from Roxby Downs. The assessment should include design, economic and environmental aspects of operation and expansion without export approval, and assessment of radiation and waste management issues for continued operation of the mine in these circumstances.	1.5, 3.12	3.2
P37.18	The EIS must assess Commonwealth and State liability to WMC in the event of export approval being withheld or withdrawn at any time.	1.5	2.2

No.	Summary	Reference in EIS	Reference in Supplement
P37.19	WMC should declare its intentions should export approval be withheld or withdrawn, and this should be addressed in the EIS.	1.5	3.2
P37.20	Proposed radiation protection for workers is inadequate.	10	1.5
P37.21	The EIS does not take into account the trend to reduce international standards for worker exposure to ionising radiation.	10	10.6
P37.22	Existing combined risks to workers from exposure to ionising radiation and conventional mining operations are unacceptable.	10	1.5
P37.23	WMC has not complied with the ALARA principle over past and current operations. It should substantiate, through design and operational changes, how worker exposures are to be reduced in line with this principle.	10	10.4, 10.6
P37.24	Government must require design improvements to reduce ionising radiation exposure during the capital outlay of any proposed expansion.	10	10.6
P37.25	Government must not consider granting approvals for expansion to 350,000 t/a on the basis of conceptual designs and in advance of substantiated design to reduce radiation risks to workers.	10	10.6
P37.26	The EIS does not address radiation management issues in a scenario where uranium export licences are withheld or withdrawn.	10	3.2
P37.27	WMC dose exposure methods may significantly underestimate exposures and do not give the benefit of doubt to mine workers.	10	10.6
	The following comments (P34.32–P34.53) are extracted from supplementary material provided by ACF and represent issues not already raised in the original submission		
P37.28	Given the spiritual and cultural association of the Aboriginal community with the mound springs, the Aboriginal heritage aspects of the projected 50 year impacts on the mound springs must be assessed.	6.3	2.4
P37.29	The EIS should set production limits on uranium.	–	1.5
P37.30	Given that Commonwealth uranium export provisions specify quantitative limits, the EIS should specify the limits for uranium from Roxby Downs.	–	1.5
P37.31	The EIS should assess the tailings dam leak from Roxby Downs and the findings of the South Australian Parliamentary Committee on the leak.	8.1	8.2
P37.32	The proposed expanded tailings dam system should be analysed in the context of its previous failure, its capacity to manage waste for the life of the mine, the decommissioning of the mine, and the radioactive life of the waste.	8.1, 8.10	8.2, 8.5

No.	Summary	Reference in EIS	Reference in Supplement
P37.33	The EIS must make provision through design and operational procedures for reduced radiation dose levels to 10 mSv/a. Under the design proposed by WMC, only administrative measures to reduce worker exposure are available, which is unacceptable.	10	10.6
P37.34	Government should not consider further approvals to an operator that cannot demonstrate a record of successful initiative in regard to ALARA.	10	10.6
P37.35	WMC is not proposing to significantly reduce individual radiation exposures for underground mining personnel.	10	10.6
P37.36	The EIS does not provide information on the proposed use by WMC of the cycling of workers.	10	10.6
P37.37	WMC should substantiate how it intends to reduce individual and total exposure without recourse to cycling of workers.	10	10.6
P37.38	Design and operation of the ventilation system, local ventilation control and mining methods must demonstrate reductions in individual and total exposure before approvals are considered.	3.3	10.6
P37.39	WMC must not be allowed to circumnavigate the EIS process by its decision to construct facilities for expansion to 200,000 t/a prior to assessment of its design and granting of approvals.	–	1.5
P37.40	It is not acceptable to postpone investigation of the effect of a design change on individual exposures until after the change is operational, as proposed for the electric train haulage system. Demonstrated radiation exposure reduction must be a requirement of all design parameters associated with exposure.	10	10.6
P37.41	If the 200,000 t/a expansion is approved, WMC should have to demonstrate a record of reduced worker radiation exposures through design and operational procedures before Government considers approval for further expansion.	10.2	1.5
P37.42	WMC calculates radiation dose at Olympic Dam using a method that Worksafe Australia has described as greatly reducing the dose estimation and as not consistent with the recommended method. Worksafe has suggested that WMC's method of calculation should be investigated further.	10.2	10.6
P37.43	WMC's use of a conversion factor of 5 mSv = 1 WLM contrasts with the accepted practice of 10 mSv = 1 WLM, as recommended by the Australian Radiation Laboratory. Why does WMC use methods inconsistent with those recommended in the code?	10	10.6
P37.44	The EIS should address the greatly reduced exposure estimates resulting from WMC's methods and the influence on worker radiation exposure health records.	10	10.6

No.	Summary	Reference in EIS	Reference in Supplement
P37.45	The EIS should provide the radiation dose levels of workers at Olympic Dam as estimated using methods that are recommended in the Code and that do not greatly reduce dose estimates.	10	10.6
P37.46	The EIS does not address the right of all workers at Olympic Dam, since operations began, to know WMC's reasons for using the methods it does and the resultant extent of reduction in reported dose levels.	10	10.6
P37.47	Compliance with the Australian national standard for occupational exposure to ionising radiation is dependent on calculation of dose levels using appropriate and recommended conversion factors and procedures. The investigation recommended by Worksafe must proceed as a matter of urgency.	10	10.6
P37.48	The Commonwealth must require WMC to adopt conversion factors and dose calculation methods that are framed conservatively and give benefit of doubt to workers' health and not WMC compliance with standards.	10	10.6
P19 Australasian Radiation Protection Society			
P19.1	The radiation safety aspects of the Olympic Dam Expansion Project (Chapter 10) are well presented and provide both explanation and justification of the project radiation doses. In general, the information provided is based on current radiological standards and best practicable technology for radiation protection.	10	10.4
P19.2	Radiation is only one of many occupational and public hazards associated with mining and mineral processing, and sufficient resources must be available for more 'conventional' hazards. The amount of effort spent on radiation protection is commendable but may represent a higher commitment than the actual risk would justify. However, due to the high level of public concern relating to radiation the effort is worthwhile if it provides the public with the information required to understand and accept the radiological impact of the project.	15.5	15.2
P19.3	ARPS supports the WMC initiative to adopt the ALARA principle but requests that some detail of the ALARA programme should be presented in the EIS.	10	10.4
P19.4	From the radiation protection standpoint, the decommissioning and rehabilitation of tailings impoundments is of major importance. ARPS recommends that some planning for the rehabilitation of the tailings structure should be incorporated into the EIS. A programme of research into tailing rehabilitation should be provided if there is no current plan for the rehabilitation.	8.10	8.5
P19.5	The EIS should contain information on the source of dose conversion factors and also any models used to modify default values.	10	10.4

No.	Summary	Reference in EIS	Reference in Supplement
P19.6	The EIS should provide information on the projected releases of radioactive substances and the proposed mechanisms for monitoring these releases.	10, N	10.4
P19.7	Figure 2.19 shows a suitable management structure for radiation protection but does not include to whom the Radiation, Environment, Safety, Quality (RESQ) Manager reports.	2.5	10.4
P19.8	The use of a central thickened discharge (CTD) tailings management system may cause problems in the future when it comes to decommissioning and rehabilitating the tailings structure. The shape that arises from the CTD system will cause any water run-off to move to the outside of the structure, which may increase the risk of erosion and decrease its structural life.	8.10	8.5
P19.9	As limestone may commonly have karst structures within it (dolines and caves), it is important that any tailings area is investigated for imperfections in the base that may adversely affect the structural integrity of the system.	8.5, 8.6	8.3
P19.10	In Figure 10.8 the ratio of airborne radionuclides appears to be incorrect. In the text there is mention of the importance of ^{210}Po in the smelter yet there is no contribution of this radionuclide to workers on Smelter level 1. This figure should be checked for correctness for all work areas.	10.2	10.4
P19.11	In Figure 10.11 it appears that the contribution of alpha-emitting radionuclides to workers in the uranium product packer is relatively small. Is a Respiratory Protection Factor (RPF) being used in the calculation of occupational exposures to airborne radionuclides.	10.2	10.4
P19.12	The numbers quoted in Table 10.3 are only the extrapolated probable occurrence of death in the defined population. The table gives the impression that this will be an actual number when it is only the probability and having 0.04 deaths is a meaningless concept (a person is either dead or alive and there is no intermediate state).	10.2	10.4
P19.13	There is some confusion about the current and previously used ICRP systems of dose limitation (p. 10-24, 'comparison of risks'). The current system of dose limitation is based on a level 'just tolerable' and the system based on comparison of risks with 'safe' industries is no longer used.	10.2	10.4
P19.14	The probability of cancer death associated with radiation in Figure 10.19 should be compared with the cancer risk from other causes and with the normal cancer risk of 250,000 per million. For example, the percentage of deaths from malignant tumours in Australia is 25% (Bourbeau, R. 1993. *World Health Statistics Quarterly* 46(1):4–33).	10.2	10.4
P19.15	If information is available on the environmental distribution of ^{210}Po and the other radionuclides in the uranium series, it would be useful to display it in the EIS in a similar manner to Figures 10.24, 10.25 and 10.26.	10.3	10.4

No.	Summary	Reference in EIS	Reference in Supplement
P26 Big Scrub Environment Centre Inc.			
	This author provided a comprehensive submission on the damages from the tailings. This submission is similar to Submission P9.		
P28 Blyth, J.			
P28.1	The EIS is too narrow to bring into consideration several major consequences of the proposed Expansion Project.	–	1.5
P28.2	Extraction of water from the Great Artesian Basin should not be allowed at all. Increased extraction for an expanded mine will hasten degradation of the mound springs.	4.2	4.2, 7.4
P28.3	There is no safe level of exposure to ionising radiation. Levels of 'allowable' exposure for uranium miners are constantly being lowered in response to new data. Workers should not have to expose themselves to these dangers in order to make a living.	10	10.5
P28.4	The nuclear fuel cycle has been demonstrated to be dangerous, whether uranium is used for nuclear fuel reactors or weapons.	10	1.5
P28.5	The problem of safe disposal of nuclear waste is unsolved. The decommissioning of nuclear power stations now facing the USA, ex-Soviet Union countries and Europe is an expensive and technically difficult process involving storage of vast quantities of radioactive materials.	10	1.5
P28.6	It is not sensible to continue to mine and export uranium under these circumstances.	10	1.5
P23 Bowen, Z.			
P23.1	Off-road driving has increased in the municipal lease. What will be done to control the current damage, when will action be taken and how will the current damage be repaired? How many new control measures would be enforced (i.e. which legislation can be utilised)? The municipality should be jointly involved with WMC and the local authorities to solve the problem, with legislation being utilised to discourage and prosecute offenders.	7.2	5.3, 12.9
P23.2	The EIS should provide further explanation of the following issues relating to the Roxby Downs township sanitary landfill: • no adequate fencing to trap wind-blown refuse; • lack of daily trash cover; • no regular removal of wind-blown refuse from landfill surrounds; • acceptance of green waste at the landfill when there is a green waste recycling station in the township; • no recovery of woody material for use as firewood; • older sections not being progressively rehabilitated.	11.5	11.2, 12.9

No.	Summary	Reference in EIS	Reference in Supplement
P23.3	Who is responsible for the management of the clean landfills to the north and south of the township?	11.5	11.2, 12.9
P23.4	Why does the Council not provide a recycling service in conjunction with the refuse collection service?	11.5	11.2, 12.9
P23.5	The issue of safe disposal or recycling of waste oil and batteries requires further clarification.	11.5	11.2, 12.9
P23.6	Why has the WMC practice of preserving nature trees on new residential allotments and public areas not been encouraged by the Council?	11.7	12.9
P23.7	The following measures have not been made requirements for all housing in the Municipality: • inclusion of guttering and rainwater tanks • reduced water flow shower-heads • solar hot water systems.	11.7	11.3, 11.4
P23.8	Why has the local council not undertaken a cat control programme or introduced legislation for the control of domestic cats?	7.3, 12.9	7.3, 12.9
P23.9	The EIS does not define the legal status of the Municipal Lease, nor does it clarify which environmental Acts apply and can be enforced.	5.2	5.1
P23.10	Why was it agreed by the State Government and WMC to maintain the current arrangements of Town Administrator? What is being done to address concerns raised during the EIS community consultation process? When will the town be large enough to support an elected council?	12.9	12.9
P23.11	Procedures for inviting public submissions to the EIS should be improved: • A public meeting should be held within a week of EIS publication. • Comments made at public meetings should be recorded and included with submissions. • A submission guidelines form should be included in the EIS document.	1.3	12.3

P8 Cichon, S.

P8.1	What has been the outcome of the request for additional police officers during construction?	12.7	12.7
P8.2	The existing recreation centre is overtaxed at present. Are there any plans for expanding these facilities?	12.7	12.6
P8.3	The town lacks opportunities for young people.	12.7	12.6
P8.4	What is the status of the single men's quarters in relation to rumours that this area will not be completed to the standard that was first publicised.	11.7	11.6
P8.5	The conclusion that the increase in population would have minimal impact on existing facilities is surprising.	12	12.5
P8.6	Would it be possible to have a recycling programme running in Roxby Downs.	11.5	11.2, 12.9

No.	Summary	Reference in EIS	Reference in Supplement
P8.7	When will the town justify its own council.	12.9	12.9

P5 Conservation Council of South Australia

P5.1	The EIS contains gaps in basic essential information and this is inconsistent with the aim of public participation in the environmental impact assessment process.	1	1.5
P5.2	The EIS does not contain an analysis of the economic impact of the project, and the chapter on Economic Impacts incorrectly deals with levels of production at Olympic Dam.	13	2.5
P5.3	The EIS has completely and deliberately confused and intertwined the present project and the proposed project, and therefore should be rewritten with the existing project described in one section of the EIS and the proposed project in other sections.	1	2.5
P5.4	Assessment of expansion beyond 200,000 t/a of copper, to 350,000 t/a, should not be undertaken at the present time, some ten years in advance, and all references to production beyond 200,000 t/a should be removed from the EIS.	1	2.6
P5.5	The Department of Housing and Urban Development should notify the proponent that the EIS is unacceptable and that it should be redrafted and the public consultation process repeated. The reprinted EIS should be distributed at no charge to interested parties.	1.3	1.5

P27 Evans, Mrs P.A.

P27.1	The EIS was not readily available to the Roxby Downs community prior to the public meeting; nor was any information available on making a submission.	1.3	12.3
P27.2	The EIS and any similar public documents should be made available from the day of issue in sufficient quantities for overnight borrowing, and should include an explanatory 'How to make a submission' notice. This availability should be widely and effectively published in the area.	1.3	12.3
P27.3	The timing for the public meeting is of concern. It allowed only fourteen days to obtain a copy of the EIS, study it and compile and post a submission. The meeting also clashed with a well-attended Men's Health Night.	1.3	12.3
P27.4	The publicity for the public meeting was inadequate. Had it been well publicised in advance, an alternative date could have been selected for the health night. Was this a deliberate attempt to minimise local input, or contempt for the needs of a remote community?	1.3	12.3
P27.5	Publicity should be commenced well before the event, using local publicity avenues such as notice boards, local radio, letterboxing, school newsletters and posters.	1.3	12.3

No.	Summary	Reference in EIS	Reference in Supplement
P27.6	With the expansion project predicted to increase regional tourism, what provision is being made for an interpretative visitor centre? This facility could provide an additional drawcard as well as an educational tool. Tourism may also provide alternative employment opportunities.	5.2, 5.4	5.2
P27.7	Why is construction of a spur railway line from Pimba not included in the current proposal? This would reduce damage to roads and pollution from heavy vehicles, make travel safer and reduce impact on the fauna of the area.	11.3	3.2, 11.1
P27.8	The Roxby Downs sanitary landfill continues to be poorly managed by the Municipality of Roxby Downs (MRD), despite criticism by both the EPA and a KESAB Tidy Towns judge. MRD does not respond to suggestions for improvement from local residents or WMC's Environment section.	11.5	11.2, 12.9
P27.9	A separate area for disposal of tyres was only recently provided, despite being a legal requirement since January 1996. Why was the issue of management plans for tyres, or any separated materials, not addressed?	11.5	11.2, 12.9
P27.10	A request for an area to be provided for green waste has been ignored. The statement that there is an area allocated for tree disposal (p. 11-26) is wrong.	11.5	11.2, 12.9
P27.11	No attempt has been made to rehabilitate completed landfill sites, despite access to WMC expertise and equipment.	11.5	11.2, 12.9
P27.12	There has been no attempt to discuss dump design, layout, signage etc. with its users. Any proposal to alter management practices would benefit from this input.	11.5	11.2, 12.9
P27.13	The transfer station concept is an improvement on trench management but is more time-consuming and costly. The money would be better spent on 'point of collection' recycling.	11.5	11.2, 12.9
P27.14	Street sweeper's refuse should not be dumped in clean landfill. The contractors should be directed to dispose of this waste at the town dump or a site for contaminated fill.	11.5	11.2, 12.9
P27.15	Why should remediation of clean landfill (south) be a responsibility of ratepayers and not the infrastructure providers?	11.5	11.2, 12.9
P27.16	Existing recycling measures are to be commended, but these exist only because of efforts by WMC and private individuals/businesses, not MRD.	11.5	11.2, 12.9
P27.17	Reduction of solid waste requires a major attitude shift by MRD and early implementation of active reuse and recycling strategies.	11.5	11.2
P27.18	The use of reclaimed water in Roxby Downs is commendable, but effective use is a concern. Extra reclaimed water should be used on new parks and areas currently using potable water, not the community oval and sur-rounds. Reclaimed water should also be available for restricted irrigation and toilet flushing in new subdivision housing.	11.6	4.4

No.	Summary	Reference in EIS	Reference in Supplement
P27.19	The care taken in the southern subdivision design is pleasing and the concept of alternative housing is supported. Could rural blocks/hobby farms/English style cottage gardens (with reclaimed water and vegetation protection) be incorporated in the future? These could provide social benefits as well as alternative sources of income/ employment.	11.7	11.5
P27.20	The EIS addresses the problem of traffic management control devices in the southern subdivision, but not for existing major roads, particularly Axehead Road.	11.7	11.4
P27.21	The proposed parking bays should also be constructed on existing major roads for visual amenity and shade.	11.7	11.4
P27.22	Landscaping to the kerbline should be actively encouraged, but is currently opposed by the MRD. The concept should also be extended to homes adjoining cycle paths.	11.7	11.4
P27.23	The proposed teenage recreation facilities are commendable and very much needed, as are playground equipment, seating, and provision of vandal-proof drinking fountains. Shading of playgrounds, in addition to trees, is also essential, and any cover should provide all-day protection.	11.7	12.6
P27.24	There is no reference to stormwater harvesting as a freshwater source. Could stormwater from new housing be directed to a suitable location to provide a freshwater park/-reserve/wetland, rather than to existing sewerage lagoons.	11.7	11.5
P27.25	Community services are generally good, and most of the shortfalls have been noted in the EIS. Hopefully the improvements will be implemented.	12.7	1.5
P27.26	The auditorium acoustics are poor and require urgent attention. There are also demands for improved sporting facilities and teenage recreation.	12.7	12.6
P27.27	The library is heavily used and greatly appreciated but needs more space. Why is the mezzanine floor not to be constructed? The Chief Librarian has also stated that library funding would be severely cut by the establishment of full local government in Roxby Downs. Is this true and how is the library funded?	12.7	12.6
P27.28	The outreach service planned for ODVs 1 and 2 has not eventuated, apparently owing to lack of funds. This is unsatisfactory treatment of the Expansion Project workforce, whose limited leisure time may not be satisfied by the tavern and/or gymnasium.	12.7	12.6
P27.29	Why is it proposed that the existing arrangement of a Town Administrator continue until 2001? There has been no consultation with residents on this issue. Roxby Downs residents are unable to obtain information on the funding, expenditure and management of the MRD as the town is administered by MESA and not the Minister for Local Government.	12.9	12.9

No.	Summary	Reference in EIS	Reference in Supplement
P27.30	Rates levied in Roxby Downs are similar to several affluent Adelaide suburbs, which have more and better council services than Roxby. Residents have been told that rates will rise significantly if an elected council is installed, but have no way of assessing the truth of this.	12.9	12.9
P27.31	A large proportion of revenue in rural council areas equivalent or smaller in population to Roxby is spent on repairs and maintenance of ageing infrastructure. Roxby does not have this problem. Existing rate, water and electricity revenue is substantial and will increase with expansion. Residents do not know how this money is spent.	12.9	12.9
P27.32	A State Government investigation into the now defunct Advisory Committee recommended that the committee be given more power in decision-making processes. This never eventuated. The appointed administrator was indifferent to the community, and members were not replaced when they left town or resigned.	12.9	12.9
P27.33	The MRD has no interest in the preservation of native vegetation. Protected species preserved during construction can be destroyed later with MRD consent, contrary to the Supplementary Development Plan and the Native Vegetation Act. A legally binding caveat or heritage listing should be implemented to protect significant vegetation.	12.9	12.9
P27.34	Amenity plantings in Roxby Downs are either neglected or 'hacked'. There is little education or control of MRD maintenance contractors. Irrigation is spasmodic, often ineffective, and badly maintained. Dead or diseased plants are rarely replaced.	12.9	12.9
P27.35	Off-road vehicle control is very poor, causing severe damage to the fragile environment.	12.9	5.3
P27.36	Cat control in the town is non-existent , despite the concern of a large proportion of the community, including cat owners.	12.9	7.3
P27.37	There is a lack of positive environmental initiatives, such as encouraging use of rainwater tanks, solar hot water systems and reuse of grey water, and no support for local environmental groups.	12.9	4.4, 12.9
P27.38	As stated in the EIS, residents sharing town administration/ownership would be more committed to the community. This would encourage better care of the immediate environment and facilities.	12.9	12.9
P27.39	The re-establishment of the Advisory Committee is not a viable option under the current State-appointed administrator. The ideal solution is an elected local government. If this is not a viable option, residents need to be told why.	12.9	12.9
P27.40	The current administration needs urgent replacement with people with a proven track record of sound environmental practice and a clearly demonstrated willingness to work with the community.	12.9	12.9

No.	Summary	Reference in EIS	Reference in Supplement
P27.41	Roxby Downs has the potential to be a leader in best environmental practices and a showcase for the rest of Australia.	12.9	12.9

P33 Fisher, W.A.

P33.1	This public consultation process should not have excluded the issues related to the use of exported uranium. This exclusion from the EIS contradicts WMC's stated commitment to the National Strategy for Ecologically Sustainable Development. In addition, the Commonwealth Government has stated that uranium export issues will be considered separately to the EIS (a joint Commonwealth–State process). This is taken to mean that the Commonwealth Government will consider these issues without public consultation.	1.6	1.5
P33.2	The EIS and consulting process are a mockery. The 1996 Roxby Downs Amendment Bill, which was rushed through State Parliament, has already committed the South Australian Government to the expansion of the mine.	1.3	1.5
P33.3	The economic benefits predicted in the EIS lack credibility. Actual employment figures and royalties to date are considerably less than those predicted in the 1982 Draft EIS. The South Australian Government has paid more in infrastructure support than it has received in royalties. In addition, WMC receives taxpayer subsidies in the form of diesel fuel rebates, discounts on electricity, and free water.	13.3	2.2, 2.7
P33.4	WMC claims that the cost of extracting water results in water costs to the company of two to three times that levied on Adelaide consumers, and this is an incentive to conserve water. WMC is not accountable for this extraction. A sliding scale of water charges would provide a genuine, observable and accountable incentive to conserve water.	4.1	4.3
P33.5	No money will flow to SA from the 42 ML to be extracted from the Great Artesian Basin daily for the next forty years. The real cost is the threat to the mound springs and ultimately the Great Artesian Basin.	4.1	4.1, 4.3
P33.6	During 1993–1994 there was a government cover-up of the consequences (leakage of liquor) of a major design fault in the tailings storage facility. This design fault resulted from a radical modification of the original design proposed in the 1982 Draft EIS.	8.1	8.1
P33.7	The allowable radiation dose rate for mine workers is continually dropping. The health of Roxby workers and their families should be monitored, including after they have left Roxby. Australia is the only developing nation that does not have a national monitoring system to record exposure of mine workers.	10	10.7
P33.8	The terms of the Roxby Downs Amendment Bill would allow SA to become the uranium oxide processing centre for Australia, possibly with no financial benefit to the State.	1.3, 13	3.3

No.	Summary	Reference in EIS	Reference in Supplement
P33.9	Virtually every clause of the legislation, the original Indenture Bill and the 1996 Roxby Downs Amendment Bill, bestows enormous legal power on WMC in respect to the SA Government, without public accountability.	1.3	2.2
P18 Friends of the Earth, Australia			N/A
	Supplementary comments included with P3		
P3 Friends of the Earth, Australia			
P3.1	The terms of reference rule out questions related to the use of the mined uranium, and make it difficult to address the issue of export licences.	1.3	1.5
P3.2	The EIS does not consider alternatives to the proposed expansion.	3.12	3.2
P3.3	The terms of reference do not allow discussion of uranium markets, buyers or end users. It is not proven that there will be a market for expanded uranium production. What methods will WMC use to attract customers?	1.3	1.5
P3.4	Will new markets for uranium be opened in the Australian region, and if so, with what health and defence consequences for Australia?	1.3	1.5
P3.5	The EIS does not deal adequately with concerns related to the tailings, occupational health and safety, Aboriginal heritage or the mound springs.	3, 10, 6, 7	1.5
P3.6	There is no independent judge of the EIS, as the State government has financial interests in the mine expansion.	1.3	1.5
P3.7	Vested interests and the rework location will deter the State Government from adequately monitoring the mining operations.	1.3	1.5
P3.8	Many of the Aboriginal sacred sites held by the company have not been registered with the State Heritage Body.	6	6-1
P3.9	The State Government has a conflict of interest in its role of implementing, monitoring and regulating environmental conditions at Roxby Downs while maintaining a close connection with WMC.	1.3	1.5
P3.10	Material required for public assessment of the EIS, including technical difficulties, economic projections and sacred sties, has been concealed as 'commercially sensitive'.	1.3	1.5
P3.11	The cost of exporting uranium will be borne by the Commonwealth Government.	1.3	1.5
P3.12	WMC's groundwater use predictions for ten years are based on a suspect model.	4.5	4.1
P3.13	The survey of mound springs is inadequate and incomplete.	7.4	7.4
P3.14	Who is responsible for rehabilitation and long-term monitoring of the tailings after decommissioning?	8.10	8.5

No.	Summary	Reference in EIS	Reference in Supplement
	If standards for rehabilitation are inadequate or change in the future, who will be responsible for effecting new rehabilitation measures?		
P3.15	A register of all mine workers should be publicly accessible.	–	1.5
P3.16	WMC should use the standard Australian method of measuring (radiation) exposure.	10.1	10.2
P3.17	ICRP radiation exposure standards are considered to be too high; WMC exposure standards should not be higher than the levels accepted for mine workers in Britain and Canada.	10.1	10.2
P3.18	The EIS has not analysed the effect of climate change on the mine operations of tailings dams.	8.3	8.5
	The design of the proposed expansion does not allow for increased climate extremes.		
P3.19	The EIS appears to be more a propaganda instrument than a true cost–benefit analysis.	1.6	1.5
	The EIS should address the full economic, social, environmental and occupational health and safety consequences associated with the complete life cycle, i.e. 'cradle to grave', of the uranium mined from Roxby Downs.		
P3.20	The EIS confuses data and information related to different stages of the planned expansion and this needs clarification. The economic impact assessment is not valid.	1.1	2.5
	The two phases of the project should be defined in the EIS as 150,000 t/a to 200,000 t/a and 200,000 t/a to 350,000 t/a respectively, and all reference to the 85,000 t/a to 150,000 t/a stage should be deleted except in relation to the project background and existing operations.		
	Since the 200,000 t/a to 350,000 t/a phase has not been approved by the WMC Board, it should not be included in the EIS.		
P3.21	There are inconsistencies between royalty and capital investment figures supplied in the EIS and those from the State Government. The EIS compares dollar values from different periods without equating to constant dollar figures.	1.1	2.2
P3.22	The EIS should contain an accurate comparison between Government expenditure on infrastructure and royalties in constant dollar terms.	1.1	2.2
P3.23	The EIS should comment on all aspects of the *Roxby Downs (Indenture Ratification) (Amendment of Indenture) Amendment Act 1996* that impinge on the EIS. For example, what would be the State's liability if the assessment of the EIS led to a decision not to proceed with the project?	1.3	2.2
P3.24	The EIS should include all players in the uranium industry.	1.5	1.5
P3.25	What is the standing of the Uranium Institute; is it an independent body or an industry group and how reliable are its forecasts?	1.5	1.5

No.	Summary	Reference in EIS	Reference in Supplement
	It is considered that the Uranium Institute is an industry body with vested interests in promoting the industry. Forecasts from the Uranium Institute should be deleted from the EIS.		
P3.26	The EIS should provide figures on employment, GSP, GDP, royalties, taxes and balance of trade that pertain only to the expansion from 150,000 t/a.	1.5	2.2
P3. 27	The section on economic consequences of not proceeding with the project does not provide information on the benefits of not proceeding with the project or information on the negative effects of the project. This breaches the requirements of the 'Terms of reference' of the EIS. The EIS should include both the negative and positive economic effects that are avoided if the project does not proceed.	1.5	2.8
P3.28	The reference to minimising the seepage from the tailings storage facility (TSF) to underlying soils on p. 1-24 is a subjective term with vague meaning. When did this management practice come into being and what does it mean in quantitative measurement? Vague and/or subjective language, meaningless provisos and soft promises should be removed from the text. The EIS should give: • a quantitative definition of minimal/minimise; • the date from which the TSF design and management minimised the seepage.	1.5	8.2
P3.29	There is no mention of health benefits if the project does not proceed. The EIS should contain an estimate of cancers, birth defects etc. avoided if the project does not proceed.	1.5	2.8
P3.30	The description of the tailings management practices are inconsistent with actual management practices carried out for most of the period described. A more accurate account should be presented. The EIS should give more details, including dates, about the operations and environmental management used in the past at Olympic Dam.	2.4	2.1
P3.31	There are inconsistencies between statements in the EIS and what is permitted under the Indenture in regard to importation and processing of uranium ores and concentrates from sources outside the mine. The EIS should state that 'uranium ores or concentrates will not be imported and processed'.	3.1	3.3
P3.32	WMC should not have free access to Great Artesian Basin (GAB) water.	4.1	4.3
P3.33	Water cost comparisons are misleading and do not investigate the relationship between subsidy rates and conservation incentives.	4.1	4.3

