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OLYMPIC DAM PROJECT Supplement to the Draft Environmental Impact Statement KINHILL STEARNS

ROXBY MANAGEMENT SERVICES PTY LTD

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Permission is acknowledged from the Director-General, South Australian Lands Department, to reproduce the base maps used for Figures 7.2 and 7.3.

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# 1 INTRODUCTION

## 1.1 STRUCTURE OF THE SUPPLEMENT

The Draft Environmental Impact Statement (EIS) for the Olympic Dam Project was released for public comment on 14 October 1982. Thirty public submissions were received. In addition, a number of Federal and State Government Departments reviewed and commented on the Draft EIS. Where appropriate, their comments were forwarded to the Joint Venturers through the Department of Home Affairs and Environment for Federal comments and the South Australian Department of Environment and Planning (DEP) for State comments. This document is a Supplement to the Draft EIS which responds to the comments made in public submissions and Government Department review. This Supplement together with the Draft EIS form the Final EIS which will be assessed by the relevant Federal and State Departments.

The structure of the document reflects the comments received. Each chapter brings together related comments with an introductory section indicating the issues raised. Chapter 2 addresses comments on Project description and justification. Chapter 3 responds to queries on the tailings retention system while Chapter 4 responds to queries on radiation and other emissions. Indirect impacts of the Project beyond the Project area and infrastructure corridors are considered in Chapter 5. Chapter 6 not only addresses comments in relation to the mound springs and water supply but also summarizes additional ecological data on mound springs which was brought forward following the public review period. Chapter 7 brings together the responses to a diverse range of other issues raised in public and Government comments. Chapter 8 discusses the environmental management approach being adopted by the Joint Venturers both in their current activities and in the future.

A number of appendices are also provided. The first appendix summarizes the main points raised in public submissions. Appendix 2 lists all of the supporting documents and background reports which officially form part of the Final EIS. Appendix 3 lists some of the various Acts, codes and other provisions with which the Project must comply and which are relevant to environmental considerations. Appendix 4 summarizes the commitments made in the Draft EIS and the Supplement by the Joint Venturers to mitigate adverse environmental effects. Appendix 5 lists errata to the Draft EIS. Appendix 6 lists the proposed development for which environmental approval is now sought. Since the publication of the Draft EIS, the decision has been made by the Joint Venturers to proceed with an on-site pilot plant as part of the feasibility study for the Project. The pilot plant proposal and associated environmental considerations are discussed in Appendix 7.

In the next section of this first chapter, the Federal and State assessment processes are outlined. This is followed by an overview of the comments received in the public submissions then an indication of the nature of the comments by Government Departments. The final section responds to procedural issues raised in public submissions.

## 1.2 FEDERAL/STATE ASSESSMENT PROCESSES

According to the Administrative Procedures under the Environment Protection (Impact of Proposals) Act 1974-1975, the Federal Department of Home Affairs and Environment shall examine the Final EIS within 28 days of receiving the Final EIS or additional information requested by the Minister. The Minister, or the Department on behalf of the Minister, shall make any comments, suggestions or recommendations concerning the proposal which are thought necessary or desirable for the protection of the environment.

Since the Draft EIS was prepared prior to the proclamation of South Australian Planning Act, the Administrative Procedures under that Act do not apply. However, an examination and review process similar to the Federal procedure will be performed at the State level. The South Australian Department of Environment and Planning will prepare an Assessment Report on the Final EIS for its Minister and for consideration by State Cabinet.

## 1.3 PUBLIC SUBMISSIONS

This section provides a general overview of the comments made and examines the frequency with which particular broad issues were raised rather than specific points. Appendix 1 provides a summary of items agreed with the DEP to be the specific points raised in the public submissions received.

The issue which received the greatest attention in public submissions was that of effects on the mound springs due to the extraction of groundwater from the Great Artesian Basin (GAB) for Project water supply requirements. Some comment concerning mound springs or water extraction from the GAB was raised in fifteen of the thirty submissions. The main theme was that the mound springs represent a unique habitat and that flow reduction may adversely affect that habitat.

Five of the submissions raised points indicating opposition in principle to uranium mining as a component of the nuclear fuel cycle. In five of the submissions some comment was made with respect to sources of radiation exposure or the health risks associated with radiation exposure. Five submissions also made some comment on EIS procedures.

The next most frequently mentioned issues were effects on pastoral activity, items relating to the terrestrial environment, the economic viability of the Project, the methods or processes proposed for the Project, and the integrity of the tailings retention system. Each received comments in three submissions. Issues cited in two submissions were the indirect effects of the Project, anthropological surveys and town development considerations. One submission was concerned with aspects of seismic risk analysis.

## 1.4 GOVERNMENT DEPARTMENT COMMENTS

Relevant Federal and State Government Departments were asked to comment upon the Draft EIS and these comments were compiled by the Department of Environment and Planning together with the DEP'S own comments on the Draft EIS. The comments were mainly requests for further information, clarification of statements in the Draft EIS and background papers, as well as requests for commitments for future action in relation to environmental mitigation and code compliance. After discussions between DEP officers and RMS representatives, agreement was reached on how these comments should be addressed in the Supplement.

Departmental comments range widely throughout the Draft EIS so it is not possible to provide a general overview of them. The comments made are summarized at the beginning of each chapter together with the public comments, or where appropriate, the Government Department comments are brought out in the body of the text.

## 1.5 PROCEDURAL ISSUES

A number of issues of a procedural nature were raised in public comments. These can be summarized as follows:

- the passage of the Indenture Agreement could pre-empt environmental assessment procedures
- parliamentary hearings should be held on the Project
- there was no opportunity for public comment on an EIS in the exploration phase
- the time period allowed for the feasibility study and commitment to proceed was considered either too long or too short
- criticisms of EIS procedures
- the period for public comment on the Draft EIS was inadequate
- the name 'Olympic Dam Project' was used to discourage public input
- the EIS format is different from the EIS guidelines.

Each of these procedural issues are discussed below.

**Indenture Agreement**

The main purpose of the Indenture Agreement is to define the terms and conditions under which Project development and production could take place. It was therefore an important determinant of Project definition without which an assessment of environmental effects was not possible. The passage of the Indenture Agreement does not alter the environmental assessment procedures whereby the EIS forms an input to the Federal Government's decision making process in relation to export licence approvals.

**Parliamentary Hearings**

There have already been two South Australian Parliamentary Select Committees which relate to the Olympic Dam Project, these being:

- A Legislative Council Select Committee on Uranium Resources was appointed in 1980 to report on matters that would have a bearing on the 'mining, development and further processing and sale of South Australian uranium resources'. The terms of reference included the safety of workers involved in the industry.
- A House of Assembly Select Committee was appointed in 1982 to review the Roxby Downs (Indenture Ratification) Bill.

Both these Committees took submissions and heard evidence from members of the public and other interested parties. The Joint Venturers do not consider that there are grounds for further parliamentary hearings on the Project.

**Exploration Phase Assessment**

As noted in the preface to the Draft EIS, major components of the exploration phase have already been subject to environmental assessment by the State Government. These were:

- the exploration shaft (the Whenan shaft) and its associated ancillaries - buildings, storage areas, power supply, accommodation and access
- the access road from Olympic Dam to Phillips Ponds near Woomera.

The mechanism for assessment was a Declaration of Environmental Factors (DEF), an internal Government document which addressed all those aspects normally dealt with in such an assessment. The scale of the developments was such that the State Government considered the DEF to be the appropriate assessment mechanism.

**Time Period for Feasibility/Commitment to Proceed**

Section 1.4 of the Draft EIS deals in detail with the reasons why the commencement date of the Project cannot be specified at this stage. It also foreshadows the possibility of a staged construction programme rather than the commissioning of the total capacity of the proposal at one time.

These reasons relate to:

- the need to understand more fully the physical properties, number and geometry of the ore positions which will be mined initially
- technical, marketing and economic factors from the detailed feasibility studies which might show the desirability of phased development
- marketing and financial considerations which, under Federal law, cannot be negotiated until the Final EIS has been approved and 'development status' granted by the Federal government.

**EIS Procedures**

For discussion of matters relating to EIS procedures interested readers are referred to the forthcoming Assessment Report by the Department for Environment and Planning in which these matters will be addressed.

**Project Name**

The correct name of the Project is the Olympic Dam Project and this name has consistently been applied by WMC since its discovery in 1975 and more recently by the Joint Venturers.

**EIS Format**

A public comment has criticized the Draft EIS for being at odds with the guidelines in terms of its format. The guidelines agreed by the Federal and State governments and the Joint Venturers indicate the issues which are believed to warrant consideration but do not provide any requirements as to format. The table of contents was reviewed by State and Federal government officers during EIS preparation to ensure its acceptability for assessment purposes.

## 2 PROJECT DESCRIPTION AND JUSTIFICATION

In relation to the description and justification of the Project, a number of points were raised which have been grouped under the following headings:

- selection of technology
- economic feasibility
- mine development
- Project disposition.

### 2.1 SELECTION OF TECHNOLOGY

A number of public comments referred to the need to consider alternatives for mining methods or processing. There were suggestions for new techniques still in developmental stages e.g. robotic mining and the Dextec process, and older techniques. The following responses are made.

**Mining Methods**

There has been criticism in a public comment about the mining methods proposed on the grounds of safety and orthodoxy. The Joint Venturers do not accept this criticism, and, as noted in Section 2.1 of the Draft EIS, have chosen only proven mining methods.

The selection of mining method depends on the geometry of the orebody and the nature and conditions of the rock. The methods proposed for use at Olympic Dam are commonly used throughout the world. Examples in Australia include:

- Room and pillar - Renison (Tasmania)
- Post pillar cut and fill - King Island and Renison (Tasmania)
- Open stoping - Mt Isa (Queensland), Mt Charlotte (Western Australia), Mt Lyell (Tasmania), New Broken Hill Consolidated (New South Wales).

The methods proposed as 'orthodox' in the public comments were square set and shrink stoping. Square set mining involves permanent support (e.g. timber or steel) against rockfall. Shrink stoping is commonly used for narrow and steeply dipping orebodies. Because the rock at Olympic Dam is very competent and therefore not prone to rockfall, and, because the geometry of the orebody is generally shallow dipping and thick, both these methods are considered by the Joint Venturers to be inappropriate.

**Robotic Mining**

Some prototype robotic mining has been undertaken in coal mines in Europe and metalliferous mines in Japan. No techniques have been developed for large scale production in hard rock mining. The Joint Venturers have not therefore considered robotic mining as it remains outside the area of proven techniques.

The mine at Olympic Dam will be designed to maximize the use of automated and mechanized techniques in order to promote safety and efficiency. Examples include automatic charging machines, rockbolting units, scaling units, rockdrilling, hoisting and haulage equipment. The Joint Venturers do not accept the contention that the mine presents hazards of such a nature that special techniques will need to be employed.

The Joint Venturers intend to remain cost-competitive and will select techniques which offer the lowest cost consistent with safety and efficiency.

**Processing : Dextec Process**

The Dextec process has been mentioned as a technological development that should have been considered for inclusion as a processing option. Because there are a very great number of possible metallurgical processes that might be used, the Joint Venturers restricted discussion in the Draft EIS to alternatives that they currently considered to be practical (as required by the EIS guidelines). The Dextec process has been considered by the Joint Venturers but the process does not represent a practical alternative at present because it is still in the early stages of development.

The process was patented in Australia in 1975. It is based on the direct electrolytic extraction of copper from chalcopyrite or other iron-containing copper sulphides. A suspension of finely divided concentrate in a chloride electrolyte is placed in the anode compartment of an electrochemical diaphragm cell and treated with air/oxygen. A current is passed through the cell to maintain a pH of 2 - 2.5. Iron is solubilized and precipitated as ferric oxide while copper is deposited at the cathode. Sulphur is recovered as elemental sulphur. Low power consumptions are claimed (1.0 kWh/kg copper).

Following laboratory demonstration in Sydney, a larger scale experimental plant (9,000 litre cells) has been operated at Port Kembla on a batch basis. The Joint Venturers believe that it would be necessary for the process to undergo a considerable amount of applied engineering and continuous pilot plant testing and commercial scale demonstration before it can be considered a proven technology.

## 2.2 ECONOMIC FEASIBILITY

A range of issues were raised which relate to the economic feasibility of the Project. They can be summarized as:

- a need to critically assess economic viability - if Olympic Dam is a marginal project it is implied that attention to safety and environmental issues will be diminished in order to remain economically viable
- the price and demand for both uranium and copper
- the economic viability of the no-uranium extraction option
- the justification of the production target
- the military use of uranium was not mentioned
- the possibility of further copper processing within Australia
- the possibility of extracting rare earth elements
- the consequences of not proceeding with the Project.

**Economic Viability**

A detailed study of the economics of the Project is not sought by the EIS guidelines and it is considered that the EIS is not an appropriate document for such a study. Much of the information such as detailed cost data that would be required for an analysis of the Project's feasibility is properly regarded by the Joint Venturers as confidential. Other data such as final product form for copper and precious metals and the terms of sales for all products cannot yet be determined. Thus it is neither practical nor appropriate to provide detailed costs and economic assessments in the EIS.

**Product Price/Demand**

Comments have raised questions about both the copper and uranium markets, their present depressed state and the availability of future markets for product from Olympic Dam. Metal markets are traditionally highly cyclic in their behaviour because most metals, including copper and uranium, are dependent on the general economic health of major industrial nations. The principal end markets for copper are in electrical cable and wiring, water tubing, and in vehicles. All these markets are closely linked through housing, electricity generation and the automotive industry to general economic trends. The principal industrial use of uranium is in electricity power generation which is similarly dependant on economic trends. The variability of recent metal prices is shown in Table 2.1. The change in market prices for oil is also shown for comparison.

**Table 2.1** **Recent metal price variations**

| Metal | | Recent price | | | | % difference between high & low |
|---|---|---|---|---|---|---|
| | | High | | Low | | |
| Copper | (t)[1] | £ 1,352.40 | (2/80) | £ 719.15 | (6/82) | 47% |
| Nickel | (lb)[2] | US$ 3.21 | (3/80) | US$ 1.48 | (11/82) | 54% |
| Gold | (oz)[3] | US$ 737.80 | (1/80) | US$304.10 | (6/82) | 59% |
| Uranium | (lb)[4] | US$ 43.25 | (5/79) | US$ 17.25 | (10/82) | 60% |
| Silver | (oz)[5] | £ 9.28 | (3/80) | £ 2.93 | (6/82) | 68% |
| Lead | (t)[6] | £ 675.80 | (6/79) | £ 274.13 | (12/82) | 59% |
| Zinc | (t)[7] | £ 546.20 | (8/81) | £ 283.25 | (8/79) | 48% |
| Aluminium | (t)[8] | £ 952.50 | (2/80) | £ 509.43 | (6/82) | 47% |
| Oil | (bbl)[9] | US$ 41.42 | (11/80) | US$ 28.50 | (3/82) | 31% |

Sources: (all weekly averages unless indicated)

(1) London Metal Exchange (LME) cash price for electrolytic wirebars
(2) LME cash price
(3) London final fixing
(4) NUEXCO exchange value at month end for $U_3O_8$
(5) LME cash price
(6) LME cash price
(7) LME cash price
(8) LME cash price
(9) US crude oil spot price.

Thus the fall in copper prices experienced between February 1980 and June 1982 was of similar magnitude to that experienced by zinc and aluminium and the fall in uranium prices similar to that experienced by gold and lead and slightly less than that experienced by silver. This is indicative of the degree of variability in the prices for industrial metals. Prices of all the above metals have now risen from the lows cited in the table.

**Uranium market:** The uranium market forecast (Uranium Institute (1981)) in Section 1.5 of the Draft EIS has been subject to revision since the Draft's publication. Global economic activity has continued to stagnate since the publication of that forecast

(November 1981) and this has reduced electrical power demand both now and in the future. Utilities have in consequence further delayed and cancelled new power generating facilities including nuclear reactors. The Institute revised its 1981 forecast in September 1982 (Bonny and Fulton, 1982). Its conclusions were as follows:

- Nuclear generating capacity forecasts have fallen by a small margin (less than 2%) in the 1985-1988 period, by about 8% in 1990 and 6% in 1995.

- Uranium requirements have fallen by similar amounts beyond 1986 although they remain essentially unchanged up to 1985. The 1982 - 1995 requirement is now expected to increase by 5.0% per annum under the 'Most Probable' scenario (that used as the forecast requirement in the Draft EIS).

- Forecasts of production capability from existing mines have increased, most notably in Australia, France, Japan and South Africa. Canada and the United States have shown a net reduction in capacity.

- The combined supply capability of existing facilities and those under construction has decreased slightly relative to the 1981 forecast.

The net result of these changes is that the point at which most probable demand exceeds the capacity of existing operations to supply has remained in substantially the same time frame - that is about the end of 1985. The point at which the forecast demand exceeds the forecast supply capability of existing operations and those presently under construction has been deferred from the end of 1987 to 1989. This is the consequence of the forecast decline in demand accompanied by a small decrease in supply capacity. It must be noted that this production capability is a maximum output that could be produced in any year and actual production will differ from this depending on price/cost relationships and other market factors.

**Copper market:** Two analyses have been prepared recently predicting the future of the copper market. Rudolf Wolff (1982) identifies the following factors as pointing to a market improvement:

- the decreasing imbalance in supply and demand as a result of producer cut-backs particularly in North America

- the growing technical and political problems confronting the two major African producers Zaire and Zambia

- the possibility of market support from the producer group CIPEC

- the possibility of labour disputes in the United States copper industry in mid-1983 when labour contracts come up for renewal.

Anthony Bird and Associates (1982) base their forecast on the following factors:

- confidence in a general recovery of industrial activity

- the effects of increased optimism on consumers' stock levels

- the possibility of industrial unrest in the USA.

The Joint Venturers believe that the copper market will continue to behave in its traditional cyclical manner and that the present recession in the market should not be taken as representative of any long term trend.

**No Uranium Option**

The Draft EIS points out (Section 2.8.1) that the failure to extract uranium would render the Project uneconomic. This is because certain of the principal components of Project infrastructure are generally independent of the uranium circuit. For example the uranium processing circuit will use only about 5% of the electric power requirements, about 7% of the workforce and about 20% of the water requirement. Thus without the uranium circuit, as noted in the Draft EIS, a similar sized water pipeline, transmission line and town would be required. The operating costs associated with these infrastructure components would also remain substantially the same. The mining operation would be unchanged both in capital and operating costs. The capital costs of the Project are set out in Table 12.10 of the Draft EIS. It should be noted that 50% of the capital cost relates to mine and infrastructure. This would not be substantially reduced by the omission of the uranium circuit, as pointed out above. The uranium plant represents in the order of 30% of the remaining capital cost and therefore about 15% of the overall Project capital cost.

Against this would be set the loss of between 28% and 46% of Project revenue. The Joint Venturers are satisfied that the option is not economically viable and that uranium extraction must be considered an integral part of any Project development.

**Production Target**

The Draft EIS has been criticized for the lack of consideration of different start-up tonnages or different Project life-spans. The Joint Venturers have recognized (Draft EIS Section 1.4) that the rate of build up to 150,000 t/a of copper is dependent on a number of of factors including:

- detailed mine planning and the disposition and size of ore blocks underground;
- final feasibility studies that might demonstrate the desirability of developing process facilities in a staged manner. This will be determined by detailed financing and marketing considerations which cannot by law presently be negotiated until the Project has 'development status' which in turn cannot be achieved until the Final EIS is approved.

The intended capacity of the Project for which WMC and BP have provided special financial relationships under their Joint Venture Agreement and which forms the basis of the Indenture Agreement between the parties and the South Australian Government is 150,000 t/a of copper and associated products. It is for this reason RMS and the relevant Government Departments agreed that this would be the appropriate size to be addressed in the Draft EIS. Thirty years was discussed with Government as an appropriate period over which environmental impacts should be assessed.

The Preface to the Draft EIS sets out the agreed mechanism whereby changes to the proposed development approach will be considered. The Joint Venturers must notify such changes to Government, and in the event of the changes resulting in any significant environmental impacts in addition to those already envisaged then it is anticipated that further environmental assessment will be required by Government.

**Military Use of Uranium**

The Draft EIS deliberately omitted the mention of the military uses of uranium. The safeguards required by the Australian Government to be included in any contract that the Joint Venturers will conclude for sales of Olympic Dam uranium prohibit the use of that uranium for other than peaceful purposes. Thus because it is a market not open to the Joint Venturers it is not considered relevant to the Draft EIS discussion of the uranium market.

Any sales contract for Australian uranium is subject to approval by the Federal Government. Sales can only be made to countries that are party to the Treaty on the Non-Proliferation of Nuclear Weapons. Recipient countries must agree to be bound by International Atomic Energy Agency safeguards, and are required to undertake that:

- Australian uranium will not be used for military purposes
- appropriate physical security measures must be undertaken
- prior consent from the Federal Government must be obtained before Australian uranium can be transferred to others, enriched beyond 20% $U_{235}$ or reprocessed.

The mechanism for this is through negotiation of bilateral agreements between Australia and potential recipient countries which provide for regular consultations between the parties.

The Federal Government has the right to withhold supply and may require the return of nuclear material in the event of any breach of these undertakings. Safeguard agreements have been signed with Finland, the Philippines, the Republic of Korea, the USA, Britain, France, Sweden, Canada, Switzerland, the European Economic Community and Japan.

Sales of Olympic Dam yellowcake by the Joint Venturers will be subject to these and any other safeguard provisions that may be required by the Federal Government. The Joint Venturers cannot export $U_3O_8$ without the consent of the Federal Government through its export licensing powers.

**Further Copper Processing**

Submissions raised the possibility of a copper refinery as an additional processing stage with respect to the Smelt/Convert option, and the fabricating of copper beyond the refined metal stage.

**Non-inclusion of electro-refining step:** Both the Roast/Leach/Electrowin (RLE) and Pressure Leach/Electrowin (PLE) options produce copper in a refined state and therefore no additional refining step is required. The Smelt/Convert (SC) route produces blister copper which can then be further refined by electrolytic means to produce high purity copper cathodes. At this stage there is no perceived marketing or economic reason for the inclusion of an electrolytic refinery in the Project configuration and it was not included. If in time such a step becomes attractive then it is anticipated that environmental assessment will be necessary prior to the refinery's construction.

**Downstream copper processing:** Clause 26 of the Indenture Agreement obliges the Joint Venturers to review on a continuing basis the further processing of mine production within South Australia and report to the State government within 3 years of commencement of production and at 3 yearly intervals thereafter the results of such reviews. However, processing of copper beyond the refined metal stage has not been contemplated at present by the Joint Venturers. The mining industry generally does not go beyond the refined metal or semi-fabricating stage. Examples within Australia include the Mt Isa copper operations in Queensland, Western Mining Corporation's nickel operations in WA, and lead and zinc production at Broken Hill which is smelted and refined at Port Pirie and Risdon or Cockle Creek respectively. The principal reason for this is that the skills and expertise applicable to a fabricating operation are generally more related to manufacturing or secondary industry rather than to a primary industry. The establishment of the Olympic Dam Project may offer opportunities for fabricating industries to set up to process Olympic Dam copper. However the tariff structures of the major copper users, which includes most of the industrialized countries, are structured so as to protect their own fabricating industries while allowing the import of primary metal on favourable terms.

**Rare Earth Extraction**

Public comment raised the issue of rare earth extraction. The Joint Venturers have considered the extraction of the rare earth content in the Olympic Dam ore. This could be achieved by solvent extraction and stripping of the pregnant liquor from leaching of flotation tailings. However the economics of such an operation are not attractive and this option is not presently contemplated. Further evaluations will be undertaken from time to time if a sufficient improvement in the economics is perceived. As pointed out in this section above, it is anticipated that further environmental assessment will be required by the government if the rare earth extraction option is taken up.

**Consequences of not proceeding with the Project**

If the Olympic Dam Project were not to proceed then as pointed out in Section 1.6 of the Draft EIS, its expected production would be supplied from increased output from existing producers or by the development of new projects. Australia has the potential to take up the replacement uranium production either through increased production from existing mines or through the development of new mines. However, South Australia does not have sufficiently large known alternative sources of uranium production to replace all the production proposed at Olympic Dam and it is probable that overseas projects would take up a proportion of it.

## 2.3 MINE DEVELOPMENT

Comments relating to the following matters were received with respect to the proposed mining methods, ventilation design, and related issues:

- secondary ventilation requirements
- potential for rock falls
- air velocity in relation to radon gas dispersion
- use of the decline as a transport route for explosives
- occupational safety of mine workers
- effects of blasting
- blockage of ore passes and drawpoints
- the possibility of exothermic reaction in underground ore stockpiles
- quarry size
- quarry noise
- the need for detailed geological information.

**Secondary Ventilation Requirements**

The term 'secondary ventilation' is applied to a situation such as occurs in a development end where there is no air circulation and air must be forced to the working face in order that the heading may be ventilated. It is the only practical way of ventilating dead ends and in consequence is common practice in every underground mine in Australia. It will be used at Olympic Dam for ventilating dead ends.

**Potential for Rock Falls**

Rock mechanics studies at Olympic Dam have shown that the rock types present are very competent. Two of the mining methods proposed - room and pillar and post pillar cut and fill - are permanently supported by rock pillars during mine operations and therefore are not considered liable to rockfall. The open-stoping method can be prone to rockfall if ground conditions are poor. The method is safely used at several Australian mining operations where competent rock conditions exist. It is important to note that when this method is used (see Figure 2.5 in Draft EIS) there are no operators actually working in the stope.

**Air Velocity in Relation to Radon Gas Dispersion**

The design air velocity for a mine in relation to dust concentration represents a balance between a velocity of sufficient magnitude to disperse dust and a velocity low enough not to resuspend dust. The general relationship between respirable dust concentrations and air velocity is shown in Figure 2.1. Furthermore, air velocity is important in relation to evaporative heat transfer for maintaining satisfactory temperatures in mining areas. The design air velocity in producing areas of 1 m/s (Draft EIS p. 2.12) will ensure adequate dilution and removal of dust, gases, diesel fumes, heat and radon daughters. It is in the optimum velocity (see Figure 2.1) range which provides a balance between dust dispersion and resuspension. The minimum air velocity (0.5 m/s) is still sufficient for control of dust and other air contaminants. Below this velocity the cooling power of the air is significantly reduced.

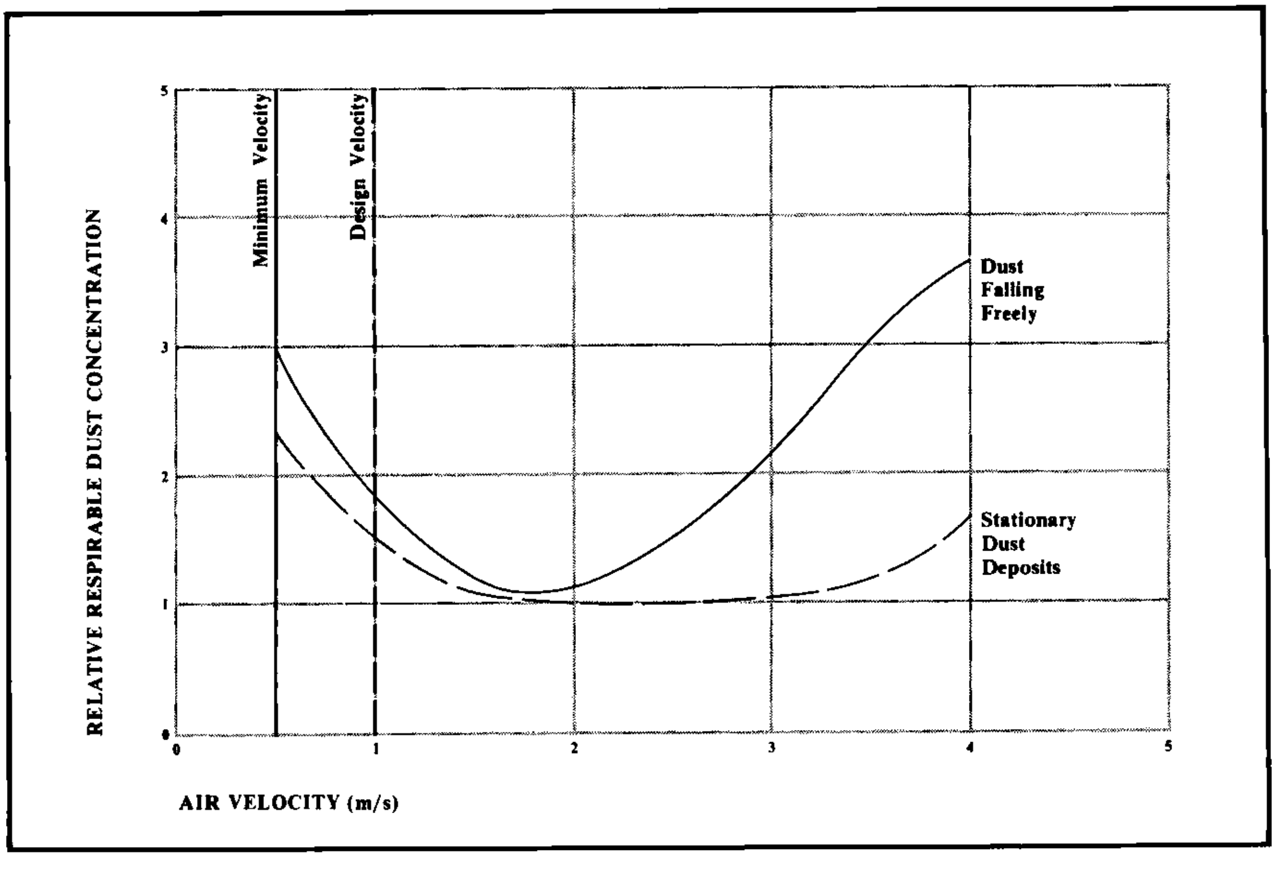



Figure 2.1

**RELATIONSHIP BETWEEN AIR VELOCITY AND RESPIRABLE DUST CONCENTRATION**

These velocities compare favourably with the standards of most underground mines. Measurements underground at Olympic Dam confirm that this air velocity is quite sufficient to control the concentration in air of respirable contaminants, including radon daughters, to within limits to which the Joint Venturers are committed and as approved by the statutory authorities. Therefore the Joint Venturers consider the public comment that the air velocity is inadequate to disperse radon to be incorrect.

**Explosives in Decline**

Explosives are routinely transported in declines at many Australian and overseas mines including WMC's Kambalda nickel mines. The Joint Venturers as well as all Australian authorities regulating mining (which in South Australia is the Department of Mines and Energy through the Mines and Works Inspection Act) do not consider it a dangerous practice.

**Occupational Safety of Mine Workers**

Industrial safety aspects are noted in Section 2.5.6 of the Draft EIS. These are mostly occupational safety matters that are adequately covered by existing legislation and normal operating safety practices (refer to Appendix 3 for the main items of legislation). Detailed analysis as part of an EIS is not considered appropriate. The Joint Venturers will abide by the provisions of the legislation relating to occupational health and safety except where new technical developments or performance standards have yet to be incorporated in current regulations and are accepted by the relevant regulatory authorities. For example, an amendment with respect to operating temperature restrictions in the mine has been approved by the regulatory authorities for the underground exploration development programme at Olympic Dam. This amendment was required because the existing regulations do not take into account the cooling effects of ventilation to control the adverse effects of heat stress. Instead of the current requirement which specifies an upper wet bulb temperature limit, the amended limit is expressed as a combination of wet and dry bulb temperature. This amended approach is consistent with current practice in underground mines elsewhere in Australia.

**Effects of Blasting**

It is not true that repeated blasting will develop fractures extending over long distances well beyond the mining lease and thereby effect groundwater movement (as has been claimed in one public submission). Underground mining operations routinely take place close to large surface water bodies (such as at Mt Isa) and in some cases below the sea both off the Australian coast and overseas. There is no evidence to suggest that extensive rock fracturing takes place beyond the immediate area of the blast. The effects on groundwater were described in the Draft EIS (Section 6.2.2) indicating that the overlying aquifer will be dewatered thereby redirecting groundwater movement towards the mine during mining and for some hundreds of years after mining ceases.

**Blockage of Ore Passes and Drawpoints**

A public submission contended that there would be dangers associated with clearing of ore passes and drawpoints because 'the ore would settle like concrete'. The Joint Venturers do not accept this contention. Settlement of the sort described requires fine particle sizes. The mined ore in the ore passes and draw-points will vary in size up to 2,500 mm with an average of about 500 mm and cannot therefore settle in the manner described.

**Exothermic Reaction in Underground Stockpiles**

The possibility of exothermic reactions because of the relatively elevated temperatures underground has been raised in Government comment. Because of the nature of the sulphide assemblages in Olympic Dam ore, the risk of fires in underground stockpiles is very low. There has been no indication of such reactions during the present exploratory mining programme. If fires do occur then they would be controlled by normal mine fire fighting procedures, such as isolation or flooding.

**Quarry Size**

The area required each year to supply 3.5 million t/a of limestone assuming an average quarry depth of 50 m is 2.6 ha. As pointed out in Section 2.3.6 of the Draft EIS, rehabilitation of the area will take place progressively as mining proceeds.

**Quarry Noise**

Section 8.4.3 of the Draft EIS discusses the likely noise effects of quarry blasting and concludes that they are within the limits specified by the State Pollution Control Commission of New South Wales. The Joint Venturers intend to use best industry practice to ensure that any noise nuisance from quarry blasting is reduced to the maximum extent practicable.

**Need for Detailed Geological Information**

A public submission criticized the lack of detailed plans and cross-sections of the Olympic Dam ore-body in the Draft EIS. The Joint Venturers consider that the plans and cross-sections in the Draft EIS (Figures 6.3, 6.4, 6.5, 6.6 and 6.7) are sufficient for environmental assessment purposes and to satisfy the guidelines under which the Draft EIS was prepared.

## 2.4 PROJECT DISPOSITION

**Rationale for Project Disposition**

The Joint Venturers do not accept the criticism in a public submission that the Project disposition is too dispersed. Section 2.8.6 of the Draft EIS sets out the reason for the distance of the town from the site, that distance being considered necessary to provide a suitable environmental buffer and to reduce radiation levels to at least one order of magnitude below regulatory public exposure limits. The plant site was selected because:

- it is the closest point to the centroid of the ore body that is not underlain by mineralized material;
- it is relatively open country with good drainage and widely spaced dunes;
- it is on the southern side of the orebody which is most suitable for access for services such as power and for access by employees from the town.

**Buffer Zones**

Under Clause 25 of the Indenture Agreement, the State Government is obliged, on committment to the Project by the Joint Venturers, to grant two buffer zones, the size of which is to be agreed between the Minister and the Joint Venturers. One is a buffer zone around the town and the other is around the mine.

The town buffer zone will be leased to the Municipality. No development will be permitted in this buffer zone and access will be restricted. However, within this area the Joint Venturers have the right to construct transportation services required for the operation of the Project.

The Municipality's management obligations for the buffer zone as set out in the Eighth Schedule of the Indenture Agreement require that:

- all adequate measures must be taken to keep the land free of vermin and pests;
- adequate measures must be taken to preserve vegetation, prevent erosion and rehabilitate degraded areas;
- fences must be maintained around the area.

The mine buffer zone will be leased to the Joint Venturers. Access to this area will be restricted. The Fourth Schedule to the Indenture Agreement sets out the Joint Venturers' management obligations which are as follows:

- take all reasonable measures to keep the area free of vermin and pests;
- take adequate measures to safeguard members of the public, the workforce and the environment in relation to the Project operations;
- take adequate measures to preserve vegetation, prevent erosion and rehabilitate degraded areas in accordance with any environmental management programme approved under Clause 11 of the Indenture Agreement;
- if required by the Minister, a suitable fence to restrict unauthorized access must be built and maintained.

## 3 TAILINGS RETENTION SYSTEM

Public and Government comments raised a number of issues with respect to the proposed tailings retention system (TRS). These can be listed as follows:

- in relation to the security of containment of the TRS:
  - the effects of extreme storms
  - the security of the tailings base
  - leakage from the TRS and seepage to groundwater
  - the potential for dusting from the tailings surface.
- in relation to the operation of the TRS:
  - examples of the sub-aerial system
  - short or medium term cessation of production
  - the pilot tailings retention system
  - neutralization of tailings
  - clean-up of spillages between tailings embankments and the surrounding bund
  - comparison with US EPA Regulations.
- in relation to radon emanation predictions:
  - surface drying and cracking increasing emanation rates
  - radon levels after decommissioning
  - the potential for radon build-up on windless days.
- in relation to associated facilities:
  - mine water disposal
  - the need for a mine dewatering contingency plan
  - the dispersivity of the clay liner in the saline evaporation pond
  - measures to prevent birds using the acid liquor evaporation pond
  - the use of tailings as mine back-fill.

### 3.1 SECURITY OF CONTAINMENT OF TRS

**Effects of Extreme Storms**

The effect of extreme storms on the TRS has been raised. In the Draft EIS the effects of both a prolonged wet period and a 1 in 200 year (210 mm) storm event were examined (refer Section 7.3.2). The water balance analysis in the Draft EIS indicated for the prolonged wet period (assumed to be the 3 wettest sequential years recorded at Roxby Downs since 1931 - a very low probability event) that:

- by recirculating decant liquor to the dry tailings beaches during the summer months when evaporation is high, the decant liquor pond would have achieved a maximum depth of 1.78 m (compared with an embankment height of 7 m). If no recirculation had taken place the depth would have reached 4.6 m;
- the maximum size of the pond around the central decant structure would have been 79 ha (20% of the total area available).

A water balance calculation in the Draft EIS for an extreme storm event (assumed to be 210 mm which would have a recurrence period of once in 200 years) would result in 25% of the area of the tailings beaches being covered. The water would be evacuated in about 40 days.

It has been requested that the most extreme storm event which is the probable maximum precipitation (PMP) also be considered. Based upon the generalized method for tropical storms (Kennedy, 1982), the Bureau of Meteorology has estimated the PMP to be 800 mm for a 72 hour storm. It is likely that the generalized method would if anything give conservatively high values. Such rainfall if distributed over a full year would be equivalent to the 1 in 500 year annual rainfall. The total volume of the PMP falling on the 400 ha tailings surface would be $3.2 \times 10^6$ $m^3$. As shown in Figure 3.1, this would create a pond in each cell with a depth at the central decant structure of 3 m and would cover 316 ha of the total TRS area. A minimum freeboard allowance of 1.5 m will be maintained between the crest of the tailings storage embankment and the tailings surface. With the sloping beach, the maximum depth available at the central decant structure would be 4.8 m. At the most critical time where the cells have maximum tailings depth just before the raising of the embankments, there would therefore be a freeboard of 1.8 m for the PMP event. The edge of the ponded water would be approximately 90 m from the embankments, and overtopping would not occur.

The total water storage capacity of the tailings storage with a 1.5 m freeboard is $10.4 \times 10^6$ $m^3$. This volume represents three times the PMP, four times the highest annual rainfall recorded at Roxby Downs homestead over the period 1931-77 and twice the total rainfall for the three wettest years 1973-75 which caused extensive flooding in Central Australia.

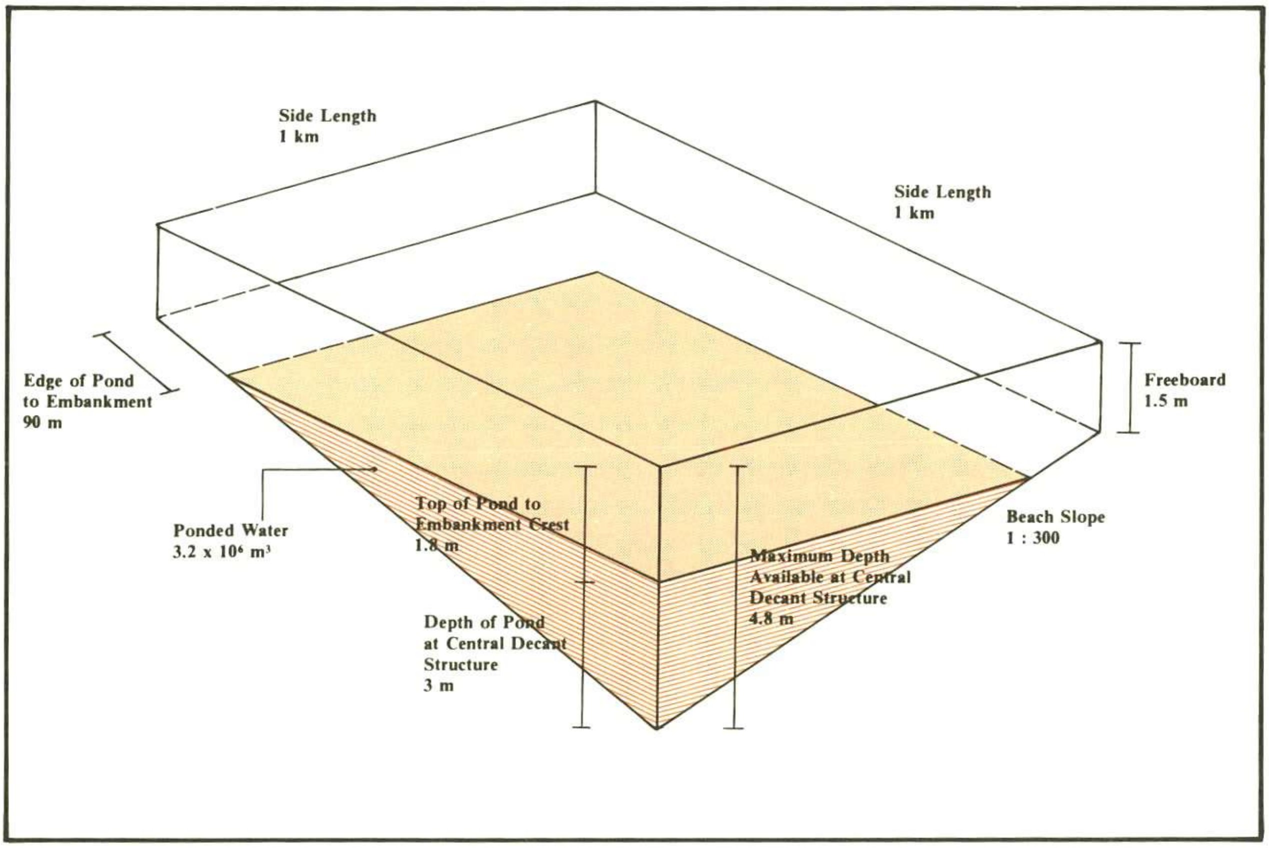



Figure 3.1

**EFFECT OF PROBABLE MAXIMUM PRECIPITATION ON A TAILINGS RETENTION CELL**

Assuming a pan factor of 0.75 (the same as assumed for the decant evaporation pond in Section 7.3.1 of the Draft EIS) and an annual rainfall of 160 mm there will be an annual excess of evaporation over free tailings liquor of approximately 800 mm. This evaporation loss combined with pumping to the decant evaporation pond would return the system to normal after a PMP storm event within a few months.

**Security of the Tailings Base**

The issue of the security of the TRS base was raised in a public submission. The suggestion was that the base should be grouted or rockbolted onto the underlying rock strata in order to withstand shock waves from the underground blasting activities. The effects of underground blasting at several thousand metres distance will be insignificant at the surface in the tailings retention area and therefore such measures are considered unnecessary by the Joint Venturers.

**Leakage from the TRS**

The tailings retention method proposed (controlled sub-aerial deposition) is designed to maintain a water content in the deposited tailings material which is sub-saturation, (i.e. water is bound by negative pore pressure, in the pore spaces). Water is not removed by drainage to a water table but by evaporation from the surface.

However a number of laboratory tests have been conducted to investigate, qualitatively, reactions which might occur between any liquor seeping from the tailings retention system and underlying material. Samples of underlying material were packed in a column (approximately 350 mm high) over which a volume (approximately 350 mm) of raffinate at a pH of 1.5 was maintained. Any liquor seeping through the column of solids was collected and analysed. The following observations were made:

- reaction occurred between the solids and the raffinate as a wetting front proceeded downwards;

- for samples which were loosely packed in the column the final pH of any percolate collected for the column was 5.5 - 7.5 where the sample contained carbonate material;

- for samples which were packed to a nominal density of 1.8 $t/m^3$ the reaction front extended to approximately 70 mm. Very little percolate was collected from these samples in tests lasting several weeks;

- chemical analyses of the samples before and after testing indicated that carbonates reacted with acid in the raffinate with the formation of gypsum (calcium sulphate). As a result of the reaction, liquor in the wetting front was effectively neutralised and the gypsum formed in the reaction probably decreased available pore space which would create a seal limiting further advance of the wetting front.