No.	Summary	Reference in EIS	Reference in Supplement
P3.34	The section on water costs should be deleted and redone giving an analysis of full public costs.	4.1	4.3
P3.35	There are inconsistencies between claims of water use minimisation programmes and water consumption figures. The claim that 'Figure 4.6 also demonstrates the effectiveness of water minimisation practices after 1993 . . .' (p. 4-9) should be deleted.	4.1	4.4
P3.36	The data in Table 4.7 is said to be approximate but no estimate of uncertainty is provided. The EIS should provide uncertainty measures for all data.	4.5	4.1
P3.37	Projected impacts on GAB potentiometric head are of concern. The EIS should: • contain an independent review of the model used by the proponent to determine trends in potentiometric heads in the region and consequent impacts on mound springs in the region; • provide a range of scenarios for trends in potentiometric heads in the region and consequent impacts on mound springs in the region, including worst case scenarios; • review the effect of closing down Borefield A on the integrity of mound spring flow rates in the region.	4.5	4.1, 4.5
P3.38	Figures and statements about the cone of depression associated with mine water seem questionable. The EIS should explain, and give the significance of, the location of the cone of depression.	4.6	4.5
P3.39	What justification is there for predictions made in regard to mine flow rates? The EIS should give adequate justification for its predicted increase in mine inflow rate.	4.6	4.5
P3.40	There is a lack of quantitative information on water quality. The EIS should contain data on the analysis of all water, including rainwater, underground water, mine water, tailings liquor and GAB water. The analysis should include radioisotopes and should be accompanied by measures of the variability and uncertainty. Chronological data, especially for the underground water and the mine water, should be provided.	4.2	4.5
P3.41	WMC has the ability to renegotiate drawdown limits in regard to localised potentiometric pressure, which is inconsistent with best environmental management practice. WMC should not be allowed to 'negotiate' a higher drawdown limit thus evading a breach in legal drawdown requirements.	4.2	4.1
P3.42	What is being done to verify WMC is operating within the legal requirements of the Special Water Licence No. 2 conditions at Borefield A?	4.2	4.1
P3.43	What steps are being taken by MESA and WMC to prevent breach of the drawdown limits as set out in the Special Water Licence No. 2 over the last two years.	4.2	4.1

No.	Summary	Reference in EIS	Reference in Supplement
P3.44	The EIS should contain a review of: • what is being done to verify if WMC is still operating within the legal requirements of the SWL conditions in regard to the drawdown limit at the boundary of the Designated Area for Borefield A; • the actions of MESA and WMC over the last two years in order to establish if legal compliance with requirements under the Special Water Licence No. 2 was carried out; • a review of the regulation of WMC's legal compliances over a two-year period if it is shown that WMC was allowed to conduct monitoring that did not comply with legal requirements under SWL conditions.	4.2	4.1
P3.45	Inconsistencies between actual drawdown rates and those predicted by WMC for Borefield A indicate the need for independent analysis of the modelling used by WMC. A cost–benefit analysis of rates of drawdown greater than those used in this EIS should be included.	4.2	4.5
P3.46	WMC consultation processes with Aboriginal people have been poor and inconsistent.	6.1	6.1
P3.47	The EIS should, without reference to specific confidential matters of significance to Aboriginal people, outline the disagreement between WMC and the KPC (as referred to in the EIS), and any other Kokotha people, explaining what the problems were and if and how they were resolved.	6.2	6.1
P3.48	The consultation between WMC and the Arabunna people has been poor. There are indications that WMC has engaged anthropologists who have drawn up territorial boundaries that favour the company, and that WMC sets up and resources Aboriginal groups favourable to its activities. The Arabunna people are also concerned about the mound springs and sites damaged by pipeline construction.	6.3	6.1
P3.49	Flawed consultation processes between the company and Aboriginal people have exacerbated tensions within the Aboriginal communities in the region.	6.3	6.1
P3.50	The EIS should specify processes that WMC has instigated to ensure all Aboriginal concerns are addressed.	6.3	6.1
P3.51	The EIS should specify the verification processes for ensuring adequate and appropriate consultation with Aboriginal stakeholders. The EIS should provide a list of Aboriginal groups and individuals consulted.	6.3	6.1
P3.52	The EIS should indicate what disagreements exist between WMC and Aboriginal people, explaining the problems and outlining and existing and/or potential dispute resolution measures. This should include identification of all disputes and disagreement, current and historic, between WMC and Aboriginal groups, individuals, elders and spokespeople (including those when the operation was conducted under joint venture contracts).	6	6.1

No.	Summary	Reference in EIS	Reference in Supplement
	The EIS should: • provide a list of Aboriginal groups and individuals consulted; • specify processes WMC have instigated to ensure all Aboriginal concerns are addressed; • specify the verification processes for ensuring adequate and appropriate consultation with Aboriginal stake-holders.		
P3.53	The EIS should review the activities of WMC that have exacerbated conflicts between Aboriginal people in the region.	6	6.1
P3.54	The EIS should contain a comprehensive description, though not site specific, of the measures WMC will execute to ensure action is taken to protect Aboriginal sites and accommodate Aboriginal wishes and concerns.	6.7	6.2
P3.55	Ecologically sustainable development is not given a prominent enough role in the EIS.	7	7.1
P3.56	Analysis of liquid in the evaporation ponds should be provided.	8.1, 8.2	8.1
P3.57	The EIS should contain information on the suitability of clay used to contain various types of liquid wastes, and should address the problem of the dolines.	8.1, 8.4	8.3
P3.58	What is meant by the use of the term 'minimise' potential liquor migration? Vague and/or subjective language, meaningless provisos and soft promises should be removed from the text.	8.1,8.5	8.2, 8.6
	The EIS should contain current and projected rates of seepage from the TSF.	8.7	8.6
P3.59	When referring to the ponding of the supernatant in the tailings dam, the term 'central' is questioned.	8.1, 8.5	8.7
P3.60	Given the poor management practices that allowed the leak from the tailings retention system to occur and the inability of the proponent to identify and rectify the causes of the leak, the Expansion Project should not be allowed to proceed.	8.1	8.2
P3.61	The EIS does not provide adequate responses to many of the recommendations set out in the ERDC inquiry into leak from the tailings retention system. In particular, the EIS does not provide adequate responses to Recommendation 4, 9 and 15 of the ERDC.	8.1	8.2
P3.62	Failure by WMC to meet requirements and design features set out in the 1983 EIS, or to respond adequately to ERDC criticisms and recommendations, creates doubt about its intent in regard to this EIS.	8.1	8.2
P3.63	The design and management of the tailings storage facility do not meet international best practice.	8.5, 8.6	8.7

No.	Summary	Reference in EIS	Reference in Supplement
P3.64	The EIS has failed to show the proponent can meet State, Commonwealth, Aboriginal and conservation requirements or international best practices in respect to the design and management of the tailings containment, therefore the Expansion Project should not be allowed to proceed.	8	8.7
P3.65	The EIS should provide an explanation of the apparent discrepancy between the implication that leaks from the tailings retention system would be returned to the mine and Figure 4.22, which suggests that this is not the case.	8.7	8.7
P3.66	Detail about the need for evaporation ponds for the second (200,000–350,000 t/a) is not provided. It is inappropriate to make unsubstantiated comments that lack adequate details about potential infrastructure or management arrangements for expansions beyond the 200,000 t/a.	8.5, 8.6	8.6
P3.67	Statements regarding the cone of groundwater depression and groundwater pollution should be substantiated. The EIS fails to substantiate the claim that the cone of groundwater depression is a safeguard against groundwater pollution.	8.7	8.7
P3.68	Statements in regard to radium grades and standard deviations do not reflect variability in the data accurately. The EIS should present data in a manner that reflects this variability.	8.10	8.1
P3.69	Radon release rates associated with tailings are not compared to background release rates. The EIS fails to make direct comparisons between radon release rates associated with the tailings and the natural (pre-exploration) rates.	8.10	8.5
P3.70	Standard deviations for radon release rates are very high and measurement methods are unreliable. As it cannot be demonstrated that reliable (e.g. to within 10%) measurement can be made of all radioisotopes, the Expansion Project should not be allowed to proceed.	8.10	8.1
P3.71	Management risks that the tailings will remain radioactive for many thousand of years are ignored in the EIS. For the purposes of considering rehabilitation and radiation hazard, the EIS should assume that the region will be populated sometime in the thousands of years that the hazard will continue to exist.	8.10	8.5, 10.3
P3.72	It is considered that the average natural flux of radon from Australian soils is not relevant to this EIS and the pre-mining flux at the site is. The EIS should give the natural flux of radon for the mining lease prior to the commencement of work on the lease site.	8.10	8.5
P3.73	Average radon decay product concentrations are given without a description of how those averages are obtained. Use of averages in the EIS should be accompanied with a description of how the averages were obtained and over what parameters (time, direction, distance) the data was averaged.	8.10	10.2

No.	Summary	Reference in EIS	Reference in Supplement
P3.74	The EIS should define what is meant by the 'design life' and 'structural life' of the project.	8.10	8.5
P3.75	Rehabilitation should require return of the site to radon release rates equal to those of the site prior to the operation. The EIS should be modified to include rehabilitation back to the original (pre-exploration) condition or better.	8.10	8.5
P3.76	Pollution of the aquifer on the grounds that it is too saline to be of use is not justifiable. The EIS should be modified to take into account future needs for water; in particular, underground water should not be polluted or, if it is, should be rehabilitated. If this cannot be ensured the Expansion Project should not be allowed to proceed.	8.10	8.7
P3.77	The EIS should include precautions against accidental intrusion into the TSF over the time span that the TSF continues to be a hazard.	8.10	8.1
P3.78	Details of construction plans and programmes and a detailed waste management programme should also be included in the EIS.	8.10	8.3
P3.79	The EIS should contain data and figures showing the distribution of individual doses for the various occupations in the mine, processing plant and administration (c.f. Figure 10-15).	10	10.2
P3.80	Data on radionuclide composition of ventilation air and comparison with natural (pre-exploration) air should be provided.	10.2	10.2
P3.81	The EIS should respond to criticisms by Worksafe Australia regarding radiation doses from radon decay products; in particular, criticism to the effect that the proponent has underestimated, by a factor of two, radiation doses from radon decay products.	10	10.2
P3.82	The EIS should outline all the procedures for reducing radiation exposures in the area of the current smelter and calciner and the planned smelter and calciner.	10.2	10.2
P3.83	Data should be checked to make sure it is presented correctly (Figure 10.16).	10.2	10.2, D
P3.84	Estimates of health problems associated with the industry and the mine are not sufficient nor are estimates of the risks and potential future health problems. The EIS should include estimates, using the best available data and information, of the excess cancers that are predicted to arise from exposure to ionising radiation. These estimates should include various scenarios, e.g. a doubling of the assessed risk every twelve years. Scenarios based on models of higher risk, which are suggested in current research, should also be provided.	10.2	10.2
P3.85	The EIS should substantiate its claim that native plants and animals will not be eaten by people over the period covered by the EIS and in fact for the lifetime of the tailings.	10.3	10.2, 10.3

No.	Summary	Reference in EIS	Reference in Supplement
P3.86	Information about averaging processes in regard to uranium concentrations in dust and deposition rates presented in the EIS is poor (Figure 10.22). It should be clarified and include parameters of time, direction and distance.	10.3	10.2
P3.87	The EIS should compare any calculated current values with baseline (pre-exploration) data.	10.3	10.2
P3.88	Information presented in Figure 10.23 is confusing and of no value. The EIS should pay more attention to presenting data in a way that will enable contributions due to the project to be detected. The statement that 'annual changes in dust deposition rates do not appear to be a result of operational factors' (p. 10-29) is considered invalid.	10.3	10.2
P3.89	Information presented in Figure 10.24 is confusing and inconsistent with other claims in the EIS. Inconsistencies in the EIS regarding the effects of the operations on dust need to be clarified.	10.3	10.2
P3.90	All data on dust dispersion should include background references and contain measures of spread and uncertainty.	10.3	10.2
P3.91	There are inconsistencies in dose rate data presented in Figure 10.30 and Table 10.30. Data should be checked to make sure it is presented correctly.	10.3	10.2
P3.92	There is no measure of reliability for the claim that radiation dose is not correlated with mine production.	10.3	10.2
P3.93	Details in regard to measurements of background and pre-operational radiation levels are lacking. The year and method of determination of the so-called 'background' and 'pre-operational' uranium concentration levels should be included in the EIS.	10.3	10.2
P3.94	The EIS should discuss the difference in time between peak uranium concentrations at the Axehead and Olympic dams. The difference should be discussed in terms of mining activity, weather and the leak in the tailings retention system.	10.3	10.2
P3.95	Measures of uncertainty in data in Figures 10.34 and 10.35 should be provided.	10.3	10.2
P3.96	The use of a dispersal principle is inappropriate. The dispersal principle should be deleted from Table 10.9 and should not be allowed as a management practice.	10.4	10.2
P3.97	There are inconsistencies between codes of safety regarding dose rates that require clarification. The definition of non-designated employees should be those whose annual radiation dose is unlikely to exceed 1 mSv/a.	10.4	10.2
P3.98	The EIS should comment on all aspects of the *Roxby Downs (Indenture Ratification) (Amendment of Indenture) Amendment Act 1996* that impinge on the EIS. This should include discussions of any restrictions on standards that governments can impose in relation to environmental requirements and radiation protection.	10.1	10.2

No.	Summary	Reference in EIS	Reference in Supplement
P3.99	It is unclear how many people work on radiation safety for the proponent. The EIS should give the number of people employed full-time by the proponent on radiation safety.	10.4	10.2
P3.100	The EIS should explain why saline water from the GAB can be made useful using a reverse osmosis process, but the local saline groundwater cannot be made useful using the same technology.	11.1	4.3
P3.101	Information pertinent to the 1983 EIS or to the expansion up to 150,000 t/a is not relevant to this EIS except as background information, and it is therefore not appropriate to include it in Chapter 12.	12.1	2.5
P3.102	The EIS should give direct comparison between the estimates of workforce levels made in the 1983 EIS, the actual results in 1997 and the current projections for 150,000 t/a. In relation to predictions of workforce requirements, the EIS should describe what if any, allowance has been made for technological improvements.	12.3	2.7
P3.103	The examples in Table 12.7 are too narrow. The EIS should state whether the examples given in Table 12.7 are representative and a reference should be provided for a more comprehensive listing.	12.3	12.1
P3.104	Economic benefits to the State and, in particular, the Northern District are not proven in the EIS and appear to be more propaganda than realistic analysis. Para. 3, the first sentence in para. 4 and the first two sentences of para. 5 on p. 13-3 and going over on to p. 13-4 should be deleted.	13.1	1.5
P3.105	The EIS should contain evidence of the validity of the economic model. In particular, the model should be applied to the current level of activity (85,000 t/a) at Olympic Dam and the predictions compared to empirical data. If such a test cannot be carried out then the entire Economic Impact section of the EIS should be deleted.	13.2	13.2
P3.106	Economic predictions and modelling should only be presented for expansion beyond the 150,000 t/a and base case information should start at 150,000 t/a. The economic modelling of the Expansion Project should be carried out for the production from 150,000 t/a to 200,000 t/a and all reference to production from 85,000 t/a to 150,000 t/a should be deleted.	13.2	2.5
P3.107	Impacts on public revenue do not include all costs incurred by government departments and agencies.	13.2	2.2
P3.108	Modelling results should include sensitivity analysis covering reasonable variations of all key parameters.	13.3	13.2
P3.109	Economic modelling is based on unrealistic export rates. The assumption that all product is exported should be replaced by a more realistic assumption, e.g. 77% of product is exported.	13.3	13.2

No.	Summary	Reference in EIS	Reference in Supplement
P3.110	The impact of the project on the Public Service Borrowing Requirements should include costs incurred by government departments and agencies.	13.3	2.2
P3.111	The relevance of predictions in regard to expansion from 200,000 t/a and 350,000 t/a is questioned, given that no decision that this expansion will proceed has been made.	13.3	2.6
P3.112	Economic benefit to the State is not assured as royalties are dependent on ore sales.	13.3	2.2
P3.113	Inconsistencies between past predictions in production rates and employment levels and those actually realised indicate possible flaws in the models used in this EIS. The EIS should address the inconsistencies in production rates and employment levels between those forecast in the original, early 1980s, documentation, including the 1983 EIS, and those rates and levels that were eventually realised. The models and predictions supplied in this EIS should incorporate these realised trends in rates and levels, and figures should be presented based on this analysis.	13.3	2.7
P3.114	The EIS should include financial arrangements that ensure full rehabilitation irrespective of the future of the project or the company.	14	14
P3.115	The lack of final rehabilitation and decommissioning plans is not appropriate. The EIS should contain final rehabilitation and decommissioning plans based on project lifetime of twenty years.	14.4	14
P3.116	The acidic nature of the tailings should not be presented as a constraint to rehabilitation. The reference to the acidic nature of the tailings in para. 3, p. 14-3 should be deleted.	14.3	14
P3.117	The last three paragraphs of Section 14.3 have nothing to do with constraints to rehabilitation and should be deleted.	14.3	14
P3.118	The EIS should address the question of reducing greenhouse gas emissions through the use of renewable energy sources.	15.7	
P3.119	The meaning of 'permanent markers' in regard to the tailings storage facility is unclear. The EIS should more adequately describe the nature of the 'permanent markers' to be erected on the tailings retention system (Table 15.8, Section 8.10)	8.10, 15.7	8.1
P3.120	The EIS should review the confidentiality powers granted to WMC and the South Australian Government, including an assessment of the confidentiality powers on full disclosure and public accountability over the life of the operation.	1.3	2.2
P3.121	The EIS should address the issue of public accountability in regard to potential impact of the Olympic Dam operations on the environmental, social and economic sectors; for example, effects on the GAB and mound springs.	1.3, 15.1	2.2
P3.122	The EIS should describe how WMC intends to implement the ERDC recommendation that the Roxby Downs operations be 'more open to public scrutiny'.	1.3, 15.1	2.2, 15.3

No.	Summary	Reference in EIS	Reference in Supplement
P10	**Geological Society of Australia (SA Division)**		
P10.1	The GSA recommends that the present and proposed practice of dust reduction on unsealed roads by application of naturally contaminated groundwater should be discontinued, because of addition of salts, uranium and radon to the surface environment.	4.1, 9.4.2	2.1
P10.2	No innovative strategy has been proposed for domestic water usage in the arid environment. Such a strategy should include a dual system of water reticulation (separate high-quality potable water and 'grey' water), domestic rainwater tanks, and domestic scale solar evaporative desalination units.	4.1	4.4, 11.3
P10.3	No single well-defined tailings management system has been provided.	8.3	8.1
P10.4	Reliance on naturally occurring clay and limestone barriers beneath the tailings storage facility to contain heavy metal-rich, radioactive tailings liquors is misplaced. A fabricated impermeable membrane must be installed at the base of any new tailings storage facility, and a carbonate-bearing slurry could be sprayed with each tailings layer to provide *in situ* neutralisation capacity.	8.1, 8.5, 8.6	8.3
P10.5	Alternative tailings storage strategies must be specified in the event that tailings do not achieve sufficient strength to hold later tailings lifts.	8.5	8.3
P10.6	The proposed new central thickened discharge (CTD) tailings system, if implemented, must be designed to cater for a 1-in-500 year rainstorm event, at least equivalent in stormwater design to the present paddock system.	8.7	8.6
P10.7	Radon measurements at the tailings facility are presently imprecisely known. The 'accumulator drum' method for radon measurement must be implemented as proposed.	8.9	8.1
P10.8	Radon emissions from the proposed CTD tailings system will be approximately 70-80% higher than from the present paddock system. Increased local pollution is unacceptable, and the present paddock method is therefore preferred.	8.9	8.4
P10.9	Firm commitment must be given to over-engineer, rather than under-engineer, the final earth and rock cover on the tailings storage facility, because this barrier is vital for sub-aerial containment of long-lived radioactive products in the tailings.	8.10	8.3
P10.10	Injuries and deaths from industrial and transport accidents at Olympic Dam operations are likely to be more numerous than those projected from radiation exposure.	15.6	1.5
P10.11	Current and proposed exposure mitigation procedures must remain in place and be implemented.	10.4	1.5
P10.12	The tailings retention facilities must be lined by fabricated impermeable bases to eliminate subsurface leakage, and must contain a final cover of 1 m of soil and rock armour to minimise radon emission in the very long term.	8.5, 8.6, 8.10	8.5, 8.6

No.	Summary	Reference in EIS	Reference in Supplement
P12 Harris, M. & S.			
P12.1	There are a number of concerns with municipal management relating to: • perceived double standards regarding caretaker occupation of light industrial blocks; • perceived lack of a mechanism for community involvement in municipal management; • perceived lack of environmental management by the municipality, including removal of disused machinery from the light industrial zone and control of mosquitoes; • perceived secrecy and bureaucracy associated with the municipality.	12.9	12.9
P1 Lewis, Peter			
P1.1	The Water Resources Act in Table 1.5 will be replaced shortly by a much wider ranging Act. Presumably approval conditions for Borefields A and B would be covered by the new Act.	1.3.1	1.5
P1.2	Why not use all the waste material in the tailings for mine backfill?	2.4.1	8.7
P1.3	Why not further treat the fine material in the tailings by melting to form a granular material suitable for use as mine backfill?	2.4.1	8.7
P1.4	The current tailings storage proposal would result in a tremendously large tailings heap.	2.4.1	1.5
P1.5	Is three days underground storage of mine water sufficient as power failures of longer duration could occur?	3.3.10	3.1
P1.6	Could the heat produced in the processing plant be used, for example, to treat the highly saline groundwater to recover water suitable for process use?	3.8.6	4.4
P1.7	Rates for re-establishing flows at Beatrice, Priscilla and Venable mound springs, given in Table 7.18, appear to be optimistic due to the slow rate of water flow quoted in Section 4.2.1.	4.2.1, 7.4.11	7.4
P36 McGovern, A.M.			
P36.1	What geophysical effects are expected as a result of this size and type of orebody being partially or totally extracted?	Summary	2.1
P36.2	How large is this orebody (in total)? Describe in map form with details of drilling finds across the Stuart Shelf.	Summary	2.1
P36.3	What is the projected area of expansion for expected maximum levels (presented in map form)?	Summary	1.5
P36.4	WMC's adherence to regulations cannot be readily assessed as no comparative raw data is released (e.g. readings from dosimeter badge).	Summary	10.7

No.	Summary	Reference in EIS	Reference in Supplement
P36.5	Some standards have been changed to meet industry needs; for example, tailings management and allowed drawdown limits in the Borefield A Designated Area.	–	4.1, 8.1
P36.6	It is inappropriate that issues such as export be omitted from the EIS.	B	1.5
P36.7	The amount of time allowed for the public to respond to the EIS is not sufficient to allow appropriate study, research and comment.	1.3	12.3
P36.8	Government provisions to establish Roxby Downs township were based on an estimated population of 9,000 people, and funds in excess of this were spent at that time. The maximum indicated population is now half that estimate.	12.4, Table 12.10	2.2, 11.4
P36.9	What is the total extent of underground development and production?	2	2.1
P36.10	What is the maximum extent of projected development and production (presented in map form).	3	2.1
P36.11	Plans and details of extensions to the Special Mining Lease need to be included in the EIS for assessment.	–	3.1
P36.12	The project lies in the vicinity of major fault zones. What impact is expected in the event of an earthquake and as expansion occurs?	Figure 3.1	2.1, 8.3
P36.13	What is the 'pulverised fuel ash' used in backfill?	Summary	2.1
P36.14	Further surface impacts caused to ameliorate damage underground are evidence of non-justifiable mining practices. More information is needed for assessment of use of this quarry.	3.3	3.1
P36.15	More information on the use of dune sand is required (source location, quantity used, impact).	2.1	2.1
P36.16	Impacts of current and proposed mining activities will preclude life-sustaining activity in the area for generations to come.	7.1	1.5
P36.17	Regulations regarding emissions levels are in question internationally, and present levels are no guarantee of air quality.	9.2	1.5
P36.18	The estimated costs to South Australia of establishing, maintaining and ensuring future safety of this project should be compared with economic recovery through royalties.	13	2.2
P36.19	Itemise the $3.2 million spent on environmental care.	Table 1.3	2.1
P36.20	The abstraction of excessive quantities of water from the Great Artesian Basin (GAB) is detrimental to the surrounding environment.	Table 4.4	1.5
P36.21	Planning an extension of the township in expectation of developments that have no company commitment or long-term future is a misuse of public resources and an unnecessary intrusion on the land.	11.1, 11.7	2.6, 11.4
P36.22	WMC's environment policy is incompatible with its uranium mining activities.	1.1	1.5

No.	Summary	Reference in EIS	Reference in Supplement
P36.23	The Environmental Management Reports do not give actual information or results, and 'interdepartmental material' (actual data) is not available to the public.	Summary	2.2
P36.24	What are the 'stringent radiation safety practices' initiated by WMC in 1988 and what practices were in place prior to this, given that workers were exposed to the same radioactive environment?	10	10.7
P36.25	Members of the public, employees and the environment are exposed to radionuclides attributable to operations found up to 5 km from the site.	10	1.5
P36.26	The presence of potential pathways from soil to people via plant and animals is another example of the non-sustainable future for this region.	10.3	10.3
P36.27	Dewatering and contamination of the surrounding country is already extensive, with both foreseen and unforeseen impacts in a very short period. Unforeseen impacts include: • tailings pond leakage; • sufficient relationship between the tailings retention system and groundwater to result in dieback of vegetation in the operations area; • uncontrollable flow of water at Gosse Bore, drilled by WMC in 1987.	4.6	4.5, 8.2, 8.7
P36.28	The short time in which the predicted loss of flow at Venable Spring occurred indicates the degree of impact caused by excessive water abstraction.	4.2	4.2
P36.29	Unforeseen impacts occurring at the same rate at Bopeechee and Hermit Springs indicate that the rate and extent of dewatering was underestimated. Part of this water loss were attributed to the uncontrolled monitoring outflow from GAB 6.	4.2	4.2, 4.5
P36.30	The Kokotha people did not agree with this venture proceeding in their country, and their rights of access were stolen from them by WMC.	2.5, 6	6.1
P36.31	The Arabunna community is deeply concerned for the future of the mound springs. The expansion will only further impinge on the lives of indigenous people.	2.5, 6	6.1
P36.32	There is no commitment from WMC to realise plans.	Foreword	2.6
P36.33	There is no assurance of water beyond six years' production at 350,000 t/a.	4.4	4.1
P36.34	Decommissioning plans for site rehabilitation, including tailings, are required as part of the assessment.	14	8.5
P36.35	The rate of development covered by the 1983 EIS is already imposing excessive impacts within the region. There is little or no reassessment by WMC or the State or Commonwealth governments.	2	1.5
P36.36	At each planned phase, WMC is planning to add infrastructure beyond the needs of that phase.	3	2.6

No.	Summary	Reference in EIS	Reference in Supplement
P36.37	WMC wants guarantees that give scope for mining beyond current levels with little regard for the greater environmental impact.	3	1.5
P36.38	The estimated 85,000 t/a of imported copper concentrates is significantly more than the projected figures for each phase of expansion. The EIS does not assess the additional energy, water and disposal processes required for this.	3.7	3.3
P36.39	What returns does Government expect for increased demand on State infrastructure and extra resource requirements?	13	2.2
P36.40	If 73†million tonnes have been extracted since 1988, the life expectancy of the project is sixty years or less. Given the already rapid rate of water depletion, the expected water supply will last less than twenty years.	4	4.1
P36.41	The 1983 EIS identified drawdown limits of 2 m at the boundaries of the Borefield A Designated Area. What justification do WMC and the South Australian Government have for the divergence from original agreements?	4.2	4.1
P36.42	The EIS states that planning for expansion to 350,000 t/a is insufficiently advanced to calculate water balances. Approvals for this level of expansion are inappropriate without all relevant data.	4.4	2.6
P36.43	What is WMC's average estimated yearly sale of water to Andamooka?	4	4.5
P36.44	Many mound springs show reduced moisture levels and degradation of surrounding vegetation. Contrary to the 1983 EIS, further studies (P. Cook, CSIRO 1987) have indicated that 'transpiration' levels have significant effects on water loss.	Table 4.7	7.4
P36.45	The EIS should show maps of the GAB below Borefield B.	Figure 4.3	4.1
P36.46	The EIS should define aquifers, their individual recharge and discharge points and recharge–discharge rates.	4	4.1
P36.47	The proposed expansions within the Roxby Downs and mound springs area are excessive, poorly planned and researched, and likely to place heavy costs on the community and the environment.	3	1.5
P36.48	The uranium industry is incompatible with principles for a sustainable future in the region.	–	1.5

P32 Margetts, Dee—Senator for Western Australia, The Greens (WA)

P32.1	The EIS does not address the wider environmental, public health and international security implications of uranium once it is exported.	1.6	1.5
P32.2	The guidelines should consider the impacts associated with mining and milling, tailings waste, nuclear energy production, radioactive waste and nuclear weapons production, commonly known as the nuclear fuel cycle.	1.6	1.5

No.	Summary	Reference in EIS	Reference in Supplement
P32.3	Environmental groups have provided information that the environmental assessment process has not been valid. The State Government has agreed to WMC's extraction of water from the Great Artesian Basin for the next forty years prior to Commonwealth environmental assessment.	1.6	4.1
P32.4	The EIS fails to assess the drawdown of 42 ML of water from the Great Artesian Basin over the next forty years.	4.2	4.1
P32.5	The EIS should take into account the arguments examined in the Select Inquiry into Uranium Mining and Milling (copy provided) and my Minority Report. The latter examines the downward trend in International Commission for Radiation Protection Standards and the impacts for uranium mining projects.	10	10.5
P32.6	Current standards of 20 mSv/a over five years or a maximum of 50 mSv in any one year are being re-examined. It is expected that acceptable standards may drop to 10 mSv by 2005. The Australian Radiation Laboratory has admitted that it does not believe the Jabiluka mine can meet existing standards. Olympic Dam's operations should be reviewed to see if the potentially lower exposure levels can be met.	10	10.5
P32.7	Occupational health and safety standards in particular should be reviewed, given Worksafe Australia's criticism of WMC's method of calculating radiation doses.	10	10.5