**Dusting from the TRS Surface**

Two items were raised in public comments concerning the potential for dusting from the TRS surface. One item was that additional water might be required to control dusting and the second was a query asking for more details of the laboratory procedures for the wind tunnel tests on dusting potential.

**Need for additional water:** The possibility of additional water requirements to mitigate dusting of tailings has been raised. As pointed out in Section 7.4.2 of the Draft EIS laboratory testing has indicated that even when in a dessicated state (less than 5%

saturation) the propensity to dust is extremely low even at relatively high wind velocities. However, the addition of extra water to the tailings mass from various sources has been considered and is addressed in the following sections of the Draft EIS:

- concentrated salt solutions from the saline water evaporation pond (Section 7.3.4)
- water from the mine (Section 6.2.2)
- miscellaneous wastewater from the metallurgical plant (Section 2.5.3)
- sewage water which may be contaminated (Section 2.5.3).

In addition liquor could be recirculated from the decant pond or the saline evaporation pond to the tailings beaches (Section 7.3.2).

Present indications are that dusting will not present a problem and this is expected to be confirmed by the pilot tailings retention system mentioned in Section 3.2 of this Supplement. Nevertheless in analysing the Project dust arisings, it has been conservatively assumed that 1 $km^2$ of the tailings surface would be continuously subject to dust arisings during any year (Draft EIS Section 9.4.2).

**Procedures for wind tunnel tests:** The tests were designed with the aim of subjecting tailings samples to wind tunnel flows of various intensities to determine if wind erosion might occur and to measure any quantities of eroded material. Tailings slurry was poured into six laboratory trays, each of which was 1,800 mm long, 300 mm wide, and 50 mm deep. The samples were subjected to drying by exposure to radiant electric heaters and fan-induced air flow, until a dry surface had formed. Sample thickness was then about 25 mm.

Each sample in turn was installed in the wind tunnel so that the dry tailing surface formed part of the bottom of the tunnel. The test wind entered as a measured stream through the tunnel entrance, and passed over the tailing surface as a uniform flow. The walls and roof of the tunnel were transparent, permitting full observation of the sample surface for any signs of particle movement. Part of the airstream which had passed over the sample was drawn off and passed through a water-bath dust collector, so that if any dust was generated from the specimen its quantity could be sampled and calculated.

For each sample the following testing sequence was followed:

- After initial drying the sample was photographed, and then placed in the wind tunnel.

- An air flow with velocity V = 2.5 m/s was maintained over the sample for a period of T = 4,000 s to provide time for drying, (V x T = 10 km approximately).

- A core was taken for moisture content measurement. The wind tunnel was then operated with an entry air speed of V = 8 m/s which was stopped after 5 minutes. During that time the sample surface was kept under observation, and dust collecting apparatus operated to sample the air which had passed over the tailings. The same operations were performed also for wind speeds of V = 16 m/s and V = 23 m/s.

- The sample was subjected to a further drying stage followed by wind tunnel testing in accordance with the above; and this process was repeated three more times. In all, the sample was subjected to five sets of wind tunnel testing, which were carried out at cumulative V x T values of approximately 10, 20, 40, 60, 200 km.

- The sample was removed from the wind tunnel, photographed and closely inspected for signs of wind erosion.

Half the samples were tested at prevailing laboratory temperatures (between 18°C and 24°C). The other half were each uniformly warmed by contact with heavy steel support bars under the laboratory tray so that the sample temperature was usually between 40°C and 60°C when a set of wind tunnel tests (see above) commenced. Apart from the temperature controls during wind tunnel testing, all samples were subjected to the same sequence of operations described above.

The results of the tests are noted in Section 7.4.2 of the Draft EIS and a report providing full details of the tests has been made available to Government officers for assessment purposes.

## 3.2 OPERATION OF THE TRS

**Examples of the Subaerial System**

The overall scheme, as proposed for the Olympic Dam Project, will be unique although the various concepts involved have been used successfully for many years in Australia and overseas.

The subaerial system proposed can be broken down into the following:

- controlled spigot discharge of tailings slurry
- monitored drying of deposited tailings
- controlled decanting of released liquor.

**Spigot discharge:** The spigot discharge of tailings is used extensively in Australia, especially in the Western Australian gold fields area and at Broken Hill in New South Wales. The aim of spigot discharge is to create laminar flow conditions which in turn allow the placement of an even layer of tailings. When tailings with a coarse grading are spigotted there is often some separation of coarse and fine particles. The grading and viscosity of the Olympic Dam tailings slurry will be such that little or no segregation will occur during placement.

The spigotted tailings are permitted to flow over relatively flat beach areas which are free of water cover. Liquor is released from the tailings as settlement occurs and flows over the surface to the decant or, in the case of a no decant system, to a central pond.

Although spigot discharge has been the almost universally used method of placing tailings into the storages at Western Australian gold and nickel mines, there has been a move lately towards the use of a controlled bulk discharge where up to 5 or 6 valved offtakes from a ring main are used simultaneously. This creates more turbulent flow conditions than would be present with the traditional spigot methods, however in most cases the tailings are sufficiently coarse to allow the development of adequate beaches.

Traditional spigot discharge methods are still in use at the gold mines in Norseman (W.A.). At Kalgoorlie, tailings impoundment at the Oroya mine is a good example of controlled bulk discharge whilst a similar system is used at the Kambalda nickel operations. The Oroya storage is operated without a decant whilst at Kambalda a decant system is in use to recover released liquor. Dried tailings are used at all three locations to construct the retaining embankments, however the tailings are considerably coarser than will be the case at Olympic Dam.

**Drying of deposited tailings:** Traditionally the drying of the deposited layers of tailings is used to enable the dried tailings to be reworked and formed into retaining embankments or bunds. Monitoring of drying has not been necessary and moisture contents are rarely measured. The spigotted discharge of tailings together with the drying of the layers is also used to ensure that the stored tailings will be of such density and strength that subsequent liquefaction will not be possible.

The relationship between the moisture content of uranium tailings and the release of radon gas has only recently been quantified (refer Section 7.4.1 of the Draft EIS). The use of controlled moisture content to attenuate the release of radon gas will be an important part of the operating procedures adopted for the Olympic Dam storage. Measurements to confirm the relationship derived during the laboratory model studies will be carried out during the operation of the proposed pilot tailings storage.

The first known full scale use of the subaerial deposition method to control radon emissions will be made at the Key Lake uranium mine in Canada. It is expected to be commissioned within the next two years and analyses of the data collected over the period prior to the start-up of the Olympic Dam Project could prove most useful.

**Controlled decanting of release liquor:** The decant method chosen for the Olympic Dam tailings storages will be uncommon in that a central decant will serve four separate storage areas. However, the principle of using stop logs to adjust the off-take level is well proven, as is the dry well method of operating pumps. The stop log system offers a simple but effective solution to the problem of providing a rising decant level as the depth of tailings increases. It is a system that has been used successfully by Mary Kathleen Uranium (MKU) and on one of the storages at the Agnew nickel mine in Western Australia. A recent inspection of the decant at MKU, where low pH conditions exist in the tailings storage, indicates that the protection applied to the stop logs has worked effectively and no deterioration of concrete was observed.

**Short or Medium Term Cessation of Operations**

In the event of a short or medium term cessation of operations (considered to be in the order of 2 to 5 years) the Joint Venturers will retain personnel on site to ensure proper control of access to the tailings, mine and other Project areas.

It is not expected that dusting will present any problem under such circumstances, as even in a dessicated state (less than 5% of saturation) the tailings have a very low propensity to dust (Draft EIS Section 7.4.2). Tests on the pilot tailings storage are expected to confirm this data. However, the mine will continue to be dewatered during any short or medium term cessation and if necessary the water from this operation will be used to add water to the tailings storage.

**Pilot Tailings System**

Public and Government comments have raised a number of issues in respect to the operation of the proposed tailings retention system. These generally relate to the need to confirm by practical application the laboratory results and calculations and the concepts put forward in the Draft EIS. Among these issues are:

- the possibility of seepage to groundwater, especially around the central decant structure
- the effects of any such seepage on the underlying strata
- the propensity of the tailings to dust
- the level of radon emanations both during and post production

- the need to measure geo-mechanical properties of the tailings such as relative density, and angle of repose

- the desirability of using liner materials for the base of the decant liquor evaporation pond

- evaporation rates from saline water surfaces under site conditions.

The Joint Venturers propose to set up a pilot tailings retention area as part of the pilot plant in order to confirm that the results and concepts set out in the Draft EIS are sustainable in practice.

The objectives of the pilot TRS have been determined in conjunction with the Department of Environment and Planning. They will seek to demonstrate the suitability of the sub-aerial method of tailings impoundment and to measure parameters of interest for the design of the full scale installation and for monitoring purposes.

The measurements proposed are as follows:

- liquor balance for the system (i.e. supernatant, underdrainage, evaporation)
- moisture profiles during the deposition cycle
- seasonal variations in required cycle time
- bulk densities of tailings deposited
- geo-mechanical properties of deposited tailings
- pond and beach evaporation rates
- surface properties and propensity to dust
- radon emanation and variations during the deposition cycle
- alternative cover materials and depths of cover for decommissioning
- composition of liquors
- profile of chemical reaction of liquor with underlying strata
- evaluation of alternative lining materials for evaporation ponds
- alternatives for disposal of concentrated liquor from evaporation ponds
- composition of any salts derived from liquor from evaporation ponds.

The Joint Venturers believe that at the completion of the pilot TRS programme sufficient confirmatory data will have been gathered to prove the performance characteristics of the system and to enable final design to proceed.

**Neutralization of Tailings**

The issue of neutralization of tailings was raised. As set out on p. 2.60 of the Draft EIS there are a number of reasons why the Joint Venturers have elected to dispose of the plant tailings in an acid state. The principal reasons were the additional cost involved in neutralization and greater water usage because the increased viscosity of the slurry requires additional water to enable it to flow satisfactorily. A greater land area would also be required for disposal and increased radon emanation would result.

As pointed out on p. 2.60, the neutralization of tailings would cause contained heavy metals to precipitate in the tailings liquor. This offers an advantage if there is a likelihood of significant seepage from the TRS. Because the method proposed will effectively eliminate seepage from the TRS this advantage is not considered sufficient to offset the disadvantages explained above.

**Clean-up of Spillages Between the Tailings Embankments and the Surrounding Bund**

Because the distribution pipeline for tailings is inside the embankment wall (Draft EIS Section 7.1.2) the possibility of any tailings spillage between the main embankment walls and the bund around the periphery is very low. However if such spillage occurs it will be contained within the bund and will be cleaned up in the manner described in Section 7.1.3 of the Draft EIS, namely that the spillage and any soil contaminated as a result of the spillage will be removed and deposited within the confines of the tailings storage.

**Comparison with U.S. Environmental Protection Agency (USEPA) Regulations**

The approach to regulation of tailings disposal defined in the Australian Code of Practice is to require that exposures of employees and members of the public are as low as reasonably achievable, and below the relevant limits prescribed in schedules 1, 2, 3 and 4 of the Radiation Protection (Mining and Milling) Code (1980).

This regulation philosophy is not readily comparable with that of the USEPA which sets specific radon flux and gamma radiation dose rate figures, regardless of whether this results in any significant exposure to workers or members of the public.

## 3.3 RADON EMANATION PREDICTIONS

**Radon Emanation Rate**

The radon emanation rate used in the Draft EIS was queried in a Government comment. The rate selected by the Joint Venturers (Draft EIS Sections 7.4.1 and 9.4.3) corresponds to 0.6 $Bq/m^2.s$ for a normalized grade of 1 Bq of Ra 226 per gram. This rate is within the range of the flux rates measured by the Government commentator for tailings from 6 Australian uranium projects.

Actual measurements by consultants to the Joint Venturers on dried Olympic Dam tailings gave a highest figure of approximately 0.1 $Bq/m^2.s$ per Bq/g.

Given these corroborations, it is considered that the figure used in the Draft EIS is adequately conservative. It should be noted that the radon emanation measurements taken during laboratory modelling of Olympic Dam tailings were taken over the whole model and therefore include that increment of emanation due to drying cracks forming at the surface of the tailings mass.

**Radon Emanation from Tailings after Decommissioning**

A public submission expressed concern about the level of radon emanation from the tailings storage after decommissioning.

This is dealt with in Sections 9.4.3 and 9.4.5 of the Draft EIS. The Joint Venturers propose on cessation of production to place over the tailings cover material of an average of 1.5 m of compacted swale material and 0.5 m of quarried rock.

Figure 9.6 in the Draft EIS shows the incremental increase in radon daughter concentrations in the post-production period. The maximum concentration in the vicinity of the Project Area occurs at the margins of the tailings storage and is two orders of magnitude (100 times) less than the public exposure limit. It is over 3 orders of magnitude (1,000 times) less than the public exposure limit at the northern end of the town site, 10 km away.

**Radon Emanations on Windless Days**

A public comment expressed concern at a perceived hazard which might result from a possible build-up of radon daughters in air on windless days over the tailings storage.

Section 9.5.1 of the Draft EIS addresses the radon daughter exposure of a worker at the TRS and indicates that under conservative assumptions annual exposure would be 0.03 WLM which is less than 1% of the 4 WLM/a limit for designated employees.

Visual inspection of the Olympic Dam meteorological data indicates that periods of calm are of short duration and infrequent. Convection from the tailings surface will tend to further reduce the frequency and duration of calms. As dosage is considered on a cumulative annual basis, the Joint Venturers do not consider that radon daughter exposure incurred as a result of calms represents a hazard.

## 3.4 ASSOCIATED FACILITIES

**Mine Water Disposal**

Clarification was requested on the disposal of contaminated mine water (refer Draft EIS Section 6.2.2). If the mine water is unsuitable as process make-up water it will be pumped to the tailings storage for evaporation. It will not be pumped to the saline water evaporation pond which is intended for evaporation only of saline water pumped from the strata overlying the mine.

**Mine Dewatering Contingency Plan**

It has been suggested that the Joint Venturers should designate a catchment area as an emergency water storage area in the event that the saline evaporation pond should provide insufficient capacity. The Joint Venturers believe that the system as proposed is sufficiently flexible to cater for emergency conditions. The saline evaporation pond will be designed with adequate freeboard to ensure even under conditions of maximum proposed pumping from the mine and above average rainfall that no overtopping will occur (refer Draft EIS Section 7.3.3).

To illustrate the effect of a period of exceptional rainfall, the average rainfall of the very wet period (1973-75) was included in the water balance for aquifer dewatering (refer Draft EIS Table 7.9). The timing of this three year period of exceptional rains was assumed to occur at the worst possible time in relation to the integrity of the saline evaporation pond, i.e. immediately after the decant evaporation pond is no longer available for evaporation of aquifer dewatering outflow. The water balance for aquifer dewatering incorporating exceptionally wet years is shown as Table 3.1. The maximum depth in the saline evaporation pond would now be 3.91 m compared to 3.12 m as indicated for the average conditions in the Draft EIS. Note this increased depth is equal to the greater rainfall - 1.26 m of the exceptional wet period less 0.48 m which is three years of average rainfall.

As stated in the Draft EIS (p. 7.16), above average rainfall would increase the depth and an adequate freeboard will be provided to ensure that overtopping cannot occur. Note that the water balance included the maximum possible pumping requirements rather than the more probably pumping requirements (refer Draft EIS Figure 6.12).

**Table 3.1 Water balance for aquifer dewatering incoporating exceptionally wet years**

| Half year** | | Daily pumping rate ($m^3$/d) | Daily potential evaporation ($m^3$/d) | Average daily change in water volume ($m^3$/d) | Half-yearly change in water volume (ML) | Volume to saline evaporation pond (ML) | Volume to decant evaporation pond (ML) | Volume stored in saline evaporation pond (ML) | Water depth in saline evaporation pond (m) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | Summer | 7,600 | 10,500 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Winter | 7,600 | 3,800 | + 3,800 | + 694 | + 416 | + 278 | 416 | 0.55 |
| 1 | Summer | 7,500 | 10,500 | - 3,000 | - 548 | - 329 | - 219 | 87 | 0.12 |
| | Winter | 7,500 | 3,800 | + 3,700 | + 675 | + 405 | + 270 | 492 | 0.67 |
| 2 | Summer | 7,400 | 10,500 | - 3,100 | - 566 | - 340 | - 226 | 152 | 0.20 |
| | Winter | 7,400 | 3,800 | + 3,600 | + 657 | + 394 | + 263 | 546 | 0.73 |
| 3 | Summer | 7,100 | 10,500 | - 3,400 | - 621 | - 373 | - 248 | 173 | 0.23 |
| | Winter | 7,100 | 3,800 | + 3,300 | + 602 | + 361 | + 241 | 534 | 0.71 |
| 4 | Summer | 6,500 | 5,760* | + 740 | + 135 | + 135 | *** | 669 | 0.89 |
| | Winter | 6,500 | 1,730* | + 4,770 | + 870 | + 870 | | 1,539 | 2.05 |
| 5 | Summer | 5,800 | 5,760* | + 40 | + 7 | + 7 | | 1,546 | 2.06 |
| | Winter | 5,800 | 1,730* | + 4,070 | + 743 | + 743 | | 2,289 | 3.05 |
| 6 | Summer | 5,200 | 5,760* | - 560 | - 102 | - 102 | | 2,187 | 2.92 |
| | Winter | 5,200 | 1,730* | + 3,470 | + 633 | + 633 | | 2,820 | 3.76 |
| 7 | Summer | 4,600 | 6,300 | - 1,700 | - 310 | - 310 | | 2,510 | 3.35 |
| | Winter | 4,600 | 2,280 | + 2,320 | + 423 | + 423 | | 2,933 | 3.91 |
| 8 | Summer | 4,100 | 6,300 | - 2,200 | - 402 | - 402 | | 2,531 | 3.37 |
| | Winter | 4,100 | 2,280 | + 1,820 | + 332 | + 332 | | 2,863 | 3.82 |
| 9 | Summer | 3,600 | 6,300 | - 2,700 | - 493 | - 493 | | 2,370 | 3.16 |
| | Winter | 3,600 | 2,280 | + 1,320 | + 241 | + 241 | | 2,611 | 3.48 |
| 10 | Summer | 3,200 | 6,300 | - 3,100 | - 566 | - 566 | | 2,045 | 2.73 |
| | Winter | 3,200 | 2,280 | + 920 | + 168 | + 168 | | 2,213 | 2.95 |

* Years assumed to have exceptional rainfall.

** Numbers in this column relate to time from Project commitment. Summer/winter refers to the six months centred on these respective seasons.

*** Decant evaporation pond not used for aquifer dewatering from year 4 onwards.

There are also several other options which the Joint Venturers can deploy to accommodate unforeseen contingencies. For example, pumping rates can be varied to reduce inflow to the saline evaporation pond. Also the tailings retention system has substantial additional capacity for storage even during extremely wet years and could be used to receive aquifer dewatering flows.

**Dispersivity of Clay Liner in Saline Evaporation Pond**

Experience at Olympic Dam has indicated that suspended clay particles will precipitate when saline water is added. Since the saline evaporation pond will be used only for receiving water from the Arcoona Quartzite aquifer dewatering, seepage from the saline water evaporation pond is unlikely to cause any significant problem. However, the dispersivity of the proposed clay base will be tested prior to final design of the pond.

**Deterring Birds using the Acid Liquor Pond**

As noted in Section 3.5.2 of the Draft EIS, there is a possibility that migratory birds, particularly water birds may be attracted to the acid liquor evaporation ponds. Bird fatalities may also result among the smaller passerines, who in an arid environment might use the pond as a drinking source. Conventional visual bird deterrent systems have been largely unsuccessful for other than short term control due to stimuli conditioning. More recently, researchers in Western Australia have used auditory deterrents as a dispersal mechanism with some success in vineyards (Christopher, 1979).

In addition to ensuring that the surrounds of the decant liquor pond are kept unattractive to birds, the Joint Venturers are investigating simple low-cost, large-area deterrent mechanisms suitable for water bodies that rely on the natural aversion of birds to certain colours. Studies both in Australia and overseas (Kalmleach and Welch, 1943; Carthness and Williams, 1971) have found that a wide range of bird species, including water birds, will avoid materials dyed with certain colours. To date, research on this natural colour aversion has been used to protect birds from accidental poisoning during vermin baiting.

The Joint Venturers will undertake further literature reviews on the subject and will experiment with deterrent trials when suitable water bodies are available.

**The Use of Tailings as Mine Back-fill**

The potential of tailings for use as mine fill was raised in public comment. This option has been considered by the Joint Venturers and is discussed on p. 2.60 of the Draft EIS. At present depending on the mining methods to be employed, it is envisaged that up to 20% of the mine back-fill requirements could be provided by tailings. However, the very fine grained nature of the tailings make them generally unsuitable for use as underground fill. Processing would be required to separate the very fine fraction and to modify the remainder of the material to produce a suitable fill. In addition, because the high evaporation rates achievable on the surface are not achievable underground, drying under layered deposition conditions which results in a solid and competent mass on the surface, would not be possible.

# 4 RADIATION AND OTHER EMISSIONS

Questions and comments with respect to Chapters 8 and 9 in the Draft EIS (which addressed emissions) focused mainly on radiation. The responses are grouped as follows:

- risk assessment considerations
  - the effects of low level radiation exposure
  - the effects of total radiation dose not just incremental dose
  - the toxicity or carcinogenicity of solvents used in processing
  - epidemiological considerations of risk factors;
- code requirements
  - the need to comply with new codes
  - the comparability of the International Commission on Radiological Protection (ICRP) recommendations and Code of Practice;
- exposure pathway considerations
  - the transport of particulates via workers' clothing
  - radiation in dust from copper roasting
  - dust effects
  - dust effects on drinking water sources
  - dust from temporary ore stockpiles;
- predictions of radiation exposure
  - methodology for air emission calculations
  - radon recirculation from ventilation outlets to inlets
  - equilibrium conditions in dispersed radon
  - radon levels in dead ends and ore passes
  - effects of higher ore grades;
- mitigation measures
  - security aspects of yellowcake transport
  - compensation for effects on miners' health
  - disposal of water from wash rooms
  - regulation of grazing on adjacent pastoral leases
  - contingency plans for toxic chemicals and radioactive materials;
- monitoring
  - further baseline measurement requirements
  - Protective Action Levels (PALs) for Government reporting;
- other issues
  - effects of sulphuric acid plant breakdown
  - the potential of the sulphur stockpile as a fire hazard
  - the potential for heavy metal leaching through thiobacillis formation
  - decontamination and burial of contaminated mine and plant solid wastes
  - particulate emissions;
- references
  - further referencing of certain quantities given in the Draft EIS was requested.

## 4.1 RISK ASSESSMENT CONSIDERATIONS

### Low Level Radiation

An internal memorandum from the United States National Institution for Occupational Safety and Health (NIOSH), dated 1 July, 1980 has gained a degree of notoriety by suggesting the necessity for a major reduction in legislated maximum permissible radon daughter exposures. However, there has been no response by the Mine Safety and Health Administration to the NIOSH document, it has not been discussed in the scientific literature (basically because it provides no new material), nor has the memorandum been endorsed by NIOSH. It was considered by ICRP in its recent assessment (ICRP, 1981) but ICRP's conclusions in respect of maximum permissible radon daughter levels remained unaltered.

### Total Dose not Incremental Dose

Naturally occurring background radiation levels at Olympic Dam are consistent with those expected over a continental land mass (Draft EIS Section 9.2). The presence of such naturally occurring background radiation is taken into account when setting standards for incremental exposure resulting from Project operations.

### Toxicity and Carcinogenicity of Solvents

The hazardous nature of certain of the process chemicals has been addressed in Section 8.3.3 of the Draft EIS. Most of these chemicals have been in common use in mining and other industries for many years during which appropriate safety practices have been developed. WMC uses both ammonia and cyanide in its mining and processing operations in Western Australia.

The Chamber of Mines of Western Australia Inc. has developed an index of hazardous materials which covers many of the hazardous materials used in the mining industry. It is expected that the materials register to be prepared at Olympic Dam will be based on this index. Disposal of hazardous process chemicals will be in accordance with relevant regulatory requirements and will be subject to approval by regulatory authorities.

### Epidemiological Considerations of Risk Assessment

In Section 9.3.2 of the Draft EIS consideration was given to epidemiological evidence of health risks. Comment suggested that the risk factor selected by the Joint Venturers was not appropriate and that a more conservative risk factor should be assumed. The Joint Venturers believe on the basis of the studies cited in the Draft EIS (p 9.14) i.e. Cohen (1982) and Dory (1979), and, on the basis of paragraph 10 (pp. 4 and 5) and paragraph 28 (p. 12) of ICRP (1981) that use of the highest risk factor is unrealistically pessimistic.

The referenced ICRP paragraphs highlight two factors. The first is that the risk factors derived from epidemiological studies necessarily include the effects of all other potential lung cancer inducing agents and that therefore the risk factor due to radon daughter exposure alone must necessarily be less. It is believed that a genuine effort must be made to separate out the various components providing the risk, in order to determine the major hazard. Cohen (1982), for example, has indicated that the Czechoslovak data can be as readily related to total years underground as to radon daughter exposure. He queries whether radon daughter exposure is in fact responsible for all excess cancers as has been assumed in the epidemiological interpretation. If exposure to airborne dust underground is significant, then it should also be accepted that improvement in ventilation techniques and standards over the twenty years since the major epidemiological surveys has greatly reduced airborne respirable dust levels underground. Secondly, there are generally recognized shortcomings in the epidemiological studies which would tend to bias the risk factors obtained to give higher values than the actual ones. For example, the area monitoring in old mines and used in epidemiological studies may be considered to give lower Working Level values than the actual levels to which miners were exposed.

## 4.2 CODE REQUIREMENTS

### New Radiation Codes

Under the Indenture Agreement, the Joint Venturers must comply with new codes which may in the future be issued and adopted in replacement of the present codes listed in the Draft EIS (p. 9.13). Reference has been made in the comments received to the IAEA Safety Guide (1982). It is queried whether the proposals in regard to the Annual Limit of Intake (ALI) for women and children given in that guide have been taken into account in the Draft EIS.

This particular IAEA document is essentially a derivative document presenting ICRP recommendations in a special format. However, it goes beyond the ICRP recommendation in that it suggests that the ALI for a critical group involving infants and children should be 1/100th of the ALI for workers and this would ensure compliance with the dose limit of 5 mSv a year. It notes that this factor of 1/100 could be used if it is not possible to calculate an individual ALI and that the factor might be over cautious in some instances. The IAEA suggestions are presently the subject of critical consideration by some ICRP members. In the UK the preference is to estimate the ALI and deal in actual values and this exercise is currently underway for about 300 nuclides. ICRP itself is understood to be carrying out some illustrative calculations of this nature which will eventually be published and these in turn could be expected to be considered for endorsement by statutory authorities in Australia and elsewhere.

The Draft EIS on p. 9.17 and 9.18 addresses the question of dose limitations to young people employing a basic approach in discussion consistent with ICRP which in turn has used the Adams (1981) approach to dose limitation in young people.

Reference has also been made in the comments on the Draft EIS received to the ICRP 26 (1977) and NHMRC (1982) suggestions that 1 mSv rather than 5 mSv be considered as appropriate for long-term exposure of members of the public. Attention was indirectly brought to this matter on p. 9.10 of the Draft EIS which states, in comparing ICRP and Code of Practice recommendations:

> 'The numerical limit for members of the public is also the same 0.005 Sv/a, although the discussion in paragraphs 118 to 122 of ICRP Publication No. 26 needs to be borne in mind, in which it is pointed out that for a critical group to approach such a level would require justification.'

### Comparability of ICRP and Code of Practice

The point being made in the Draft EIS (Section 9.3.1), was that the Australian Code of Practice and the new ICRP recommendations (when interpreted) do lead to comparable limits, and thus, modifications of the Australian Code to bring it into line with ICRP recommendations will not so substantially alter it as to set standards that the Project could not meet. The Joint Venturers specifically considered ICRP (rather than only the Australian Code) recommendations/requirements so as to determine the sensitivity (or otherwise) of the Project to reasonably foreseeable regulatory changes. The Joint Venturers and their consultants have suggested that although there are differences in detail, they are not such as to cause any significant doubt about Project viability from the point of view of either employee or public radiation dose and dose commitment.

## 4.3 EXPOSURE PATHWAY CONSIDERATIONS

**Transport Via Workers' Clothing**

The issue of transport of particles via workers' clothing has been raised. Under the Code of Practice, workers are not permitted to leave the work area in their work clothes. Prior to leaving the work area, they must shower and change clothes. Thus the hazard of transporting particles via work clothes is avoided.

**Radiation in Dust from Copper Roasting**

As discussed in the Draft EIS, parts of the copper circuit will contain or handle material containing over 0.02% $U_3O_8$ and therefore will be subject to the Code of Practice on Radiation Protection in Mining and Milling of Radioactive Ores (1980). The Joint Venturers are committed to apply the same radiation monitoring and protection standards, and the same design guidelines, required by the Code of Practice in these areas of the copper plant as in the uranium plant.

Fugitive dust emissions from the copper roaster were not mentioned in the Draft EIS because the roaster normally operates at a negative pressure. This is to enable feeding equipment to operate by gravity and to eliminate fugitive dust. In the worst case if a positive pressure is created within the roaster by an abnormal operating situation it is necessary to stop feeding the roaster because the sulphur dioxide and fugitive dust emissions that would result from its continued operation would present an occupational health risk. Calcine from the roaster is not conveyed or moved in a dry state but is passed directly to a quench tank for leaching. Thus, dust emissions from the copper roaster are considered to be negligible and no allowance has been made for them in the consideration of external radioactivity in the Draft EIS.

**Dust Effects**

The radiation exposure to workers and town residents from radionuclide ingestion was discussed at length in the Draft EIS (Section 9.5). Using the assumptions in the Draft EIS, approximately 800 tonnes of particulate matter will be discharged annually from vent shafts. If it is assumed that all of this dust deposits uniformly in a 20 km radius, a conservative assumption because much of the dust can be expected to remain suspended, then annual fallout will be approximately 0.5 gm/m$^2$; 0.5 gm of ore dust contains approximately 0.25 mg $U_3O_8$, or approximately 2.5 Bq. This compares with the natural (background) uranium content in one square metre of soil, to a depth of 10 cms, of 0.01 Bq/g (Draft EIS p. 9.8) or approximately 2 x 10$^3$ Bq. Also, as can be seen from the Draft EIS (p. 9.8), the ambient airborne dust concentration is 20 ug/m$^3$. The calculation of dust recirculation (Draft EIS p. 9.21) shows 0.3 ug/m$^3$ within the plume at 300 m downwind from mine vents. This again, indicates that dust fallout due to Project will be small compared with natural components.

**Dust Effects on Drinking Water Sources**

For an estimate of dust fallout into personal rainwater tanks, if an annual deposition of 0.5 $gm/m^2/yr$ of ore dust is assumed for a house roof area of 10 m x 15 m = 150 $m^2$, then annual ore dust input into rainwater tank is 0.5 $gm/m^2$ x $150^2$ = 75 gm, containing possibly 2 gm of copper and 0.04 gm of $U_3O_8$. With a median annual rainfall of 150 mm, total volume collected will be (0.15 x 150) = 22.5 $m^3$ (22,500 L). Thus, if it is conservatively assumed that all the copper and $U_3O_8$ are dissolved, the concentrations would be:

| Copper | | $U_3O_8$ | |
|---|---|---|---|
| $\frac{2\ g}{22.5\ m^3}$ | = 0.1 mg/L | $\frac{40\ mg}{22.5\ m^3}$ | = 1.7 ug/L |

By comparison, NHMRC current criteria recommend a limit of 1.5 mg/L for copper and the Code of Practice limit for members of the public for drinking water is 2,000 ug/L for soluble uranium and 60,000 ug/L for insoluble uranium.

The potable water storage reservoir will be an open, clay-lined excavation suitably protected around the perimeter against wave erosion. Ore dust fallout into storages as described above which are in operation at WMC's Kambalda nickel operations and other locations has not proved to present a contamination problem.

The Joint Venturers are obliged in any event under clause 13.24 of the Indenture Agreement to supply to the township water which is of a quality acceptable to the South Australian Health Commission. An unacceptable level of contamination by dust would therefore require appropriate treatment to ensure that the water supply was of satisfactory quality.

**Dust from Temporary Ore Stockpiles**

The matter of dust generation that will occur when loading the shaft surge bin from the temporary ore stockpile has been raised. This would occur only in an abnormal situation and the use of the temporary ore stockpile at No. 2 shaft will occur only in the event of failure of the mine - plant conveyor. Because the live storage capacity at the plant is 3 days capacity (Draft EIS, Section 2.4.1) there will be no necessity for an immediate response.

The ore will be generally moist on exit from the mine (Draft EIS Section 2.4.1) and its propensity to dust will therefore be low. If there is an occupational health hazard to the operator from the dust, measures such as the provision of respiratory equipment will be taken. If the Mines Inspectors who have the statutory responsibility under the Mines and Works Inspection Act, perceive an environmental hazard from the dust, appropriate dust suppression measures such as water spraying will be taken.

## 4.4 PREDICTIONS OF RADIATION EXPOSURE

**Methodology of Air Emission Calculations**

For a detailed description of the methods used for air emission calculations the interested reader is referred to the Air Quality background paper (Steedman, 1981).

**Radon Recirculation**

P. 9.21 of the Draft EIS discussed the possibility of recirculation of contaminants into mine intake shafts, and it was suggested that the calculation may have been in error.

Manual checks of the computer outputs have been carried out and the results obtained have confirmed the statement in the Draft EIS that a negligible change of ambient air quality would occur at the intakes. Reductions from an assumed source of 10 $mg/m^3$ to less than 1 $ug/m^3$ at the intake are indicated.

**Equilibrium Conditions in Dispersed Radon**

A public comment sought clarification in respect of equilibrium conditions of radon. Isopleths of annual average concentrations of radon daughters are given in Figure 9.5 of the Draft EIS. Figure 5.20 in the Air Quality background paper (Steedman, 1982) shows 10 minute averaged ground level concentrations of radon 222. From this last figure a 'worst case' figure for radon daughter concentrations can be derived in the following manner.

Working levels (WL) can be derived from radon (Rn) concentration and age of air (Draft EIS p. 9.32). From the Air Quality background paper (Steedman, 1982) the two likely worst case situations at 10 km (the distance from the plant to the town) are:

- 3 $Bq/m^3$ for mixing height L = 100 m and wind speed u = 2 m/s
- 2 $Bq/m^3$ for mixing height L = 200 m and wind speed u = 4 m/s.

Transit times or 'ages of air' are then 5,000 seconds (83 minutes) and 2,500 seconds (42 minutes) respectively.

Equilibrium, which takes about 90 minutes, is approached in the first case (83 minutes) but is conversative by a factor of 2 in the second (42 minutes). For total ingrowth to equilibrium, the values given in Figure 5.20 of Steedman (1982) can be divided by 3,700 to obtain WL.

**Radon Levels in Dead Ends and Ore Passes**

Recent measurements underground at Olympic Dam show that even in a development end 120 metres long, when secondary ventilation has been turned off for 8 hours, there is sufficient natural circulation (provided the main fan is still running), to maintain low radon daughter levels (less than $10^{-2}$ WL).

For ore passes, ventilation design will be such as to draw off air from ore passes into exhaust airways.

**Higher Ore Grade Effects**

During the present exploratory underground development programme, localized areas of high-grade uranium mineralization with correspondingly high gamma dose rates have been encountered. These are not considered to be indicative of actual average mining conditions. If extended areas of such mineralization are encountered in production conditions, then active control measures will be taken.

These measures may include employing an alternative mining method giving reduced operator exposure, some placement of shielding on mobile equipment, or even some limited use of remote controlled equipment. The point at which one or more of these options may be exercised can only be decided in the light of actual mining experience.

## 4.5 MITIGATION MEASURES

### Security of Yellowcake Transport

Security measures will be taken for protection of yellowcake both in storage and in transport. These will be defined at the appropriate time in consultation with the Australian Safeguards Office and police, but for obvious reasons will not be discussed in this public document.

### Compensation for Effects on Miners' Health

Workers Compensation is the subject of statutory requirements which will be observed by the Joint Venturers.

### Disposal of Wash Water

Mine and plant workers will be required to shower and change on site at the end of shift. Work clothing will be laundered by the Joint Venturers. Disposal of laundry water will be as plant makeup water if the detergent/soap loading does not render it unsuitable, in which case it will be discarded via the plant sewage treatment to the tailings retention system.

### Control of Grazing

Grazing will not be permitted within the Controlled Access Area (CAA). The acceptability of grazing in areas immediately outside the CAA will depend on the results of ongoing vegetation monitoring at various locations on the CAA fenceline. Studies to date suggest that impacts due to deposition of airborne particulates on vegetation will be slight, and that additional alienation of land from grazing will not be required.

### Contingency Plans for Spillages

Spillage of uranium product or toxic chemicals may occur either on or off the lease area. For both cases, contingency plans for spillage clean up will be drawn up for approval by the regulatory authorities. These approvals will be obtained before commencement of production.

## 4.6 MONITORING

### Further Baseline Measurements

The Joint Venturers will continue to be responsible for both the existing baseline monitoring programme and for the operational monitoring programme. The present baseline radiation monitoring programme will be continued with the modifications outlined below. This programme has been drawn up in consultation with the regulatory authorities, and, under the terms of the Indenture Agreement, is contingent upon their approval. The programme will run for the duration of the pre-operational period. It will be specifically aimed at obtaining further information on local variability in gamma radiation, airborne radon/radon daughter concentration, and radiochemical analyses of soils, flora, and fauna. Some of this information, specifically on background gamma, has already been collected, but has not yet been interpreted. As part of the ongoing studies, the present 'Sandhill' meterological station will continue to operate.

Extra soil, vegetation and TLD sampling points are presently being selected to encompass the areas of the tailings retention system, the pilot plant, and the full scale plant. The samples of soil and vegetation will be taken from these sites and analyzed for $Ra_{226}$, $Th_{230}$, $U_{238}$ and $Pb_{210}$. Results will be supplied to the regulatory authorities.

Some of the radiochemical results from the initial vegetation samples have suggested that further investigation into variability between species in radium uptake is warranted. Assays will also be performed on ephemeral plant species. Details of sampling (roots, stems or leaf samples, new or old growth, after rain or during dry spells, etc) will be provided to the relevant authorities, together with discussion of the significance of the results, after completion of follow-up studies. Radiochemical analysis of fauna will be expanded to include frog and rabbit tissue. Results of tissue analysis from earlier sampling are not yet available.

**Protective Action Levels (PALs) in Government Reporting**

Monthly reporting to the State Government of radiation readings has been in effect for over a year. A procedure for making special reports of elevated readings within a specified time limit has been established but has yet to be formalized.

## 4.7 OTHER ISSUES

**Sulphuric Acid Plant Breakdown**

The plant configuration envisages a contact-type sulphuric acid plant that will comprise two units of acid production with duplication of scrubbing, drying and absorption towers and converters (Draft EIS Section 8.2.1). A realistic operating emergency would envisage one of these acid producing trains going off line. Generally this would be for short duration - up to 24 hours - but during annual maintenance each unit could close for up to 14 days. This period may be used for maintenance of other components of the processing plant.

Each of the two acid production units will be of sufficient size to handle the total gas feed stream. When one unit is closed for maintenance, cleaning or emergency shut-downs, the total gas feed stream to the acid plant will be directed to the operating production unit. Therefore in the event of an acid production unit being closed the emission rates of sulphur dioxide, nitrogen oxides and hydrogen fluoride to atmosphere would be unchanged.

In the unlikely event of both acid production units going off line the Joint Venturers will continue to comply with the South Australian Clean Air regulations. This could be achieved by one or more of the following:

- temporary closure of production facilities
- adding further scrubbing equipment
- adjusting stack heights.

These options will be discussed at the stage of final design with the Air Quality Branch of the S.A. Department of Environment and Planning to ensure compliance with regulations.

**Sulphur Stockpile**

The sulphur stockpile in a climate such as Olympic Dam will represent a potential fire risk. Ignition can be caused by exhausts or sparks from vehicles on the stockpile. Sulphur fires are readily detectable by the smell and do not escalate but tend to smoulder rather than burn. They can generally be controlled by smothering or with water, but in the event of these measures failing to extinguish a fire that portion of the stockpile will be physically isolated. Preventative measures proposed by the Joint Venturers include good housekeeping practices and the limitation of vehicular traffic on the stockpile or if necessary sealing of the stockpile with a bonding agent. Any working stockpile because of its smaller size would not usually require sealing.

**Thiobacillis Formation**

The possibility of acid runoff from stockpiles containing mineralized material was raised in Government comment. The major source of such runoff is caused by the oxidation of pyrite ($FeS_2$). This oxidation process is considerably accelerated under certain physio-chemical conditions by species of Thiobacillus bacteria (T. ferro-oxidans, T. thio-oxidans, T. denitrificans).

As indicated in Section 2.3.7 of the Draft EIS because of the low sulphur content of the ore and the very low rainfall it is not expected that acidic run-off from stockpiles containing mineralized material will present any significant problem. This has been confirmed by experience with the present temporary ore stockpiles. If run-off from stockpiles is acidic it would probably contain amounts of both copper and uranium in solution and would thus be potentially valuable as a source of plant make-up water. As such it will be treated in the same manner as stormwater run-off from the plant itself (Draft EIS Section 2.5.3) and will be collected and pumped to the plant as make-up water.

In the case of a short or medium term cessation of operations the stormwater runoff from stockpiles would be collected in the same manner and pumped to the tailings retention system.

**Decontamination and Burial of Mine and Plant Solid Wastes**

The disposal of solid wastes from the mine and plant is discussed in Section 8.5.2 of the Draft EIS. Further to the information contained in that section, any disposal facilities or methods will be subject to approval by the Department of Mines and Energy who will be the responsible regulatory authority.

**Particulate Emissions**

The sulphur dioxide emission limits recommended by the NHMRC (refer Section 8.2.2 of the Draft EIS) are in conjunction with a particulate limit of 200 $mg/m^3$. Because of the necessity to clean the gas feed to the acid plant a wet gas-cleaning system will be installed (refer Section 2.4.3 of Draft EIS). This reduces particulates to a limit of 1 $mg/m^3$ total particulates in the gas feed. The manufacturer's guarantee of particulate emissions is 50 $mg/m^3$.

## 4.8 REFERENCES

On p. 9.5 of the Draft EIS reference is made to gamma dose equivalent level of 10 uSv per week being consistent with the average for a continental land mass. Reference to the range of gamma dose equivalent level characteristic of background for a continental land mass may be found in UNSCEAR, 1977, (Table 4, p.43; Table 7, p.45).

On p. 9.6 of the Draft EIS, radon daughter concentrations in air are discussed. For continental air WL values refer to Fry (1975) which gives in Table 2, p.7, a list of measured annual average radon levels. See also UNSCEAR 1977, p.72, 73 op. cit.

On p. 9.8 of the Draft EIS reference is made to the tendency for lead-210 levels to be in excess of other radionuclides. A discussion of lead-210 'natural fallout' which causes this tendency can be found in UNSCEAR (1977:63).

## 5 INDIRECT EFFECTS

Further elaboration on the nature and extent of indirect effects associated with the Olympic Dam Project was requested in public submissions and Government review of the Draft EIS. The following areas of concern were raised:

- the indirect effects on pastoral activity
- infrastructure considerations
- the effects of increased tourist and recreational activity in the region
- the potential for weed invasion
- the effects of obtaining resource requirements
- the responsibility for management of indirect effects.