P34 Mineral Policy Institute

P34.1	The EIS submitted by WMC should have been prepared following the guidelines issued by the Commonwealth Department of the Environment and the South Australian Department of Housing and Urban Development. There is little consistency between the guidelines and the EIS.	1.6, B	1.5
P34.2	The EIS fails to give the quantitative information required to enable evaluation of the project environmental impacts. It should be rewritten including the relevant information before any final environmental assessment is taken or project approval given.	–	1.5
P34.3	There is no appendix describing the ODEX1 model and a lack of proper data on which to base conclusions about its reliability.	4.5	4.1, H
P34.4	The lack of a description of the ODEX1 model is inconsistent with the guidelines for preparation of the EIS.	4.5	4.1, H
P34.5	There is no information (or references) in the EIS to allow evaluation of the assumptions used in calculations of water usage.	4.3, 4.4	4.5
P34.6	It is unclear whether calculations are based on total water balance of the Great Artesian Basin (GAB) or just in the vicinity of Borefields A and B. It appears both have been used, which introduces scale problems not discussed in the EIS.	4.2, 4.5	4.1

No.	Summary	Reference in EIS	Reference in Supplement
P34.7	No information is given on the transient nature of parameters such as porosity, permeability, hydraulic conductivity and transmissivity of an aquifer in the vicinity of the bores during ongoing extraction, and the potential impact on the local hydrogeological system, especially mound springs. Sediment consolidation and particle removal can drastically change these parameters. Failing to discuss this is a breach of the guidelines.	4.5	4.1
P34.8	Neither scale factors affecting calculations nor computational limits are discussed in the chapter on water management.	4.5	4.1
P34.9	No mention is given to the reliability and validity of forecasts and predictions, nor are the confidence limits and margins of error indicated, as required by the guidelines.	4.5	4.1
P34.10	There is no information on the confidence limits and margin of error for the 'approximate' values in Tables 4.7 and 4.8.	4.5	4.1
P34.11	There is a similar lack of information for Figures 4.11–4.17.	4.3, 4.4, 4.5	4.1
P34.12	No information is given on the effect of further extraction on the Lake Eyre North hydrology, although Figure 4.11 indicates the volume of rocks below the lake will be affected.	4.5	4.5
P34.13	There is no supporting information for the conclusion that the new borefield will be located 'to harvest water that would otherwise be lost to vertical leakage'.	4.5	4.1
P34.14	There are too many omissions and approximations to make a proper evaluation of the proposed tailings retention system (TRS), as required by the guidelines.	8	1.5
P34.15	There is no discussion of the technical aspects related to construction of the expanded TRS.	8	8.3
P34.16	There is no description of stability studies or how stability values were obtained and to what extent they are preliminary.	8	8.3
P34.17	Figure 8.5 is insufficient to evaluate the construction works. Similarities with the current TRS are not an excuse to exclude this data.	8.5	8.3
P34.18	The type of seismic conditions chosen to calculate stability factors is unknown and no references are cited. The guidelines require a clear description of seismic stability.	8.5	8.3
P34.19	The description of materials to be used for embankments is inadequate: there is no geotechnical description of sand dune material, the geotechnical properties of tailings change in response to the amount of sand fraction removed, and there is no mention of possible quick-sand effect under seismic conditions.	8.5, 8.2	8.3
P34.20	The optimal thickness of the clay liner is a function of permeability and geotechnical characteristics of the used material and the hydrostatic head. None of these factors are fully discussed.	8.5	8.3

No.	Summary	Reference in EIS	Reference in Supplement
P34.21	The soil type likely to be used as a source of material for the liner is described as 'generally low-permeability'. Neither 'generally' nor the actual order of permeability are defined.	Tables 8.6 and 8.7	8.3
P34.22	The extent to which the calcium carbonate content is 'variable' is not discussed.	Tables 8.6 and 8.7	8.3
P34.23	The 'high plasticity' of the soils makes them unsuitable as clay liner. It is unclear how the nominated soil types can be used as a source of non-calcareous material for the liner.	8.4	8.3
P34.24	For the CTD system, the increase in radiation emissions associated with the implied increase of approximately 23% in tailings quantity at each site has not been discussed.	8.9	8.5
P34.25	No discussion is provided on long-term maintenance of moisture content of the surface 2 m.	8.9	8.5
P34.26	No evidence is presented to support the assertion that rock armour will solve the long-term problem of moisture evaporation from the tailings cover.	8.3	8.5
P34.27	Long-term climatic and seismological influences are not fully examined (e.g. probability of extreme events, maximum expected intensity of earthquakes). No mention is given to the incompleteness of Australian seismic and climatic records, which limits confident prediction of maximum expected events.	8.10	8.5
P34.28	Overall there is an incomplete description of the construction works required for the TRS expansion, particularly construction standards and techniques.	8.5, 8.6	8.3
P34.29	Long-term effects have not been fully described or quantified, particularly regarding the unsteady nature of the hydrogeological conditions of the GAB, locally and regionally.	4.2	4.1, 7.4
P34.30	Long-term and very long-term prevention of radon release, seepage and erosion at the TRS are not quantified.	8.10	8.5
P34.31	It is recommended that tailings at Olympic Dam should be disposed of by return to the worked-out areas of the mine, as suggested on p. 8-29 of the EIS.	8.9	8.7
	The following comments (P34.32–P34.53) are extracted from a supplementary submission by MPI and represent issues not already raised in the original submission.		
P34.32	The predicted increased water requirement for expansion to 350,000 t/a is 42 ML/d. However, based on the present usage rates of 1,570 L/t to the reduced 1,240 L/t of water and the expanded production levels, the demand for good quality process water will be approximately 58–75 ML/d. This discrepancy is not pointed out anywhere in the EIS.	4.4	4.4
P34.33	Figures for the aquifer re-injection programme for Bopeechee and Hermit springs are presented poorly and are difficult to interpret. No flow rates prior to the commencement of Borefield A are presented to allow true assessment of the programme.	4.2	4.5

No.	Summary	Reference in EIS	Reference in Supplement
P34.34	The figures presented show that the recharge and discharge rates for the South Australian portion of the GAB are approximately equal. However, the data and underlying assumptions behind this water budget are not presented.	4.2	4.1
P34.35	Investigation has revealed that vertical leakage has been calculated based on an assumption, not field data.	4.2	4.1
P34.36	A detailed review by Keane (1997) has shown that the South Australian portion of the GAB is not in equilibrium, that rates of various hydrogeologic processes have been changing markedly, and that the numerous published estimates are highly variable. Spring flows have been decreasingly dramatically over the past century, especially since the commissioning of Borefield A in the vicinity of the mound springs. Artificial extraction has increased markedly, especially for large-scale industrial projects such as Olympic Dam and the Moomba oil and gas fields, and further increases in production and other industrial projects are planned.	4.2	4.1
P34.37	The ODEX1 model does not incorporate the flow of water across the North-East Fault Zone, assuming it is impermeable to groundwater flow. However, it is well recognised that the fault is permeable, with a transmissivity of 2 m/d (Berry & Armstrong 1985).	4.5	4.1
P34.38	The EIS assumes that reducing the flow of vertical leakage would have no impact on other hydrogeologic processes. This is untrue as further extraction leads to a decrease in artesian pressure, which in turn leads to less vertical leakage but also lower driving pressures for pastoral bore and spring flows. The ODEX1 model assumes these flows are proportional to the difference between artesian pressure and surface level. Effects known to alter spring flow, such as barometric pressure, evaporation rates and others, are not included in the numerical model.	4.5	4.2
P34.39	The EIS recognises the sustainable supply of water as one of the principal issues raised by the Expansion project. Despite this, it does not incorporate discussion of a future Borefield C.	4.5	4.1
P34.40	Higher rates of extraction will keep artesian pressures depressed and prevent any recovery of the GAB in this area. The EIS does not present any data on the long-term water requirements and impacts on the GAB and springs, only assumptions on harvesting water that would otherwise be lost to vertical leakage and evaporation.	4	4.1
P34.41	The underlying but unstated assumption that flow reductions in springs is a necessary trade-off for water extraction is not, and cannot be, justified.	4.5	1.5
P34.42	The EIS states that flow rates from springs will not be significantly affected by the operation of Borefield B, but graphs presented in Chapter 4 show significantly reduced flows.	6.3, 4	4.5

No.	Summary	Reference in EIS	Reference in Supplement
P34.43	Williams and Holmes (1978) showed that the area of wetland supported by a spring is directly proportional to the flow rate. Therefore, any reduction in a spring's flow rate will reduce its ability to support associated wetland flora and fauna.	7.4	7.4
P34.44	Flow reductions at mound springs would lead to severe impacts on the long-term survival of their ecological communities and associated cultural values, yet the EIS assumes impacts are acceptable.		7.4
P34.45	Despite the short-term benefits to some springs from reduced extraction in the vicinity of Borefield A, the long-term predictions for flow rates show a decrease in flows to below 1996 measurements. The long-term sustainability of the springs and their associated cultural and ecological values is still highly questionable if Borefield A remains in operation.	4.5, Figures 4.14–4.17	7.4
P34.46	The mound springs are a principal tourist attraction in the region. The only way to minimise further impacts on these springs is to cease extraction of water from Borefield A.	5.2	4.2, 7.4
P34.47	The EIS argues that MESA's ongoing bore rehabilitation programme (and similar programmes in other States) will result in further water savings. However most of these bores are outside the influence of the borefields and will not positively affect ODO's future plans.	4.2	4.5
P34.48	It is argued that as ODO pays for its infrastructure costs, it should not have to pay for the artesian water. However, pastoralists in the region are charged for their use of artesian water. If WMC were charged for water at the same rate as Roxby Downs residents, this would amount to $4.34 million per year at current rates of water use. WMC should be charged for the artesian water it extracts.	4.1	4.3
P34.49	The EIS consistently states that there has been a loss (in some cases a total loss) of endemic species at some mound springs. It also points out there is insufficient data to define long-term trends for many springs. This is a contravention of the spirit and practice of WMC's Environment Policy and the Australian Minerals Industry Code for Environmental Management, to which WMC is a signatory.	Table 7.18, 7.4	7.4
P34.50	The EIS states that no impacts on the Woomera Prohibited Area Weapons Facility are expected, and Woomera can only benefit from increased tourism in the area. How can increased tourism on land near a major weapons testing range and defence facility be beneficial?	5.5	5.2
P34.51	The radiation section fails to refer to recent studies on the effects of low-level ionising radiation (Professors Wolfgang Kohnlein and Rudi Nussbaum), and recent studies of workers at the Rossing uranium mine in Namibia (Zaire et al. 1995).	10	10.2
P34.52	The Roxby Indenture prevents public access to information to scrutinise operations and impacts at Olympic Dam.	1.3	2.2

No.	Summary	Reference in EIS	Reference in Supplement
P34.53	Some of the omissions in the EIS relating to the TRS are a result from the impossibility of designing a system that will endure for the thousands of years required for radiation decay, and that will prevent erosion and dusting and limit radon release for that period.	8.10	8.5
P38 Moody, L.			
P38.1	The tailings will remain highly radioactive for thousands of years, but the tailings dam will not last that long. Who will be responsible for the site after mining has stopped?	8.10	8.5
P38.2	The EIS has not addressed the transport of uranium products through South Australia.	3.6	1.5
P38.3	The EIS has not addressed the increased amount of radioactive materials produced and a decrease in worker health standards.	10	1.5
P38.4	Where do the uranium products go and who accepts responsibility for how they are used?	1.6	1.5
P38.5	The EIS does not address the detrimental effect of the increased use of water from the Great Artesian Basin on the wildlife that depend on this water source for survival.	7.4	4.5, 7.4
P38.6	Increased processing will raise the amount of carbon dioxide released, which is contrary to the world-wide commitment to lower greenhouse emissions.	3.8	15.4
P38.7	Given the long-term consequences of the nuclear industry, uranium mining has no future in an environmentally conscious society.	1.6	1.5
P11 Nature Conservation Society of South Australia Inc.			
P11.1	The NCSSA is very disappointed at the quality of this EIS and believes that the EIS trivialises many of the problems that it identifies, and often does not provides sufficient information to enable an objective assessment of problems.	1.6	1.5
P11.2	The details of the expansions being addressed in this document are confusing and, at times, misleading, with the constant discussion and analysis in this EIS of an expansion from 85,000 t/a to 200,000 t/a greatly exaggerating the potential benefits of the project. This EIS should consider expansion from a baseline of 150,000 t/a. The status of the 200,000–350,000 t/a expansion proposal is also unclear, given that it has not yet been approved by the WMC board. Why is such an unofficial project being assessed in this EIS? This assessment is also misleading, particularly with respect to the discussions of employment and economic benefits that may arise from the proposed expansion.	1.1, 1.6	2.5
P11.3	To place much of the preamble in context, the areas (in hectares) of the Project Areas, the Special Mining Lease and the Municipal Lease should be provided.	7.1	7.2

No.	Summary	Reference in EIS	Reference in Supplement
P11.4	The use of percentages of an arbitrary area is an inappropriate criterion for assessing vegetation clearance.	7.2	7.2
P11.5	The statement that disturbed areas will be 'rehabilitated promptly' is meaningless as the majority of the vegetation clearance will be for permanent infrastructure.	7.2	7.2
P11.6	What proportion of all monitoring and vegetation rehabilitation sites will be lost and can the loss of the sites be avoided?	7.2	7.2
P11.7	Describing the increased frequency of a number of bird species as a benefit of the current project is simplistic. In ecological terms, elevating the populations of species whose numbers were not unnaturally low may have negative flow-on effects. Information on impacts such as bird deaths from vegetation clearance and tailings should be presented first.	7.3	7.3
P11.8	Could WMC actively discourage domestic cats and promote an image of Roxby Downs being a cat-free town?	7.3	7.3
P11.9	The NCSSA strongly disagrees with the assertions in Section 7.3.9 that the 'mobility of most animal species will minimise the chance of injury or death in the impacted areas', expressing the view that these statements and the EIS Summary trivialise and sanitise the process of habitat clearance, do not accurately summarise the conclusions elsewhere in the EIS, and should be deleted from the EIS.	7.3	7.3
P11.10	The prediction that a small reduction in flow at a number of mound springs is expected to have a 'minimal' and 'insignificant' impact on flora and fauna is entirely subjective and makes no attempt to quantitatively analyse the results from previous monitoring.	7.4	7.4
P11.11	The discussion of impacts on mound spring biota should explicitly state the time-scale of predictions, which should cover the life of the project. The NCSSA understands that fifty-year modelling has been conducted on the effects of water extraction on the mound springs. Potential impacts on fauna and flora cannot be adequately assessed unless all such relevant material is made available. Section 7.4 should be rewritten to include analysis of all available data and modelling results.	7.4	7.4
P11.12	The spring groups Welcome, Davenport and Hergott are dismissed due to 'low conservation value owing to low species diversity and absence of species, or suites of species, of conservation significance'. More rationale should be provided for this principle of sacrificing degraded areas rather than addressing their possible restoration.	7.4	7.4
P11.13	Approval for expansion is inappropriate until the cause of the tailings leakage has been clearly ascertained.	8.1	8.2
P11.14	The NCSSA questions the effectiveness and adequacy of monitoring for leakage in the tailings management system, and believes the EIS should explicitly explain improvements that will overcome future problems.	8.1	8.2

No.	Summary	Reference in EIS	Reference in Supplement
P11.15	The following questions are posed regarding the EIS assertions that groundwater monitoring indicates that modifications to the tailings storage facility (TSF) have 'fulfilled the objective of ensuring minimum seepage from this facility': • Why does the EIS not provide data to support this statement? • What is 'minimum seepage'? Maximum seepage levels should be specified. • Has the clay lining in the TSF been installed to the depth specified in design criteria? • Is this thickness adequate to prevent seepage? • Is the clay used for this lining sufficiently impermeable?	8.1	8.2, 8.3, 8.6
P11.16	Why does the EIS not provide data to support the results described in paragraphs 1 and 2 of p. 8-6?	8.1	8.2
P11.17	What does the term 'becoming effective' on p. 8-7 mean, and is leakage is still occurring?	8.1	8.6
P11.18	The current EIS should explain why the actual benefits of the original project were so dramatically below predictions, and should justify why the new predictions may be more accurate. The model used should be justified, and examples provided showing where it has been successful in predicting impacts.	13.1	2.7, 13.2
P11.19	The discussion of different contributions of the overall economic equation appears simplistic and imbalanced. The assertion that 'the injection of more direct employment, and its flow-on effects, into the Northern Statistical Division could compensate for losses in population and employment experienced in recent years' cannot be substantiated.	13.1, 13.3	1.5
P11.20	The proponent should be required to submit a decommissioning plan for the conclusion of the 200,000 t/a production phase. This would commit the proponent to adequate decommissioning and would provide some environmental certainty.	14.4	8.5, 14
P35 Oshlack, A.			
P35.1	The proposed increased output from Olympic Dam will only magnify the existing environmental disaster. The dangers of storage of tailings and pollution of the artesian aquifers is a national scandal.	8, 4	1.5
P35.2	The short-term profit will never balance the long-term health costs of exposure to residents and workers.		1.5
P35.3	Expansion of the mining industry has made no positive impact on employment or the economy.		1.5

No.	Summary	Reference in EIS	Reference in Supplement
P14	**Port Augusta Hospital Inc.**		
	No detailed submission received		
P20	**Ratepayers and Residents of Roxby Downs–petition**		
P20.1	A petition with 412 signatures was presented with the following wording: 'We the undersigned ratepayers and residents request that the incumbent municipal administration at Roxby Downs be replaced with appointees with a proven track record in implementing positive community involvement and sound environmental management. We propose the immediate establishment of a representative ratepayers committee with accountability to the community, prior to the establishment of full local government.' The submission also included comments made by the KESAB Tidy Towns Judge, following judging of Roxby Downs from 1994 to 1997, outlining the importance to the judges for the community voice to be heard and incorporated into planning and action.	12.9	12.9
P25	**Read, J.**		
P25.1	WMC is currently investigating the use of old tyres as an alternative to fencing around evaporation ponds. It is suggested that commitment 7.3.2 in Table 15.8 be reworded to allow construction of 'suitable barriers' for the control of fauna.	7.3, 15.8	7.3
P25.2	Implementation of enforced regulation of cat control, including compulsory identification, desexing and night curfews in Roxby Downs should be addressed by the EIS.	7.3, 11	7.3, 12.9
P25.3	Investigation of the long-term efficiency of solar water heating in Roxby Downs and at the mine and processing plants should be addressed by the EIS.	11.7	11.4
P4	**Roxby Action Collective**		
P4.1	WMC's commitment to its key Policy Documents is questioned as a consequence of past losses of flora and fauna, past seepage problems with the tailings retention system and projected impacts on the mound springs.	1.1, 7.4	1.5
P4.2	Projections of uranium supply and demand are from a single source only and there is no discussion of the economic viability of uranium production.	1.5	3.1
P4.3	The claim in the EIS that the Great Artesian Basin (GAB) in South Australia will remain in equilibrium following the Expansion Project is considered to be false.	4.2	4.1

No.	Summary	Reference in EIS	Reference in Supplement
P4.4	It is argued in the EIS that water can be strategically harvested by careful location of the new borefield to capture water that would otherwise be lost to the regional water table and evaporation. However, the proportion of water lost to vertical leakage and then evaporation is only relevant in the shallow margins of the basin, not in the deeper, more productive parts of the basin where Borefield B is (and presumably Borefield C will be) located (Woods, 1990). Also, it is not mentioned in the EIS that as the borefields begin to increase their extraction, not only will lower artesian pressures lead to lower quantities of vertical leakage, but also lower artesian pressures for other hydrogeologic components such as pastoral bore flow and spring flow.	4.2	4.1
P4.5	Habermehl (1980) argued that the GAB was in approximate equilibrium but warned against large-scale exploitation, saying that 'provided that no new major developments occur which will affect this situation, discharge and potentials will not change significantly'. Large scale development has occurred in a concentrated area of the South Australian portion of the GAB and essentially this important advice of 1980 is being ignored. The springs are now experiencing reduced flows, a pattern that is predicted to continue.	4.2	4.1
P4.6	It is unclear to what extent the numerical computer model incorporates the whole South Australian portion of the GAB, the whole GAB or a small subsection. No information is given at all in the EIS concerning ODEX1, thereby denying the public the chance to properly assess this section of the EIS.	4.5	4.1
P4.7	The EIS repeatedly refers to a new borefield, presumably called Borefield C, but fails to include studies showing the likely location and extraction rates. This is of fundamental importance to the overall hydrogeological impacts on the mound springs and the GAB generally. Such a borefield would need to be located even further into the GAB if long-term drawdown limits set in Special Water Licence 2 and more severe impacts on the mound springs are to be avoided.	4.4	4.1
P4.8	There is no discussion of alternative strategies for process and potable water supply.	4.3, 4.4, 3.12	3.2
P4.9	It is argued that the bore rehabilitation being undertaken by the SA Department of Mines and Energy is leading to considerable savings of artesian water owing to capping of uncontrolled bores and water efficiency schemes. However, it should be noted that there is only one uncontrolled bore in the vicinity of the borefields and very few bores that have required rehabilitation in this area generally (Sampson 1996).	4.2	

No.	Summary	Reference in EIS	Reference in Supplement
P4.10	Such a poor assessment does not add much faith to the assertions that, despite the sustainable supply of water being recognised as one of the three principal issues raised by the Expansion Project, the long-term supply of water from the borefields in the GAB are indeed sustainable. The EIS is fundamentally flawed in its assessment of the hydrogeological impacts on the GAB and the ecologically unique mound springs. Olympic Dam must make public the results of its fifty-year modelling predictions and immediately begin investigation for Borefield C.	4.5	4.1, 7.4
P4.11	The presentation of the Seepage Inquiry fails to recognise major criticisms of ODO made at the time of the Inquiry.	8.1	8.2
P4.12	ODO should pay for the use of groundwater.	4.1	4.3
P4.13	Concern is expressed regarding the long-term viability of mound springs in the area of the borefields. The Roxby Action Collective is opposed to the view that flow reductions in mound springs are an acceptable trade-off for the ongoing development and operation of the Olympic Dam Project, and believes that radical measures must be taken to prevent further damage to the heritage and environmental values of the springs. It calls for the unequivocal closure of Borefield A and immediate commencement of studies for the new Borefield C, deeper still into the Great Artesian Basin than the newly commissioned Borefield B.	4.2	4.1, 4.2
P4.14	The projected demand for water would exceed the limit used to assess the borefields. Discussion should be provided on a new borefield required to make up the shortfall.	4.4	4.1
P4.15	There would be a direct impact on tourism resulting from further reductions in mound spring flows.	5.5	4.2
P4.16	The section on the tailings retention system departs from the guidelines and fails to state explicitly the numerous assumptions used and the uncertainties involved in any data presented. There is no discussion of the long-term (of the order of tens of thousands of years) seismic stability of the tailings, the long-term moisture covering the tailings to prevent radon release, the geotechnical properties of the various materials used in construction of the tailings, or the long-term climatic influences on the radiological and physical stability of the tailings.	8.9, 8.10	8.3, 8.5
P4.17	The tailings would remain radioactive for longer than either the design life or structural life of the containment system.	8.10	8.5
P4.18	The radiation section of the EIS clearly fails to recognise critically important scientific studies that have been done on the long-term health effects of low levels of exposure to ionising radiation, such as those experienced by workers at Olympic Dam. Cited studies show that low doses of ionising radiation are more harmful than currently thought and existing standards need to be further lowered to adequately protect workers and the general public from unwanted and unnecessary risk.	10	10.5, 10.6

No.	Summary	Reference in EIS	Reference in Supplement
4.19	The EIS fails to conform to the guidelines and, as such, does not represent a satisfactory assessment of the proposed Olympic Dam Expansion Project. The EIS contains many factual errors in data and does not explicitly quote the assumptions used for the EIS.	1.6	1.5
P17 Roxby Downs Health Advisory Committee			
P17.1	There is an immediate need for the provision of facilities for teenagers, especially for use at night-time.	12.7	12.6
P17.2	There is a need for WMC and Council representation on existing community committees.	12.9	12.9
P17.3	There is an immediate need for the provision of shade cloth over existing playgrounds and the swimming pool.	11.7.3, 12.7	12.6
P17.4	A local bus service in Roxby Downs would assist in getting children safely to school, on time.	12.3	12.5
P17.5	Provision of a regular bus service from the tavern to Camp 1 contradicts previous advice regarding separation of the workforce from the local community.	12.3.4	12.1
P13 Roxby Downs Junior and Senior Basketball Association in consultation with other sporting bodies			
P13.1	The existing Recreation Centre in Richardson Place is inadequate for the expanding population and the number of sporting bodies using this facility. An additional two-court stadium would be a great improvement. Three sites are nominated where such a stadium could be located.	12.7	12.6
P15 Roxby Downs Municipal Council			
P15.1	The public on numerous occasions has raised the issue of the provision of footpaths on all roads, including local access roads (Table 11.5).	11.7	11.5
P6 Roxby Downs Tidy Towns Team			
P6.1	Concern is expressed about the Town Administration's perceived lack of environmental interest/action and its unwillingness to listen to, and act upon, residents' concerns, resulting in:	12.9	12.9
	• minimal recycling/reuse facilities—existing measures are initiatives of the community and WMC (ODC);	11.5.5	11.2, 12.9
	• indifference to removal of indigenous vegetation by residents on reserves and privately owned allotments;		
	• water conservation not being actively encouraged and overuse of potable and reused water (especially in winter) in public areas. The municipality appears to be against reuse of treated grey water on allotments;		

No.	Summary	Reference in EIS	Reference in Supplement
	• no cat control despite local expertise in this field. At a community meeting held to discuss this issue there was 98% acceptance for cat control to be introduced, but still no action. The region contains an extremely fragile environment, where all native flora and fauna struggle to survive. Councils in other areas of Australia (including some in SA) have commenced these measures; • scant support for community-based activities such as Clean Up Australia Day, Clean Up Roxby Day; • poor control of off-road vehicle use in the Municipal Lease area—no 'can go' area maps, nor identification of picnic and camping areas; • no encouragement of positive environmental initiatives such as rainwater tanks, solar water heating and other water and energy efficient practices.		
P6.2	The control and management of the town rubbish dump by the Municipality is considered to be extremely poor. Management practices requiring attention are nominated as follows: • no revegetation of used areas; • wind-blown and haphazardly dumped rubbish covers a wide area; • no effective recycling; • no consultation with the community on any proposed changes, with offers of help and advice to improve the dump having been rejected in the past.	11.5	11.2, 12.9
P6.3	There is no effective communication between the Municipality and the community and there is no means by which the community has input into decision making.	12.9	12.3, 12.9
P6.4	The maintenance of public areas by the municipality is criticised, mentioning the following problem areas: • limited replenishment of wood chip mulch to streetscape plantings; • grassed areas being overwatered in winter and sometimes poorly maintained; • erratic and inefficient maintenance of plantings and irrigation systems.	12.9	12.9
P6.5	The municipality freely grants approval to remove trees that were carefully protected by WMC environmental staff during new subdivision development. This is against the spirit and intent of the Municipality's Supplementary Development Plan and the original EIS document.	12.9	12.9, 5.3
P6.6	Why has the position of Town Administrator not been replaced by an elected council as outlined the original EIS? The community has no voice in the running of the Municipality and requests a detailed explanation of this issue, including the viability of establishing a local council.	12.9	12.9

No.	Summary	Reference in EIS	Reference in Supplement
P6.7	The former Roxby Downs Advisory Committee was absolute tokenism and a very poor attempt at community consultation.	–	1.5

P2 Royal Australian Institute of Architects, South Australian Chapter

P2.1	The consultation of the numerous agencies during the EIS preparation is applauded.	Appendix F	–

P9 Schnelbogl, P.