### 5.1 INDIRECT EFFECTS ON PASTORAL ACTIVITY

The Draft EIS raised a number of issues which might affect pastoral activity in the region of the Olympic Dam Project (refer Draft EIS p. 4.20 ff). These were:

- beneficial effects of
  - improved access to town facilities
  - the likely availability of a reliable stock water supply
  - improved transportation in the region;
- potentially adverse effects of
  - division and loss of land
  - vehicle and stock accidents
  - dangers to stock
  - vandalism.

The potential for other adverse impacts has been raised in the public submissions received.

**Proximity to a Population Centre**

Livestock production is considered to be more difficult in areas adjacent to centres of large population than in remote areas. Livestock raising can be affected by factors such as dogs, human movement, vandalism and traffic movement. Pastoralists advocate the banning of dogs from the town, but if that is not acceptable then they recommend that controls be placed on dog movements out of the town and control of wild dog populations beyond the town. Dog control in the town will be administered by the Municipality. The vermin-proof fence enclosing the entire Project area will effectively prevent any movement of dogs from the town to adjacent grazing areas. Furthermore, the role of the environmental officer (see Section 8.1 below) will include liaison with nearby landholders so that problems, like disturbance due to dogs, can be quickly identified.

**Actions to Reduce Vandalism**

In relation to vandalism, there were requests for significant penalties for anyone engaging in acts of vandalism, requests for education programmes for town residents on the futility of vandalism and requests for fencing of roads to reduce access. Provisions of the Pastoral Act govern penalties in relation to vandalism. Part of the induction programme for employees and the community education programme for town residents will address maintaining 'good neighbour' relations with pastoralists.

**Fencing**

Fencing of roads will be consistent with the policies of other authorities responsible for road construction in the region. Generally, where fences cross the new alignment of the Stuart Highway a grid is installed. The cost of each grid is compared against the cost of erecting fencing along one side of the road reserve between cross fences to eliminate as many grids as possible. Fencing is only carried out up to the value of savings realized by the elimination of a grid. Should a station owner require more fencing erected than is justified as noted above, it is paid for by the station owner. In all cases, concurrence of the Pastoral Board is sought to any fencing arrangements made (Highways Department, pers. comm.).

**Impacts of Infrastructure**

In relation to infrastructure associated with the Project the following items were raised:

- the building of roads has the potential to divide catchments of stock watering dams;
- the location of transmission lines can represent a hazard to the approach or take-off path of aircraft from airstrips and,
- additional access roads increase the problem of unauthorized access.

Where appropriate, drainage underneath roads will be provided to maintain flows to stock dams. The transmission line alignment has been designed to avoid conflicts with existing airstrips.

In relation to additional access associated with the Project there are three new access roads or tracks:

- the main Woomera-Olympic Dam access road
- the access road from Olympic Dam to the borefields
- the maintenance access track along the transmission line corridor from Mt. Gunson to Olympic Dam.

The first two of these will be roads of a standard that will permit use by conventional vehicles. The access track along the transmission line corridor will be maintained in such a condition as to make it impassable to other than 4 wheel drive vehicles. This will minimise the use of that road and thereby any adverse impacts resulting from its use.

**Competition for Rural Workforce**

One other point raised was that higher incomes at Olympic Dam may make it difficult for pastoralists to maintain their workforce considering the wage and other conditions as laid down by the Pastoral Award. Although this is possible, there is no evidence to suggest this is occurring with the current workforce at Olympic Dam.

## 5.2 INFRASTRUCTURE CONSIDERATIONS

**Availability of Infrastructure to Third Parties**

The first consideration raised was the availability of infrastructure to third parties. Under Clause 13.13(b)(ii) of the Indenture Agreement, use of the Joint Venturers' water supply facilities by third parties is a matter for negotiation. Current policies indicate water could be made available and appropriate discussions will be held prior to construction. In respect of power availability, the very high cost of step-down transformers necessary to reduce high voltage transmission to domestic supply levels would generally render this option unpractical. The Joint Venturers do not object in principle to providing pastoralists with assistance in negotiations with Telecom to ensure pastoralists have access to telephone lines.

**Compensation**

The issue of compensation was also raised. This matter was addressed in the Draft EIS (Section 4.2.2). The Joint Venturers have a general obligation under Clause 31 of the Indenture Agreement to pay reasonable compensation for the loss of land and/or production from any land required by the Joint Venturers for the purposes of the Project.

**Power Supply**

One submission raised other considerations by suggesting the power allocated to the Olympic Dam Project represented a significant public investment in the Project through the cost of providing power generating plant. It should be noted that the Electricity Trust of South Australia (ETSA) have advised that the addition of plant capacity would proceed whether or not the Project went ahead. It should also be noted that the cost of such generating plant is recouped through electricity tariffs which the Joint Venturers will be required to pay. This same submission also suggested that ETSA should have other priorities than providing fossil fuel powered generating plant. ETSA's priorities are not a matter for comment by the Joint Venturers.

**Cargo Through Port Adelaide**

The Draft EIS (Section 10.4.4) contained the statement:

'In the last few years there has been a decline in the quantity of cargo passing through Port Adelaide.'

The SA Department of Marine and Harbours has pointed out to the Joint Venturers that they believe this statement to be an error in fact, and has provided statistical data to indicate increases in cargo handled in recent years.

## 5.3 TOURISM AND RECREATIONAL IMPACTS

The potential for indirect effects due to increased tourist and recreation activity was noted in the Draft EIS (p. 3.53, p. 4.22, p. 5.42, p. 10.44, p. 11.23). Government officers requested that this information be brought together in one section of the Supplement. These items are reproduced below. Government officers also asked for further elaboration, where possible, on potential indirect impacts.

**Vegetation**

The influence of the Project will extend over a larger area than that of the Project Area itself. In particular, the recreational use of the surrounding country will affect the vegetation in the region. Potential impacts are likely to include vegetation damage due to off-road vehicle movement, use of picnic sites at points of interest resulting in a reduced vegetation cover and increased erosion, and the removal of timber for firewood and other uses. Recreation impacts are more likely to be concentrated at distinctive landscape features, and swamp areas containing vegetation with some conservation significance can therefore be expected to receive more intense use.

The incidence of wildfires is expected to increase, primarily in the remnant vegetation in the vicinity of the town site and in informal recreation areas. The primary sources of ignition are expected to be domestic rubbish burning, children, and poorly managed barbecue fires. Fire incidence will usually be limited by seasonal conditions, and fires are likely to be of low intensity. However, some loss of trees and ground cover can be anticipated.

**Land Use**

While there are no areas of scenic or recreational attraction in the Project Area, the Olympic Dam development may have some indirect effects on tourism and recreation. For example, the Project itself may become a tourist attraction, thus increasing the number of visitors to the region, while the Olympic Dam town population will also swell general tourist activity by visiting regional areas of interest. In addition, the improvements in transportation and accommodation facilities will moderate one of the principal restraints on tourism in the region.

**Aboriginal Sites**

The potential exists for indirect impact on sites outside the area under the jurisdiction of the Joint Venturers. Hercus (pers. comm.) has quoted examples of damage to anthropological sites in the mound springs area due to stock, visitors, and road building activity. Further damage is likely to occur if the present situation continues and sites remain unprotected, as it is beyond the capability of the pastoralists, who have tenure of the land on which the sites occur, to provide effective protection. Indeed, with improved accessibility to the region resulting from the upgrading of roads to the Olympic Dam Area and to the borefields further north, together with the greater numbers of people in the region due to Project development, it is likely that the rate at which damage occurs will accelerate. The Joint Venturers can only control access to sites within the Project Area, and do not have the authority to control access to sites beyond this area. However, discussions with the relevant government authorities have commenced, with the aim of determining ways in which these indirect impacts might be mitigated.

**Infrastructure Corridors**

**Off-road vehicles:** The sole purpose of the road within the (northern) corridor is to service construction and to provide access for operation and maintenance of the pipeline and borefields. In order to minimize environmental impact, off-road movement of construction and operations vehicles will be limited. However, the Joint Venturers cannot control the use of the road by the public or off-road movement by these vehicles, although this will be deterred by the raised formation.

**Tourist potential:** An allowance has been made in the selection of (northern) corridor width to permit the expansion of the service road to 12 m, although this is not envisaged by the Joint Venturers as part of the Project development. The potential therefore exists for the State to upgrade the road in this manner, which could improve the region's tourist potential. This would effectively establish a ring route with better than average road conditions linking Port Augusta, Woomera, Olympic Dam, Marree, Leigh Creek, Hawker and Quorn, providing good access to tourist attractions such as the Olympic Dam Project, Andamooka, the Lake Eyre Basin, the Breakaway escarpment, the mound springs, and Strangways Springs repeater station.

**Town Development**

The Indenture Agreement and conceptual planning for the town provides for a range of active and passive recreational demands to be met. The active recreational facilities to be funded under the provisions of Clauses 22(2)(k) and (1) include an Olympic standard swimming pool complex and other sporting facilities such as playing fields. Tennis, squash and basketball court are allowed for in the land use budget, together with a lawn bowls club, a golf course, and ovals for football and cricket.

Sites have been set aside for a showground and racecourse, which could be used by a variety of local clubs for large scale functions. Some land outside the presently envisaged municipal boundaries, i.e. the town site and buffer zone, may need to be provided for those recreational activities which may cause nuisance to residents or environmental damage. These may include a rifle range, car racing, or trail bike riding, all of which will need to be under municipal control.

It could be expected that residents of Olympic Dam will, in time, identify and patronize a number of locations in the region seen to be attractive places for picnics or other outdoor passive recreation activities. Where these sites are not presently used or managed for recreational purposes, the State Government will need to monitor emerging recreation patterns in the region and develop appropriate management procedures to ensure that undue adverse environmental impacts are controlled.

**Further Comment**

**Sites of Environmental Significance:** The discussion of the potential indirect impacts in the Draft EIS was not site specific. In order to determine which areas in particular might be involved, an approximate travel time map from Olympic Dam was established (Figure 5.1). Two travel time contours were estimated. One is for a three-hour travel time. Within this contour are areas which can reasonably be visited in a day trip from Olympic Dam. The second contour is for a six-hour travel time. The areas within this contour can be reasonably reached in a two-day (or week-end) trip from Olympic Dam. Location of the travel time contours was estimated from known driving times and advice from the RAA Travel Department that 80 km/h represented a typical average speed for travel on bitumen roads and 40 km/h was appropriate for Far North tracks. Travel times in the Far North are highly variable particularly in relation to weather and road conditions. Thus the contours in Figure 5.1 should be considered approximate.

Table 5.1 lists the places of known environmental significance which fall within the three-hour and six-hour travel time contours. It is these areas which are anticipated to be visited most frequently by future Olympic Dam residents. For environmental features generally to the north and west of Olympic Dam (e.g. the mound springs), significant increases in the number of visitors over present levels can be expected. To the south and east (e.g. Northern Spencer Gulf, Flinders Ranges) the additional numbers of visitors from Olympic Dam is unlikely to be discernible over current tourist visitation, because of the accessibility of these areas to existing population centres.

**Table 5.1** **Areas of environmental significance in the Olympic Dam Region**

| Environmental Feature | Within 3-hour Travel Time | Within 6-hour Travel Time |
|---|---|---|
| Mound Springs | Coward Springs Complex (including The Bubbler and Blanche Cup)<br>Hermit Hill Complex<br>Finnis Springs | Strangway Springs Complex (including Beresford Hill)<br>Peake Springs Complex |
| Major Creek Lines | Stuart Creek<br>Gregory Creek | Margaret Creek<br>Cooper Creek (near Ferry)<br>Frome Creek<br>Clayton Creek |
| Western Salt Lakes | Lake Hart<br>Pernatty Lagoon<br>Island Lagoon<br>Lake Eyre South<br>Lake Torrens<br>Lake Gairdner | Lake Kopperamanna<br>Lake Killalpaninna<br>Lake Harris<br>Lake Everard |
| Range Country | | The Breakaways<br>Peake and Denison Ranges<br>Flinders Ranges |
| Coastal Areas | | Northern Spencer Gulf |

Note: Areas of Environmental Significance as defined by Department of Environment and Planning in Far North Planning Area Development Plan (State Planning Authority, 1981 p. 9).

**Types of Environmental Impact:** The types of environmental impact which could be anticipated from recreational activity have been listed in Table 5.2. The table also indicates the likely sensitivity of the environmental features identified in Table 5.1 to these types of impacts. Issues of particular concern are noted below:

- Off road vehicle movements are expected to be of greatest concern as a source of landform disturbance in range country. This is considered likely because of the more challenging terrain attracting more vehicles and the steeper slopes being more susceptible to erosion.

- Firewood collection resulting in damage to vegetation is anticipated to be greatest along major creek lines both because of the attractiveness of these areas as picnic and camping sites as well as being the main source areas of woody plants.

- Potential for habitat disturbance is foreseen to be most significant in relation to mound springs because of limited distribution of the species present and the known susceptibility of the mound springs to trampling impacts (e.g. cattle damage to mound springs).

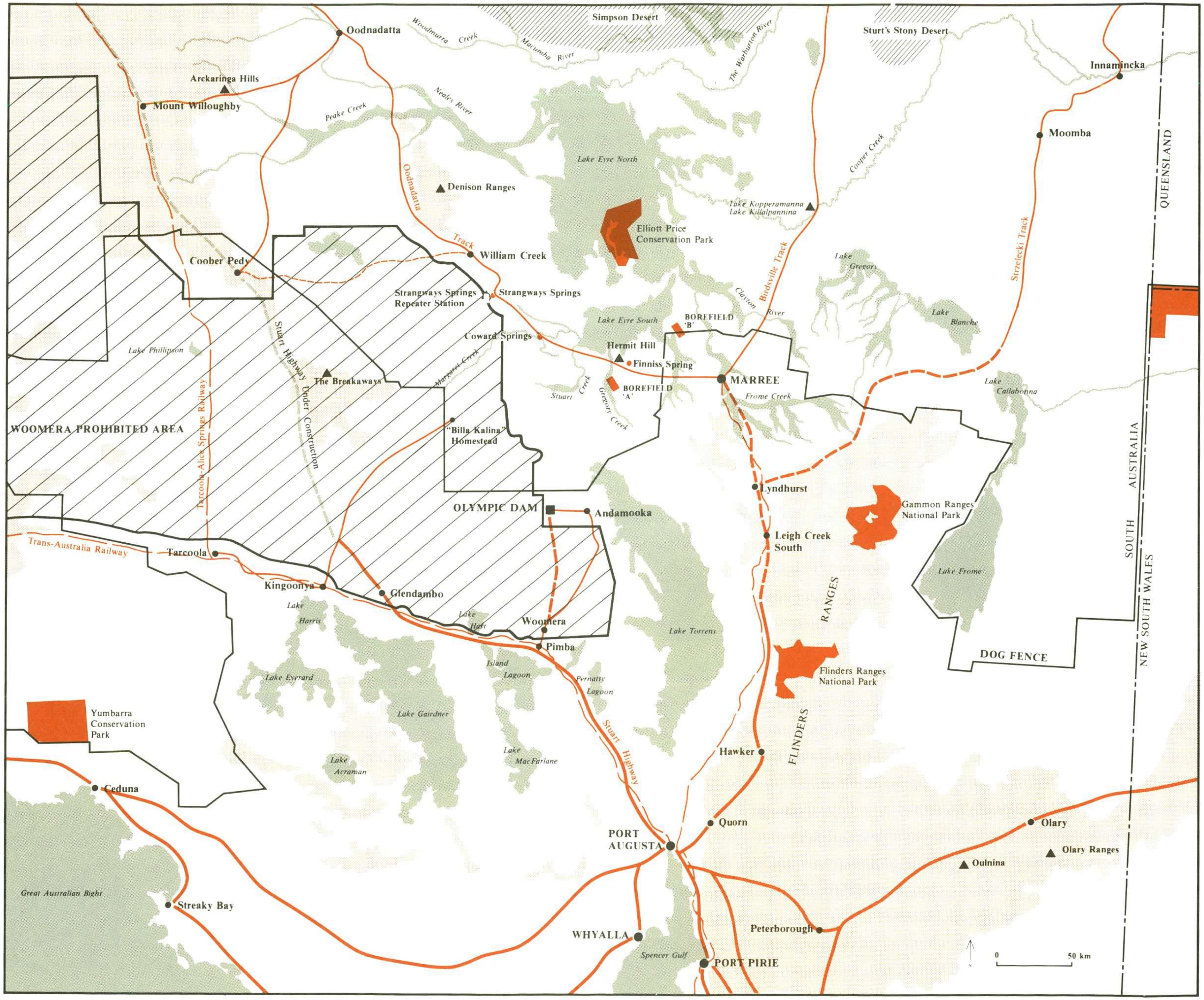



Figure 5.1
**APPROXIMATE TRAVEL TIME MAP FROM OLYMPIC DAM**

- 6 Hour Travel Time Contour
- 3 Hour Travel Time Contour
- Sealed Road
- Unsealed Road
- Secondary Road
- Major Track
- Area of Interest
- Site of Interest
- Conservation or National Park
- Land above 200 m
- Mound Spring

- Physical disturbance of fauna, particularly birdlife, due to human activity is expected to be greatest at mound springs and major creek lines because of the likely association of fauna (especially birds) with water sources.

- Landscape disturbance is likely to be most noticeable along major creeklines and in range country.

- Contamination of water resources is expected to be greatest in waterholes on major creek lines where water use for camping and picnicking (e.g. swimming, washing) may lead to increases in such water quality parameters as turbidity and BOD levels.

- Damage to aboriginal sites as well as removal of artefacts and engravings is already a concern in the mound springs area (as noted above) and on major creek lines. Further damage could be anticipated with greater activity in the area.

**Table 5.2 Sensitivity of environmental features to Recreational Impacts**

| Types of Environmental Impact | Mound Springs | Major Creek Lines | Western Salt Lakes | Range Country | Coastal Areas |
|---|---|---|---|---|---|
| Landform Disturbance | | | | | |
| - vehicle/human traffic as a source of erosion | * | * | | ** | |
| Vegetation | | | | | |
| - damage due to trampling | ** | * | | * | |
| - firewood collection | | ** | | * | |
| - incidence of wild-fires | | * | | * | |
| Fauna | | | | | |
| - habitat disturbance | ** | * | * | * | |
| - physical disturbance (noise, human activity) | ** | ** | | | |
| - shooting and trapping | * | * | | * | |
| Scenic Amenity | | | | | |
| - landscape disturbance | * | ** | | ** | |
| - litter | * | * | | | |
| Water Resources | | | | | |
| - contamination | * | ** | | | |
| Aboriginal Sites | | | | | |
| - vandalism | ** | ** | | | |
| - removal of artefacts & engravings | ** | ** | | | |
| Additional Development | | | | | |
| - weekenders | | | | | * |

* Issue of some concern
** Issue of particular concern

**Possible Mitigation Measures**

Mitigation measures which might be contemplated by authorities with jurisdiction relating to these issues could include:

- restrictions in access to off road vehicles to designated areas which might be used in rotation to allow vegetation regeneration or are considered as 'sacrifice' areas;
- establishment of firewood stores in picnic and camping areas to reduce indiscriminate collection of natural vegetation;
- restrictions on access to mound springs of known habitat significance and provisions of board walks or defined trails to accessible mound springs;
- development of picnic and camping sites in locations away from important avifauna habitat and scenic areas;
- the establishment of toilets, taps, tent sites, and fireplaces to reduce the potential for contamination of water resources, vegetation damage and the spread of wildfires;
- physical protection of and access restrictions to aboriginal sites of significance.

## 5.4 POTENTIAL FOR WEED INVASION

The introduction of weed species into the pastoral lands of South Australia by a variety of transport modes has continued for many years, although recent evidence (SADE 1980) suggests that in some areas weed invasion by certain species is on the increase.

While disturbance inevitably leads to weed invasion, invading species - the so called common weeds - do not always colonize beyond the immediate area disturbed. The more serious threat however, is posed by 'paddock' or 'environmental' weeds (Amor and Stevens, 1975) able to grow in a natural community and capable of invasion even in the absence of any disturbing factors. The Australian arid lands appear to be less susceptible to weed invasions than the more temperate areas, as the proportion of alien plants to natives is much lower in the former (Buckley, 1981). Furthermore, recent studies (Lay, pers. comm.) suggest that a number of these so called environmental weeds are in fact native to the arid lands. Many of the weeds may however perform useful functions in rehabilitation work, and also as early stabilising agents without active human intervention. After a century of grazing, the Olympic Dam flora contains a number of weed species capable of colonizing areas disturbed by mining activity - for example Salvation Jane, Echium plantagineum, Tobacco Bush, Nicotiana glauca, and a number of crucifers. The full complement of weeds present has not been recorded in the EIS because studies have coincided with a drought period.

It is probable that the frequency of certain weed species will increase within the townsite and on access road verges as a result of disturbance to the physical environment. However, experience at Woomera and Mount Gunson - towns in similar regional settings, would suggest that invasion by Schedule (1) Weeds at Olympic Dam is unlikely to be a problem due to the absence of suitable colonization habitats such as water courses and permanent water bodies. In the Olympic Dam area, results to date from the vegetation monitoring programme established in 1981 in areas affected by extensive exploration activities, have not shown any marked increase in weed infestations despite favourable rainfalls in January of that year.

Effective control methods for most weed species are well established. The responsibility for monitoring and controlling weed infestations in public areas in the townsite will be with the Municipality. Within areas controlled by the Joint Venturers, vegetation monitoring, destocking and restrictions on the off-road use of company vehicles have been in effect for some time, and these actions should continue to reduce the risk of undesirable seed transport, as well as provide adequate warning of unnatural increases.

## 5.5 RESOURCE REQUIREMENTS

The environmental impact of the resources that are required for the Project have been considered in the Draft EIS in two main categories. The first of them (Section 2.6.5) gathers together those resources for which it is considered that the environmental impact connected with their production will be negligible. This is because they are generally items that are in common use in many other industries within the State and within Australia and the incremental requirement represented by the Olympic Dam Project is very small in comparison with the production at the source quoted. Table 5.3 below indicates the proportions represented by some major inputs.

**Table 5.3 Project resource consumption as a percentage of annual production**

| Item | Annual consumption (a) | Annual production from expected source (b) | (a) as % of (b) |
|---|---|---|---|
| Cement | 65,000 t | 1,030,000 t (1) | 6.3 |
| Manganese Dioxide | 90,000 t | 2,020,000 t (2) | 4.5 |
| Salt | 3,200 t | 760,000 t (3) | 0.4 |
| Coal | 80,000 t | 49,500,000 t (4) | 0.2 |

(1) Production in 1981/82: Australian Bureau of Statistics, Publication 1303.4.
(2) Production in 1980: Australian Mineral Industry Annual Review, 1980, BMR (1982).
(3) Production in 1981: Australian Mineral Industry Quarterly, BMR (1982).
(4) NSW Production in 1980/81: Black Coal in Australia, Joint Coal Board.

The second category of resources were those for which a significant environmental impact was perceived. These are:

- water
- electric power
- labour.

Collectively these also represent a significant proportion of the Joint Venturers' operating cost.

The environmental impacts of the provision of these items have been examined in detail in Chapters 10 and 11 of the Draft EIS and the social effects of the labour requirement have been examined in Section 12.5.

**Source of sand supply**

There will be two discrete requirements for sand by the Project which are as follows:

- Construction Sand

  The exact sources of this material are not yet defined. However, a number of potential sites to the north of the Project area are known. During the construction phase it is expected that contractors will be responsible for the development of these sand sources. They would be subject to the normal environmental and other development procedures.

- Silica Sand for Process Flux

  In Table 2.3 of the Draft EIS, an annual requirement of 80,000 t of silica sand is noted. This sand will be local dune sand from within the lease area at Olympic Dam. The Joint Venturers must abide by the requirements of the Special Mining Lease and the Mines and Works Inspection Act in the establishment and operation of any operations on the lease area. The following principles will be adopted in the extraction of dune sand:

  - material must be suitable for metallurgical use
  - maximum use will be made of sand removal from developed areas (such as the plant site)
  - low or devegetated dunes will be preferred as sand sources
  - removal of whole dunes will be practised in preference to removal of sections of dunes.

## 5.6 RESPONSIBILITY FOR MANAGEMENT OF INDIRECT EFFECTS

With respect to indirect effects generally the Joint Venturers can only accept responsibility where they have legal authority to do so. Furthermore, in a democratic society, the Joint Venturers are only responsible for employees whilst 'on the job'. Non-work related activities in areas outside the Joint Venturers' authority are beyond the Joint Venturers' control. Government is the only body with power to minimize impacts due to such activities and thus such controlling action is a Government responsibility.

In relation to the maintenance of roads, the relevant responsibilities are generally specified in Clause 14 of the Indenture Agreement. The Municipality must maintain roads in the town. The State Government must maintain the Pimba to Olympic Dam road. The Joint Venturers must maintain private roads for the Project. However, exact details of the classification of roads is not yet available.

One submission suggested the creation of reserves in the region. Again, such action is a government responsibility.

# 6 MOUND SPRINGS AND WATER SUPPLY

In relation to the mound springs, information presented in this Supplement not only includes responses to public submissions and Government comments but also provides additional ecological baseline data, environmental considerations arising from this additional information, the scope of further studies referred to in the Draft EIS, and the progress towards the formation of a consultative committee for ecological management of mound springs. The final section below responds to comments relating to other issues concerned with water supply from the GAB.

## 6.1 ADDITIONAL DATA ON MOUND SPRINGS

From a number of the public comments received and subsequent discussions with scientists who either made comments or were referred to the Joint Venturers, additional ecological data on the mound springs has been identified. This data has been collected by researchers from museums and universities, and much is unpublished. Significant data has been collected on fishes, hydrobiids and ostracods. Summaries of this information are presented below.

**Fishes in the Lake Eyre Drainage Division**

The South Australian Museum has reviewed the available literature on fish studies in Central Australia (Glover and Sim, 1978a) and undertaken its own studies in the area (Glover, 1971; Glover, 1973; Glover and Inglis, 1971; Ivantsoff and Glover, 1974; Glover and Sim, 1978b; Glover, 1979). This information presented below is summarized from this work and from discussions with Mr. C.J.M. Glover, Curator of Fishes, South Australian Museum.

Central Australia's fish fauna appears to be largely restricted to the Lake Eyre drainage division (Figure 6.1). The relevant mound springs are in the Lake Frome drainage basin of this division. The principal aim of the Museum study has been to survey all types of water bodies (artesian and non-artesian, natural and artificial) throughout the Lake Eyre system for the occurrence of fish to provide more complete distribution data and taxonomic material. Environmental data (water temperature, salinity, ionic composition, oxygen content and vegetation) have been recorded at representative locations to correlate some of these variables with the distribution of fish. In addition, relative tolerances of some adult species to extremes of the physical environment (temperature, salinity and oxygen) and habitat preferences were also examined.

The frequency of occupation of aquatic habitats by fish in Central Australia is shown in Table 6.1. The frequency of occurrence and number of species in river systems suggests their significance in the dispersion of fish within the region. Natural springs are more important as habitat than bores and dams. A provisional checklist of species and the drainage basins and habitats in which they are found is given in Table 6.2. Where the data is available, information on physiological tolerances of species in relation to salinity, temperature and dissolved oxygen is also indicated.

Amongst the most widely dispersed fish within the Lake Eyre Drainage Division are bony bream (Nematalosa erebi), the MacDonnell Ranges rainbow fish (Melanotaenia tatei), the spangled perch (Terapon unicolor) and the desert goby (Chlamydogobius eremius). The most restricted appear to be the Dalhousie hardyhead (Craterocephalus dalhousiensis), the penny fish (Denariusa bandata) and flathead goby (Glossogobius giurus), each apparently limited to a single drainage basin.

**Table 6.1** **Frequencies of occupation of aquatic habitats by fish in Central Australia**

| Habitat | No. of localities inspected | No. of localities inhabited by fish | Maximum no. of fish species at any one locality |
|---|---|---|---|
| Springs | 35 | 17 | 6 |
| Bores | 75 | 27 | 3 |
| River Systems | 124 | 77 | 8 |
| Dams | 29 | 11 | 4 |

The table indicates that the species likely to be present in the mound spring areas affected by the drawdown from the borefields are:

- catfish (Neosilurus spp.)
- mosquito fish (Gambusia affinis) - an introduced variety
- Mitchellian freshwater hardyhead (Craterocephalus stercusmuscarum)
- Lake Eyre hardyhead (Craterocephalus eyresii)
- spangled perch (Terapon unicolor)
- purple-spotted gudgeon (Mogurnda mogurnda)
- desert goby (Chlamydogobius eremius).

Each of these species are present in other drainage basins and habitats other than artesian springs. All except the purple-spotted gudgeon are found in artesian bores. The occupation by fishes of so many of the artesian bores sunk since European settlement reflects an efficient dispersal mechanism. Floodwaters and topographical barriers directing and restricting their spread appear to be predominant factors in governing large scale dispersal of fish within Central Australia. There appears to be no fundamental difference between the natural and artificial artesian habitats. Of the eleven fishes known from artesian waters at least six inhabit both types. Occupation of either habitat appears to be a chance affair, though springs a priori must be considered the basic artesian niche.

Preliminary analysis of environmental and experimental data suggests that fish of the Lake Eyre system tend to show greater tolerance to more variable temperatures and salinities, and to lower dissolved oxygen levels than do those Australian fish not inhabiting Central Australia. Among the species present in Central Australia, the successful establishment of certain species in the more rigorous habitats (e.g. springs, bores, and waterholes subject to drying up) appears to correlate in part with the superior capacity of these species to tolerate or adapt to wide fluctuations in water temperature, salinity and oxygen content to which such habitats are prone. However, the overall distribution of fishes within Central Australia seems to be independent of chemo-physical factors to a large degree, although those factors clearly influence specific habitat preference and distribution within the individual water body.

**Hydrobiids**

Further to the work reported in the Draft EIS on limnology which was undertaken by the Nature Conservation Society, extensive taxonomic work on hydrobiids is in progress at the Australian Museum under the direction of Dr W.F. Ponder. The information contained in this section is primarily drawn from discussions and notes provided by Dr Ponder. Hydrobiidae are gastropods (commonly known as snails) which are generally small (less than 5mm) with dark-coloured shells (Williams, 1968). Earlier collecting had discovered three undescribed species associated with the mound springs. Further

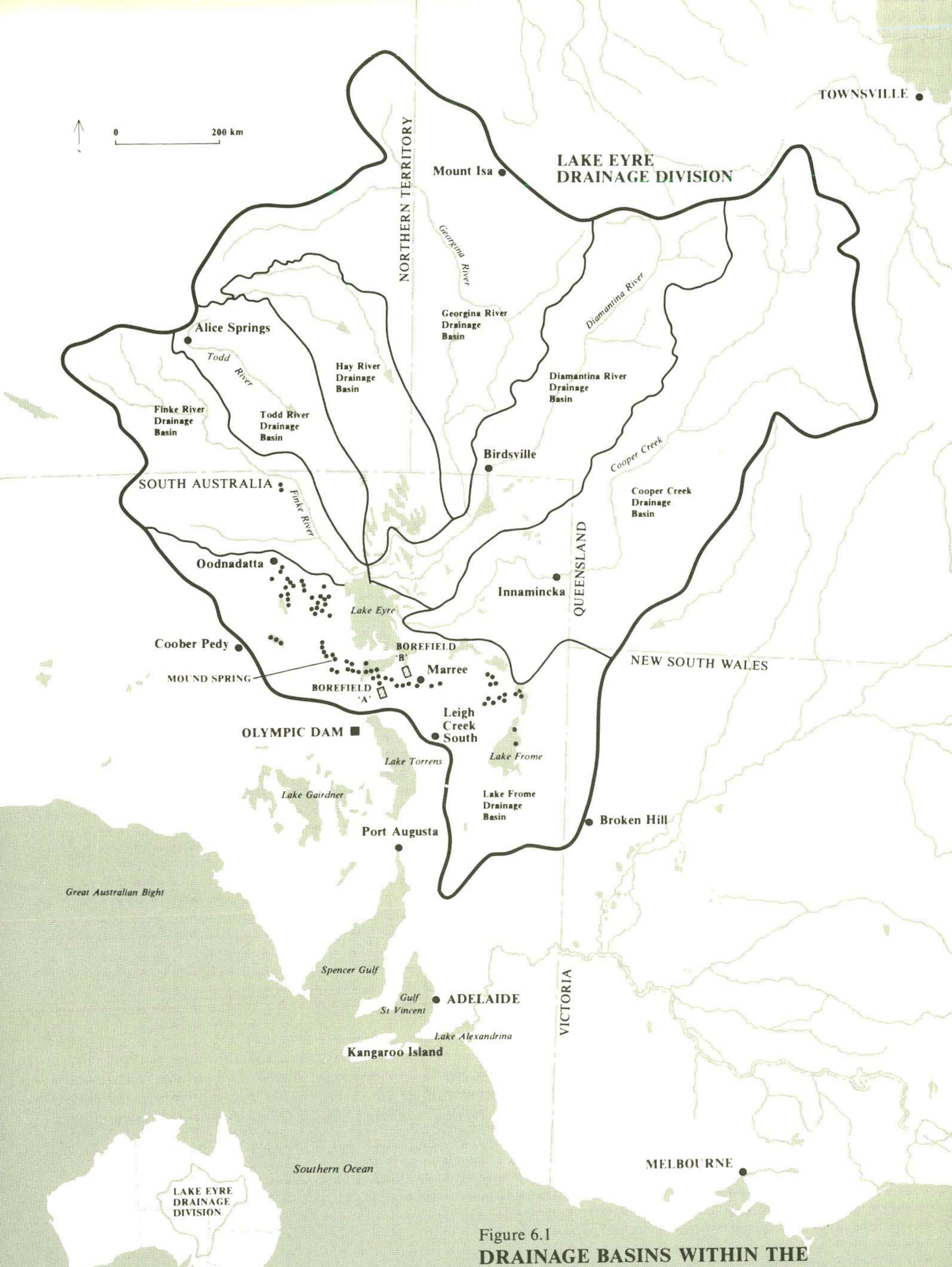



Figure 6.1
**DRAINAGE BASINS WITHIN THE LAKE EYRE DRAINAGE DIVISION**

## Table 6.2 Provisional check-list of Central Australian fishes

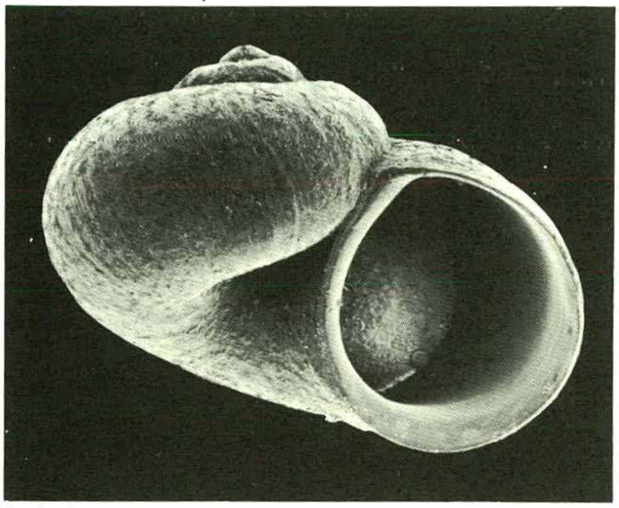
| | | | Lake Eyre Division Drainage Basins | | | | | | | | Habitats | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Family | Species | Common Name | Georgina River | Diamantina River | Cooper Creek | Lake Frome | Finke River | Todd River | Hay River | Lake Eyre | River Systems | Artesian Springs | Artesian Bores | Dams & Reservoirs | Salinity tolerance (parts per thousand) | Upper temperature tolerance (°C) | Lower temperature tolerance (°C) | Lower Dissolved oxygen tolerance (mg/L) |
| Clupeidae | Nematalosa erebi | Bony bream | x | x | x | x | x | | | x | x | | x | x | | 30 | 14 | |
| Retropinnidae | Retropinna semoni | Australian smelt | | | x | x | x | | | x | x | | | | | | 14 | 5.3 |
| Plotosidae | Neosilurus hyrtlii | Hyrtyl's catfish | | x | x | | x | | | | x | | | | | | | |
| | Neosilurus argenteus | Central Australian catfish | x | x | x | | x | | | | x | | | | | 27 | | |
| | Neosilurus sp. nov. | Dalhousie catfish | | | | | x | | | | | x | | | | 44 | 17 | |
| | Neosilurus spp. | Catfish | x | x | x | x | x | | | | x | x | x | x | | | 14 | |
| Poeciliidae | Gambusia affinis | Mosquito fish | | x | x | x | | | | | x | x | x | x | 25 | 40 | 3 | 0.5 |
| | Gambusia dominicensis | Domingo mosquito fish | | | | | x | | | | x | | | | | | | |
| Melanotaeniidae | Melanotaenia tatei | MacDonnell Ranges rainbow fish | x | x | x | x | x | x | | | x | | x | x | | 26 | 12 | |
| Atherinidae | Craterocephalus stercusmuscarum | Mitchellian freshwater hardyhead | | | | x | x | | | | x. | x | x | | | | | |
| | Craterocephalus eyresii | Lake Eyre hardyhead | | | x | x | x | | | x | x | x | x | x | 52 | 37 | | 6.0 |
| | Craterocephalus dalhousiensis | Dalhousie hardyhead | | | | | x | | | | | x | | | 10 | | 15 | 0.5 |
| | Craterocephalus sp. | Hardyhead | | | | | x | | | | x | | | | | | | |
| Centropomidae | Ambassis castelnaui | Western chanda perch | x | | x | | x | | | | x | | | | | 33 | 11 | |
| | Denariusa bandata | Penny fish | x | | | | | | | | x | | | | | | | |
| Serranidae | Plectroplites ambiguus | Yellowbelly | x | x | x | x | | | | x | x | | | | | 37 | 4 | |
| Teraponidae | Terapon unicolor | Spangled perch | x | | x | x | x | x | x | x | x | x | x | x | 5 | 44 | 5 | 1.0 |
| | Amniataba percoides | Black-striped grunter | x | | | | x | | | | x | | | | | 21 | | |
| | Hephaestus welchi | Welch's perch | x | x | x | x | x | | | | x | | | x | 10 | 34 | | 5.4 |
| | Scortum hillii | Perch | | | x | | | | | | z | | | | | | | |
| | Scortum barcoo | Barcoo perch | x | | x | | | | | | x | | | | | | | |
| Gobiidae | Glossogobius giurus | Flathead goby | x | | | | | | | | x | | | | | | | |
| | Mogurnda mogurnda | Purple-spotted gudgeon | | | | x | x | | | | x | x | | | 10 | 31 | 5 | 1.2 |
| | Chlamydogobius eremius | Desert goby | | x | | x | x | | | | x | x | x | x | 37 | 41 | 5 | 0.8 |
| | Hypseleotris spp. nov. | Carp-gudgeon | | | x | x | | | | | x | | | | 10 | | 14.5 | 4.0 |

Source: Glover and Sim (1978) as modified by Glover (1979).

collections have been made by Mr W. Zeidler of the South Australian Museum and Dr Ponder. Laboratory studies at the Australian Museum have now identified two previously undescribed and endemic genera and at least eleven species of snails in the mound springs between Oodnadatta and Marree. Microphotographs of hydrobiid species morphology are shown in Figure 6.2.

**Museum studies to date:** Twenty one mound springs have been sampled (Figure 6.3). There is at least one species endemic to the eastern-most springs (including Davenport

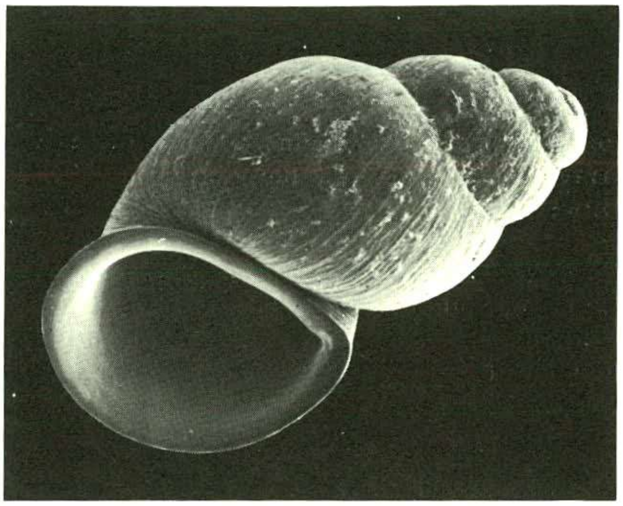
**Genus 2**
Note diversity of shell characteristics between species



**Species 8**
Blanche Cup Spring

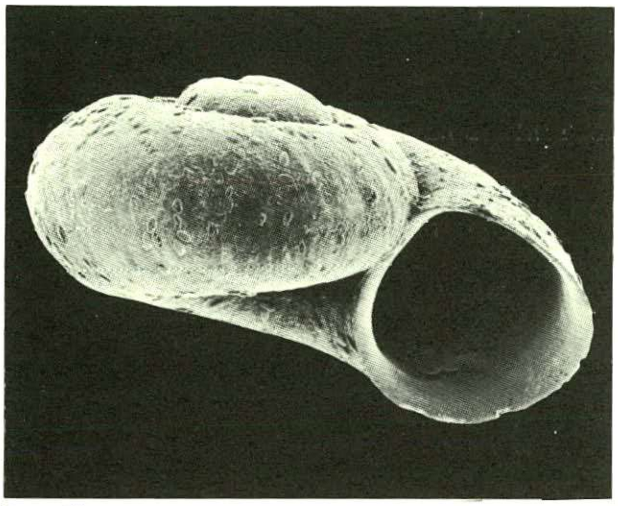
0 0.4 mm

**Genus 1**



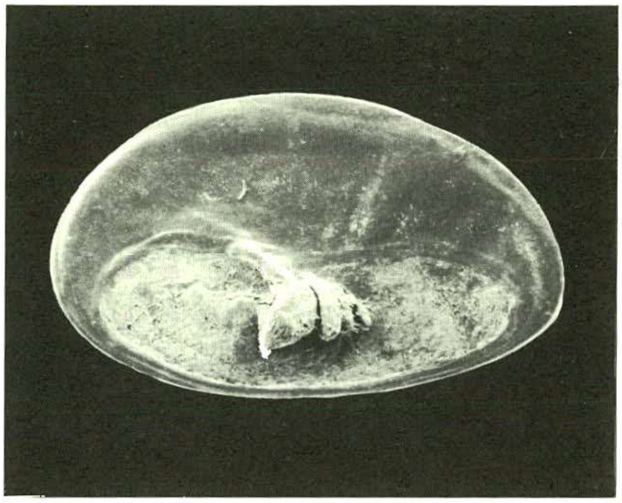
**Species 5**
Old Billa Kalina Spring

0 0.4 mm



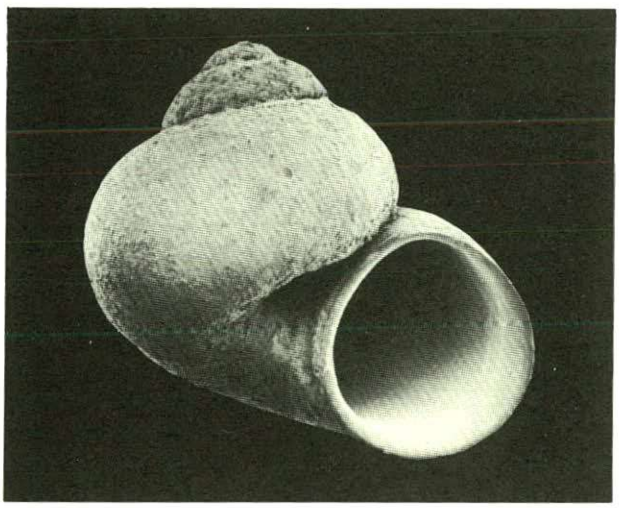
**Species 10**
Freeling Spring

0 0.2 mm



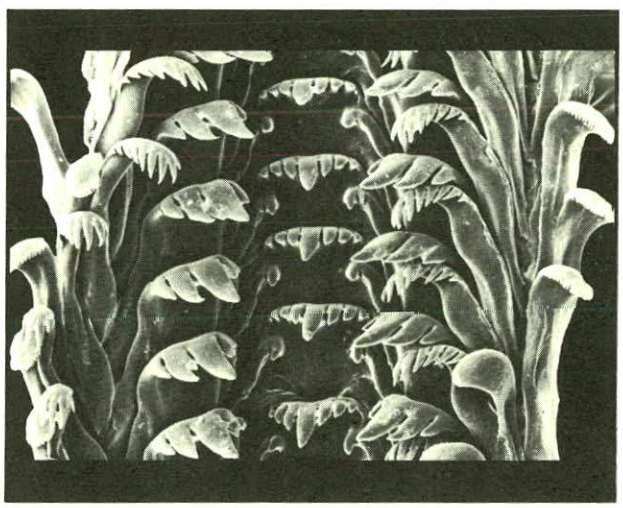
Operculum of **Species 3**
Bubbler Spring