P9.1	The most commonly known health effect due to tailings radiation is lung cancer triggered by the inhalation of airborne tailings isotopes (gaseous and fine particles). Radiation contamination of water and soils will result in the ingestion of tailings becoming the main contamination pathway, leading to numerous diseases and disorders.	10	10.3
P9.2	The main tailings radiation hazard is alpha radiation, which once ingested or inhaled becomes many more times dangerously bio-effective than beta or gamma radiation. In the milling of ore, there are increased risks associated with the inhalation and ingestion of alpha radiating rocks.	10	10.3
P9.3	Tailings particles can be as small as fine sand and talcum powder and readily become airborne, with the potential to travel great distances through the atmosphere.	8	10.3
P9.4	There are fourteen radiation decay stages, and ten of these stages (six of which are alpha decays) occur in the tailings. This explains why the permissible dose limit for uranium tailings is set so low.	8	10.3
P9.5	The main problem with the tailings is their very long-term radioactivity, leading to an eventual ninety million deaths.	8, 10	10.3
P9.6	Knowledge of the tailings will be lost within a few thousand years, at which time humans could be expected to inadvertently work, grow food and live near the tailings deposits.	8, 10	10.3
P9.7	Radionuclides are more toxic and enduring than other chemical toxins and wastes.		10.3
P9.8	Within fifty years of mining at the current level, Olympic Dam will have accumulated as much as 160 million cubic metres of tailings, and this figure would double with post-expansion production levels.	8	10.3
P9.9	The structural integrity of the Olympic Dam tailings dam walls is unlikely to prevent incremental wall increases from sinking into the tailings material. Sinking would lead to breaches with consequential rapid and large-scale erosion of the very fine tailings material.	8	8.3
P9.10	Highly acidic and radioisotope enriched tailings liquor has escaped into the groundwater despite scientific claims that this was not possible. Uranium contaminants are water-soluble and able to be leached from the tailings into the groundwater and eventually to surface springs.	8	10.3, 8.2

No.	Summary	Reference in EIS	Reference in Supplement
P9.11	The life of any tailings dam is highly unlikely to exceed 10,000 years, after which time the tailings retain 91.4% of their radioactivity. The Olympic Dam tailings dam is unlikely to survive 100 years.	8	10.3
P9.12	Wind erosion of the Olympic Dam tailings is of little concern for a few hundred years until the tailings cover is partly eroded. At this time tailings would still have 99% of their radiation left. The crust that forms on the tailings surface provides little long-term protection to erosion as it would be subjected to wind tunnel effects that could spread the contents of the tailings dams over a huge area within 200,000 years. As a theoretical result of this erosion, between ten and fifty billion adults worldwide per year could be subjected to radiation doses above inhalation limits.	8	10.3
P9.13	Although the main criterion for storage facilities is their capacity to prevent the escape of tailings material into the biosphere, there is no storage option that could effectively achieve this. Recognising that no option is entirely suitable, the storage options need to be considered in terms of the time span of protection. The pros and cons of several options are investigated: • dumping the waste material next to the mine • storage in a tailings dam • storage in an open mine pit • storage in old or specifically built mine shafts • Synroc and similar technologies.	8	10.3
P9.14	The dose limit for a member of the public continually exposed to radiation is 1 mSv per year. Where the person is exposed to different types and pathways of radiation, this dose limit applies to the sum of all components.	10	10.3
P9.15	The 'critical group' is the group of people most exposed to the radiation. Critical group members have a risk factor or exposure aspect in common. The radiation exposure of the critical group determines the project limitations against a standard and has implications for project approval. In the distant future this critical group could conceivably involve millions of people.	10	10.3
P9.16	The maximum permissible quantity of inhaled tailings from Olympic Dam is 1.4 g/a. Considering that exposure is likely from more than one source, the permissible dose should be considerably lower than this. Due to the mobility of tailings and the mechanics of wind erosion, the inhalation of tailings by the critical group will be between 30 g and 150 g per year. With an average inhalation of 60 g/a, this equates to an annual dose contribution of 40 mSv.	10	10.3

No.	Summary	Reference in EIS	Reference in Supplement
P9.17	In time, there is a substantial risk of alpha radiation exposure through the ingestion of tailings particles through the food chain. Recent examples indicate exposures of 74 mSv annually through the ingestion of grain crops. In a few thousand years the contamination of the Olympic Dam region will result in a critical group exposure from ingestion of 500 mSv per year.	10	10.3
P9.18	Tailings contain the most dangerous isotope (Radon-222), which is gaseous and carries four of the six alpha decays of the tailings. If left underground, radon escape from the ore body is minimal. In contrast, the escape of radon from the tailings will eventually be comparatively unobstructed, with resultant annual doses ranging from 3 mSv to 170 mSv.	10	10.3
P9.19	Beta radiation will become a problem for people living on or near the tailings as they would be exposed to up to 60% of the dose limit from this one radiation source.	10	10.3
P9.20	The gamma radiation dose for someone living, working and sleeping on tailings material would result in the exceedence of the annual dose within sixty-seven hours, with an annual dose of approximately 130 mSv.	10	10.3
P9.21	The residual radiation content of the tailings may be sufficient to contaminate the area for billions of years.	10	10.3
P9.22	The total of all those dose contributions for the critical group would be 840 mSv. The exposure to the critical group is expected to be 100 times the legal dose limit in 1,000 years, decreasing to double the legal dose limit in 730,000 years.	10	10.3
P9.23	As many as 2.2 billion future radiation cancer deaths could be attributable to Roxby Downs tailings; however, this figure could be reduced by using ICRP guidelines.	10	10.3
P9.24	There are several types and pathways of radiation, and the dose limit is set for the sum of those individual components. The distance from the tailings dictates exposure pathways, with the critical group in close proximity to the tailings being exposed to higher levels of external radiation than those living in Melbourne. Melbourne residents would be more exposed to radon and the inhalation and ingestion of alpha emitting particles. The pathway distribution model requires that the permissible quantity of tailings dust be reduced.	10	10.3
P9.25	The real cost of safeguarding the tailings deposit for 500,000 years is $80 billion. This figure has not been considered in the EIS.	10	10.3
P9.26	The long-term viability of uranium mining is uncertain due to the enormous compensation costs paid to health-affected workers in other situations. Governments are unwilling to accept responsibility for their actions and public pressure may at any moment lead to the closure of Olympic Dam and Ranger mines.	–	10.3

No.	Summary	Reference in EIS	Reference in Supplement
P9.27	The international regulatory body, the ICRP, has lost credibility since the Second World War and is currently undemocratic, unrepresentative, and has no legitimacy whatsoever. The ICRP represents the industry and not the human health they supposedly support.	10	10.3
P9.28	Australian nuclear regulations for radiological protection are considered good, but supervision is below standard. Australia has adopted outdated ICRP dose limits and has since further weakened those limits by providing for exceptions with considerably higher dose limits.	10	10.3
P9.29	The current environmental supervision of uranium mining and milling in Australia is totally inadequate. At Olympic Dam, the basic requirement of an independent supervisor is not being met.	10	10.3
P9.30	The nuclear industry is often seen as antagonistic to democracy and human rights. There are enormous risks involved with the nuclear industry, and laws that permit uranium mining are laws that commit crimes against present and future generations. The protection of the dignity of human life should enable acts and laws to be overwritten.	10	10.3
P9.31	The Roxby Downs Indenture Agreement prohibits the government from making public certain information. The hiding of information about the tailings is indicative of government and industry dishonesty, whereas speaking out the truth is a major responsibility of everybody.	1.3	2.2
P9.32	The permeability of the evaporation ponds multiplied by the proposed area would lead to an annual leakage of 37.2 ML. If the HPDE foil breaks, the evaporation ponds would rely only on the semi-permeable clay liner. Under this scenario, the leakage may equate to 740 ML/a.	3.8	10.3
P9.33	The mine water disposal pond appears to be contributing to a large groundwater mound directly beneath the pond. The pre-extraction wastewater is expected to be high in uranium-238 and therefore potentially dangerous. More information on the composition of this mine wastewater is needed in the EIS.	4.6	10.3
P9.34	There is insufficient radiation information provided in the EIS on: • radiation measurement; • techniques; • instrumentation; • independent consultants/engineers employed; • baseline studies; • components of other man-made contamination to the baseline; • areas of atmospheric contamination; • radioactive contamination of food sources; • design of steel drums for yellowcake.	10	10.3

No.	Summary	Reference in EIS	Reference in Supplement
	Other information areas considered insufficient:		
	• no report of previous environmental incidents at Olympic Dam;		
	• no provision of contour maps of the area;		
	• edited aerial photography;		
	• composition of various process solids and fluids;		
	• WMC's intention for the waste rock.		
P9.35	There appears to be vast discrepancies between:		
	• the specified radioactivity of the tailings liquor in the Expansion Project and 1982 EIS;	10	10.3
	• ore grade in the Expansion Project and 1982 EIS;	3 10.3	10.3 10.3
	• fifteen of eighteen fauna contamination measurements.		
P9.36	WMC has a questionable attitude to responsible business ethics. This particularly relates to the issue of WMC's 'confidentiality' powers negotiated in the Roxby Downs Indenture Act 1982 and Ratification.	–	2.2
P9.37	The consultants engaged by the proponent appear to have completely overlooked the scientific fact that, after 1,000 years, the tailings still retain 99% of their radioactivity, and therefore should not be released to the biosphere for a further several hundred thousand years. The independence and objectivity of the engaged consultants is also questionable.	–	10.3

P39 Spencer Gulf Environmental Alliance

P39.1	As the WMC Board has not approved expansion up to 350,000 t/a, the EIS should be rewritten to cover the proposed expansion from 150,000 t/a to 200,000 t/a only.	1.6	2.6
P39.2	The EIS should cover the ethics of mining uranium.	B	1.5
P39.3	The EIS should examine the recycling of copper and how this could be expanded from present supplies.	1.5	1.5
P39.4	The EIS should distinguish more clearly between construction/operations of current moves from 85,000 t/a to 150,000 t/a and proposals to 350,000 t/a.	1.1	2.5
P39.5	The EIS should give full account of the economic costs/benefits of the proposal, taking into account destruction of habitats, microscopic creatures (not mentioned), structure of soil, movement of water away from the mine (particularly after mine closure), and the long-term impacts of the tailings dumps.	13	7.1, 8.5
P39.6	The very long-term effects of tailings dams after mine closure should be covered. The proposed 1 m covering plus rock armour is ludicrous in a climate subject to flooding and high winds. What about probable climate change?	8.10	8.5

No.	Summary	Reference in EIS	Reference in Supplement
P39.7	Exposure to radiation is a constant danger to workers, and long-term monitoring of workers should be essential.	10.2	10.7
P39.8	WMC should support a national register of past/present/ future workers with radioactive material.	10.4	1.5
P39.9	Self-monitoring is inadequate. The Office of the Supervising Scientist should monitor radiation.	10.4	1.5
P39.10	There is no adequate examination of leakage from tailings dams, including current independent assessment.	8.1	8.2
P39.11	There is no mention of the creation of less than 1,000 jobs rather than the promised 2,500, only a weak reference to there being less jobs. The EIS should provide evidence for the jobs promised.	13	12.1
P39.12	There is no distinction between long-term, short-term and casual jobs.	13	12.1
P39.13	There was no invitation to comment published during January in Port Augusta's local paper, and no approach was made to this group to comment. WMC approaches only those people who favour its proposals; for example, development boards and local councils only interested in economic gain.	1.3	12.3
P39.14	There should be a complete survey of the Great Artesian Basin (GAB) prior to any further abstraction to avoid problems like those experienced with the Murray/Darling basin.	4.2	4.5
P39.15	The public meetings at Roxby Downs and Port Augusta were inadequately publicised and highly favourable to expansion. A representative of WMC and three public servants were present, as opposed to two conservation representatives who were limited to ten minutes.	–	1.5
P39.16	There should be an independent (not paid for by WMC) survey of impacts on mound springs and other water users prior to expansion.	4	4.5
P39.17	The SGEA objects to WMC obtaining up to 42 ML/d of free water. The cost of infrastructure argument is invalid.	4	4.3
P39.18	The nuclear industry relies heavily on coal and oil for operations, which contribute to greenhouse gases.	3.8	1.5
P39.19	WMC receives free land for easement for power lines from Port Augusta to Olympic Dam. This is undemocratic.		1.5
P39.20	Economic details do not include all the discounted benefits to WMC—electricity, water, diesel rebate etc.	13	2.2
P39.21	Why are the costs of services to Roxby Downs township (e.g. education, police, emergency services, electricity) not included in costs to the public?	13	2.2
P39.22	Why are the details of costs such as imported equipment and materials such as sulphur not included in the balance of payments?	13	13.8
P39.23	Why isn't more information provided on the proposals to import copper and any firm plans to do so?	3.7	3.3

No.	Summary	Reference in EIS	Reference in Supplement
P39.24	What pressures are being placed on Aboriginal communities and what promises are being made? What about the Arabunna people's concerns?	2.5, 6	6.1
P39.25	How can the Indenture prohibit traditional owners from entering their own land without permission from WMC?	2.5, 6	6.2
P39.26	The EIS should include details of uranium export destinations and quantities, overseas public opinion, nuclear plant accidents, information on politically and geographically unstable potential customers, and potential for terrorism.	B	1.5
P39.27	The EIS should examine the existence or lack of adequate safeguards for uranium once it leaves Australia.	B, 1.6	1.5
P39.28	The EIS should acknowledge that destruction of a fragile interior environment cannot be measured in dollars and cents.	–	1.5
P16 Stone, P.J. & S.L.			
P16.1	The opportunity to remain as caretaker occupiers of a block in the light industrial area is desired. Currently such status is not provided under the Development Plan (1993).	12.9	12.9
P16.2	There are concerns with the following perceptions of municipal management: • no effort to minimise the local mosquito problem; • lack of encouragement or assistance for the Tidy Towns team; • no control of off-road vehicle activities around the perimeter of the town; • the untidy nature of some housing and light industrial blocks, including that occupied by the Council.	12.9	12.9
P16.3	Why doesn't the Roxby Downs township come under the umbrella of the South Australian Minister for Housing and Urban Development rather than the South Australian Minister for Mines and Energy.	12.9	12.9
P16.14	The community concern regarding town governance reported in Chapter 12.9 is supported.	12.9	12.9
P22 Stop Uranium Mining, Sydney			
P22.1	It was difficult to order a copy of the EIS, which was slow to be delivered.	1.3	12.3
P22.2	Stop Uranium Mining is opposed to uranium mining for the following reasons: • it creates long-lived nuclear waste and mine tailings; • the use of uranium in weapons; • nuclear power is not cheap, safe, clean or the solution to greenhouse problems.	1.6	1.5

No.	Summary	Reference in EIS	Reference in Supplement
P22.3	With regard to water abstraction from the Great Artesian Basin (GAB), the submission raised the following questions: • What effect will the additional water usage have upon the mound springs and the GAB? • Can the artesian bores cope with the extra strain on their resources? • Will WMC be expected to pay the full price for additional water it uses? • Will WMC pay compensation to pastoralists who find their bores have dried up due to WMC operations?	4.5	4.1, 4.2, 4.3, 4.5, 7.4
P22.3	What is the EIS plan to safely dispose of tailings for longer than 500,000 years when the tailings will have reduced to about 1.1% of the original radioactivity?	8.10	8.5
P22.4	What effects will possible future climate change have on the land use of the project area in relation to the safety of tailings disposal. The claims that the future existence of the Olympic Dam Mine will be well known and that possible intrusion into the tailings pile is not a credible event are disputed. There is a moral responsibility to consider all possible implications of the Olympic Dam mine for future generations.	8.10	8.5
P22.5	The effects of erosion on the tailings mound must be considered in the long term to prevent the tailings being spread throughout Australia by wind and rain, contaminating agricultural land.	8.10	8.5
P22.6	If the mine currently has problems with tailings disposal, how will it deal with the extra tailings following the Expansion Project?	8.1	8.2
P22.7	Details on the construction, operation, monitoring and regulation of the existing and proposed expansion to the tailings retention system are required. New facilities must be constructed in accordance with the EIS and not modified as previously.	8.1, 8.5, 8.6	8.2, 8.3
P22.8	What effect will the additional processes to extract copper, silver and gold have on the tailings retention system? Additional chemicals result in toxins in the ponds which pose a substantial threat to bird life. What steps is WMC taking to prevent bird deaths?	8.1, 8.8	7.3, 8.7
P22.9	Will an accident at the mine contaminate the groundwater supply? The massive leak of tailings water from the mine still poses a substantial threat to artesian water supplies.	4.6	8.7
P22.10	WMC only consults with Aboriginal groups that are supportive of the Olympic Dam Project. The EIS should have specified the process with which WMC will ensure that the concerns of all the Aboriginal groups, including the Kokotha and the Arabunna, are addressed.	6	6.1

No.	Summary	Reference in EIS	Reference in Supplement
P22.11	It is questioned that the Expansion project is economically viable given the: • current slump in gold prices; • current trend against nuclear power resulting in uranium demand and price dropping in future.	1.5	3.1
P31 Summers, S.K.			
P31.1	The artesian water is an irreplaceable resource and increased drawing on this water is unsustainable. This is evident in the drying up of Black Creek and the drastic reduction of flow in its surrounds.	4.2	1.5
P31.2	The EIS must address the radioactive nature of uranium and the hazards for future generations.	10	1.5
P31.3	Why are bird scarers necessary on the tailings dams? Is this an admission of the potential harm to birdlife?	8.8	7.3
P31.4	The leakage from the tailings dams, although detected through monitoring some time later, is irresponsible and negligent.	8.15	8.2
P31.5	Further expansion is suicidal for the delicate environment of Olympic Dam and the Earth.	–	1.5
P7 Trutwin, S.			
P7.1	Concern is expressed about the lack of cat control measures in place at Roxby Downs and requested information on what is being done to control this pest to prevent the devastation of local wildlife.	7.3	7.3
P7.2	Would it be appropriate to use rainwater tanks to reduce water demand on the Great Artesian Basin.	11.6	11.3
P7.3	There is concern that there is no kerbside recycling in the township and information on future plans is requested.	11.5	11.2
P24 Zeptner, M.			
P24.1	Why has the Council refused permission for me to live on my industrial block as caretaker while others in the area apparently have permission to do so.	12.6, 12.9	12.9
P21 Zwar, J.			
P21.1	The timing of the public meeting allowed only sixteen days before the closing date for submissions, and was advertised inadequately. The meeting clashed with other widely advertised community events. Liaison with locals could have provided accurate information on promotion and timing.	–	12.3
P21.2	The availability of the EIS document should have been widely publicised in the community with provision to borrow if from the community library at least overnight from the beginning of the eight-week period.	–	12.3

No.	Summary	Reference in EIS	Reference in Supplement
P21.3	The EIS document should contain information on making a submission. Such information has been difficult to obtain.	–	1.5
P21.4	Not all heavily trafficked roads in the Roxby Downs area are sealed, resulting in some fugitive dust problems.	9.4, 11.3	11.1
P21.5	Sealing roads within the ODV industrial area mine site, rather than reliance on dust suppression using saline water, is recommended in order to obtain the following benefits: • reduce fugitive dust; • reduce the need to wash vehicles leaving the site; • reduce vehicle corrosion; • reduce salt build-up along road verges with long-term benefits to vegetation.	2.4	2.1
P21.6	Consideration should be given to providing a rail link to Olympic Dam.	11.3	3.2, 11.1
P21.7	Comment is requested on value adding on site, producing copper products other than copper cathode sheets.	1.5	3.2
P21.8	The treatment of acidic liquor in the evaporation ponds for reuse should be regularly investigated as a water conservation measure.	4.1, 4.6	4.4
P21.9	Every attempt should be made to maximise the use of collected stormwater, treated sewer effluent and treated (neutralised) evaporation pond water.	4.1, 4.7	4.4
P21.10	Concern is expressed about problems with the current management and operation of the Roxby Downs sanitary landfill. Perceived problems are outlined as: • wind-blown rubbish • no recycling • no attempt to rehabilitate landfilled areas.	11.5	11.2, 12.9
P21.11	Operation of the landfill should be handed over to an experienced operator of a waste management service.	11.5	11.2, 12.9
P21.12	The Municipality appears to be indifferent to the removal of significant trees from building allotments and parklands. What is the legal position relating to the official sanctioning of tree removals, particularly in relation to the town's Supplementary Development Plan and WMC's practice of tree retention on developments undertaken by the company?	11.7	12.9, 5.3
P21.12	Noise, dust and environmental damage are caused by off-road vehicles in bushland around the town. What control mechanisms are available for this activity?	5.5	5.1, 12.9
P21.13	A mixture of alternative housing types should be developed at Roxby Downs to assess their popularity. The option of some larger rural blocks (1–4 ha) should be investigated.	11.7	11.5
P21.14	The development of neighbourhood parks with recreation facilities for children and youth should be given urgent priority.	11.7	11.5, 12.6

No.	Summary	Reference in EIS	Reference in Supplement
P21.15	The proposed modifications to house design, siting and off-road parking outlined in the EIS are strongly supported.	11.7	–
P21.16	The Community Consultative Programme undertaken as part of the township expansion was an excellent initiative and much appreciated.	12.5	–
P21.17	Issues of concern are the following perceived problems with Roxby Downs: • limited retail shopping competition; • lack of facilities for youth; • lack of shade over playgrounds, and parkland development and maintenance; • lack of footpaths on some busy residential streets; • lack of and very high cost of accommodation; • high staff turnover and restricted senior secondary curriculum at the school; • lack of a family doctor; • lack of accountability of municipality to the ratepayers.	12.5	11.5, 12.6, 12.8, 12.9
P21.18	Further development of accommodation and rental accommodation in Woomera is suggested to alleviate shortfall and improve viability of community facilities.	12.6	12.4
P21.19	Hospital facilities at Roxby Downs are long overdue. Will the promised facility have a maternity section?	12.7	12.5
P21.20	Some heavily utilised sporting facilities should be duplicated and the community library expanded. The outreach library service for ODV residents has not commenced by the date specified in the EIS. Poor acoustics of the Auditorium reduce the usefulness of this facility.	12.7	12.6
P21.21	The community would like to see open competition of the retail facilities; such competition would lower prices and create local employment. Additional, appropriate shaded parking should be provided at the existing retail facilities.	12.8	12.8
P21.22	Why does Roxby Downs not have a democratic local government and why, in amendments to the Indenture in December 1996, did the State Government and WMC agree to maintain the current arrangement without consultation with the local community. Previous attempts with the Roxby Downs Advisory Committee were a dismal failure.	12.9	12.9
P21.23	The funding arrangements for the Municipality is questioned, as is why these should be an impediment to greater community involvement in the local governance.	12.9	12.9

No.	Summary	Reference in EIS	Reference in Supplement
P21.24	Concern is expressed at the Municipality's poor environmental performance with regard to: • town dump • vegetation removal • standard of landscape maintenance • off-road vehicle control • cat control • water conservation.	12.9	12.9
P21.25	The Municipality appears not to respond to or show support for community and sporting groups.	–	12.9
P21.26	The expansion will result in more jobs, with economic spin-offs in the wider region, and is supported subject to action on the issues raised.	12	–

APPENDIX B

SUMMARY OF STATE GOVERNMENT COMMENTS

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SUMMARY OF STATE GOVERNMENT COMMENTS

This appendix contains a summary of all the State government submissions relating to the Expansion Project Environmental Impact Statement (EIS) that were received from the public by the Department of Housing and Urban Development on or before 25 July 1997. This was two weeks after the advertised period during which the EIS was available for public comment. Submissions received after this date were not considered.

The submissions were numbered in order of receipt, and each comment summarised. The summarised submissions were then placed in alphabetical order according to the name of the author.

The entry for each submission is divided into four columns in which the following information is provided:

- Column 1—the submission and comment number. The whole number is the number allocated to each submission by the Department of Housing and Urban Development in order of receipt, while the decimal component refers to the individual comments within each submission. For example, comment number 9.3 is the third comment made in Submission Number 9.
- Column 2—summaries of the comments made in each submission.
- Column 3—the number of the EIS section (or sections) that is considered to most closely relate to the comment made in the submission.
- Column 4—a reference to the section(s) in the Supplement where the response from the proponent to the comment may be found. A reference to Section 1.5 of this Supplement indicates that a response is not provided for the reasons outlined in that section.

To locate the relevant responses to their comments, authors of submissions should refer to the sections of the Supplement listed in column 4.

List of submission authors

Department for Education and Children's Services (G11)

Department of Environment and Natural Resources (G13)

Department of the Premier and Cabinet (G3)

Department of Transport (G7 and G12)

Department of Treasury and Finance (G5)

Economic Development Authority (G10)

Environment Protection Authority (G8)

Mines and Energy South Australia (G9)

Native Vegetation Council (G4)

SA Water (G2)

SA Health Commission (G6)

South Australian Metropolitan Fire Service (G1)

Table B1 Summary of State Government comments

No.	Summary	Reference in EIS	Reference in Supplement
G11	**Department for Education and Children's Services**		
G11.1	In accordance with an indenture agreement between WMC and the South Australian Government, DECS is responsible for the provision of schooling and care facilities at Roxby Downs.	12.7	1.5
G11.2	DECS is currently liaising with WMC regarding provision of facilities in response to an expected increase in student numbers as a result of the project expansion. The EIS will facilitate this planning.	12.7	1.5
G13	**Department of Environment and Natural Resources**		
G13.1	The EIS acknowledges the possibility that increased visitation resulting from the mine expansion could have an impact on sensitive sites within the wider region around Olympic Dam. This needs further consideration by both WMC and Government.	5.5	5.2
G13.2	The Natural Resources Group of DENR regards the impacts of the project on plant and animal communities in the project area as localised and is satisfied with previous and proposed methods of handling these impacts.	4, 7	7.2
G13.3	The figures in Table 4.7 are influenced favourably by a short-term increase in flows for a number of springs up to 1998–99 as a result of the commissioning of Borefield B. Beyond 2000 the flow trend is downward for all springs shown in Figures 4.14–4.17. It is important to note that even minor flow reductions can have a critical impact on invertebrate animal populations dependent on the springs.	4.5	7.4
G13.4	Ponder and Ziedler consider that the relationship between flow and animal populations is almost certainly not linear—a flow rate reduction of 20% can cause a 70% population decline.		7.4
G13.5	The significance of some population changes may be missed with current monitoring programmes; for example, all hydrobiid species are treated as one, thus potentially missing decreases and increases in individual species.	7.4	7.4
G13.6	Hydrological monitoring is still an imprecise science—note the discrepancies between predicted and actual drawdown in Table 4.4, particularly for HHS170. The statement that the 1994 estimates 'were shown to be reasonable' is of concern.	4.2	4.2
G13.7	The EIS considers the ODEX1 model to be more reliable than earlier models and erring on the conservative side. Similar arguments were used for the 1980s models.	4.5	4.1, H
G13.8	The twenty-year timeframe (1996–2016) is relatively short against the projected longevity of the mine. The critical period for mound springs impacts will be during the twenty years following that period.	4.5	4.1

No.	Summary	Reference in EIS	Reference in Supplement
G13.9	By 2016, drawdown at the boundary of the Designated Area is expected to have reached the 5 m limit. Taking into account this and previous comments and the significance of the mound springs, DENR would expect the option of a third borefield to be adopted rather than renegotiation of the Special Water Licence conditions.	4.5	4.1
G13.10	There is a need to improve both the quality of mound springs monitoring and the dissemination and evaluation of results. DENR currently receives monitoring results in the form of the EMMP Annual Report and data can be eighteen months or more old. MESA receives quarterly hydro-geology reports, and these should be routinely passed on to DENR and a suitable Government/WMC forum for discussion and evaluation. Regular, open communication is essential.	15	7.4
G13.11	It is recommended that a condition of approval might be the reconvening of a network between Government (with DENR as a key member) and WMC to analyse monitoring results regularly and to discuss management of environmental impacts.	15	7.4
G13.12	Development of the existing mine and town sites has been sensitive to environmental issues.	–	5.1, 7.2
G13.13	Pastoral lessees may be concerned with recreational vehicles using station tracks, vandalism and disruption of livestock.	–	5.3
G13.14	In general, the Pastoral Management Branch of DENR has a good relationship with WMC.	–	5.3, 7.2

G3 Department of the Premier and Cabinet

G3.1	Is it the case that sulphur dioxide emission levels have been difficult to maintain within the requirements of the EPA licence using existing smelting technology?	9.2	9.1
G3.2	If so, how will the expanded operations, using the same technology, maintain sulphur dioxide levels within EPA requirements?	9.2	9.1
G3.3	What will be the approval process for the selected tailings storage facility, and how will differences from the facilities described in the EIS be accommodated in that process?	8.3, 1.3	8.1
G3.4	What level of differences in facilities will initiate additional public consultation and how will that need be assessed?	8.3, 1.3	8.1
G3.5	Why are stormwater ponds required for the central thickened discharge method?	8.6	8.1
G3.6	What will the facilities be 'lined' with?	8.6	8.3
G3.7	What process will be used to assess ongoing effects of drawdown on the Great Artesian Basin beyond the twenty-year model for Borefield B?	4	4.1
G3.8	What obligations does WMC have to make housing sites available for non-WMC people?	11.7, 12.6	11.4, 5.1

No.	Summary	Reference in EIS	Reference in Supplement
G3.9	What is the arrangement for development of housing sites?	11.7, 12.6	5.1, 11.4, 12.4
G3.10	What are the obligations regarding Aboriginal and community consultation on the progress of the expansion?	6, 12.5	6.1
G3.11	How effective has consultation been for the Borefield B project?	6, 12.5	6.1, 12.3
G3.12	What is the external environmental auditing process used by WMC?	15.7	15.1
G7 Department of Transport (*see also G12*)			
G7.1	No mention is made of the implications of transport of large modules from Port Augusta to Olympic Dam via the Stuart Highway and the Pimba – Roxby Downs road during the expansion development phase (e.g. vegetation removal).	11.3	11.1
G7.2	A number of important unsealed roads maintained by the Department of Transport, especially those used for water supply at Borefields A and B, are not mentioned.	11.1, 11.3	11.1
G7.3	There is no indication of increasing traffic volumes and any contribution by WMC to the maintenance of these roads.	11.3	11.1
G12 Department of Transport (*additional submission to G7*)			
G12.1	The unsealed roads not mentioned by the EIS (Comment G7.2 above) are Borefield Road, Oodnadatta Track, Muloorinna Station Road and Birdsville Track.	–	11.1
G12.2	The EIS proponents have based their work on forecasts provided by the department, and this is considered reasonable.	11.3	–
G5 Department of Treasury and Finance			
	No comment as the department was not involved in the development of the EIS and does not have the expertise to comment on the content.		
G10 Economic Development Authority			
G10.1	The EDA supports WMC and its contribution to the economic development of the State. The proposed expansion is likely to increase the positive impact of WMC operations in the northern region of South Australia and provide a timely boost to its economy.	–	1.5
G8 Environment Protection Authority			
G8.1	There should be a more detailed description of WMC's obligations under the *Environment Protection Act 1993*, including a summary of conditions contained in the 'licence to undertake a prescribed activity of environmental significance'.	2.4	2.1

No.	Summary	Reference in EIS	Reference in Supplement
G8.2	Details of the six-monthly, self-monitoring reporting requirement and the necessity for approvals of certain works and process changes should be expanded.	2.4	2.1
G8.3	A description of the blister copper filling stage and an estimate of sulphur dioxide (SO_2) emissions (concentration and duration) should be given.	3.5	9.4
G8.4	It is unclear if Case 3 (the ground-level emission concentrations at 285,000 t/a copper production) models the situation of processing additional imported concentrates and ores. When will this part of the project be staged?	9.3, L7.3	9.3
G8.5	In Table 9.8, the distance from the source (smelter/acid plant) should be shown with each predicted SO_2 value. Distances of the highest values are particularly required for the modelling of Case 3.	9	9.3
G8.6	Section 3.11 should mention additional controls or minimisation measures for occupational exposure to SO_2 emissions during the construction phase.	3.11	9.2
G8.7	Appendix L implies that high volume samplers are operated on a one-week continuous basis. An explanation should be given for the departure from the normal procedure of a 24-hour, six-day rotating basis.	L4.3.1	9.4
G8.8	The sampling regime used by WMC is incompatible with EPA air quality assessment criteria. Changing or supplementing the monitoring regime at the Roxby Downs township to comply with normal protocol should be investigated, or an explanation of past data provided to justify the present practice.	9.4, L4.3	9.4
G8.9	The NHMRC criterion of 90 $\mu g/m^3$ for particulates specifies that it is to be used in conjunction with SO_2 measurements taken concurrently at the same site. Where only dust measurements are taken (without concurrent SO_2), those results should be compared with USEPA dust criteria.	9.2	1.5
G8.10	The 1993 data showed some brief periods in which SO_2 concentrations reached high levels. If these instances co-incided with particular meteorological conditions, the likelihood of frequency of occurrence and extent of impact should be discussed.	L4.3.2	9.4
G8.11	Noise associated with the proposed expansion has been adequately addressed in the EIS.	9.5	–
G8.12	WMC envisages that no significant changes will be required to the waste management system, although it is acknowledged that there are problems associated with current landfill operations. The proposed expansion provides the opportunity to review current solid waste management and investigate alternative systems and technologies suitable for remote communities, with a view to providing an improved system. Any review should consider an assessment of the impact of the current landfill sites and options for their closure and rehabilitation.	3.8, 11.5	11.2, 12.9