0 0.2 mm



**Species 11**
Freeling Spring

0 0.4 mm



Radula of **Species 3A**
Freeling Spring

0 0.02 mm

**Photographs Courtesy of Dr W F Ponder, The Australian Museum**

Figure 6.2
**MICROPHOTOGRAPHS OF HYDROBIID SPECIES MORPHOLOGY**

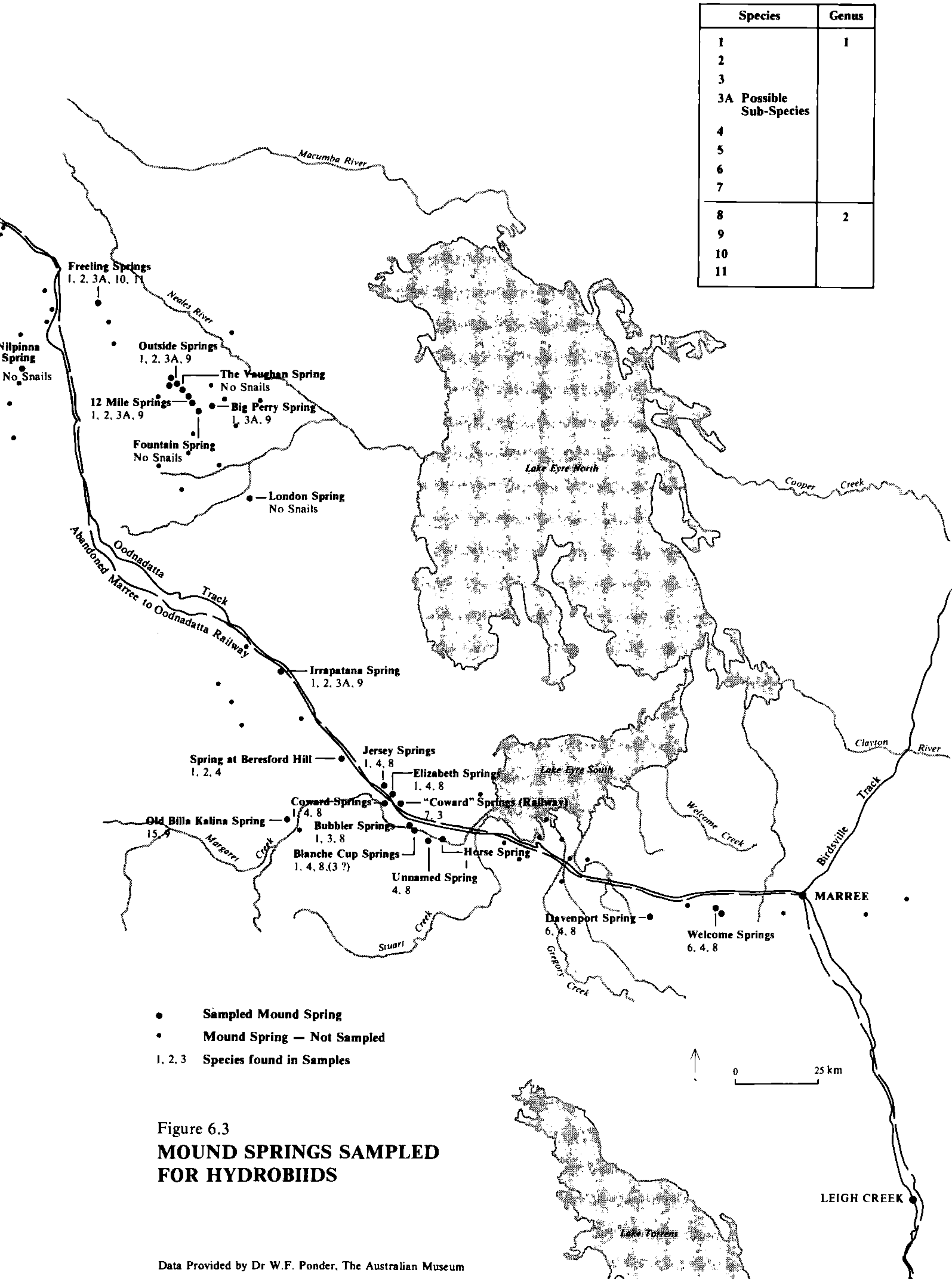



Figure 6.3

**MOUND SPRINGS SAMPLED FOR HYDROBIIDS**

Data Provided by Dr W.F. Ponder, The Australian Museum and Welcome Springs). At least two springs (the spring at the old Coward Springs railway station and at the old Billa Kalina homestead) contain species which appear to be endemic to those springs alone. The groups of springs around Hermit Hill have not been sampled. Therefore it is not known what species are present and whether they are represented in springs elsewhere. Sampling work undertaken outside the Marree-Oodnadatta area, such as the Flinders Ranges and the Lake Frome/Lake Callabonna area, indicates that the species found at the mound springs are restricted to that area. An undescribed fauna occurs in the Dalhousie Springs (near Oodnadatta) which is related but represents a minor radiation of a different genus.

The survey work to date has demonstrated the following general points:

- Some species are highly localized and may exist only in a single spring.

- The fauna of the western springs (Freeling Springs to Fountain Spring) is different from that in the middle group (Jersey Spring to Horse Spring) and the southern group (including Davenport and Welcome Springs) is also distinct.

- Each species occupies a specific habitat within the spring (up to 5 species of snail can exist in a single spring) and most cannot tolerate standing water.

- None of the mound spring snail species have been observed to exist in water or swamps associated with bore outflows although they do exist in some springs with bores sunk into them.

- Moderate cattle damage in many of the springs has reduced but not eliminated the snail and crustacean fauna. Heavy stock damage has apparently eliminated the fauna in some springs.

**Habitat requirements:** The profile of Blanche Cup Spring demonstrates the marked microhabitat specialization of each species (Figure 6.4). Species 8 prefers the still-water reedy habitat around the edges of the pool at the top of the mound whereas the other two species are hardly represented in this habitat. Species 4 tends to prefer hard substrate and flowing water whereas species 1 is semi-amphibious and seems to prefer a sandy substrate.

The distribution of size classes also varies. Species 8 is represented almost entirely by adults, whereas in site B (Figure 6.4) mainly juveniles are present. Similarly, the number of juveniles present in site C and D is much higher for Species 1 than in site E (Figure 6.4). These data suggest that there may be some migration up and down the flow by the snails at different stages in their life history or, alternatively, that the hydrodynamic or other physical properties are selecting particular size groups of each species. An alternative possibility is that breeding times vary at different levels in the flow.

Thus each spring represents a mosaic of habitats, each level providing a series of microhabitats which the fauna may be utilizing in different ways. Although additional ecological and biological data is required to determine the detailed habitat requirements and life cycle of each species the indications are that the biology and ecology of these snails is complex and requires further study to determine how significant environmental changes, such as the alteration of flow rates, will effect them.

Flow reductions which have taken place in other springs have resulted in loss of fauna. Ponder (public submission on Draft EIS) cites the case of Horse Spring where three species were collected in 1970, but with reduced flows only one species was found alive in 1981.

**Scientific significance:** The hydrobiids associated with the mound springs also have scientific significance. Each spring is equivalent to an 'oasis in a desert' with endemic species representing different adaptations to different habitats. The mound springs as a group therefore represent an exceptional natural laboratory of endemic radiation to study speciation events and genetics in a relatively simple environmental setting.

**Ostracods**

Further to the paper by Mitchell in the unpublished report on the mound springs by the Nature Conservation Society, De Deckker (1979, 1983 pers. comm.) has provided information on the ostracod fauna of the mound springs. De Deckker (1979) describes Ngarawa dirga which is not only a new species but also belongs to a new genus for which the new subfamily Ngarawinae had to be established. This was noted as an 'undescribed genus' in the Nature Conservation Society report.

The species was collected from mound springs and spring seeps in the Strangways-Curdimurka area south-west of Lake Eyre South. Two other cyprididid ostracods were also recorded from temporary pools in the same area: Reticypris walbu n.sp. and Heterocypris tatei (Brady, 1886).

Ngarawa dirga is a benthic ostracod found in most springs in the Strangways-Curdimurka area. Specimens have been collected from the following springs and seeps:

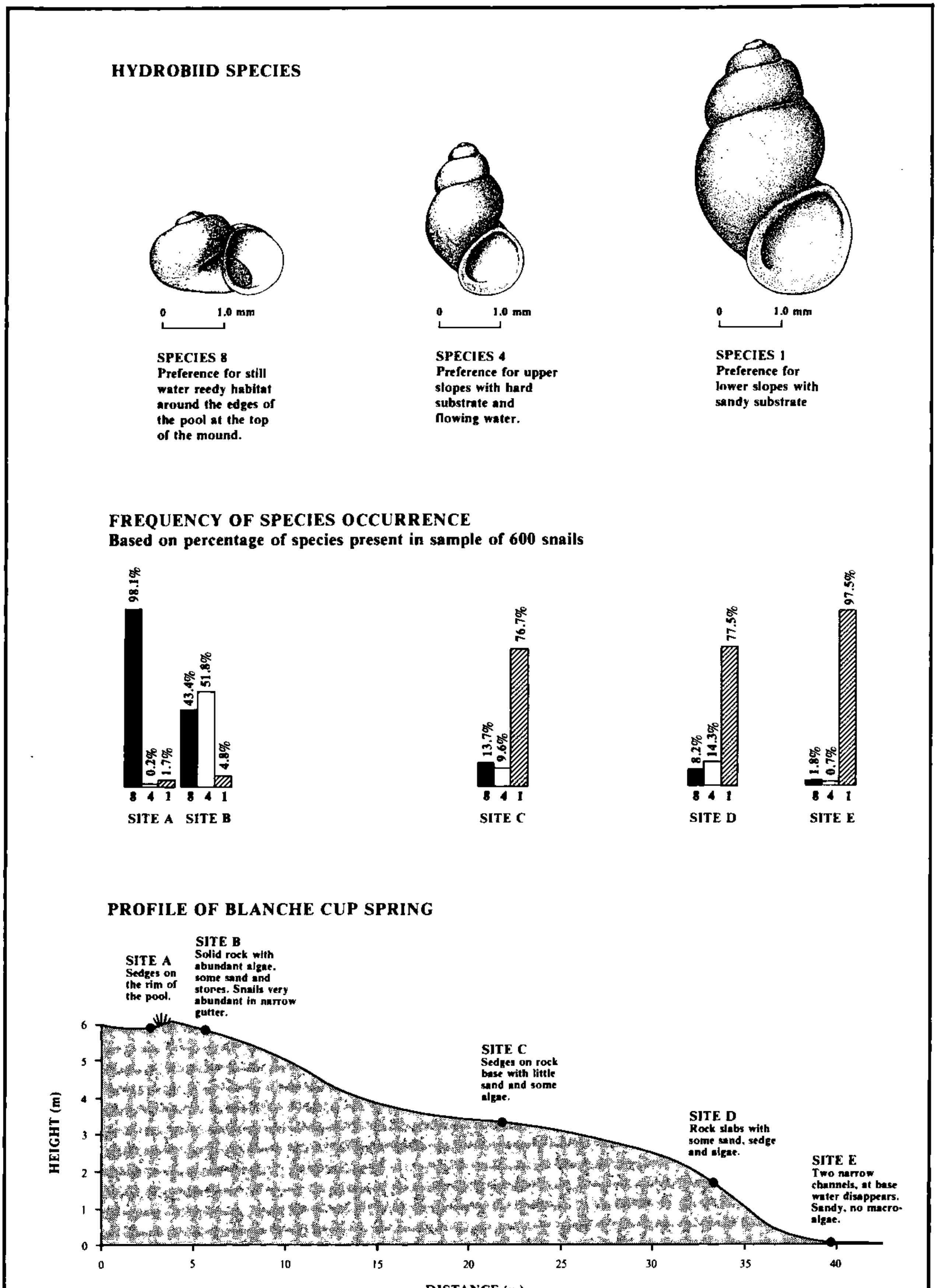
- Hamilton Hill Homestead Spring
- Blanche Cup and an unnamed spring near Blanche Cup
- The Bubbler and the nearly Little Bubbler
- the swamp associated with the Coward Spring Railway Bore
- Coward Spring
- Warburton Spring
- Strangways Spring
- Horse Springs Seep
- Blanche Cup Seep.

De Deckker (1979, p. 160) reports that Mitchell observed that in seeps, N. dirga was crawling on a rocky bottom covered with algae and also within sandy sediment. N. dirga was not found swimming but has anatomical characteristics useful for crawling. De Deckker (pers. comm.) states that the ostracods which inhabit the seepage zones of the springs have developed particular ways of surviving unusual conditions. The sediment in places is only covered with a very thin film (a few millimetres) of water, temperatures are high due to direct solar radiation, and there are dangers of desiccation. The ostracods have lost all power to swim and have developed stronger limbs for crawling. Their shell is unusually thick and hirsute with the hair helping to trap water around the shell and also helping the shell to remain in a vertical position by offering lateral support. It is suspected that the thick shell might help to prevent dessication. These functional adaptations are of scientific interest.

There has been no sampling of ostracods in the Hermit Hill area. However, because dispersal of ostracods is believed to occur during major flooding, similar ostracod species are anticipated in this area.

## 6.2 ENVIRONMENTAL CONSIDERATIONS

In relation to the species known to be present in the mound springs, the following environmental considerations are relevant to the effects of drawdown associated with




Source: Data provided by Dr W F Ponder and Mr B W Jenkins, The Australian Museum

Figure 6.4

**HYDROBIID HABITATS AT BLANCHE CUP SPRING**

borefield development. For the fish present in the indicated area of drawdown, the main potential impact is the loss of habitat. The area of the drawdown cone represents a very small percentage of available habitat and thus would not be of great significance. Ostracods also appear to be capable of dispersal by floodwaters (DeDeckker pers. comm.) However the efficiency of dispersal does not appear to be as high as for fish. For the hydrobiids, there is a greater potential for impacts of environmental significance. Unlike fish, there appears to be no dispersal mechanism which enables a widespread species distribution, thus it is possible that localized habitat loss may result in the loss of species not represented elsewhere. However, whether this is the case or not is not known. A study programme to investigate this is set out in Section 6.3 below.

## 6.3 MOUND SPRING STUDY PROGRAMME

As stated in the Draft EIS (p. 10.67) the Joint Venturers will undertake a range of environmental studies related to the mound springs including vegetation, limnology, fauna and avifauna. Furthermore, the Joint Venturers recognize the need for additional geological and hydrogeological studies (Draft EIS, Section 10.3.4). The objectives of the studies are to gather baseline data, assess the impact of the borefield development, provide a basis for future monitoring, and recommend any necessary mitigation measures or modifications to the proposed borefield development.

The basic elements of the study programme parts of which have already commenced are as follows:

- a topographical survey of the Hermit Hill area to provide an accurate mapping base and to determine levels of springs and seeps;
- surface geological mapping to define the geological formations and to improve the understanding of hydrogeology in the borefield areas and Hermit Hill;
- seismic traverses to delineate bedrock profiles and faults along selected alignments particularly in the vicinity of Borefield A and Hermit Hill;
- the establishment of monitoring positions by equipping existing bores to permit the regular recording of water pressures, temperature and quality both for the measurement of natural variations as well as the monitoring of drawdown from pump tests or Project usage;
- the drilling of two bores near Hermit Hill to ascertain the geology of the area in which the springs are located and the aquifer characteristics, as well as to permit ongoing monitoring of changes in head or water quality;
- a botanical survey which is designed to locate unusual and endemic plant species occurring in the Hermit Hill area and their replication in the region;
- aquatic invertebrate fauna surveys to sample the Hermit Hill area, determine species present and their habitat associations, as well as identification of the regional replication of Hermit Hill habitat types and sampling of the species they support;
- fish sampling and recording in the Hermit Hill area to compare with existing regional data of likely species present and their habitat associations;
- avifauna surveys to determine species present, their regional distribution and to provide a benchmark for further monitoring work;

- mound spring surface hydrology investigations to record the nature and volume of flows from the mounds, particularly as they relate to habitat characteristics of invertebrate fauna;
- sampling of mound springs for water chemistry including temperature, salinity and dissolved oxygen.

## 6.4 CONSULTATIVE COMMITTEE

Discussions are taking place with the Department of Environment and Planning in order to establish a consultative committee relating to the study programme and ecological management of the mound springs. This committee has yet to be formalized but is likely to include other government departments such as Mines and Energy, and Engineering and Water Supply who also have responsibilities in this area.

## 6.5 OTHER ISSUES RELATED TO WATER SUPPLY

In relation to the proposed water supply system there were comments relating to the ability of the Great Artesian Basin (GAB) to supply the long term Project requirement as well as suggestions for alternative sources of water for either part or all of the water requirements. Five specific alternatives have been put forward in public submissions and Government comments:

- desalinate sea water from Spencer Gulf
- use River Murray water for potable supply
- use supplies from elsewhere in the GAB
- use existing bores in the GAB
- use the Arcoona Quartzite aquifer to supply mine water.

In addition, the control of withdrawal of water from the GAB and the arrangement of services in the pipeline corridor have been raised. These matters are addressed below.

**Ability of GAB to Supply Project Long Term Requirement**

The Draft EIS (Section 10.3.3) dealt with the ability of the GAB to supply water. The areal extent of the basin in South Australia is about 310,000 km$^2$ and is estimated to contain in storage about 12,000,000,000 ML of water (Shepherd, 1978). This capacity represents approximately 450 times the total capacity of existing dams and water storages in the Murray/Darling system. The total Project requirement for 30 years at 33 ML/day represents about 0.003% of the water stored.

**Use Sea Water from Spencer Gulf**

The Joint Venturers consider this alternative impractical for the following reasons:

- The salinities of Gulf water are generally very high (in excess of 40,000 mg/L). Thus the total Project supply would require desalination because the metallurgical process requires water of less than 3,000 mg/L. This would impose unacceptable additional capital and operating costs on the Project.

- As noted in Section 2.8.3 of the Draft EIS the very low recoveries from highly saline waters when treated in desalination plants render such treatment economically impractical.

- It would require the construction of a large diameter pipeline (to carry 33 ML/d) from Port Augusta to Olympic Dam, a distance of some 270 km - approximately 110 km further than the presently planned Borefield B.

**Use River Murray Water for Potable Supply**

This alternative is discussed in Section 2.8.3 of the Draft EIS. The following are the reasons that render it unacceptable:

- The River Murray is a water source that is already heavily committed and the Joint Venturers consider that placing an additional burden on its capacity to supply water would be undesirable.

- During periods of drought there would be a risk of supply restrictions.

- It would require the construction of a potable water pipeline from Port Augusta to Olympic Dam but because of the need for process water supplies the construction of a pipeline to the GAB would still be required.

- The overall water supply costs would increase considerably.

The Joint Venturers consider that for economic and environmental reasons supply from the River Murray does not represent a realistic alternative.

**Use Supplies from Elsewhere in the GAB**

The Joint Venturers recognize that concern exists in respect of the effect of the water supply borefields on the mound springs. They have therefore in consultation with relevant specialists prepared a programme that will enable a more detailed assessment of these effects. It is recognized that the present level of knowledge of both hydrogeological and ecological aspects of the springs and the southern portion of the GAB is limited. This is noted in Sections 10.3.4 and 10.3.6 of the Draft EIS. Section 6.3 of this Supplement deals in more detail with the proposed approach to obtain such knowledge. Final decisions as to the safe and sustainable yield from the proposed borefields on both hydrogeologic and environmental grounds can be better assessed at the conclusion of the programme. Final planning decisions as to the siting of the borefields can be made at that time.

In any event the Indenture Agreement provides that the Minister of Water Resources must be satisfied as to a range of criteria before a Special Water Licence can be granted and in addition the Joint Venturers must design and install a monitoring programme which is also subject to that Minister's approval.

**Use of Existing Bores as the Water Supply Source**

The use of existing bores in the Great Artesian Basin within a practical distance for a Project water supply is not considered a viable option.

The reasons are as follows:

- Many of the individual bores are stock bores and flow only small quantities of water. Thus any supply to the Project would require the use of a very large number of these bores and a very extensive collection system.

- The large geographical area over which the bores are sited renders the development of such a collection system uneconomic and the Joint Venturers consider the development of a relatively closely spaced well-field can more efficiently provide the Project supply.

The SA Department of Mines and Energy have an on-going programme of bore rehabilitation aimed at minimising the wastage from existing bores.

**Use Arcoona Water Instead of GAB Water Underground**

The local groundwater from the Arcoona Quartzite aquifer at Olympic Dam is highly saline, generally in the order of 30,000 mg/L total dissolved solids. This renders it corrosive to machinery and therefore unsuitable for other than limited uses underground.

**Control of Withdrawal from the GAB**

The control of withdrawal of water by the Joint Venturers from the Great Artesian Basin rests with the State Government. Under Clause 13 of the Indenture Agreement the State will grant a Special Water Licence to the Joint Venturers which sets out certain terms and conditions. In the event of a breach of those conditions by the Joint Venturers or if the continued abstraction of water by the Joint Venturers is believed by the Minister to be detrimental to the resource then the licence may be revoked or the ability of the Joint Venturers to draw water restricted.

**Arrangement of Services Within the Northern Corridor**

Figures 10.5 in the Draft EIS showed a typical cross-section of the pipeline corridor with the access road in the centre with the transmission line and pipelines on either side of the road. The SA Highways Department (SAHD) submitted that it would be desirable to site both the pipelines and transmission lines on the same side of the road so as to facilitate the possible future up-grading of the road. The Joint Venturers have accepted this viewpoint and have adopted the SAHD's recommendations. The width of the corridor (50 m), and its impacts and the mitigation measures proposed (Section 10.24 of the Draft EIS) will remain unchanged.