No.	Summary	Reference in EIS	Reference in Supplement
G9 Mines and Energy South Australia			
G9.1	It is noted that WMC is proposing only a few major changes to the current approach; in particular, changes to underground haulage, the need for cooling owing to higher underground temperatures, and improved ground procedures and systems to accommodate higher rock stresses.	3	1.5
G9.2	The lack of detail on tailings rehabilitation and other issues is addressed in the report 'A Review of WMC Olympic Dam Expansion Project—Environmental Impact Statement', prepared for MESA by R. Jewell. *(Issues raised in this report are included as comments G9.8 to G9.35.)*	14	8.5, 14
G9.3	Impacts on the groundwater system at Olympic Dam will be localised within the general region of the mine; the proposed measures to manage these impacts are acceptable.	4.1	4.5
G9.4	Issues concerning Borefield B were largely dealt with in a previous assessment process that culminated in the issue of the Special Water Licence.	4.2	4.1
G9.5	The numerical model ODEX1 is considered to be conceptually sound and the best technical approach for estimating potential groundwater drawdowns over the Designated Area for the period 1996–2016.	4.5	4.1, H
G9.6	Drawdown will approach the 5 m limit along the eastern boundary towards 2016. As groundwater extraction will continue well beyond 2016, the EIS recognises the need to monitor aquifer response closely and to develop alternative sources.	4.5	4.1
G9.7	It is essential that a comprehensive management strategy be developed for the Great Artesian Basin as a whole. MESA is developing a numerical model for the South Australian portion of the basin to assess long-term impacts of Borefield B and other groundwater extraction to guide this State's management strategies.	4.2	4.5
G9.8	Contrary to expectations expressed in the EIS, after decommissioning the potential of the central thickened discharge (CTD) mound to create dust will be quite high.	8.10	8.4, 8.5
G9.9	There are several CTD storage systems in operation in Australia, including the Mt Keith operation recently commissioned by WMC in Western Australia. However, there are no CTD storages in the country that demonstrate how tailings mounds will perform following decommissioning.	8.6	8.4, 8.5
G9.10	In the section on floor preparation it is noted that the soil–limestone interface will be identified by electromagnetic survey, shallow bores and test pits. It is also stated that the base would be proof rolled to identify any near-surface dolines. While we are unaware of any alternative techniques, there is no guarantee that these methods will be totally effective, and there remains the possibility of failure of the base.	8.5	8.3

No.	Summary	Reference in EIS	Reference in Supplement
G9.11	The final paragraph in Section 8.5.5 indicates that a low permeability clay layer or membrane would be used in the vicinity of the decant structures. However, Figure 8.6 notes that the liner would comprise a compacted clay layer overlain with a geomembrane. This inconsistency needs to be resolved. It is strongly recommended that both clay and geomembrane should be used; data can be provided to support this.	8.5	8.1
G9.12	It is assumed that the clay layer on the outer face of the embankment will dry out after construction. It will be important to place the clay as dry as possible to minimise shrinkage cracking (accepting the higher permeabilities that will result).	8.5	8.3
G9.13	If sand dune materials are used to construct embankments, a layer of clay should be used to face the embankment, just as is suggested for separating tailings from the downstream protection layer.	8.5	8.3
G9.14	The structural stability of an embankment made from sand dune materials would be adequate if a high phreatic surface is not permitted to develop and if downstream face erosion is avoided.	8.5	8.3, 8.5
G9.15	The sheet of 500 mm of rock armouring will protect the 20° embankment slopes from erosion. The provision of a graded filter between the rock and embankment soil is a standard practice in the construction of water-retaining dams and needs to be investigated for possible use in tailings structures.	8.5	8.3, 8.5
G9.16	No information has been provided on the expected rate of evaporation from the tailings surfaces. An estimate of evaporation from the supernatant ponds of 65% of pan evaporation has been quoted, but evaporation from the beaches would be only between 10% and 30% of pan evaporation. This information could have significant influence on the estimated rate of filling and on water balance calculations and should have been included in the EIS. Unless appropriate values are adopted for the rate of filling, the water balance calculations and estimates of base seepage are meaningless.	8.5	8.4, 8.6
G9.17	The belief that fewer evaporation ponds for CTD will be required owing to the availability of more beach slopes for evaporation surfaces is of concern. Experience indicates that some cells are built up and completed earlier than others to enable rehabilitation. If this happens, the ratio of beach area to production will not rise and additional evaporation ponds may well be required.	8.6	8.4, 8.6
G9.18	It is questioned whether the proposed system of clay-lined open drains to collect supernatant liquor will fulfil the design objectives. Such drains would need a minimal fall of approximately 1 in 500 from the centre to the perimeter.	8.6	8.1, 8.4

No.	Summary	Reference in EIS	Reference in Supplement
	In addition, the surface across the site would have to be steeply contoured to direct run-off from the toe of the mound to the drains and prevent it from seeping into the base.		
G9.19	It is suggested that there will be little water available from the thickened tailings for release downslope, resulting in very little discharge of liquor on to the base and probably little beach segregation. Therefore, are the drains necessary? Further studies are required to determine the real extent of likely run-off from the mounds.	8.6	8.4
G9.20	There is an inconsistency in terminology in the reference to 'decant liquor ponds' in Section 8.6.6 and 'reclaim ponds' in Figures 8.7 and 8.8.	8.6	8.1
G9.21	Clarification will be required as to whether these ponds are to be lined with clay alone (Section 8.6.6) or clay and geomembrane (Figure 8.6). This is the same problem as noted for the paddock system (Comment G9.11).	8.6	8.1
G9.22	The third dot point in Section 8.6.6 indicates that drains will be lined with clay or tailings. It is assumed that this means the clay-sized fraction of tailings rather than tailings *per se*. This should be clarified.	8.6	8.1, 8.4
G9.23	There is concern that clay-sized tailings will not provide an adequate seal to drains.	8.6	8.1, 8.4
G9.24	It is likely that the consequences of an embankment around a CTD system being overtopped and washed out would be less than that for a paddock structure, but still unacceptable. There will be a need to provide protection against overtopping and erosion of the downstream slope.	8.7	8.3
G9.25	There is a suggestion that the additional evaporation area provided by the CTD system would eliminate the need for further evaporation ponds. This concept could result in an increase in the amount of base seepage from the tailings storage facility and would be inconsistent with the stated intent of minimising seepage. However, the system may be practical provided the water application rate does not exceed the evaporation rate.	8.6, 8.7	8.4, 8.6
G9.26	It is not reasonable to assume that the crust predicted to form on the paddock storages will remain intact in the future. Even with the formation of crusts, considerable dusting will occur once the crust has dried out.	8.6, 8.10	8.1, 8.5
G9.27	Erosion that could occur on the surface of the CTD tailings mound has not been considered. The beach slopes will not be much steeper that the natural landforms in the area and therefore should be structurally stable. However, if the slopes are not protected, erosion is highly likely in the periodic high rainfall events that can occur in the region.	8.10	8.1, 8.5
G9.28	The EIS suggests that rehabilitation issues are to be addressed while operations continue and as soon as the site to be rehabilitated becomes available.	8, 14	8.4, 8.5

No.	Summary	Reference in EIS	Reference in Supplement
	This is possible with the perimeter embankments of both paddock and CTD options. However, rehabilitation of the upper surfaces of paddocks has to wait until a cell has been topped off and decommissioned, and disposal operations have to be completed before rehabilitation of slopes of a CTD mound.		
G9.29	The introductory paragraph to Chapter 8 indicates that proposals for eventual decommissioning and rehabilitation of the tailings retention system are described in greater detail in Chapter 14. There is very little in Chapter 14 that relates to tailings.	8, 14	8.5
G9.30	The tailings surfaces appear to have been ignored in Chapter 14 apart from brief references in Table 14.1.	14	8.5
G9.31	There is a suggestion that trials are to be undertaken with various capping and surface layers of different depths to provide protection against erosion and inhibit evaporation in order to reduce radon emission. This is probably reasonable and leaves the way open for further work.	14	8.5
G9.32	Further clarification of the specific soils to be used for embankment construction is required. The source of clay for the outer faces and the clay lines should be identified.	8.5	8.3
G9.33	There is very little information on the rehabilitation measures to be adopted for the top surfaces of the paddock cells and the CTD mound.	8.10	8.5
G9.34	A major concern for both the paddock and CTD systems is the high probability of dust generation in the future unless some positive capping measures are adopted. The EIS fails to address this.	8.10	8.1, 8.4, 8.5
G9.35	The EIS does not address adequately the issue of rehabilitation of the decommissioned storages.	8.10	8.5
G4 Native Vegetation Council			
G4.1	The council commends the detail and accuracy of the biological information provided, and considers it to be sufficient to assess the impact on native vegetation.	7	7.2
G4.2	The council supports the continuing and proposed monitoring of the biological environment in and adjacent to the Project Area (including the mound springs near Lake Eyre South) and the public dissemination of results.	7	7.2
G4.3	The council supports the ongoing and proposed management actions to alleviate biological problems (e.g. introduced species).	7	7.2
G4.4	The council considers that the impacts associated with the proposed clearance of up to 1,600 ha of native vegetation may be offset by the: • permanent destocking of Roxby Downs, Parakylia South and Purple Downs pastoral leases, possibly to be protected under the terms of heritage agreements under the *Native Vegetation Act*.	7.2	7.2

No.	Summary	Reference in EIS	Reference in Supplement
	Following decommissioning, consideration could be given to resumption/transfer of the leases (including Andamooka pastoral lease) to the Crown for conservation purposes, as an extension to the Lake Torrens National Park. A major publicity campaign could be undertaken by WMC on this environmental initiative; • extension of the existing rabbit-proof fencing and rabbit control to include the whole of the Project Area; • provision of sufficient staffing levels to manage the destocked and rabbit-proofed areas for conservation purposes.		
G4.5	The council is concerned with the damage to the mound springs flora and fauna caused by Borefield A. It suggests that earlier remedial action should be taken if monitoring detects such damage at Borefield B.	7.4	4.1, 4.2, 4.5, 7.4
G4.6	WMC should consider the use of desalinated water from Spencer Gulf as an alternative to the continued use of groundwater from existing or new borefields.	4.1	4.5
G2 SA Water			
	No comment as the water supply is not administered by SA Water.		
G6 South Australian Health Commission			
G6.1	The matters related to radiation are well presented, and there is sufficient information for adequate assessment of the radiological consequences of the proposal.	10	–
G6.2	Section 3.5.3 states that the dust from the waste heat boiler and the electrostatic precipitator will be mixed before being returned to the smelter, or bled to the hydrometallurgical plant (p. 3-28). However, Section 10.2.3 (p. 10-17) states that electrostatic precipitator dust will preferentially go to the dust bleed and waste heat boiler dust to the smelter feed to minimise recycling of ^{210}Po in the smelter and reduce concentrations in smelter fume. This point needs to be clarified and justification given if dust is to be mixed.	3.5 10.2	10.1
G6.3	The Special Mining Lease boundary is not a convincing 'constraint' to the siting of tailings retention system facilities (Table 8.2). There is no apparent reason why the boundary could not be extended, as envisaged in Section 5.5.2.	8.1, 5.5	8.3
G6.4	Collection of supernatant liquor would need to be very efficient owing to the permeability of unprotected local soils. Drains would need to be closely spaced and would be susceptible to blocking by tailings.	8.6	8.4
G6.5	The liquor collection ponds are described as being lined with clay (only). Current practice is for a composite clay/polymer liner. This change should be justified.	8.6	8.1, 8.4

No.	Summary	Reference in EIS	Reference in Supplement
G6.6	The EIS states that excess runoff from high intensity rainfall would be discharged to the environment as it would be 'significantly diluted'. This statement needs to be justified as rainwater would dissolve evaporites and other soluble components of the tailings surface layers.	8.6	8.6
G6.7	Owing to greater area (increased evaporation) and drier initial moisture content, the central thickened discharge (CTD) tailings would be expected to lead to a drier tailings surface and hence greater radon emanation and dust generation than the paddock system. Unlike the paddock system, there does not appear to be a mechanism by which liquor or tailings can be directed to a section that becomes excessively dry.	8.6	8.4
G6.8	The CTD system would need a large volume of suitable cover material during rehabilitation. Suitable cover materials for revegetation (clay and topsoil) are in short supply in the area. Thus the CTD system would affect a much greater area than the paddock system both in itself and with the excavation required for cover material.	8.6	8.4, 8.5
G6.9	The CTD system has greater potential for erosion from runoff than the paddock system. If erosion penetrates the cover, tailings could be dispersed into the environment. Therefore the cover design will need to incorporate a high level of erosion control, particularly for a system with multiple discharge points. The effective control of erosion over the very long term must be addressed.	8.6	8.5
G6.10	It is stated that no increase in staff will be required for radiation monitoring. However, monitoring programmes for the expanded project are yet to be developed and approved, and it is possible that additional staff may be required to achieve the necessary level of monitoring.	10.4	10.1
G6.11	The rehabilitation of the tailings retention system is probably the most important long-term rehabilitation task. There is very little detail on the programmes being undertaken to gather appropriate information on local conditions, e.g. the nature of trials, objectives and timescales. Further details should be supplied.	14.4	8.5
G1 South Australian Metropolitan Fire Service			
G1.1	The area is not within the SAMFS gazetted fire district.	–	
G1.2	SAMFS is satisfied that ongoing consideration and expertise from the appropriate agencies will result in a suitable level of fire safety being maintained.	12.7, 15.6	–

APPENDIX C

SUMMARY OF COMMONWEALTH GOVERNMENT COMMENTS

APPENDIX C

SUMMARY OF COMMONWEALTH GOVERNMENT COMMENTS

This appendix contains a summary of all the Commonwealth Government submissions relating to the Expansion Project Environmental Impact Statement (EIS) that were received from the public by the Department of Housing and Urban Development on or before 25 July 1997. This was two weeks after the advertised period during which the EIS was available for public comment. Submissions received after this date were not considered.

The submissions were numbered in order of receipt, and each comment summarised. The summarised submissions were then placed in alphabetical order according to the name of the author.

The entry for each submission is divided into four columns in which the following information is provided:

- Column 1—the submission and comment number. The whole number is the number allocated to each submission by the Department of Housing and Urban Development in order of receipt, while the decimal component refers to the individual comments within each submission. For example, comment number 9.3 is the third comment made in Submission Number 9.
- Column 2—summaries of the comments made in each submission.
- Column 3—the number of the EIS section (or sections) that is considered to most closely relate to the comment made in the submission.
- Column 4—a reference to the section(s) in the Supplement where the response from the proponent to the comment may be found. A reference to Section 1.5 of this Supplement indicates that a response is not provided for the reasons outlined in that section.

To locate the relevant responses to their comments, authors of submissions should refer to the sections of the Supplement listed in column 4.

List of submission authors

Environment Australia, Biodiversity Group (F1)

Environmental Economics Unit, Environment Australia (F3)

Office of the Supervising Scientist (F2)

Table C1 Summary of Commonwealth Government comments

No	Summary	Reference in EIS	Reference in Supplement
F1 Environment Australia, Biodiversity Group			
F1.1	The Group commends WMC on its monitoring and research of the mound springs and its commitment to continue to do so. It is preferred that this commitment be formalised, possibly with the State Government as part of an environmental management plan. This plan could address mechanisms to ensure that hydrogeological changes did not detrimentally impact the unique species and ecological communities of the mound springs.	7.4	7.4
F1.2	Could details be provided on the frequency of presence, abundance and fatalities (if any) of JAMBA and CAMBA bird species found in or adjacent to the Olympic Dam area?	7.3	7.3
F1.3	Could a copy of the Environment Management Programme Annual Report 1.3.95–29.2.96 be provided to enable verification that JAMBA/CAMBA bird species are not being exposed, or potentially exposed, to fatal levels of tailings?	7.3	7.3
F3 Environmental Economics Unit, Environment Australia			
F3.1	The assumptions and approaches taken in the economic modelling are generally accessible to the reader. The modelling exercise appears to be generally of good standard, except in relation to employment estimates, and provides useful estimates.	1.5.3, 13, O	–
F3.2	The phrase '1,750 jobs in South Australia and no additional employment nationally' (p.13-9) is misleading. Under Scenario 1 of constant national employment, the 1,750 jobs created in South Australia are offset by the same number of jobs lost in other States, as explained on p.13-6 (para. 8) and in Section O2 (para. 4).	13, O	D1
F3.3	The assumption of constrained national employment is inappropriate given the current high level of unemployment in Australia.	O2	13.6
F3.4	Scenario 2 assumes unconstrained national employment and implies an employment multiplier of 4.2. Such a large flow-on effect is very unlikely, particularly as the construction phase lasts only two-and-a-half years.	O2	13.7
F3.5	A CGE model simulates long-term, steady states in which long-run effects work through a whole economy. This model does not seem to be the appropriate tool for modelling a short-run activity such as a two-and-a-half-year mine expansion.	O	13.2, 13.5
F3.6	The excessive estimate of employment indicates that there may be a structural problem in the model or unrealistic values for some parameter(s), which casts some doubt on other results.	O	13.7

No	Summary	Reference in EIS	Reference in Supplement
F3.7	Line two, paragraph two, on p.O3, should read 'associated with the construction phase', not 'associated with the operational phase'.	O2	D1
F3.8	The assumption of constrained employment for the operational phase seems unrealistic given current levels in unemployment and the lack of any indications of an imminent fall in unemployment.	13	13.6
F3.9	The unrealistic assumption of constrained employment for the operational phase implies the consequence of 1,100 extra jobs in South Australia is the loss of the same number of jobs in other States. The phrase 'no additional jobs in the rest of Australia' (p.13-11, para. 1) misrepresents this consequence of the assumption.	13	13.6
F3.10	The estimated employment effects in South Australia (191 direct jobs generating a total of 1,100 jobs) imply a multiplier of 5.8, which is extremely high. The source of this multiplier effect is given as the 'calibration' of the model with a supposed relationship between growth of employment in Western Australia at the time of the mining boom in that State. There is no statistical evidence or justification given for this, and a range of other causal factors are also likely to have contributed to that growth. Without statistical evidence, the claimed correlation is not credible and cannot be extrapolated to the South Australian case.	O	13.5, 13.7
F3.11	The basis for the large employment multiplier effect estimated for South Australia should be stated explicitly in Chapter 13, alongside the estimate of 1,100 jobs.	13	13.7
F3.12	Statistical evidence for the claimed relationship between new mines and employment in Western Australia should be presented, and explicit information provided on how the relationship has been incorporated in the model	O	13.5, 13.7
F3.13	Employment should be modelled as unconstrained in the long term for the same reason that capital has been modelled as unconstrained. The model represents a long-term, steady state in which long-run responses to changed conditions are seen from workers entering the labour market and firms raising the capital they need for profitable investment.	O	13.6
F3.14	Paragraph 2 on page O11 states that the assumption of unconstrained employment overestimates job creation, indicating problems in the model. The following paragraph indicates the problem of over-estimation may be related to how capital is modelled as well as labour.	O3	13.6
F3.15	For the construction phase of expansion to 350,000 t/a, the reasonableness of the estimate of 1,240 total jobs in South Australia cannot be judged as the number of direct jobs is not given.	O4	13.7
F3.16	The same criticisms of the assumption of constrained employment for the construction phase to 200,000 t/a apply to the assumption for expansion to 350,000 t/a.	O4	13.6

No	Summary	Reference in EIS	Reference in Supplement
F3.17	Estimates for the operational phase of expansion to 350,000 t/a seem more realistic than those for 200,000 t/a. The EIS should explain why the employment multipliers are so different for the two operational phases.	O4	13.7
F3.18	The same comments and criticisms relating to the assumptions of constrained employment and unconstrained capital made for the operational phase of expansion to 200,000 t/a apply to the assumptions for the operational phase of expansion to 350,000 t/a.	O4	13.6
F3.19	It is misleading for estimates of the net effect of the construction phase on balance of trade (p.13-9, para. 4) to be net of the value of exports of current production levels. This pre-existing benefit cannot be attributed to the expansion.	13.3	13.8
F3.20	It would be more appropriate to report employment effects estimated by the model under an intermediate assumption about the labour market in which jobs created by the expansion are partly a net addition to national employment but also partly displace some interstate jobs.	13.3	13.6
F3.21	Given that the model seems to have a major structural problem in its capacity to estimate jobs, substantial reformulation may be necessary to produce credible employment estimates. If this is not done, the EIS should simply state predicted direct job numbers in each of the different construction and operational phases of the expansion and not quote model estimates.	13.3	13.6, 13.7
F3.22	The model provides useful estimates of variables such as GSP, GDP and exports.	–	–
F3.23	Tables such as Table 13.6 and Tables O1–O17 should give magnitudes of absolute changes as well as percentage changes for macroeconomic, broad sectoral and industry level variables.	13.3, O	13.9
F3.24	Model results should be supplemented by full information on specific economic benefits and costs of the project *per se*. These would include predicted direct employment, total wages and salaries, tax and royalty revenues, sales revenue, export revenue, construction and operational costs, and profits at each stage of the project.	13	13.9
F3.25	Notwithstanding preceding comments, the evidence presented does indicate that there are net economic benefits to Australia.	13	–

F2 Office of the Supervising Scientist

F2.1	As part of the expanded project, additional radiological protection features to be incorporated into new process plant are expected to reduce radiation dose to plant workers. Radiation management systems appear to be adequate and there is no reason to believe that additional radiological staff will be required post-expansion.	10	–

No	Summary	Reference in EIS	Reference in Supplement
F2.2	A significant increase in the radon source term is expected owing to the increased surface area of the expanded tailings retention pond system, which may increase radon progeny concentrations at Roxby Downs and in the project area. However, compared with natural levels, the incremental increase is expected to be small. The EIS does not specifically address this issue, but given the small impact expected this is not a reason to oppose the expansion.	8.9	–
F2.3	The increase in production is not expected to increase significantly environmental radionuclide levels or radiation doses to members of the public. No incremental radiological burden in local fauna is evident from pre-mine and post-mine sampling.	10.3	–
F2.4	Radionuclide concentrations in surface water appear to have remained essentially at pre-mining levels and the expansion is not expected to increase surface water concentrations.	10.3	–

APPENDIX D

CORRECTIONS TO THE ENVIRONMENTAL IMPACT STATEMENT

APPENDIX D

CORRECTIONS TO THE ENVIRONMENTAL IMPACT STATEMENT

This appendix comprises amendments to the EIS to correct errors or omissions identified in public submissions. These amendments relate to:

- **text**
- **tables**
- **figures.**

D1 AMENDMENTS TO TEXT

Chapter 1

In Section 1.5.4, p. 1-23, the rate of water consumption per tonne of ore milled is stated to have reduced from 2.10 kL/t in 1989–90 to 1.57 kL/t in 1995–96. This figure should be amended to 1.50 kL/t for 1995–96. This same change is also necessary to Section 4.1.4, p. 4-8, Section 4.3, p. 4-20 and Section 4, p.7 of the Summary.

Chapter 2

In Section 2.1.1, p. 2-1, the first sentence of the second paragraph reads in part: '. . . and rare earth minerals, occur in a magnetic hydrothermal breccia complex'.

This should read: '. . . and rare earth minerals, occur in a magmatic hydrothermal breccia complex'.

Chapter 8

In Section 8.10, p. 8-29, the final sentence on the page reads:

> Thus, for example, in the United States the Nuclear Regulatory Commission has recommended a maximum flux from rehabilitated tailings of 0.074 $Bq/m^2.s$, while the Atomic Energy Control Board of Canada has recommended a limit of 0.074–0.370 $Bq/m^2.s$, the precise figure depending on the outcome of discussions with other regulatory agencies and the industry.

This should read:

> Thus, for example, in the United States the Nuclear Regulatory Commission has recommended a maximum flux from rehabilitated tailings of 0.74 $Bq/m^2.s$, while the Atomic Energy Control Board of Canada has recommended a limit of 0.74–0.370 $Bq/m^2.s$, the precise figure depending on the outcome of discussions with other regulatory agencies and the industry.

Chapter 13

In Section 13.3.1, p. 13-9, the second paragraph reads: '. . . 1,750 jobs in South Australia and no additional employment nationally (Scenario 1)'. This should be replaced with: '. . . 1,750 jobs in South Australia, offset by the loss of the same number of jobs in the rest of Australia (Scenario 1)'.

In Section 13.3.2, p. 13-11, the sentence at the end of the first paragraph reads: 'No additional jobs are predicted for the rest of Australia because labour at the national level is constrained in the model'. This should be replaced with: 'Under the constrained national employment assumption, the 1,100 additional jobs in South Australia are offset by the same number of jobs in the rest of Australia.'

In Section 13.3.3, p. 13-12, the first sentence of the second paragraph reads: 'The construction phase is modelled to occur over twenty-seven months at a total investment of about $900 million'. This should read: 'The construction phase is modelled to occur over twenty-seven months at a total investment of about $900 million and involving annual direct employment of 1,100 people'.

Appendix O

In the second paragraph on p. O-3, the phrase 'associated with the operational phase' should be changed to read 'associated with the construction phase'.

D2 AMENDMENTS TO TABLES

Chapter 7

In Table 7.16, p. 7-56, which indicates the distribution of fish species in the Lake Eyre supergroup mound springs, the desert goby is incorrectly shown as 'not recorded' at Birribiana and Weedina North. In addition, all references to the purple spotted gudgeon should be deleted. The amended table is shown below.

Table 7.16 Distribution of fish species in the Lake Eyre supergroup mound springs

Spring complex	Spring group	Desert goby	Lake Eyre hardyhead	Mosquito fish*
Beresford Hill	Beresford Hill	X	–	–
Coward	Blanche Cup	X	–	–
	Jersey	X	–	–
	Little Bubbler	X	–	–
Francis Swamp	Francis Swamp	X	X	–
Hermit Hill	Dead Boy	X	X	–
Mount Denison	Unnamed group	X	–	X
Mount Dutton	Big Cadna-owie	X	–	–
	Ockenden Proper	X	–	–
Neales River	Hawker	X	X	–
	The Fountain	X	–	–
Neales River	Outside	X	–	X
Peake Creek	Birribiana	X	–	–
	Cootanoorinna	X	–	–
	Cardajalburrana	X	–	–
	Nilpinna	X	–	–
	Old Nilpinna	X	X	–
	Warrangarrana	X	–	–
	Weedina North	X	–	–
Wangianna	Welcome	X	–	–

* *Introduced species.*

Source: D. Niejalke, WMC, pers. comm., November 1996.

Appendix I

Table I.2, p.p. I-6 – I-11, presents only those plant species recorded in the small (10 m^2) quadrat monitoring, and does not present species recorded in large (1,000 m^2) quadrat monitoring, in rehabilitation monitoring and during other surveys. Table I.2a, showing the full list of plant species recorded during monitoring of flora in the Olympic Dam region, is presented below. This table is updated periodically and presented in the Environmental Management and Monitoring Plan annual reports.

Table I.2a Plant species in family order recorded in the Olympic Dam, Roxby Downs and borefield areas

Family	Species name	ODO	GT	LED
Acanthaceae	*Rostellularia adscendens* subsp. *adscendens* var. *pogonanthera*		OD	OD
Adiantaceae	*Cheilanthes lasiophylla*		OD	OD
Adiantaceae	*Cheilanthes sieberi* subsp. *sieberi*		OD	OD
Aizoaceae	* *Galenia pubescens*			OD
Aizoaceae	*Glinus lotoides*		OD	OD
Aizoaceae	*Gunniopsis calva*		OD	
Aizoaceae	*Gunniopsis kochii*		OD	OD
Aizoaceae	*Gunniopsis papillata*		OD	OD
Aizoaceae	*Gunniopsis quadrifida*	OD	OD	OD
Aizoaceae	*Gunniopsis septifraga*	M	OD	OD
Aizoaceae	*Gunniopsis tenuifolia*		OD	OD
Aizoaceae	*Gunniopsis zygophylloides*			OD
Aizoaceae	* *Mesembryanthemum crystallinum*	OD		
Aizoaceae	*Mollugo cerviana*	OD	OD	OD
Aizoaceae	*Sarcozona praecox*	OD	OD	
Aizoaceae	*Tetragonia eremaea*	OD	OD	OD
Aizoaceae	*Tetragonia tetragonioides*	M	OD	OD
Aizoaceae	*Trianthema triquetra*	OD	OD	OD
Aizoaceae	*Zaleya galericulata*	OD	OD	OD
Amaranthaceae	*Alternanthera denticulata*	M	OD	OD
Amaranthaceae	*Alternanthera nana*			OD
Amaranthaceae	*Alternanthera nodiflora*			OD
Amaranthaceae	*Amaranthus grandiflorus*	OD	OD	OD
Amaranthaceae	*Amaranthus mitchellii*	OD	OD	OD
Amaranthaceae	*Hemichroa diandra*		OD	
Amaranthaceae	*Hemichroa mesembryanthema*			OD
Amaranthaceae	*Ptilotus exaltatus* var. *exaltatus*	OD	OD	OD
Amaranthaceae	*Ptilotus incanus*			OD
Amaranthaceae	*Ptilotus nobilis* var. *nobilis*			OD
Amaranthaceae	*Ptilotus obovatus* var. *obovatus*	OD	OD	OD
Amaranthaceae	*Ptilotus parvifolius*		OD	
Amaranthaceae	*Ptilotus polystachyus*	OD	OD	OD
Amaranthaceae	*Ptilotus sessilifolius*	OD	M	OD
Amaryllidaceae	*Calostemma lutea*			OD
Amaryllidaceae	*Crinum flaccidum*		OD	OD
Anacardiaceae	* *Schinus areira*		M	
Asclepiadaceae	*Leichhardtia australis*		OD	
Asclepiadaceae	*Sarcostemma viminale* subsp. *australe*		OD	OD
Aspleniaceae	*Pleurosorus rutifolius*			OD
Boraginaceae	* *Echium plantagineum*	OD	M	
Boraginaceae	* *Heliotropium curassavicum*	M	OD	OD
Boraginaceae	* *Heliotropium europaeum*	OD		OD
Boraginaceae	* *Heliotropium supinum*			OD

Family		Species name	ODO	GT	LED
Boraginaceae		*Heliotropium undulatum*			OD
Boraginaceae		*Omphalolappula concava*	OD	OD	OD
Boraginaceae		*Plagiobothrys plurisepaleus*	OD	OD	OD
Boraginaceae		*Trichodesma zeylanicum*	OD	OD	OD
Cactaceae	*	*Opuntia imbricata*		OD	
Cactaceae	*	*Opuntia stricta*		OD	
Cactaceae	*	*Opuntia vulgaris*	M	OD	
Callitrichaceae		*Callitriche sonderi*			OD
Campanulaceae		*Isotoma petraea*			OD
Campanulaceae		*Wahlenbergia aridicola*	M		OD
Campanulaceae		*Wahlenbergia communis*	M	M	OD
Campanulaceae		*Wahlenbergia gracilenta*			OD
Campanulaceae		*Wahlenbergia queenslandica*		OD	OD
Campanulaceae		*Wahlenbergia tumidifructa*	OD	OD	OD
Capparaceae		*Cleome viscosa*			OD
Caryophyllaceae		*Gypsophila australis*		OD	
Caryophyllaceae		*Polycarpaea arida*			OD
Caryophyllaceae	*	*Sagina apetala*	OD		
Caryophyllaceae	*	*Spergularia diandra*	OD	OD	OD
Caryophyllaceae	*	*Spergularia marina*			OD
Caryophyllaceae	*	*Spergularia rubra*			M
Centrolepidaceae		*Centrolepis eremica*	OD	OD	OD
Centrolepidaceae		*Centrolepis polygyna*			OD
Chenopodiaceae		*Atriplex acutibractea* subsp. *acutibractea*			M
Chenopodiaceae		*Atriplex angulata*	OD		OD
Chenopodiaceae		*Atriplex cordifolia*		OD	
Chenopodiaceae		*Atriplex crassipes*	OD	OD	OD
Chenopodiaceae		*Atriplex eichleri*			OD
Chenopodiaceae		*Atriplex elachophylla*			OD
Chenopodiaceae		*Atriplex fissivalvis*	M	OD	OD
Chenopodiaceae		*Atriplex holocarpa*	OD	OD	OD
Chenopodiaceae		*Atriplex incrassata*			OD
Chenopodiaceae		*Atriplex intermedia*		OD	
Chenopodiaceae		*Atriplex leptocarpa*			OD
Chenopodiaceae		*Atriplex limbata*	M	OD	OD
Chenopodiaceae		*Atriplex lindleyi*	OD	OD	OD
Chenopodiaceae		*Atriplex lobativalvis*		OD	OD
Chenopodiaceae		*Atriplex macropterocarpa*			OD
Chenopodiaceae		*Atriplex nummularia* subsp. *nummularia*			OD
Chenopodiaceae		*Atriplex nummularia* subsp. *omissa*			OD
Chenopodiaceae		*Atriplex obconica*	M	OD	OD
Chenopodiaceae		*Atriplex pseudocampanulata*			OD
Chenopodiaceae		*Atriplex quadrivalvata* var. *quadrivalvata*			OD
Chenopodiaceae		*Atriplex quinii*			OD
Chenopodiaceae		*Atriplex spongiosa*	M	OD	OD
Chenopodiaceae		*Atriplex sturtii*		OD	OD
Chenopodiaceae		*Atriplex suberecta*			OD
Chenopodiaceae		*Atriplex velutinella*	OD	OD	OD
Chenopodiaceae		*Atriplex vesicaria*	OD	OD	OD
Chenopodiaceae	*	*Chenopodium album*	OD		
Chenopodiaceae		*Chenopodium auricomum*		OD	OD
Chenopodiaceae		*Chenopodium cristatum*	OD	OD	OD
Chenopodiaceae		*Chenopodium desertorum*	OD	OD	
Chenopodiaceae	*	*Chenopodium murale*			OD
Chenopodiaceae		*Chenopodium nitrariaceum*			OD
Chenopodiaceae		*Chenopodium pumilio*	M	OD	OD

Family	Species name	ODO	GT	LED
Chenopodiaceae	*Chenopodium truncatum*		OD	
Chenopodiaceae	*Dissocarpus biflorus* var. *biflorus*	OD	OD	OD
Chenopodiaceae	*Dissocarpus fontinalis*			OD
Chenopodiaceae	*Dissocarpus paradoxus*	OD	OD	OD
Chenopodiaceae	*Dysphania glomulifera* subsp. *eremaea*	OD	OD	OD
Chenopodiaceae	*Dysphania plantaginella*			OD
Chenopodiaceae	*Dysphania platycarpa*	OD	OD	OD
Chenopodiaceae	*Dysphania simulans*		OD	OD
Chenopodiaceae	*Einadia nutans*	M	OD	OD
Chenopodiaceae	*Enchylaena tomentosa*	OD	OD	OD
Chenopodiaceae	*Eriochiton sclerolaenoides*	OD	OD	OD
Chenopodiaceae	*Halosarcia halocnemoides* subsp. *halocnemoides*		M	OD
Chenopodiaceae	*Halosarcia halocnemoides* subsp. *longispicata*			OD
Chenopodiaceae	*Halosarcia indica* subsp. *leiostachya*		OD	OD
Chenopodiaceae	*Halosarcia pergranulata* subsp. *divaricata*			OD
Chenopodiaceae	*Halosarcia pergranulata* subsp. *pergranulata*			OD
Chenopodiaceae	*Halosarcia pruinosa*			OD
Chenopodiaceae	*Maireana aphylla*	OD	M	OD
Chenopodiaceae	*Maireana appressa*	M	OD	OD
Chenopodiaceae	*Maireana astrotricha*	M	M	OD
Chenopodiaceae	*Maireana brevifolia*		B	
Chenopodiaceae	*Maireana campanulata*		OD	
Chenopodiaceae	*Maireana cannonii*		OD	
Chenopodiaceae	*Maireana ciliata*	M	OD	OD
Chenopodiaceae	*Maireana coronata*			OD
Chenopodiaceae	*Maireana eriantha*	M	OD	OD
Chenopodiaceae	*Maireana erioclada*	OD	OD	OD
Chenopodiaceae	*Maireana georgei*	M	OD	M
Chenopodiaceae	*Maireana integra*	OD	OD	OD
Chenopodiaceae	*Maireana lobiflora*			OD
Chenopodiaceae	*Maireana melanocarpa*			OD
Chenopodiaceae	*Maireana microcarpa*		OD	OD
Chenopodiaceae	*Maireana pentagona*	M	OD	OD
Chenopodiaceae	*Maireana pentatropis*			OD
Chenopodiaceae	*Maireana pyramidata*	M	OD	OD
Chenopodiaceae	*Maireana sedifolia*	M	M	
Chenopodiaceae	*Maireana spongiocarpa*		OD	OD
Chenopodiaceae	*Maireana tomentosa* subsp. *urceolata*			OD
Chenopodiaceae	*Maireana trichoptera*		OD	
Chenopodiaceae	*Maireana triptera*	M	OD	
Chenopodiaceae	*Maireana turbinata*		OD	OD
Chenopodiaceae	*Malacocera albolanata*		M	OD
Chenopodiaceae	*Malacocera tricornis*		OD	
Chenopodiaceae	*Neobassia proceriflora*		OD	OD
Chenopodiaceae	*Osteocarpum acropterum* var. *acropterum*	OD	OD	OD
Chenopodiaceae	*Osteocarpum dipterocarpum*	M	OD	OD
Chenopodiaceae	*Rhagodia spinescens*	M	OD	OD
Chenopodiaceae	*Salsola kali*	OD	OD	OD
Chenopodiaceae	*Sclerolaena articulata*			OD
Chenopodiaceae	*Sclerolaena bicornis*		OD	OD
Chenopodiaceae	*Sclerolaena bicuspis*			OD
Chenopodiaceae	*Sclerolaena blackiana*			OD
Chenopodiaceae	*Sclerolaena brachyptera*	OD	OD	OD
Chenopodiaceae	*Sclerolaena constricta*		OD	OD
Chenopodiaceae	*Sclerolaena cuneata*	OD	OD	OD

Family	Species name	ODO	GT	LED
Chenopodiaceae	*Sclerolaena decurrens*	OD	OD	OD
Chenopodiaceae	*Sclerolaena diacantha*	OD	OD	OD
Chenopodiaceae	*Sclerolaena divaricata*	OD	OD	OD
Chenopodiaceae	*Sclerolaena eriacantha*		M	OD
Chenopodiaceae	*Sclerolaena glabra*		OD	
Chenopodiaceae	*Sclerolaena holtiana*	M	OD	OD
Chenopodiaceae	*Sclerolaena intricata*	M	OD	OD
Chenopodiaceae	*Sclerolaena johnsonii*			OD
Chenopodiaceae	*Sclerolaena lanicuspis*	OD	OD	OD
Chenopodiaceae	*Sclerolaena limbata*		OD	
Chenopodiaceae	*Sclerolaena obliquicuspis*	OD	OD	OD
Chenopodiaceae	*Sclerolaena parallelicuspis*	OD	OD	OD
Chenopodiaceae	*Sclerolaena patenticuspis*	OD	M	OD
Chenopodiaceae	*Sclerolaena tatei*		OD	OD
Chenopodiaceae	*Sclerolaena uniflora*	OD	OD	OD
Chenopodiaceae	*Sclerolaena ventricosa*	OD	OD	OD
Chenopodiaceae	*Sclerostegia disarticulata*		OD	
Chenopodiaceae	*Sclerostegia medullosa*		OD	OD
Chenopodiaceae	*Sclerostegia tenuis*	OD	OD	OD
Chenopodiaceae	*Threlkeldia inchoata*			OD
Compositae	*Actinobole uliginosum*	OD	OD	OD
Compositae	*Anemocarpa podolepidium*		OD	OD
Compositae	*Angianthus brachypappus*		OD	OD
Compositae	* *Arctotheca calendula*	OD		OD
Compositae	* *Aster subulatus*	OD		
Compositae	*Brachycome campylocarpa*		OD	OD
Compositae	*Brachycome ciliaris* var. *ciliaris*	OD	OD	OD
Compositae	*Brachycome ciliaris* var. *lanuginosa*	OD	OD	OD
Compositae	*Brachycome ciliaris* var. *lyrifolia*			OD
Compositae	*Brachycome dichromosomatica* var. *dichromosomatica*	OD	OD	OD
Compositae	*Brachycome eriogona*		OD	OD
Compositae	*Brachycome iberidifolia*	OD	OD	
Compositae	*Brachycome lineariloba*	OD	OD	OD
Compositae	*Calocephalus platycephalus*		OD	OD
Compositae	*Calocephalus* sp. aff. *platycephalus* (sp. nov.)			OD
Compositae	*Calotis cymbacantha*	OD	OD	OD
Compositae	*Calotis hispidula*	OD	OD	OD
Compositae	*Calotis latiuscula*			OD
Compositae	*Calotis multicaulis*	OD	OD	OD
Compositae	*Calotis plumulifera*	OD	OD	OD
Compositae	* *Carthamus tinctorius*		OD	
Compositae	* *Centauria melitensis*		OD	OD
Compositae	*Centipeda cunninghamii*		OD	OD
Compositae	*Centipeda minima*			OD
Compositae	*Centipeda thespidioides*	OD	OD	OD
Compositae	*Chrysocephalum apiculatum*	OD		OD
Compositae	*Chrysocephalum pterochaetum*		OD	OD
Compositae	*Chthonocephalus pseudevax*	OD	M	
Compositae	* *Conyza bonariensis*	OD	M	
Compositae	*Cotula australis*	OD		
Compositae	* *Cotula coronopifolia*			OD
Compositae	*Craspedia pleiocephala*	OD	OD	OD
Compositae	*Dichromochlamys dentatifolius*		OD	OD
Compositae	*Dimorphocoma minutula*	OD	OD	OD
Compositae	*Elachanthus pusillus*		OD	

Family	Species name	ODO	GT	LED
Compositae	*Epaltes australis*	OD	OD	OD
Compositae	*Epaltes cunninghamii*			OD
Compositae	*Eriochlamys behrii*		OD	OD
Compositae	*Flaveria australasica*		M	OD
Compositae	* *Gazania linearis*	M		
Compositae	* *Gnaphalium polycaulon*			OD
Compositae	*Gnephosis arachnoidea*	M	OD	OD
Compositae	*Gnephosis eriocarpa*			OD
Compositae	*Gnephosis tenuissima*	OD	OD	OD
Compositae	*Gratwickia monochaeta*		OD	
Compositae	* *Helianthus annuus*	OD		
Compositae	*Hyalosperma semisterile*		OD	
Compositae	* *Hypochoeris glabra*		OD	
Compositae	*Isoetopsis graminifolia*	OD	OD	
Compositae	*Ixiochlamys cuneifolia*			OD
Compositae	*Ixiochlamys filicifolia*			OD
Compositae	*Ixiochlamys nana*	OD	OD	
Compositae	*Ixiolaena chloroleuca*		OD	OD
Compositae	*Ixiolaena leptolepis*	OD	OD	OD
Compositae	*Ixiolaena tomentosa*		OD	
Compositae	*Kippistia suedifolia*		OD	
Compositae	* *Lactuca saligna*	M	OD	
Compositae	* *Lactuca serriola*	OD		
Compositae	*Lawrencella davenportii*	OD	M	
Compositae	*Lemooria burkittii*	OD	OD	OD
Compositae	*Leptorhynchos bayleyi*		OD	
Compositae	*Leucochrysum fitzgibbonii*			OD
Compositae	*Leucochrysum molle*	OD	OD	OD
Compositae	*Millotia macrocarpa*	OD	OD	
Compositae	*Millotia myosotidifolia*	OD		
Compositae	*Minuria annua*		OD	OD
Compositae	*Minuria cunninghamii*	OD	OD	OD
Compositae	*Minuria denticulata*	OD	OD	OD
Compositae	*Minuria integerrima*		OD	OD
Compositae	*Minuria leptophylla*	OD	OD	OD
Compositae	*Minuria rigida*	OD	M	OD
Compositae	*Myriocephalus pluriflorus*	OD	OD	OD
Compositae	*Myriocephalus rhizocephalus*			OD
Compositae	*Myriocephalus rudallii*			OD
Compositae	*Othonna gregorii*	OD	OD	OD
Compositae	*Picris angustifolia* subsp. *angustifolia*		OD	OD
Compositae	*Pluchea rubelliflora*		OD	OD
Compositae	*Pluchea tetranthera* var. *tetranthera*			OD
Compositae	*Podolepis capillaris*	OD	OD	OD
Compositae	*Podolepis davisiana*		OD	OD
Compositae	*Polycalymma stuartii*	M	OD	OD
Compositae	*Pseudognaphalium luteoalbum*	M	OD	OD
Compositae	*Pterocaulon sphacelatum*	M	M	OD
Compositae	*Rhodanthe charsleyae*		OD	OD
Compositae	*Rhodanthe corymbiflorum*			OD
Compositae	*Rhodanthe floribunda*	OD	OD	OD
Compositae	*Rhodanthe microglossa*	M	OD	OD
Compositae	*Rhodanthe moschata*	OD	OD	OD
Compositae	*Rhodanthe polygalifolia*		OD	
Compositae	*Rhodanthe pygmaea*	OD	OD	
Compositae	*Rhodanthe stricta*	OD	OD	OD

Family	Species name	ODO	GT	LED
Compositae	*Rhodanthe stuartiana*	OD	OD	OD
Compositae	*Rhodanthe uniflora*	OD	OD	OD
Compositae	*Rutidosis helichrysoides*			OD
Compositae	*Schoenia ramosissima*	OD	OD	OD
Compositae	*Senecio cunninghamii*	OD	OD	OD
Compositae	*Senecio glossanthus*	OD	OD	OD
Compositae	*Senecio lautus*	M	OD	OD
Compositae	*Senecio magnificus*		M	OD
Compositae	*Senecio runcinifolius*		OD	OD
Compositae	* *Sonchus asper* subsp.	M		OD
Compositae	* *Sonchus oleraceus*	OD	OD	OD
Compositae	* *Sonchus tenerrimus*	OD	OD	OD
Compositae	*Streptoglossa adscendens*			OD
Compositae	*Streptoglossa cylindriceps*			OD
Compositae	*Streptoglossa liatroides*		OD	OD
Compositae	*Trichanthodium skirrophorum*	M	OD	OD
Compositae	*Vittadinia cervicularis* var. *cervicularis*		OD	
Compositae	*Vittadinia eremaea*	OD	OD	OD
Compositae	*Vittadinia pterochaeta*			OD
Compositae	*Waitzia acuminata*	OD	OD	
Compositae	* *Xanthium spinosum*		OD	
Convolvulaceae	*Convolvulus erubescens*	M	M	OD
Convolvulaceae	*Convolvulus eyereanus*	M		OD
Convolvulaceae	*Convolvulus remotus*	OD	OD	OD
Convolvulaceae	*Cressa cretica*		M	OD
Convolvulaceae	*Cuscuta australis*			OD
Convolvulaceae	*Ipomoea lonchophylla*			OD
Convolvulaceae	*Ipomoea polymorpha*			OD
Crassulaceae	*Crassula colorata* var. *acuminata*	OD	OD	OD
Crassulaceae	*Crassula colorata* var. *colorata*	OD	OD	
Crassulaceae	*Crassula sieberana* subsp. *tetramera*	OD	OD	OD
Cruciferae	*Arabidella filifolia*		OD	OD
Cruciferae	*Arabidella glaucescens*		OD	OD
Cruciferae	*Arabidella nasturtium*	M	OD	OD
Cruciferae	*Arabidella procumbens*		OD	OD
Cruciferae	*Arabidella trisecta*	OD	OD	OD
Cruciferae	*Blennodia canescens*	OD	OD	OD
Cruciferae	*Blennodia pterosperma*	OD	OD	OD
Cruciferae	* *Brassica tournefortii*	OD	OD	OD
Cruciferae	* *Cardamine hirsuta*	OD		
Cruciferae	* *Carrichtera annua*	OD	OD	OD
Cruciferae	*Harmsiodoxa brevipes* var. *brevipes*			OD
Cruciferae	*Harmsiodoxa brevipes* var. *major*			OD
Cruciferae	*Harmsiodoxa puberula*		OD	OD
Cruciferae	*Lepidium muelleri-ferdinandi*	M	OD	OD
Cruciferae	*Lepidium oxytrichum*	OD	OD	OD
Cruciferae	*Lepidium phlebopetalum*	OD	OD	OD
Cruciferae	*Lepidium sagittulatum*	OD	OD	OD
Cruciferae	*Menkea australis*			M
Cruciferae	*Menkea crassa*		OD	OD
Cruciferae	*Phlegmatospermum cochlearinum*		OD	OD
Cruciferae	* *Rapistrum rugosum*	OD		
Cruciferae	* *Sisymbrium erysimoides*		OD	OD
Cruciferae	* *Sisymbrium irio*		OD	OD
Cruciferae	* *Sisymbrium orientale*	OD		OD
Cruciferae	*Stenopetalum lineare*	OD	OD	OD

Family		Species name	ODO	GT	LED
Cruciferae		*Stenopetalum velutinum*	OD		
Cucurbitaceae	*	*Citrullus colocynthis*	M	M	OD
Cucurbitaceae	*	*Citrullus lanatus*	OD	M	OD
Cucurbitaceae		*Cucumis melo*			OD
Cucurbitaceae	*	*Cucumis myriocarpus*	OD	OD	OD
Cucurbitaceae		*Mukia maderaspatana*		OD	
Cucurbitaceae		*Mukia micrantha*		OD	
Cupressaceae		*Callitris glaucophylla*	OD	OD	OD
Cyperaceae		*Baumea juncea*			OD
Cyperaceae		*Bolboschoenus caldwellii*			OD
Cyperaceae		*Cyperus alterniflorus*		OD	OD
Cyperaceae		*Cyperus bifax*		OD	OD
Cyperaceae		*Cyperus bulbosus*		OD	OD
Cyperaceae		*Cyperus difformis*	OD	OD	OD
Cyperaceae		*Cyperus exaltatus*		OD	OD
Cyperaceae		*Cyperus gilesii*		OD	OD
Cyperaceae		*Cyperus gunnii*			OD
Cyperaceae		*Cyperus gymnocaulos*	OD	OD	OD
Cyperaceae		*Cyperus involucratus*	OD		
Cyperaceae		*Cyperus iria*			OD
Cyperaceae		*Cyperus laevigatus*			OD
Cyperaceae		*Cyperus rigidellus*		OD	OD
Cyperaceae		*Cyperus squarrosus*	OD	OD	OD
Cyperaceae		*Cyperus victoriensis*		OD	OD
Cyperaceae		*Eleocharis acuta*			OD
Cyperaceae		*Eleocharis* sp. aff. *atricha*			OD
Cyperaceae		*Eleocharis pallens*		OD	OD
Cyperaceae		*Fimbristylis dichotoma*		OD	OD
Cyperaceae		*Fimbristylis ferruginea*			OD
Cyperaceae		*Gahnia trifida*			OD
Cyperaceae		*Isolepis australiensis*	OD	OD	
Cyperaceae		*Isolepis fluitans*		OD	
Cyperaceae		*Schoenoplectus dissachanthus*	OD		
Cyperaceae		*Schoenoplectus litoralis*			OD
Cyperaceae		*Schoenoplectus pungens*			OD
Elatinaceae		*Bergia trimera*	OD	OD	OD
Elatinaceae		*Elatine gratioloides*			OD
Eriocaulaceae		*Eriocaulon carsonii*			OD
Euphorbiaceae		*Euphorbia australis*	M	OD	OD
Euphorbiaceae		*Euphorbia coghlanii*			OD
Euphorbiaceae		*Euphorbia drummondii*	OD	OD	OD
Euphorbiaceae		*Euphorbia "Marree"*			OD
Euphorbiaceae		*Euphorbia parvicaruncula*			OD
Euphorbiaceae		*Euphorbia stevenii*	OD	OD	OD
Euphorbiaceae		*Euphorbia tannensis* subsp. *eremophila*	OD	OD	OD
Euphorbiaceae		*Euphorbia wheeleri*	OD	OD	
Euphorbiaceae		*Phyllanthus fuernrohrii*		OD	OD
Euphorbiaceae		*Phyllanthus lacunarius*	M	OD	OD
Euphorbiaceae		*Phyllanthus maderaspatensis*	OD		
Euphorbiaceae		*Sauropus trachyspermus*	OD	OD	OD
Frankeniaceae		*Frankenia cupularis*			OD
Frankeniaceae		*Frankenia foliosa*			OD
Frankeniaceae		*Frankenia pauciflora* var. *gunnii*			OD
Frankeniaceae		*Frankenia serpyllifolia*	OD	OD	OD
Gentianaceae	*	*Centaurium spicatum*	M	OD	OD
Geraniaceae		*Erodium angustilobum*	M	OD	OD

Family		Species name	ODO	GT	LED
Geraniaceae	*	*Erodium aureum*	OD	OD	OD
Geraniaceae	*	*Erodium cicutarium*	OD	OD	OD
Geraniaceae		*Erodium crinitum*	OD	OD	OD
Geraniaceae		*Erodium cygnorum* subsp. *glandulosum*	OD	OD	OD
Goodeniaceae		*Goodenia berardiana*		OD	OD
Goodeniaceae		*Goodenia calcarata*			OD
Goodeniaceae		*Goodenia cycloptera*	OD	OD	OD
Goodeniaceae		*Goodenia fascicularis*		OD	OD
Goodeniaceae		*Goodenia glauca*			OD
Goodeniaceae		*Goodenia heterochila*			OD
Goodeniaceae		*Goodenia lunata*	M	M	OD
Goodeniaceae		*Goodenia pinnatifida*	OD	OD	OD
Goodeniaceae		*Lechenaultia divaricata*			OD
Goodeniaceae		*Scaevola collaris*		OD	OD
Goodeniaceae		*Scaevola parvibarbata*			OD
Goodeniaceae		*Scaevola spinescens*	M	OD	OD
Gramineae		*Agrostis avenacea*		OD	OD
Gramineae	*	*Alopecurus geniculatus*			OD
Gramineae		*Aristida anthoxanthoides*	M	M	
Gramineae		*Aristida contorta*	OD	OD	OD
Gramineae		*Aristida holathera* var. *holathera*	OD	OD	OD
Gramineae		*Aristida obscura*		OD	OD
Gramineae		*Aristida strigosa*			OD
Gramineae		*Astrebla lappacea*			OD
Gramineae		*Astrebla pectinata*		OD	OD
Gramineae	*	*Avena fatua*	OD		
Gramineae	*	*Avena sativa*	OD		OD
Gramineae		*Bothriochloa ewartiana*			OD
Gramineae		*Brachyachne ciliaris*			OD
Gramineae		*Bromus arenarius*		OD	OD
Gramineae	*	*Bromus rubens*		M	
Gramineae	*	*Cenchrus ciliaris*	OD		OD
Gramineae		*Chloris pectinata*	M	OD	OD
Gramineae	*	*Chloris virgata*	OD	OD	OD
Gramineae	*	*Critesion murinum*		M	OD
Gramineae		*Cymbopogon ambiguus*		M	OD
Gramineae	*	*Cynodon dactylon*	OD		OD
Gramineae		*Dactyloctenium radulans*	OD	OD	OD
Gramineae		*Dichanthium sericeum* subsp. *humilius*	M	OD	OD
Gramineae		*Dichanthium sericeum* subsp. *sericeum*		OD	OD
Gramineae		*Digitaria ammophila*			OD
Gramineae		*Digitaria brownii*	OD	OD	OD
Gramineae	*	*Digitaria ciliaris*	OD	OD	
Gramineae		*Digitaria coenicola*		OD	OD
Gramineae	*	*Digitaria sanguinalis*		OD	
Gramineae		*Diplachne fusca*	OD	OD	OD
Gramineae	*	*Echinochloa crus-galli*	OD		
Gramineae	*	*Echinochloa utilis*	OD		
Gramineae		*Enneapogon avenaceus*	M	OD	OD
Gramineae		*Enneapogon caerulescens*	OD	OD	OD
Gramineae		*Enneapogon cylindricus*	OD	OD	OD
Gramineae		*Enneapogon nigricans*	M		OD
Gramineae		*Enneapogon polyphyllus*	OD	OD	OD
Gramineae		*Enteropogon acicularis*	M	OD	OD
Gramineae		*Eragrostis australasica*	OD	OD	OD
Gramineae	*	*Eragrostis barrelieri*		OD	OD

Family	Species name	ODO	GT	LED
Gramineae	*Eragrostis basedowii*		OD	OD
Gramineae	* *Eragrostis cilianensis*		OD	
Gramineae	*Eragrostis dielsii*	OD	OD	OD
Gramineae	*Eragrostis elongata*		OD	OD
Gramineae	*Eragrostis eriopoda*	OD	M	OD
Gramineae	*Eragrostis falcata*		OD	OD
Gramineae	*Eragrostis laniflora*	OD	M	
Gramineae	*Eragrostis leptocarpa*		OD	OD
Gramineae	*Eragrostis parviflora*		OD	
Gramineae	*Eragrostis setifolia*	OD	OD	OD
Gramineae	*Eragrostis xerophila*	M	OD	OD
Gramineae	*Eriachne aristidea*			OD
Gramineae	*Eriachne helmsii*	OD	M	
Gramineae	*Eriachne mucronata*		OD	
Gramineae	*Eriachne ovata*			OD
Gramineae	*Eriochloa australiensis*		OD	OD
Gramineae	*Eriochloa creba*			OD
Gramineae	*Eriochloa pseudoacrotricha*		OD	OD
Gramineae	*Eulalia aurea*		OD	OD
Gramineae	* *Holcus lanatus*	OD		
Gramineae	* *Hordeum vulgare* subsp. *distichon*	OD		OD
Gramineae	*Iseilema eremaeum*			OD
Gramineae	*Iseilema membranaceum*			OD
Gramineae	*Iseilema vaginiflorum*			OD
Gramineae	*Leptochloa digitata*			OD
Gramineae	* *Lolium rigidum*	OD	OD	OD
Gramineae	*Monachather paradoxa*	OD	M	
Gramineae	*Neurachne munroi*	M	OD	
Gramineae	*Panicum decompositum*	OD	OD	OD
Gramineae	*Panicum laevinode*		OD	OD
Gramineae	*Paractaenum novae-hollandiae*	OD	M	OD
Gramineae	*Paractaenum refractum*	OD	OD	
Gramineae	*Paspalidium basicladum*		OD	
Gramineae	*Paspalidium constrictum*	M	OD	
Gramineae	*Paspalidium jubiflorum*		OD	
Gramineae	* *Paspalum dilatatum*	OD		
Gramineae	* *Pennisetum clandestinum*	OD		
Gramineae	* *Pennisetum setaceum*	OD		
Gramineae	* *Phalaris canariensis*	OD		
Gramineae	*Phragmites australis*			OD
Gramineae	*Phragmites karka*			OD
Gramineae	* *Poa annua*	OD		
Gramineae	* *Polypogon monspeliensis*	OD	OD	OD
Gramineae	* *Rostraria pumila*	OD	OD	OD
Gramineae	* *Schismus barbatus*	OD	OD	OD
Gramineae	*Setaria dielsii*		OD	OD
Gramineae	* *Setaria italica*	M	OD	
Gramineae	* *Sorghum halepense*	OD		
Gramineae	* *Sorghum x almum*	OD		
Gramineae	*Sporobolus actinocladus*	OD	OD	OD
Gramineae	*Sporobolus mitchellii*			M
Gramineae	*Sporobolus virginicus*			OD
Gramineae	*Stipa nitida*	OD	OD	OD
Gramineae	*Stipa nodosa*	OD		
Gramineae	*Stipa scabra* subsp. *falcata*			OD
Gramineae	*Themeda triandra*		OD	OD

Family	Species name	ODO	GT	LED
Gramineae	*Tragus australianus*	OD	OD	OD
Gramineae	*Tripogon loliiformis*	OD	M	OD
Gramineae	*Triraphis mollis*	OD	M	OD
Gramineae	* *Triticum aestivum*	OD		
Gramineae	*Urochloa gilesii* subsp. *gilesii*			OD
Gramineae	*Urochloa piligera*	M		
Gramineae	*Urochloa praetervisa*		OD	OD
Gramineae	*Urochloa subquadripara*			OD
Gramineae	*Zygochloa paradoxa*	M	OD	OD
Gyrostemonaceae	*Gyrostemon ramulosus*		OD	
Haloragaceae	*Haloragis aspera*			OD
Haloragaceae	*Haloragis glauca*		OD	
Haloragaceae	*Haloragis uncatipila*		OD	
Haloragaceae	*Myriophyllum verrucosum*		OD	OD
Juncaceae	*Juncus bufonius*		OD	
Juncaceae	* *Juncus capitatus*			OD
Juncaceae	*Juncus kraussii*			OD
Juncaginaceae	*Triglochin calcitrapum*	M	OD	OD
Juncaginaceae	*Triglochin centrocarpum*	OD		
Juncaginaceae	*Triglochin hexagonum*			OD
Labiatae	* *Marrubium vulgare*		OD	
Labiatae	*Mentha australis*		OD	OD
Labiatae	*Teucrium racemosum*	OD	OD	OD
Leguminosae	*Acacia aneura* var. *aneura*	OD	OD	OD
Leguminosae	*Acacia burkittii*	OD	OD	
Leguminosae	*Acacia cambagei*			OD
Leguminosae	*Acacia cibaria*			OD
Leguminosae	*Acacia farnesiana*			OD
Leguminosae	*Acacia kempeana*	OD	OD	
Leguminosae	*Acacia ligulata*	OD	M	OD
Leguminosae	*Acacia oswaldii*	OD	OD	OD
Leguminosae	*Acacia papyrocarpa*	OD	OD	
Leguminosae	*Acacia ramulosa*	OD	M	OD
Leguminosae	*Acacia salicina*			OD
Leguminosae	*Acacia* sp. aff. *papyrocarpa*		OD	
Leguminosae	*Acacia stenophylla*			OD
Leguminosae	*Acacia stowardii*			OD
Leguminosae	*Acacia tetragonophylla*	OD	OD	OD
Leguminosae	*Acacia victoriae*	OD	M	OD
Leguminosae	*Aeschynomene indica*		OD	
Leguminosae	*Crotalaria cunninghamii*		OD	OD
Leguminosae	*Crotalaria eremaea* subsp. *eremaea*	OD	OD	OD
Leguminosae	*Crotalaria eremaea* subsp. *strehlowii*	M	M	OD
Leguminosae	*Crotalaria smithiana*			OD
Leguminosae	*Glycine canescens*		OD	OD
Leguminosae	*Glycine clandestina* var. *servicea*	OD	OD	OD
Leguminosae	*Indigofera australis*		OD	
Leguminosae	*Indigofera colutea*			OD
Leguminosae	*Indigofera psammophila*	OD	OD	OD
Leguminosae	*Isotropis wheeleri*			OD
Leguminosae	*Lotus australis*		OD	OD
Leguminosae	*Lotus cruentus*	OD	OD	OD
Leguminosae	* *Medicago polymorpha*	OD	M	
Leguminosae	* *Medicago sativa*	M		
Leguminosae	*Neptunia dimorphantha*			OD
Leguminosae	*Psoralea australasica*	OD	OD	OD

Family	Species name	ODO	GT	LED
Leguminosae	*Psoralea cinerea*		OD	OD
Leguminosae	*Psoralea graveolens*		OD	OD
Leguminosae	*Psoralea pallida*	OD	OD	OD
Leguminosae	*Psoralea patens*		OD	OD
Leguminosae	*Senna artemisioides* nothossp. *artemisioides*			OD
Leguminosae	*Senna artemisioides* nothossp. *coriacea*	OD	OD	OD
Leguminosae	*Senna artemisioides* nothossp. *sturtii*		M	OD
Leguminosae	*Senna artemisioides* aff. subsp. *alicia*			OD
Leguminosae	*Senna artemisioides* subsp. *filifolia*	OD	M	
Leguminosae	*Senna artemisioides* subsp. *helmsii*	OD	OD	OD
Leguminosae	*Senna artemisioides* subsp. *oligophylla*		M	
Leguminosae	*Senna artemisioides* subsp. *petiolaris*	OD	OD	OD
Leguminosae	*Senna artemisioides* subsp. *quadrifolia*	M	OD	OD
Leguminosae	*Senna artemisioides* subsp. *zygophylla*			OD
Leguminosae	*Senna glutinosa* aff. subsp. *pruinosa*		OD	
Leguminosae	*Swainsona adenophylla*		OD	OD
Leguminosae	*Swainsona campylantha*			OD
Leguminosae	*Swainsona flavicarinata*			OD
Leguminosae	*Swainsona formosa*	OD	OD	OD
Leguminosae	*Swainsona minutiflora*			OD
Leguminosae	*Swainsona oligophylla*			OD
Leguminosae	*Swainsona oliveri*	M	OD	
Leguminosae	*Swainsona oroboides*			OD
Leguminosae	*Swainsona phacoides*		OD	OD
Leguminosae	*Swainsona stipularis*		OD	OD
Leguminosae	*Swainsona tephrotricha*			OD
Leguminosae	*Templetonia egena*	OD	OD	
Leguminosae	*Tephrosia sphaerospora*	OD	OD	OD
Leguminosae	* *Trifolium dubium*	OD		
Leguminosae	* *Trifolium glomeratum*			OD
Leguminosae	*Trigonella suavissima*	M	OD	OD
Leguminosae	*Vigna lanceolata*			OD
Liliaceae	* *Asphodelus fistulosus*	OD		
Liliaceae	*Bulbine alata*	M	OD	OD
Liliaceae	*Dichopogon fimbriatus*		OD	
Liliaceae	*Murchisonia volubilis*	OD	M	
Liliaceae	*Thysanotus baueri*	OD		
Liliaceae	*Thysanotus exiliflorus*	OD	M	
Liliaceae	*Wurmbea centralis*		OD	
Liliaceae	*Wurmbea dioica* subsp. *citrina*		OD	OD
Limoniaceae	* *Limonium lobatum*		OD	
Limoniaceae	* *Limonium sinuatum*	OD		
Loranthaceae	*Amyema maidenii*	OD	OD	OD
Loranthaceae	*Amyema miquelii*			M
Loranthaceae	*Amyema miraculosum* subsp. *boormanii*		OD	OD
Loranthaceae	*Amyema preissii*	OD	OD	OD
Loranthaceae	*Amyema quandang* var. *quandang*	M	OD	
Loranthaceae	*Lysiana exocarpi*	OD	OD	OD
Loranthaceae	*Lysiana murrayi*	OD	OD	OD
Loranthaceae	*Lysiana subfalcata*		OD	OD
Lythraceae	*Ammania multiflora*			OD
Lythraceae	*Lythrum hyssopifolia*		OD	OD
Malvaceae	*Abutilon cryptopetalum*		OD	OD
Malvaceae	*Abutilon fraseri*		OD	OD
Malvaceae	*Abutilon halophilum*	M	OD	OD
Malvaceae	*Abutilon leucopetalum*		OD	OD

Family		Species name	ODO	GT	LED
Malvaceae		*Abutilon malvaefolium*	OD		OD
Malvaceae		*Abutilon otocarpum*	OD	M	OD
Malvaceae		*Abutilon oxycarpum*		OD	
Malvaceae		*Gossypium sturtianum* var. *sturtianum*		OD	
Malvaceae		*Hibiscus brachysiphonius*		OD	OD
Malvaceae		*Hibiscus krichauffianus*	OD	OD	OD
Malvaceae		*Hibiscus trionum* var. *vesicarius*			OD
Malvaceae		*Lavatera plebeia*		OD	OD
Malvaceae		*Lawrencia glomerata*		OD	OD
Malvaceae		*Lawrencia squamata*			OD
Malvaceae	*	*Malva parviflora*	M	OD	OD
Malvaceae	*	*Malvastrum americanum*	OD	OD	OD
Malvaceae		*Sida ammophila*	OD	OD	OD
Malvaceae		*Sida corrugata*	M	M	OD
Malvaceae		*Sida cunninghamii*	M	OD	OD
Malvaceae		*Sida fibulifera*	OD	OD	OD
Malvaceae		*Sida goniocarpa*			OD
Malvaceae		*Sida intricata*	OD	OD	OD
Malvaceae		*Sida petrophila*		OD	OD
Malvaceae		*Sida trichopoda*		OD	OD
Marsileaceae		*Marsilea drummondii*		OD	OD
Marsileaceae		*Marsilea exarata*		OD	
Marsileaceae		*Marsilea hirsuta*	OD	OD	OD
Marsileaceae		*Marsilea* sp. aff. *angustifolia*		OD	OD
Myoporaceae		*Eremophila alternifolia*	OD	M	
Myoporaceae		*Eremophila decussata*			OD
Myoporaceae		*Eremophila deserti*		OD	OD
Myoporaceae		*Eremophila duttonii*		OD	OD
Myoporaceae		*Eremophila freelingii*		OD	OD
Myoporaceae		*Eremophila glabra*	OD	M	OD
Myoporaceae		*Eremophila latrobei* subsp. *glabra*	M	OD	OD
Myoporaceae		*Eremophila longifolia*	OD	M	OD
Myoporaceae		*Eremophila maculata* subsp. *maculata*		OD	OD
Myoporaceae		*Eremophila oppositifolia* subsp. *oppositifolia*		OD	OD
Myoporaceae		*Eremophila paisleyi*	OD	M	
Myoporaceae		*Eremophila rotundifolia*		OD	OD
Myoporaceae		*Eremophila scoparia*	OD	M	OD
Myoporaceae		*Eremophila serrulata*		OD	OD
Myoporaceae		*Myoporum brevipes*			OD
Myoporaceae		*Myoporum montanum*		OD	OD
Myrtaceae		*Eucalyptus camaldulensis*		OD	OD
Myrtaceae		*Eucalyptus coolabah* subsp. *coolabah*		OD	OD
Myrtaceae		*Eucalyptus socialis*			OD
Myrtaceae		*Melaleuca glomerata*		OD	OD
Myrtaceae		*Melaleuca pauperiflora*	OD	OD	OD
Myrtaceae		*Melaleuca uncinata*		OD	
Nyctaginaceae		*Boerhavia coccinea*	OD	OD	OD
Nyctaginaceae		*Boerhavia dominii*	OD	OD	OD
Nyctaginaceae		*Boerhavia schomburgkiana*		OD	OD
Nyctaginaceae		*Commicarpus australis*			OD
Ophioglossaceae		*Ophioglossum lusitanicum*	OD	M	
Ophioglossaceae		*Ophioglossum polyphyllum*	M	OD	
Orobanchaceae		*Orobanche cernua* var. *australiana*			OD
Oxalidaceae	*	*Oxalis corniculata*			OD
Oxalidaceae		*Oxalis perennans*	OD	OD	
Palmae	*	*Phoenix dactylifera*			M

Family		Species name	ODO	GT	LED
Pittosporaceae		*Pittosporum phylliraeoides*	M	OD	OD
Plantaginaceae		*Plantago debilis*		OD	
Plantaginaceae		*Plantago drummondii*	OD	OD	OD
Plantaginaceae		*Plantago hispida*		OD	
Polygonaceae	*	*Acetosa vesicaria*	M	M	OD
Polygonaceae	*	*Emex australis*		OD	OD
Polygonaceae		*Muehlenbeckia coccoloboides*			OD
Polygonaceae		*Muehlenbeckia florulenta*		OD	OD
Polygonaceae	*	*Polygonum aviculare*	OD	OD	
Polygonaceae		*Polygonum plebeium*		OD	OD
Polygonaceae		*Rumex crystallinus*	OD	OD	OD
Portulacaceae		*Calandrinia balonensis*		OD	
Portulacaceae		*Calandrinia disperma*	OD	M	
Portulacaceae		*Calandrinia eremaea*	M	OD	OD
Portulacaceae		*Calandrinia ptychosperma*	M	OD	OD
Portulacaceae		*Calandrinia pumila*	OD	OD	OD
Portulacaceae		*Calandrinia remota*	M	OD	OD
Portulacaceae		*Calandrinia volubilis*		OD	
Portulacaceae		*Portulaca intraterranea*			OD
Portulacaceae		*Portulaca oleracea*	OD	OD	OD
Potamogetonaceae		*Potamogeton pectinatus*			OD
Potamogetonaceae		*Ruppia maritima*			OD
Primulaceae	*	*Anagallis arvensis*		OD	OD
Primulaceae		*Samolus repens*			OD
Proteaceae		*Grevillea nematophylla*	OD	OD	OD
Proteaceae		*Hakea leucoptera*	OD	OD	OD
Ranunculaceae		*Myosurus minimus* var. *australis*		OD	OD
Ranunculaceae		*Ranunculus pentandrus* var. *platycarpus*		OD	OD
Ranunculaceae		*Ranunculus pumilio* var. *pumilio*	OD		OD
Rosaceae		*Aphanes australiana*	OD		
Rubiaceae		*Dentella pulvinata*			OD
Rubiaceae		*Synaptantha tillaeacea*		OD	OD
Santalaceae		*Exocarpos aphyllus*	OD	OD	M
Santalaceae		*Santalum acuminatum*	M	M	OD
Santalaceae		*Santalum lanceolatum*	OD	OD	OD
Santalaceae		*Santalum spicatum*	M	OD	
Sapindaceae		*Alectryon oleifolius* subsp. *canescens*	M	M	OD
Sapindaceae		*Dodonaea lobulata*		OD	OD
Sapindaceae		*Dodonaea microzyga* var. *microzyga*		M	OD
Sapindaceae		*Dodonaea viscosa* subsp. *angustissima*	OD	OD	OD
Scrophulariaceae		*Glossostigma diandrum*		OD	OD
Scrophulariaceae		*Glossostigma* sp. A			OD
Scrophulariaceae		*Limosella curdieana*	OD	OD	OD
Scrophulariaceae		*Mimulus prostratus*			OD
Scrophulariaceae		*Mimulus repens*		OD	OD
Scrophulariaceae		*Peplidium foecundum*		OD	OD
Scrophulariaceae		*Peplidium muelleri*			OD
Scrophulariaceae		*Stemodia florulenta*	OD	OD	OD
Scrophulariaceae		*Stemodia glabella*			OD
Solanaceae	*	*Datura leichhardtii*[1]			OD
Solanaceae		*Lycium australe*	OD	M	OD
Solanaceae	*	*Nicotiana glauca*	OD	M	
Solanaceae		*Nicotiana simulans*	OD	OD	OD
Solanaceae		*Nicotiana velutina*	OD	OD	OD
Solanaceae		*Solanum ellipticum*	OD	OD	OD
Solanaceae		*Solanum esuriale*			OD

Family		Species name	ODO	GT	LED
Solanaceae		*Solanum lacunarium*		M	OD
Solanaceae	*	*Solanum marginatum*	OD	OD	
Solanaceae	*	*Solanum nigrum*	M	OD	OD
Solanaceae		*Solanum oligacanthum*			OD
Stackhousiaceae		*Stackhousia clementii*		OD	
Sterculiaceae		*Gilesia biniflora*	OD	OD	OD
Tamaricaceae	*	*Tamarix aphylla*			OD
Thymelaeaceae		*Pimelea microcephala*	OD	OD	OD
Thymelaeaceae		*Pimelea simplex*	M	OD	OD
Thymelaeaceae		*Pimelea trichostachya*		OD	OD
Typhaceae		*Typha domingensis*	OD		OD
Typhaceae		*Typha orientalis*			OD
Umbelliferae		*Daucus glochidiatus*	OD	OD	OD
Umbelliferae		*Trachymene glaucifolia*	OD	M	OD
Urticaceae		*Parietaria debilis*		OD	
Verbenaceae	*	*Verbena officinalis*		OD	
Verbenaceae	*	*Verbena supina*	M	OD	OD
Zygophyllaceae		*Nitraria billardieri*		M	OD
Zygophyllaceae		*Tribulus eichlerianus*	M	M	OD
Zygophyllaceae		*Tribulus hystrix*			OD
Zygophyllaceae	*	*Tribulus terrestris*[2]	OD	OD	OD
Zygophyllaceae		*Zygophyllum apiculatum*	M	M	
Zygophyllaceae		*Zygophyllum aurantiacum*	M	OD	OD
Zygophyllaceae		*Zygophyllum compressum*		OD	OD
Zygophyllaceae		*Zygophyllum crenatum*			M
Zygophyllaceae		*Zygophyllum emarginatum*	OD	OD	OD
Zygophyllaceae		*Zygophyllum eremaeum*	M	OD	OD
Zygophyllaceae		*Zygophyllum howittii*	OD	OD	
Zygophyllaceae		*Zygophyllum humillimum*			OD
Zygophyllaceae		*Zygophyllum iodocarpum*	OD	OD	OD
Zygophyllaceae		*Zygophyllum ovatum*		OD	
Zygophyllaceae		*Zygophyllum prismatothecum*	OD	OD	OD
Zygophyllaceae		*Zygophyllum simile*	OD	OD	OD

ODO Olympic Dam Operations mine lease and Roxby Downs municipality areas
GT Gairdner-Torrens botanic region; areas surrounding ODO
LED Lake Eyre Drainage
OD Collections in ODO Herbarium and/or collections donated to the South Australian State Herbarium
M Species recorded during regular monitoring but not collected
* Introduced species
1 Based on circumstantial evidence, *D. leichhardtii* is probably a recent introduction to Australia within the last 300 years. It is similar, if not identical, to *D. pruinosa* from Central America (L. Haegi, State Herbarium, pers. comm., 1997).
2 Both native and introduced forms occur. The native form only has been recorded at ODO; the introduced form has been recorded elsewhere.

Appendix J

In Table J.2, p. J-9, under 'white-browed woodswallow', the species name (*A. superciliosus*) and status (nomadic) should be moved one column to the right.

In Table J.4, pp. J-13 – J-14, reference to the beaded gecko (*Lucasium damaeum*) should be deleted. In the same table, the species name for the blind snake should read *Ramphotyphlops bituberculatus*.

There are four amendments to Table J.5, p. J-14: under Gekkonidae, *Diplodacylus byrnei* should appear as *Diplodactylus byrnei*, and the beaded gecko should be listed with the species name of *D. damaeus*; *Ctenophorus fionni* should be listed under Agamidae; and *Lerista bipes* should be changed to *Lerista labialis*.

Appendix K

In the last ten rows of Table K.2, p. K-4, the spacing in column four is incorrect. The correct alignment of the rows is shown below.

Table K.2 Flora recorded in association with mound springs and frequency classification of species recorded during the flora monitoring programme

Common name	Family	Species	Status
Sago weed	Plantaginaceae	*Plantago drummondii*	very uncommon[1]
Bristly dock	Polygonaceae	*Rumex crystallinus*	very uncommon[1]
Pondweed	Potamogetonaceae	*Potamogeton pectinatus*	uncommon
Creeping brookweed	Primulaceae	*Samolus repens*	uncommon
Velvet tobacco	Solanaceae	*Nicotiana velutina*	uncommon
Athel pine	Tamaricaceae	*Tamarix aphylla*[2]	uncommon
Desert riceflower	Thymelaeaceae	*Pimelea simplex*	very uncommon[1]
Cumbungi	Typhaceae	*Typha domingensis*	common
Cumbungi		*T. orientalis*	status not recorded
Native carrot	Umbelliferae (Apiaceae)	*Daucus glochidiatus*	uncommon[1]
Nitrebush	Zygophyllaceae	*Nitraria billardierei*	common
Sand twinleaf		*Zygophyllum ammophilum*	uncommon
Clasping twinleaf		*Z. howittii*	very uncommon
Square-fruit twinleaf		*Z. prismatothecum*	very uncommon[1]

1 Species recorded only following 1989 floods.
2 Introduced species.
3 Species distribution outside mound springs is limited.
Status: Abundant: frequency of occurrence greater than 10% and less than or equal to 100%.
Common: frequency of occurrence greater than 1% and less than or equal to 10%.
Uncommon: frequency of occurrence greater than 0.1% and less than or equal to 1%.
Very uncommon: frequency of occurrence greater than 0.01% and less than or equal to 0.1%.
Frequency classification based on 2,251 sampling units (Fatchen and Fatchen 1993).

D3 AMENDMENTS TO FIGURES

Chapter 4

The groundwater contours for the Arcoona Quartzite aquifer shown in Figure 4.22, p.4-43, are not correctly located. They have been replotted in the correct location and updated using more recent data. The revised figure is shown in Chapter 4 as Figure 4.1 of this Supplement.

Chapter 10

Figure 10.8, p. 10–11, shows incorrect proportions for polonium-210 and lead-210 in the gold room. The revised figure has been corrected and appears as Figure 10.5 in this Supplement.

In Figure 10.16, p. 10-20, the first point on the annual dose axis was incorrectly shown as 0.50 mSv. This should read 0.05 mSv.

In Figure 10.23, p. 10-29, the unit of measurement should be $mg/m^2/d$ instead of mg/m^2.

The information in Figure 10.24, p. 10-30, is incorrect and has been revised. The correct information appears as Figure 10.2 of this Supplement.

In Figure 10.30, p. 10-35, the radiation dose levels indicated on the y-axis were incorrectly shown as ranging from 0.00 mSv to 0.35 mSv. They should be shown as ranging from 0.000 mSv to 0.035 mSv.

Chapter 11

This scale bar for Figure 11.6, p. 11-29, has been incorrectly labelled as 200 km. This should be amended to show 200 m.

Appendix I

In Figure I.1a, p. I-2, *Callitris glancophylla* should be labelled *Callitris glaucophylla*.

APPENDIX E

GLOSSARY

APPENDIX E

GLOSSARY

A-weighted sound level (dBA)	A logarithmic measurement scale in which each increase of about 3 dBA represents a two-fold increase in sound intensity.
Accumulator drum technique	A technique used to measure the rate of radon (^{222}Rn) exhalation from a surface. An open-ended drum is placed on to the surface and sealed. Air is drawn from the airspace in the drum, through a radon measuring device and returned to the airspace in the drum. The rate of increase of radon concentration is a measure of the rate of radon exhalation from the surface.
Allozyme electrophoresis	Separation of different forms of an enzyme by the electrical charge of each form, thereby providing an assessment of allelic difference of the gene encoding each enzyme.
Alpha particle	A positively charged particle containing two protons and two neutrons which is emitted by certain radioisotopes. It is the least penetrating of the three main forms of radiation (alpha, beta and gamma), in that it may be stopped by a sheet of paper.
Anode furnace	A copper refining furnace in which blister copper (q.v.) is refined.
Aquifer	A permeable rock formation that stores and transmits sufficient groundwater to yield economically significant quantities of water to wells, bores or springs.
Artesian water	Groundwater under sufficient hydrostatic pressure to rise above the level at which it is encountered by a well.
Backfill	The process of refilling a mine opening, or the waste material (sand, rock, dirt, etc.) used for that purpose.
Becquerel (Bq)	The SI unit of measurement of radioactive activity defined as one radioactive disintegration per second.
Beta particle	An electron or positron emitted by the nucleus of a radionuclide during radioactive decay. Beta particles will pass through paper but are stopped by a thin sheet of metal.
Blister copper	Unrefined copper, prepared from ore by a smelting or converting process, containing approximately 1% sulphur and 1% other impurities.

Calcine	The residue derived from heating a mineral substance to drive off the chemically combined volatile portion of the substance and to convert the non-volatile mineral to an oxide.
Central thickened discharge (CTD) method	A tailings storage method that involves further thickening of the tailings slurry, followed by discharge through central risers to form a final tailings profile resembling a series of intersecting flat cones.
Class A pan	A standard pan used for measuring rates of evaporation.
Comminution	The process of size reduction of ore involving crushing or grinding.
Computable general equilibrium (CGE) model	Models of economies (regional, State, national) which portray the links between sectors of the economy in terms of how inputs and outputs flow and which are able to simulate the effects of price changes and resource constraints.
Cone of depression	A cone-shaped depression in a water table caused by pumping.
Decay product	The product of the spontaneous radioactive decay of a nuclide (q.v.). A nuclide such as uranium-238 decays through a sequence of steps and has associated with it a number of successive decay products in a decay series.
Desliming	The removal of very fine particles from an ore pulp, or the classification of it into relatively coarse and fine fractions.
Disaggregate	To break down data in order to focus on one particular aspect, when modelling economic effects.
Doline	A funnel-shaped cavity, created by the dissolution of carbonate rock by water, which communicates with the underground drainage system in a limestone region.
Dolomitic limestone	A limestone with a high proportion of the mineral dolomite ($CaMg(CO_3)_2$).
Dose	The radiation energy absorbed in a unit mass of material.
Dose equivalent	The mathematical product of the absorbed dose, the quality factor, and any other specified modifying factors. The quality factor accounts for the effectiveness of energy transfer of the ionising radiation in producing a biological detriment. Modifying factors are those which may act to modify the effect of the energy imparted to the matter.
Drawdown	The fall of water-level in a natural reservoir such as an aquifer due to pumping or artesian flow.
Driving head	Water pressure causing flow.

Electrostatic precipitator	An air pollution control device used to remove fine particulate matter from industrial waste gases. In the device, a very high voltage is imparted between sets of electrodes. One set of electrodes induces a charge on the particles, which are then attracted to and collected on the other set of electrodes.
Evaporites	Deposits of mineral salts from salt lakes due to evaporation.
Flow-on effects	The effects on other areas of an economy as a result of a change in activity in a particular industry sector.
Gamma radiation	A form of electromagnetic radiation similar to light or X-rays, distinguished by its high energy and penetrating power. Gamma radiation is emitted after nuclear reactions, or by radioactive atoms when the nucleus is left in an excited state after the emission of an alpha or beta particle.
Great Artesian Basin	A groundwater basin covering about one-fifth of Australia that includes an artesian aquifer whose potentiometric surface is above the land surface in topographically lower parts of the area.
Grey water	Untreated sewage which does not include faecal matter.
Gross domestic product (GDP)	The total money value of all final goods and services produced in the national economy over a one-year period.
Gross state product (GSP)	The total money value of all final goods and services produced in a State economy over a one-year period.
Groundwater	Underground water contained within a saturated zone or rock (aquifer).
HAZOP	A HAZOP (hazard and operability) study identifies potential hazards and operability problems in industrial plant. The concept involves investigating how the plant might deviate from the design intent under all possible operating conditions.
Hydraulic gradient	The change in static head or hydraulic potential per unit of distance in a given direction.
Hydrogeology	The science dealing with groundwater and with related geologic aspects of surface water.
Input–output analysis	A technique of economic analysis describing the interaction of sectors of the economy, and allowing estimation of the effect of change in one sector on other sectors.
Ionising radiation	Radiation which interacts with matter to add or to remove electrons from (i.e. to ionise) the atoms of the material absorbing it, producing electrically charged (positive or negative) atoms called ions.

Karst	A topology formed over limestone or dolomite and characterised by sinkholes, caves and underground drainage.
Lagooning	The use of artificial shallow pools for the treatment of effluent.
Lung Dose Evaluation Program (LUDEP)	Computer programme developed to predict radiation doses to lungs.
Mineral resource	An identified *in situ* mineral occurrence from which valuable or useful minerals may be recovered.
Mullock	Waste rock (generally unmineralised) which is extracted during mine development and production.
Multiplier	Indicator of the size of flow-on effects (q.v.) in economic modelling.
Net present value (NPV)	Discounted cash flow over time.
Nuclide	An atom of a particular element distinguished by the number of protons and neutrons in its nucleus.
ODEX1 model	Numerical model developed by WMC to model the hydrogeology of the Great Artesian Basin.
Ore reserve	That part of a mineral resource which could be mined, inclusive of dilution, and from which valuable or useful minerals could be recovered economically under conditions realistically assumed at the time of reporting.
Pasquill stability classes	Classes of atmospheric stability which are indicators of the degree of turbulent mixing in the atmosphere varying from Class A (the most unstable condition, with rapid mixing) to Class F (the most stable, with very limited mixing).
Permeability	The capacity of a porous rock for transmitting a fluid.
Phreatic surface	The planar surface between the zone of saturation and the zone of aeration.
Project Area	The combined Municipal Lease and Special Mining Lease area.
Radionuclide	Any nuclide (isotope of an element) which is unstable and undergoes natural radioactive decay.
Radon	Radon is the heaviest of the 'noble' or inert gases. The predominant isotope, radon-222, is the decay product of radium-226. It has a half-life of 3.82 days and decays to polonium-218 by the emission of an alpha particle.
Raise	A more or less vertical underground opening developed upwards from a level below. At Olympic Dam nearly all raises are developed by boring.
Rheology	The study of the deformation and flow of matter.

Sievert (Sv)	The SI unit of measurement of effective dose. One sievert is equal to the product of the absorbed dose by the quality factor and any modifying factor(s). It allows a comparison of the relatively greater biological damage caused by some particles such as alpha particles and fast neutrons. For most beta and gamma radiation, one sievert is equal to an absorbed dose of one joule per kilogram of biological matter.
Slurry	A thin paste produced by mixing certain materials with water, sufficiently fluid to flow viscously.
Stope	An underground opening from which ore is extracted.
Subaerial	Descriptive of a process that takes place in the open air on the land surface rather than under water or underground.
Supernatant	Descriptive of the liquid above settled solids.
Swale	The area lying between sand ridges.
Synroc®	Technique for encapsulating radioactive waste in synthetic rock.
Tailings	The waste material remaining after the processing of finely ground ore.
Tailings dam	A dam, usually made from earth, and possibly with clay or other liners, used to retain tailings.
Uranium (decay) series	A series of radionuclides produced in the decay of radioactive uranium to stable lead. The most important steps of this series are uranium-238 to uranium-234 to thorium-230 to radium-226 to radon-222 (and its decay products) to lead-210 and finally to lead-206, the stable non-radioactive end-product.
Yellowcake	Historically, the name 'yellowcake' was given to the bright yellow substance ammonium diuranate (ADU). In Australia, ADU is usually calcined at high temperature to produce a mixture of uranium oxides, principally U_3O_8 which is dark green in colour, and is also called uranium oxide concentrate (UOC). Colloquially UOC is sometimes (incorrectly) referred to as 'yellowcake'.

APPENDIX F

ABBREVIATIONS

APPENDIX F

ABBREVIATIONS

MEASUREMENTS

Technical units of measurement in this report are based on the International System of Units (SI) wherever possible. These technical units may be broadly grouped as prefixes and measurements. A prefix applies to the unit of measurement that immediately follows it—for example, milligram is abbreviated as mg. Superscripts ^{2} and ^{3} following a linear unit indicate area and volume respectively—for example, m^2 (square metres) and m^3 (cubic metres). Different units are combined by a full stop (.) to differentiate units of the same exponential sign, and a solidus (/) to indicate 'per'. For example, kilometres per hour is abbreviated as km/h, while megalitres per day per square kilometre is ML/d.km^2.

PREFIXES

G	giga	1,000,000,000
M	mega	1,000,000
k	kilo	1,000
c	centi	0.01
m	milli	0.001
μ	micro	0.000001

UNITS OF MEASUREMENT

a	year (annum)
αd/s	alpha disintegrations per second
αd/s/m^3	alpha disintegrations per cubic metre
Bq	becquerel
Bq/m^2.s	becquerel(s) per square metre per second
cm	centimetre
d	day
$	dollar
g	gram
g/a	gram(s) per annum
GJ/a	gigajoule(s) per annum
ha	hectare
h	hour
J	joule

kg	kilogram
kL/a	kilolitre(s) per annum
kL/d	kilolitre(s) per day
kL/t	kilolitre(s) per tonne
km	kilometre
kPa	kilopascal
kPa/a	kilopascal(s) per annum
kV	kilovolt
L	litre
m	metre
m/a	metre(s) per annum
mg/L	milligram(s) per litre
$mg/m^2/d$	milligram(s) per square metre per day
ML	megalitre(s)
mm	millimetre
ML/d	megalitre(s) per day
mSv/a	millisievert(s) per annum
Mt/a	megatonne(s) per annum
Pa	pascal
pH	degree of alkalinity/acidity
µg	microgram
Sv	sievert
t	tonne
t/a	tonne(s) per annum
V	volt
WLM	working level month
$\mu Bq/m^3$	microbecquerel(s) per cubic metre
µSv/a	microsievert(s) per annum

CHEMICAL SYMBOLS

^{210}Po	polonium-210
^{210}Pb	lead-210
^{226}Ra	radium-226
SO_2	sulphur dioxide
^{230}Th	thorium-230
U_3O_8	uranium oxide
^{238}U	uranium-238

GENERAL

AGPS	Australian Government Publishing Service
AHD	Australian Height Datum
ALARA	'as low as reasonably achievable' (social and economic factors being taken into account)
AMCORD	Australian Model Code for Residential Development
ARL	Australian Radiation Laboratory
AS	Australian Standard
CAF	cemented aggregate fill
CAMBA	Agreement between the Government of Australia and the Government of the Peoples Republic of China for the protection of migratory birds in danger of extinction and their environment.
CGE	computable general equilibrium
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTD	central thickened discharge
DENR	Department of Environment and Natural Resources
EDRC	Environment, Resources and Development Committee
EIS	environmental impact statement
EMMP	environmental management and monitoring plan
EMP	environmental management programme
EPA	Environment Protection Authority (South Australia)
ERRP	Ecosystem Restoration and Research Project (Roxby Downs)
ESD	ecologically sustainable development
GAB	Great Artesian Basin
GNP	gross national product
GSP	gross state product
HAZOP	hazard and operability study
ICRP	International Commission on Radiological Protection
ISO	International Standards Organisation
JAMBA	Agreement between the Government of Australia and the Government of Japan for the protection of migratory birds in danger of extinction and their environment
LET	linear energy transfer
LUDEP	Lung Dose Evaluation Program
MESA	Mines and Energy South Australia
MRD	Municipality of Roxby Downs
MSFMP	mound spring invertebrate fauna monitoring programme
NHMRC	National Health and Medical Research Council
NOHSC	National Occupational Health and Safety Commission (also called 'Worksafe Australia')

ODO	Olympic Dam Operations
ODV1	Olympic Dam Village No. 1
ODV2	Olympic Dam Village No. 2
OECD	Organization for Economic Cooperation and Development
OH&S	Occupational Health and Safety
pers. comm.	personal communication
RPF	Respiratory Protection Factor
SAHC	South Australian Health Commission
State	Government of the State of South Australia
TDS	total dissolved solids
TRS	tailings retention system
TSF	tailings storage facility
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
WMC	WMC Limited

APPENDIX G

REFERENCES

APPENDIX G

REFERENCES

CHAPTER 1

No references in this chapter.

CHAPTER 2

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APPENDIX H

DESCRIPTION OF NUMERICAL MODEL ODEX1

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DESCRIPTION OF NUMERICAL MODEL ODEX1

The ODEX1 model was constructed to run on the industry standard finite difference groundwater modelling platform MODFLOW developed by US Geological Survey (McDonald and Harbaugh 1988). The current model evolved from previous modelling exercises, especially GAB95 which was developed prior to any exploration work for Borefield B.

The basic model grid, comprising sixty-eight rows and eighty-five columns (i.e. 5,780 cells per layer), covers an area of 260,000 km^2, extending from northern South Australia into New South Wales, Queensland and the Northern Territory.

H1 CONCEPTUAL MODEL GAB95

This section describes the GAB95 model, which forms the basis for development of the ODEX1 model.

H1.1 Vertical discretisation

A generalised conceptual diagram is shown in Figure H.1. The model comprises four layers, the positions of which were defined in metres AHD by three hydrogeologic contour maps:

- Depth to Algebuckina Sandstone: The position was interpolated between drill holes, using maps of the seismic 'C' horizon.
- Thickness of Algebuckina Sandstone: Thickness was interpolated between drill holes on the basis of the available seismic data.
- Ground surface: Topographic contour maps were digitised in the marginal parts of the basin with some adjustment made using survey data. To the north the contours were interpolated between widely spaced point data.

Layer 1

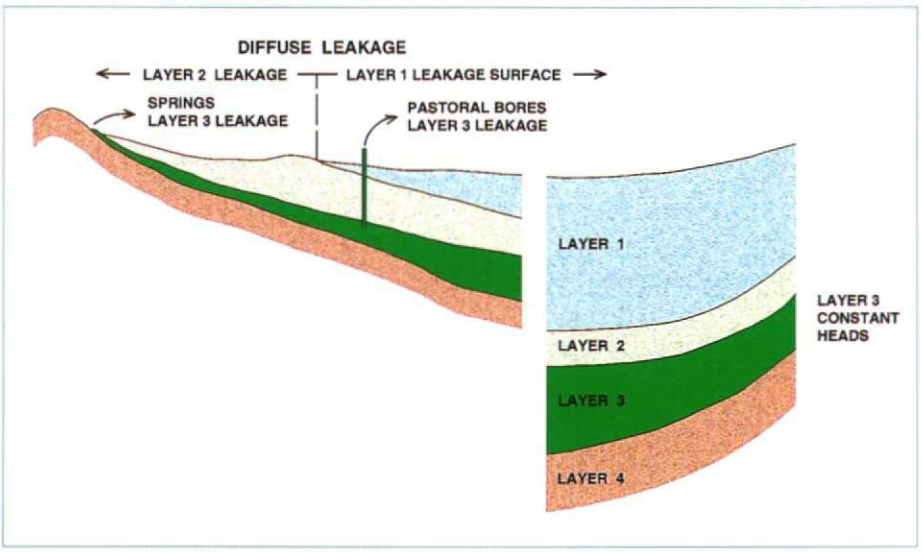
Cenozoic to Coorikianna Sandstone

Uniform aquifer parameters were set for this layer, which is defined by transmissivity and confined storativity. A global function was used to operate on the layer thickness to calculate conductance between Layer 1 and Layer 2, simulating the confining nature of Layer 1.

Layer 2

Bulldog Shale to Cadna-owie Formation

The Layer 2 top is 250 m above the top of Layer 3, or at the ground surface if this is the lesser. Layer base is equal to the top of Layer 3. The layer has uniform permeability, storage coefficient and storativity.



Layer 1 Aquitard	Cenozoic to Lower Cretaceous	Lake Eyre Basin Eromanga Basin - Winton Formation - Mackunda Formation - Oodnadatta Formation - Coorikiana Formation
Layer 2 Aquitard	Lower Cretaceous	- Bulldog Shale - Cadna-owie Formation
Layer 3 Aquifer	Lower Cretaceous Mid Jurassic	- Mooga Formation - Birkhead Formation - Hutton Formation - Algebuckina Sandstone
Layer 4 Aquifer	Lower Jurassic Proterozoic	- Poolowanna Beds Simpson Desert Basin Cooper Basin Proterozoic Metasediments

FIGURE H.1
CONCEPTUAL FLOW MODEL

A global function was used to operate on layer thickness to calculate conductance between Layer 2 and Layer 3, simulating the confining nature of Layer 2.

Layer 3

Algebuckina Sandstone and correlatives

The Layer 3 top is defined by ground surface minus aquifer depth. The Layer 3 base is defined by layer top minus thickness. The storage factor and storativity are uniform throughout the model. Permeability is variable.

Layer 4

Underlying aquitard

Layer 4 is defined by transmissivity and confined storativity. All parameters are globally uniform.

H1.2 Lateral extent of layers

The lateral extent of active cells in Layer 3 is shown with the model grid in Figure H.2. The lateral extent of Layer 4 is identical to Layer 3 and Layer 2 is very similar. Layer 1 has lesser extent, being inactive to the south where the younger formations pinch out. The northern boundary of the model consists of a constant head isopotential. To the west the boundary closely approximates a flow line and the Peake Denison Range no-flow boundary. To the south is the discharge zone of interest, abutted by a no-flow boundary. The eastern model boundary is an arbitrarily positioned no-flow boundary, placed at sufficient distance so as to have negligible impact on model solutions.

Groundwater inflow

Inflow is simulated by constant head cells in Layer 3 across the north of the model. Locations are shown in Figure H.2. The position of the constant head boundary was defined by reference to potentiometric maps presented by Audibert (1976) and Habermehl (1980), which are reasonably well constrained by reliable determinations at Birdsville and Oodnadatta. The level of the potentiometric surface (metres AHD at 25°C) at the constant head isopotential was calculated from the most recent pressure reading at Birdsville, provided by the Queensland Water Resources Commission.

Groundwater discharge

Diffuse discharge in areas of Layer 1 outcrop are to constant heads set at ground level in Layer 1, which cover much of the extent of the layer. This method of simulation embodies the assumption (verified by the model) that the potentiometric surface will not drop below ground level in areas where Layer 1 is active.

Diffuse discharge in areas of Layer 2 outcrop is to a mixed type boundary. Head at the boundary is set to ground level and conductance between the Layer 2 cell and the boundary made proportional to the cell area. Using the MODFLOW 'Drain' package, the boundary was made inactive when head in the Layer 2 cell dropped below ground level; that is, no recharge was allowed via the boundary.

Direct discharge from Layer 3 (springs and unpumped bores) is to mixed type boundaries. Head at the boundary was set to ground level and conductance between the Layer 3 cell and the boundary adjusted to simulate estimated discharge rate. Using the MODFLOW 'River' package, the boundary flux was set to zero when head in the Layer 3 cell dropped below ground level.

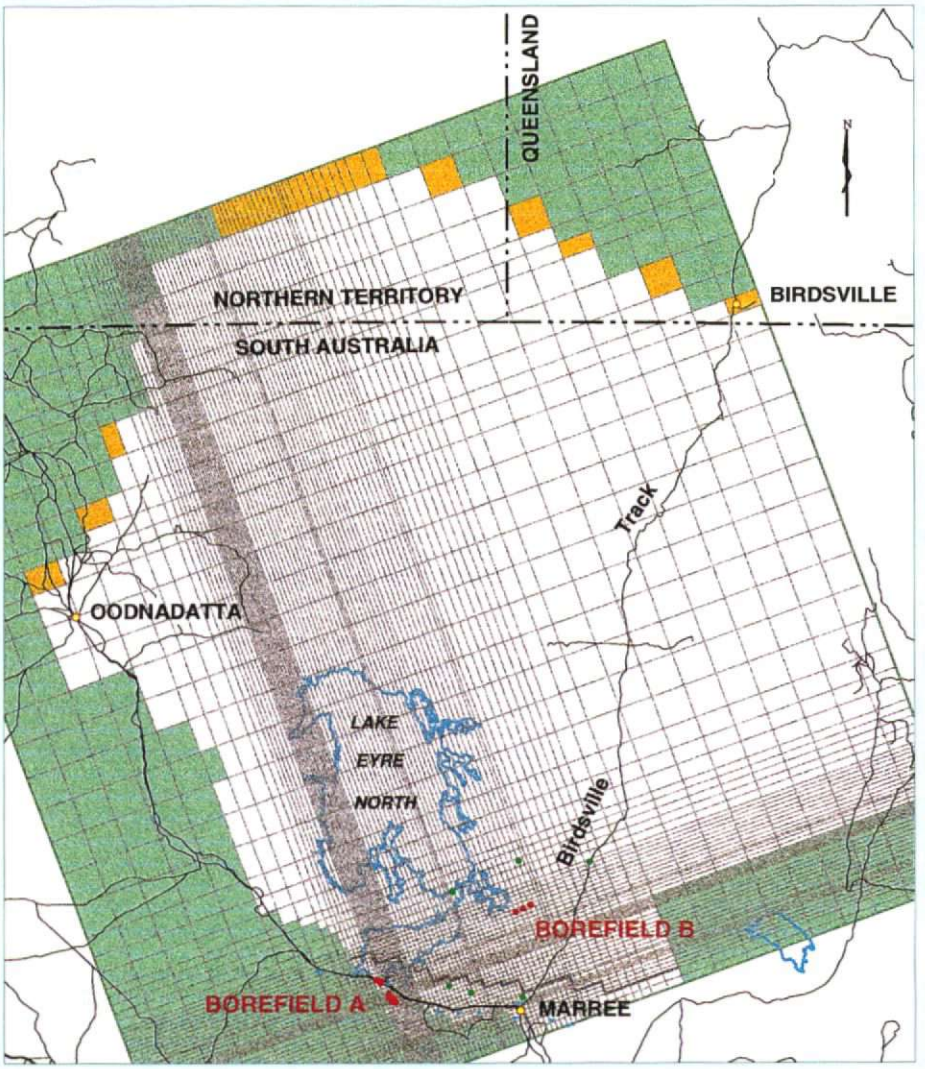


FIGURE H.2
GROUNDWATER MODEL NUMERICAL GRID

Constant head
Inactive area

N 0 100 km

H2 STEADY STATE CALIBRATION

Parameters adjusted during steady state calibration are discussed individually in the sections following.

Layer 3 permeability

Calibration was commenced with a uniform permeability (K) of 7.5 m/d. Zoning was introduced to match observed heads in the southern part of the model area. K remains at 7.5 m/d over much of the northern part of the model; a value of around this magnitude is required to propagate the observed head at Birdsville to the observed head at Muloorina. There is little sensitivity to Layer 3 permeability in the far east or west of the model. To the south, K zones range from 2.5 m/d (southern margin) to 12.5 m/d (Borefield A Sub-Basin) except for cells representing known structures or areas where the Algebuckina Sandstone is thin or absent.

Layer 1 vertical permeability

The confining effect of Layer 1 is simulated by a conductance term between Layers 1 and 2 (LEAK 1).

The conductance term was initially calculated from the equation LEAK 1 = KV_1/b_1, where:

KV_1 = initial estimate of vertical permeability

b_1 = thickness of Layer 1

Based on trial and error calibration, the following global function was used to define the conductance term:

$$\text{LEAK 1} = \frac{1 \times 10^{-7} \text{ m/d}}{b_1 \log b_1}$$

Conceptually, the factor log b_1 represents the decline in permeability with depth (total thickness) of the aquitard. Overall the term indicates very low vertical permeability, as was required during calibration to propagate head from north to south across the model.

Layer 2 vertical permeability

In a similar manner to the previous section, the term 'LEAK 2' provides the hydraulic resistance between Layer 3 and the storage and diffuse discharge in Layer 2. Steady state calibration uses the following global function:

$$\text{LEAK 2} = \frac{1.8 \times 10^{-4} \text{ m/d}}{b_2 \log b_2}$$

where b_2 = thickness of Layer 2

Leakage was enhanced by a factor of 5 in a small zone in the south-west corner of the model, extending north to Row 44 and east to Column 31. This corresponds to the Borefield A–Hermit Hill area, where structural complexities and thin confining bed contribute to increased leakage. Note that the leakage rate obtained during calibration was constrained by values measured by Woods (1990) in the Borefield A area.

Layer 3 mixed type boundaries

Conductance between the boundary and the aquifer was adjusted such that for flowing bores, the model correctly matched estimates of bore discharge. On this basis, the model

will correctly predict any decline in bore flow rate due to reduced aquifer pressure, provided that bore hydraulics (including bore head valve settings) are not changed.

For springs, the calibration provides a relatively unconstrained estimate of total discharge of spring groups contained within a cell.

Features of steady state calibration

Steady state heads determined by model calibration are shown in Figure H.3 along with model data over the broader GAB (GABHYD model) as interpreted by Habermahl (1980). A major feature of the calibration is that it has lead to the rejection of much of the potentiometric data from the north-east of South Australia. This is because the hydraulic gradients indicated by the observed data are too low to be consistent with hydraulic head to the north, at Birdsville, and are inconsistent with whole basin potentiometric maps produced by Habermehl (1980) and Audibert (1976).

In the area south of latitude 27°, deviations of simulated head from observed head range up to 5 m. Most of this error relates to the approximations made in digitising the layer positions. With greater refinement of the model this inconsistency could be reduced; however, overall model solutions with respect to the proposed borefield location would not be expected to change greatly, unless significant amounts of new structural and hydraulic data are obtained. Further zonation of the calibration parameters could also be used to reduce the observed discrepancies. This process should await results of investigations that justify further zonation.

In the Borefield A area the model differs considerably from the previous GABROX92 model of this area. Steady state inflow rate south into the borefield sub-basin is about 38% of that indicated by GABROX92. Another major difference is that the fault zone separating the borefield northern sub-basin is not impermeable, but has a transmissivity of up to 2 m/d. Calibrated diffuse leakage rates are much lower in the current model because of lower inflow rates into the sub-basin.

H3 TRANSIENT CALIBRATION

H3.1 Storage characteristics

Storage characteristics are uniform for each of the layers except for the storativity of Layers 2 and 3. Layer 3 storativity was calculated from the following equation:

$$SC_3 = b_3 \times 3 \times 10^{-6}$$

where b_3 = aquifer thickness (Layer 3).

The values are in accord with the rule of Lohman (Lohman 1972), which gives a typical multiplier of 3.3×10^{-6} for confined aquifers, and with Siedel (1978), who used water balance methods to estimate a multiplier of 2.75×10^{-6} for the Great Artesian Basin.

Layer 2 storativity is set at a uniform value of 1×10^{-3} for most of the model area. Where the full thickness is present (250 m) this closely approximates the value that would be obtained from the above equation. In the Borefield A area (Rows 36 to 68 and Columns 1 to 30) the value was increased to 1×10^{-2} during calibration, which represents all water storage sources in the Borefield A area under high stresses applied as a result of pumping in the area. A proportion of this locally derived water may be from unconfined storage and recharge to the minor aquifer at the top of the Bulldog Shale in the Borefield area, which has not been directly simulated. Other possible sources of locally derived water include lateral inflow from the Bulldog Shale to the west and upward leakage from minor basement aquifers.

FIGURE H.3
SIMULATED POTENTIOMETRIC HEAD AND GABHYD BASIN-WIDE HEAD

Since there is no monitoring data for pressure levels in these 'aquitards', a realistic partitioning of local storage contributions is not possible.

H3.2 Calibration of Borefield A abstraction history

A simplified production schedule was used to facilitate rapid model runs during calibration. The schedule is shown in Table H.1.

Table H.1 Summary of abstraction history—Borefield A

Period	Average abstraction rate (ML/d)			
	Southern bores total GAB 6, 15,16	Central bores GAB 12, 14, 18	Northern bores GAB 30, 31, 32	Overall total
1983–86	1.30	0	0	1.30
1986–87	2.30	0	0	2.30
1987–88	2.34	2.08	0	4.42
1988–89	4.27	4.56	0	8.83
1989–90	5.69	4.32	0	10.01
1990–91	6.23	4.34	0	10.57
1991–92	5.62	4.28	1.57	11.47
1992–93	5.59	4.11	3.01	12.71
1993–94	4.49	2.95	4.46	11.90
Jul–Nov 1994	4.30	3.43	4.44	12.17

Abstraction for each of the three groups of bores was aggregated and ascribed to a single central cell location. Note that production bores are located within or adjacent to the ascribed cell, hence the simplification has negligible impact at two to three cell distances from the ascribed cell.

H4 DEVELOPMENT OF REVISED NUMERICAL MODEL ODEX1

Investigation and development work associated with Borefield B included review of all existing data plus detailed gravity surveys in the vicinity of proposed drilling sites, together with the drilling of eight observation bores and three production bores. New information obtained in this process was used in the revision of the GAB95 model.

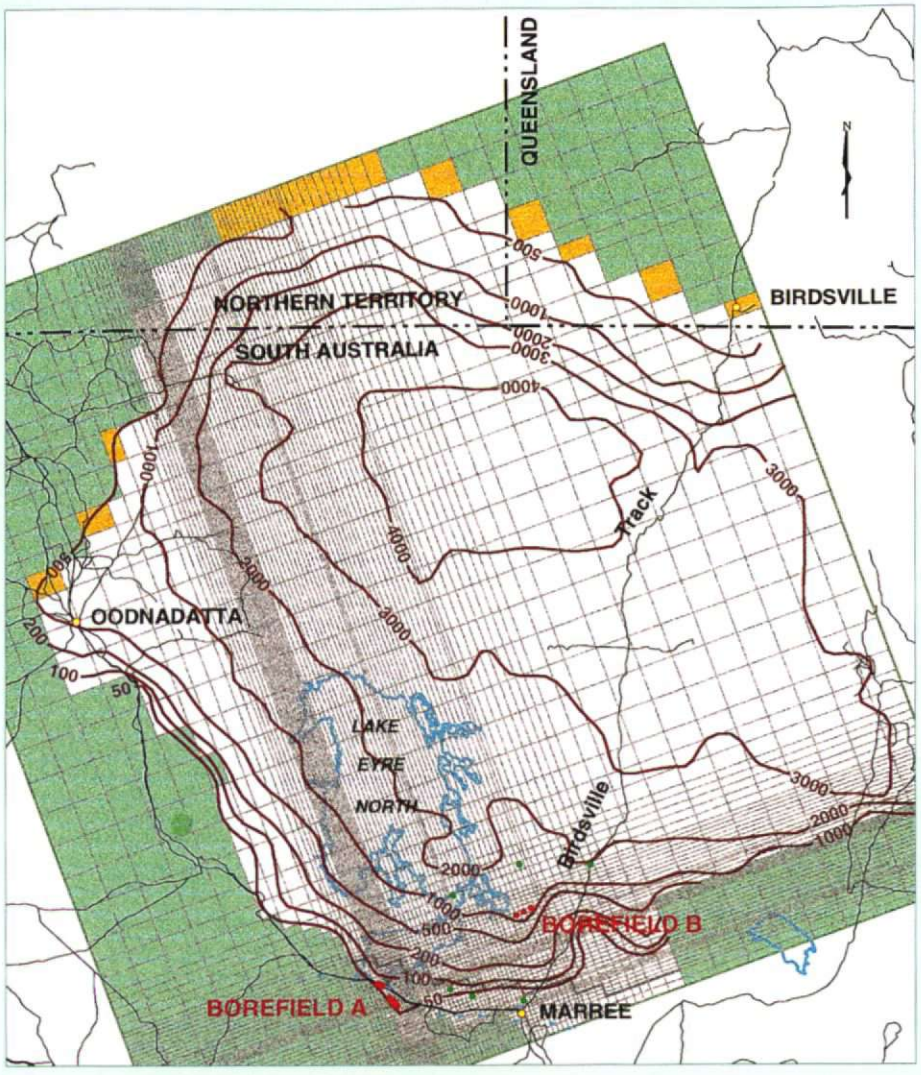
In order to avoid confusion with previous models such as GABROX92 and GAB95, the updated version has been named Olympic Dam Expansion 1 (ODEX1).

Changes to the model set-up have been carried out to take account of new data arising from the drilling programme of 1996, associated geophysical work and the re-evaluation of observed piezometric data.

H4.1 Transmissivity changes

The major changes have been in the distribution of hydraulic conductivity (k) and aquifer thickness and therefore transmissivity (t). Some new structural information has led to modifications to the south and east of Borefield B, where drilling and gravity work has indicated structural complexity and, in places, very poorly developed aquifers (e.g. sites S3, S3a and S4).

Figure H.4 shows the newly adopted transmissivity distribution.



Constant head

Inactive area

FIGURE H.4
ODEX1 MODEL TRANSMISSIVITY

N 0 100 km

H4.2 Initial head and boundary condition changes

The initial heads from the previous model were used as a starting point with the constant head cell values reduced from 125 m to 110 m, and the model was run with springs and natural leakage as the only discharge for 27,378 years (1×10^7 days) until a quasi steady-state head distribution was achieved.

It was found that heads were falling extremely slowly in the south-western corner of the active model domain, therefore general head boundary cells were introduced at 19/6 and 23/6 to simulate discharge in the vicinity of Coward Springs. The extremely conservative eastern boundary of the domain in GAB95 was considered to be too extreme and was modified by introducing further general head boundary cells at 17/85 and 23/85, thus allowing a small contribution of inflow from the eastern side. The resulting quasi steady-state head distribution was a considerable improvement on the GAB95 version.

Pastoral bores were introduced in two phases:

- Pre-rehabilitation—50 years (Qwells = 57, 294 m^3/d)
- Post-rehabilitation—15 years (Qwells = 42,346 m^3/d)

This took the time-frame for head development to the beginning of Olympic Dam activities in 1983.

Figure H.5 shows the heads selected as 1983 starting heads compared with a selection of corrected observed heads.

The model initial heads are in reasonable agreement with the observed data when it is realised that many of the bores are greater than 500 m deep. Agreement is generally better than 5 m, which is only 1% of the total head existing at the level of the aquifer. This includes the flat gradient area in the vicinity of the Birdsville Track, where the observed values were discounted in GAB95.

H4.3 Aquifer/aquitard parameter changes

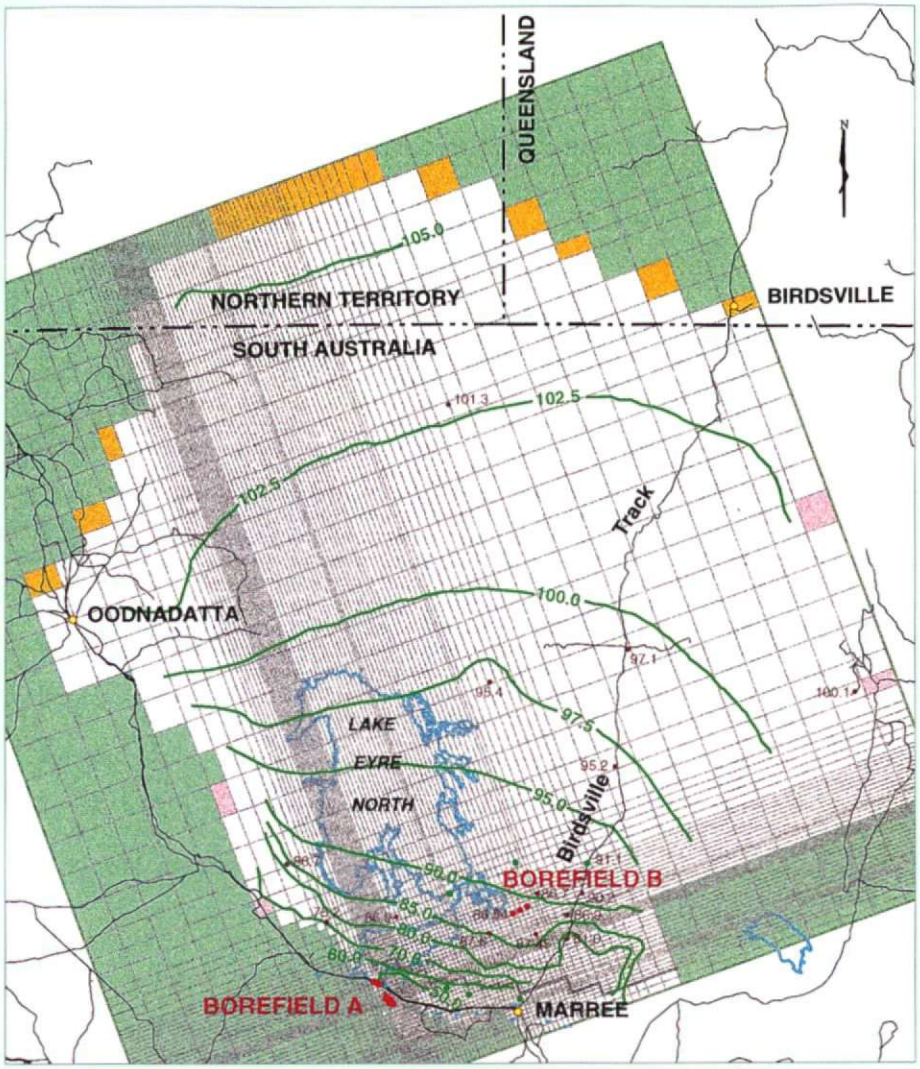
In the course of running the revised model interactively to obtain a reasonable set of initial heads, it was necessary to make the following changes in parameters to ensure a good simulation:

- The vertical conductance multiplier for Layer 2 was changed from 0.00018 to 0.00015.
- Layer 1 transmissivity was changed from 1.0 to 0.001. Note that the overall water model balance is insensitive to this parameter. The reduction results in a reduced (more conservative) estimate of leakage to Layer 1, which is already a very minor component.
- The vertical conductance multiplier for Layer 1 was changed from 1×10^{-7} to 1×10^{-8}.

H4.4 Discharge schedule changes

Fluid discharge rates from the Eromanga Basin oil/gas developments in the Moomba area have been incorporated in the new model. The discharge rates up to 1996 and estimated rates for the future are given in Table H.2.

The most recent schedule of water requirements for Olympic Dam and Roxby Downs has a water requirement of 33.4 ML/d for a copper production rate of 200,000 t/a and 42 ML/d for 350,000 t/a copper. However, 34 ML/d was used as the basis for modelling the copper production rate of 200,000 t/a copper.



Constant head
General head
Inactive area

FIGURE H.5
ODEX1 MODEL INITIAL POTENTIOMETRIC HEAD

Table H.2 Moomba model flow rates (ML/d)

Period	Rate
1986–87	2.0
1987–88	4.9
1988–91	5.6
1991–92	12.2
1992–93	22.0
1993–95	26.0
1995–2003	22.0
2003–11	15.0
2011–16	10.0

For the purpose of this modelling exercise, Borefield A has been assumed to supply 6 ML/d with the balance coming from Borefield B. Table H.3 shows the revised borefield discharge schedule adopted for running the ODEX1 numerical model.

Table H.3 Revised borefield extraction schedule as modelled (ML/d)

Period	Borefield A	Borefield B	**Total**
1996–98	6.0	11.0	**17.0**
1998–99	6.0	14.0	**20.0**
1999–2010	6.0	28.0	**34.0**
2010–11	6.0	33.0	**39.0**
2011–16	6.0	36.0	**42.0**

H5 CONCLUSION

In general, ODEX1 retains the same conservative conceptual approach as used in GAB95 with respect to vertical leakage. Evidence from existing pastoral bores suggests that a steady state drawdown develops around pastoral bores within a few tens of years. However, this observed effect cannot be incorporated into the model because there is no reliable data in the form of discharge rates or sufficiently detailed time series drawdown measurements from pastoral bores to evaluate the parameters that control the localised tendency to steady state.

Careful monitoring of the drawdown around Borefield B will enable the vertical leakage situation to be evaluated within the next one to five years at which time the numerical model can be modified, if necessary, to incorporate leakage rates based upon these measurements.

As the model currently stands, it is considered that the drawdown predicted in the deeper parts of the basin may be overestimated, but in the absence of better data it is believed to be better to err on the conservative side.