## 7 OTHER ISSUES

This chapter comprises responses to comments relating to a wide range of other issues. These have generally been grouped together according to chapter or section headings of the Draft EIS as follows:

- terrestrial environment
- soil salinity
- infrastructure corridors
- seismic risk
- social effects and town design
- aboriginal environment.

## 7.1 TERRESTRIAL ENVIRONMENT

In relation to Chapter 3 of the Draft EIS comments with respect to the following matters were raised:

- Terrain
  - the methodology used in the assessment of terrain
  - progress on the location of dolines by geophysical methods
  - the environmental effects associated with soil compaction due to vehicle traffic;
- Surface Hydrology
  - a commitment for detailed hydrologic study of catchments
  - consideration of the indirect effects of flooding;
- Flora
  - the use of character species for vegetation mapping
  - revisions to conservation status of plants in light of a recent publication on rare and endangered species
  - the relevance of recent studies on the phytotoxic effects of sulphur dioxide
  - the level of detail provided on vegetation for the infrastructure corridor
  - the taxonomic status of *Acacia linophylla*;
- Fauna
  - the impacts on fauna due to the transmission line corridor
  - the suitability of pitfall trapping techniques
  - the relevance of ningauis to the Olympic Dam region.

**Terrain Assessment Methodology**

In summarizing the information from background papers associated with terrain analysis for the Draft EIS, the process of improved understanding gained from successive terrain studies was considered by Government officers to have been inadequately explained.

This meant that some of the information in early background papers, which were written without the benefit of subsequent work, was not consistent with the content of the Draft EIS. This particularly relates to the use of the terms 'terrain patterns', 'terrain units' and 'terrain features' and their relevance to baseline description, impact assessment and mitigation recommendations.

The initial terrain baseline survey described terrain patterns and terrain units. Terrain patterns are appropriate for describing large areas of land as they delineate recurring landscape types with a common geological base. The terrain unit information is more specific and describes individual physiographic features which have a characteristic natural slope or range of slopes and a distinctive soil or soil association; it is the basic element for impact assessment purposes. These two levels of terrain description are commonly used for terrain classification and evaluation (Renfrey 1975; Dowling and Beavan 1969).

During the subsequent impact assessment work, it became clear that the terrain units were too fine a category to conveniently employ in the impact assessment of such a large area with frequently recurring physiographic features. Furthermore, in many instances, adjacent terrain units were sufficiently similar in terms of potential for impact that they could be considered together. As much useful information for environmental assessment could be obtained by defining 'terrain features' which aggregated similar terrain units. Terrain features were therefore used in the Draft EIS rather than terrain units, for describing the potential for impacts and for environmental planning in the proposed town area. It was also apparent that mitigation measures could be grouped together at the terrain pattern level. Therefore this level was used for summary purposes in the Draft EIS.

Government also wished to have defined the areas which had been mapped at the various terrain levels. Figure 7.1 shows the coverage of terrain pattern, terrain feature and terrain unit mapping for the environmental study area. The entire study area was mapped at the pattern level, the proposed town site was mapped at the feature level, and the operations area was mapped at the unit level.

A second area considered inconsistent was the discussion of sand movement in the terrain impact assessment report and the dune history and sand movement report. In the initial terrain impact assessment report sand movement was identified as the most significant environmental concern from a terrain viewpoint. On the basis of this report, further work was undertaken to try and quantify sand movement potential. From the results of sand trap measurements it was possible in the dune history and sand movement report to refine the more general statements of the terrain impact assessment report.

**Dolines**

The presence of dolines in the Andamooka Limestone and their characteristic vegetation signature was discussed in Section 3.4.1 of the Draft EIS.

In areas where the Andamooka Limestone outcrops at or near the surface, these solution features form typical infilled cavities varying in diameter from 2 - 5 m. Within the Project area, surface features are only recorded in two locations in the northern portion.

Because of the possible engineering and hydrologic implications if concealed cavities occurred at shallow depths in proposed Project development area, a commitment was made in Section 7.4 of the Draft EIS to undertake preliminary studies to determine if selected geophysical methods were suitable for detecting and mapping concealed dolines at Olympic Dam. Studies commenced in October 1982 and were restricted to the testing of various resistivity arrays whose routine use in geotechnical studies in similar geological terrain world-wide is well documented (Cook and Van Nostrand, 1954; Brown et al., 1977; Dutta et al., 1970; Van Nostrand and Cook 1966).

The resistivity method is designed to electrically differentiate between infilled dolines whose resistivity contrasts with the resistivity of the surrounding rock. Control arrays were established over exposed and concealed voids in the north of the Project area prior to testing for concealed dolines in the proposed Project development areas, where loss of drilling fluids had been reported during exploration drilling. Preliminary analysis on the survey results suggest that detection of shallow dolines under the condition monitored is feasible although likely to be expensive and time consuming if large areas are to be covered. Other faster methods, such as Ground Penetrating Radar (GPR) are being considered.

**Effects of Compaction**

Tracks created by vehicles will be associated with minor surface compaction of the soil. This can be expected to reduce the soil sorptivity (i.e. the initial rate of water entering the dry soil surface when rain starts) compared to adjacent undisturbed soil surfaces.

Where sand is at the surface this is unlikely to change infiltration rates because infiltration capacities are significantly greater than rainfall intensities. With swale surfaces the proportion of rainfall infiltrating the soil is very small. Most rainfall is carried by overland flow to depressions. The change in infiltration rate will not significantly change this pattern.

Tracks will also change topography at a microscale. Those across the slope on clay soils will tend to capture small volumes of overland flow with narrow puddles of water forming until surface water infiltrates or evaporates. Tracks down the slope may form small scale channels and act as an initiation point for surface soil erosion. These effects are similar in nature but at a much smaller scale to those addressed in the Draft EIS (p. 3.18) as 'alteration of surface water flows'. Where appropriate, stabilization or drainage works would be implemented to control erosion or contain changes in surface water flows (Draft EIS p. 3.19).

**Hydrologic Study of Catchments**

The Draft EIS provided information on the conceptual approach to surface run-off considerations and drainage. As part of the town design phase of the Project, the Joint Venturers will undertake detailed engineering studies of catchments for drainage design purposes.

**Indirect Effects of Flooding**

Project development will lead to changes in surface hydrology (Draft EIS, Section 3.3.3). One possible indirect affect could be changes to the flooding regime in areas such as western myall groves. Studies in relation to myall grove soil moisture and salinity characteristics are currently in progress (see Section 7.2 below).

**Character Species Approach**

The reasoning used to arrive at the use of 'character species' has a long and soundly established basis. Leaving for the moment the actual term 'character species', the concept was first put forward by J.G. Wood (1939) and subsequently clarified in the scheme of Crocker & Wood (1947). The concept arose through the failure of a Clementsian framework to provide a reasonable basis for vegetation studies in South Australia in particular. Wood (1937) had attempted to describe the vegetation of South


Figure 7.1

**TERRAIN MAPPING IN ENVIRONMENTAL STUDY AREA**

Australia in a successional framework, but on completion and publication of the work decided that successional classification and its implications for the functioning of the ecosystems he was dealing with was, if not a total failure, then almost so. Wood was so dissatisfied with the results of application of Clementsian theories that he went so far as to prohibit reprinting of his Vegetation of South Australia (Wood, 1937).

Crocker & Wood (1947) proposed instead, a formal classification with a factual rather than a philosophical base, in which a community was used for any assemblage of plants living naturally together, without implying a specific degree of composition or environment. The word 'dominant' was used to describe species which give 'the characteristic look or facies to the community', not implying that the species were necessarily exerting ecological control over other species, and not carrying any successional connotations. The Crocker & Wood nomenclature has been widely used particularly in the region of current concern. The papers of Jessup (1951) referenced in the Draft EIS, for example, use the words 'association' and 'dominant species' as proposed by Crocker & Wood: they are not used in either a Clementsian sense or according to the tenets of the Zurich-Montpellier school.

The use of the words 'character species' in the Draft EIS correspond to the Crocker & Wood use of 'dominant species': the explanation given in the Draft EIS is an extended statement saying that the species which are being discussed are those which give 'the characteristic look or facies to the community'. Whether or not they are dominant in the sense of exerting major control on the plant community is not known - in some cases the species almost certainly are dominant, in other cases unlikely to be so, and the trees in particular may not be as ecologically significant as their appearance would suggest - and until there is clear experimental or observational evidence for all the species concerned, it is not intended to indicate that species are dominant in the same sense as would be used for a northern hemisphere Beech-Maple forest. However, the word 'dominant' is all too often interpreted in the sense of direct ecological control over the other species and seems to have maintained its Clementsian successional overtones in many quarters.

The term 'character species' was used to get completely away from the word 'dominant' because of the misconceptions the latter was likely to raise. This is also following convention: looking for a way around the diffuse terminology has been attempted in a number of studies. A clearly stated example is given by Coaldrake (1961)...

> 'The term 'dominant' and its connotations of importance in communities might well be dropped in ecological usage for describing the tallest or most important species. Too often, its use results in diverting attention from species which are highly significant to the environment, yet not so obvious to the eye. In the present work, the author has used the term 'obvious species' to indicate those plants which are prominent in the community over its geographical range ...'

'Character species' was used as the phrase most closely relating to Crocker & Wood's 'characteristic look or facies' without invoking the already loaded term 'dominant species'. In doing so, we have transgressed into the terminology of the Zurich-Montpellier phytogeographic school, in which a 'character species' is not necessarily an obvious plant, but rather an indicator of fidelity of stands. While this is unfortunate in some respects, the Zurich-Montpellier school is not well established within this country, particularly within arid areas. A phytogeographic scheme devised for use in temperate countries where the vegetation has been modified by human activities such as agriculture and animal husbandry for a very long period of time is singularly inappropriate for southern Australian arid lands.

**Conservation Status Revisions**

After the vegetation baseline survey was complete, a revised publication on rare and endangered species was released (Leigh et al., 1981). Using Leigh et al. only, all comment on rarity in Table 3.9 of the Draft EIS disappears - none of the species are listed.

Elsewhere, only two species are encountered in the lists of Leigh et al. Myoporum refractum is classified 2E (very restricted distribution, endangered) and Sclerolaena lanata is classified 3R (range over 100 km, not presently endangered but vulnerable). The former was associated with mound springs at Bopeechee near the northern infrastructure corridor, and the latter encountered along corridors.

**Sulphur Dioxide Effects**

More recent literature indicates that low chronic doses of air pollutants such as sulphur dioxide can cause physiological damage to plants. In recent experiments physiological responses to sulphur dioxide were observed at concentrations as low as 20 pphm (Unsworth and Black, n.d.). This is half the level quoted in the Draft EIS (p. 3.50) as the level below which impacts were not detectable but is still more than 20 times the average ground level concentrations predicted as a result of operations at Olympic Dam. Even though no adverse impacts are therefore anticipated, the flora monitoring programme will include plant examination for signs of air pollutant damage.

**Level of Detail for Infrastructure Corridors**

Basic vegetation information (species lists, vegetation descriptions, and detailed mapping) was gathered for the corridor from Olympic Dam to the general borefield area and a detailed evaluation of likely impacts made. This information could not all be included within the Draft EIS itself, without making the document unnecessarily bulky. The Draft EIS as published does not misinterpret the findings of the vegetation study: its summary presentation is accurate. The detailed information for the corridors is available in the background papers which constitute part of the Draft EIS.

**Status of Acacia linophylla**

The criticism raised in public comment as to the correct classification of A. linophylla appears to result from recent taxonomic disagreement. The present understanding is that A. linophylla has not been reduced to a synonym, but that it may eventually be so reduced. The point is taken that A. ramulosa has precedence.

The use of A. linophylla on Roxby Downs station has a long and somewhat involved history. The two species cannot be told apart in the field, although it is only recently that taxonomic doubt has arisen. Specimens from the Olympic Dam area, taken in 1972 and 1973, were checked against specimens in the State Herbarium, Adelaide, and ascribed to A. linophylla rather than A. ramulosa. A. linophylla was then used as the name in Fatchen (1975), in preference to referring to a species complex of A. linophylla-A. ramulosa e.g. see Jessup (1951). In the early stages of exploration specimens were identified by Herbarium Australiense (CSIRO) as A. linophylla (Graetz and Tongway 1980) although the verification may have been prompted by Fatchen's (1975) usage. The name was retained in subsequent reports primarily for reasons of continuity.

**Transmission Line Corridor Impacts on Fauna**

It has been requested that the Joint Venturers make comment on the potential impacts of the transmission line corridor on fauna. The development of the corridor will consist of an access track and widely spaced towers. The access track (as noted in Section 7.3 below) will be maintained to a standard suitable for 4 wheel drive vehicles only and this, together with the near proximity of the main Olympic Dam to Woomera access road is expected to result in infrequent use of the access track. For most of its length the corridor is in an area already affected by similar developments. Thus, apart from minor habitat loss, the impact is considered insignificant.

**Pitfall Trapping Techniques**

Criticism was raised that pitfall trapping was not the best method for trapping reptiles and should not be relied upon as the only technique. In response to this, it is contended that:

- pitfall trapping is well suited for the arid land sandhill-swale terrain at Olympic Dam;

- pitfall trapping is the optiminal method for collection of the more abundant smaller ground dwelling reptiles which constituted 75% of anticipated species present;

- as outlined in the background paper on herpetology, other sampling methods such as daytime foot search, vehicle-based and foot spotlighting were utilized to capture the larger reptiles that would not be induced into pitfall traps or could readily escape;

- further evidence for the suitablity of this sampling technique to the terrain and justification for the man hours expended on this method can be gleaned from the capture success figures which show that 75% of the larger reptile species anticipated to be present were recorded.

**Ningauis**

Ningauis are a newly discovered tiny member of the marsupial family Dasyuridae which includes most of Australian insectivorous and carnivorous marsupials (Aslin, 1976). During the last decade two species, N. timealeyi and N. ridei have been described (Archer, 1975). Both are recorded inhabiting arid localities with sandy soils, a dominant eucalypt woodland or scrub cover and a spinifex (Triodia) understory - a habitat not found in the Olympic Dam region. As most of the small Dasyurids appear to have specific habitat preferences it is unlikely that Ningauis will be found in the Olympic Dam area.

## 7.2 SOIL SALINITY

Soil salinization due to the addition of water for garden development in the town has been raised as a possible problem. The situation under natural conditions, the effects of irrigation, the options available for garden maintenance and the status of current studies into soil salinity are described below.

**Natural Conditions**

Under natural conditions, the salinity of the soil solution results from incoming precipitation containing small amounts of salts and the dissolution of soil minerals. With the low rainfall available for leaching of salts and high evaporation leading to water loss from the soil, the concentration of soluble salts can increase. In the Project Area, there are several terrain types with characteristic soil profiles. Soil analyses have shown that salt storage levels vary considerably even on a local scale for different terrain features, at different depths, and involving different salts. An indication of this variability is shown in Tables 7.1 and 7.2. In the sand dunes, sufficient percolation occurs even with low rainfall to leach salts from the sand and salinities are low - .01 to .02 mS/cm. At the transition to clay soils, increases in salinity to around 0.2 mS/cm occur and further increases occur with depth. In the interdunal areas, surface salinities are approximately .04 mS/cm which increase with depth to levels greater than 2 mS/cm. In drainage depressions (claypans, canegrass, swamps and local scalds), surface salinities are higher and increase more rapidly with depth. Chloride concentrations of the 1:5 soil:water suspension are also shown. The relation between total salt and chloride varies down the profile and it is anticipated that where high soluble salt content occurs in the absence of high chlorides then this is due to the presence of calcium sulphate.

**Table 7.1 Soil Salinity Results in Project Area**

| Terrain location | Depth (mm) | Soil description | EC * (1:5 soil:water suspension) mS/cm | Chloride ppm |
|---|---|---|---|---|
| Sand dune at crest | 0 - 15 | Red sand | .011 | 0.3 |
| | 15 - 50 | Red sand | .014 | 2.1 |
| | 50 - 200 | Red sand | .007 | 2.0 |
| | 200 - 250 | Red loamy sand | .012 | 3.0 |
| | 250 - 540 | Red clayey sand | .250 | 1.0 |
| Interdune corridor | 0 - 400 (variable) | Red sand | .041 | 1.2 |
| | 0 - 50 | Sandy loam | .058 | 4.1 |
| | 50 - 150 | Sandy loam | .168 | 66 |
| | 150 - 400 | Sandy clay loam (calcareous) | .580 | 560 |
| | 400 - 1600 | Sandy clay loam | .426 | 170 |
| | 1750 - | White clayey mudstone (gypseous and calcareous) | 2.8 | 2921 |
| Scald in swale | 0 - 3 | Sandy clay crust ) | .098 | 61 |
| | 3 - 15 | Sandy clay loam ) | | |
| | 15 - 65 | Fine sandy loam | 2.77 | 4121 |
| | 65 - | Loam (calcareous) | - | - |
| Claypan | 0 - 30 | Reddish-yellow light clay (calcareous) | .920 | 712 |
| | 30 - 250 | Clay (calcareous) | - | - |
| | 250 - 1000 | Sandy clay loam (calcareous) | - | - |
| | 1000 - | White mudstone (gypseous) | 4.28 | 4355 |

* Electrical conductivity for 1:5 soil water extract using method described by Piper (1944).
Source: Graetz and Tongway (1980)

Note that these electrical conductivities are for 1:5 soil:water suspension and indicate relative differences in salinity and not actual salinities. For plant growth considerations, the electrical conductivity of the saturation extract is more relevant, and where this information is available it is included in Table 7.2. Some examples of relative plant tolerances to salinity are given in Table 7.3.

Table 7.2 Soil Salinity Results in Town Site

| Terrain location | Depth (mm) | Soil description | EC * (saturation extract test) mS/cm | EC ** (1:5 soil:water suspension) mS/cm | Chloride ppm |
|---|---|---|---|---|---|
| Dune flank (with Acacia spp.) | 0 - 2000 | Sand | 0.57 | .02 | 80 |
| | 2000 - 2800 | Sand | - | .02 | 110 |
| Sand sheet (with Callitris) | 0 - 200 | Sand | - | .05 | 80 |
| | 200 - 800 | Sand | - | .02 | 150 |
| | 800 - 1400 | Medium coarse sand | 0.54 | .02 | 80 |
| | 1400 - 2000 | Clayey sand | - | .05 | 40 |
| | 2000 - 2400 | Clayey sand (moderately calcareous) | - | .26 | 60 |
| | 2400 - 3000 | Sandy clay | 3.0 | .40 | 200 |
| Interdunal Depression (myall grove) | 0 - 100 | Loamy sand | 2.06 | 0.34 | 250 |
| | 100 - 300 | Clay | - | 2.08 | 3200 |
| | 300 - 900 | Sandy clay (with calcareous material) | 14.6 | 1.05 | 1500 |
| | 900 - 1100 | Sandy clay (with calcareous material) | - | 2.20 | 1050 |
| | 1100 - 1700 | Sandy clay | 11.1 | 3.03 | 800 |
| | 1700 - 1900 | Sandy clay | - | 2.33 | 500 |
| Drainage depression (canegrass swamp) | 0 - 100 | Sandy clay loam (minor calcareous material) | 4.2 | 0.35 | 260 |
| | 100 - 300 | Medium clay (moderately calcareous) | | 0.72 | 900 |
| | 300 - 500 | Clay (moderately calcareous) | 10.8 | 1.27 | 1750 |
| | 500 - 700 | Clay (highly calcareous) | | 1.83 | 3400 |
| | 700 - 900 | Clay (highly calcareous) | - | 2.23 | 3100 |
| | 900 - 1100 | Sandy clay (weakly calcareous) | - | 2.88 | 3500 |
| | 1100 - 2500 | Sandy clay | 27.9 | 4.14 | 7200 |
| | 2500 - 3500 | Clayey sand | 35.4 | 6.0 | 7500 |

* Electrical conductivity of extract of soil at saturation according to USDA (1954).
** Electrical conductivity for 1:5 soil water extract using method described by Piper (1944).
Source: Department of Agriculture (in press)

## Effects of Irrigation

The salinity of the soil water that results from the use of an irrigation water is related to the salinity and ionic composition of the water used, and to the amount of leaching achieved. The long-term salinity effect of irrigation on different soils will depend on the properties of the soil, the water composition and the management techniques employed.

The concentration of soluble salts in soils increases over that in the applied irrigation water due to water loss by evaporation and transpiration. Without leaching, the salt constituents will accumulate in the soil. This is true for the chlorides and sulphates of sodium, potassium and magnesium. However, the relatively low solubilities of calcium and magnesium carbonates and calcium sulphates, limit their accumulation in soil waters to concentrations below those harmful to plant growth. With leaching, the accumulation of salt in soil water is reduced.

**Table 7.3 Relative salt tolerances of plants**

| Salinity | Grasses | Fruit | Vegetables | Ornamentals |
|---|---|---|---|---|
| Water Classes 1 and 2<br>0 - 0.8 mS/cm<br>(0 - 500 mg/L) | Red clover<br>Subterranean clover | Persimmon<br>Passionfruit<br>Apricot<br>Orange<br>Walnut | Green beans<br>Squash<br>Carrot<br>Potatoes<br>Lettuce | Violet<br>Gardenia<br>Azalea<br>Dahlia |
| Water Class 3<br>0.8 - 2.3 mS/cm<br>(500 - 1500 mg/L) | Cocksfoot<br>Perennial ryegrass | Apple<br>Pear<br>Raspberry<br>Quince | Cauliflower<br>Bell pepper<br>Tomato<br>Artichoke | Geranium<br>Gladiolus<br>Rose<br>Poinsettia |
| Water Class 4<br>2.3 - 5.5 mS/cm<br>(1500 - 3500 mg/L) | Lucerne<br>Wimmera ryegrass<br>Couch grass | Oilive<br>Fig<br>Cantaloup | Spinach<br>Asparagus<br>Gherkins | Oleander*<br>Bougainvillea*<br>Australian Hop bush*<br>(Dodonea angustissima)<br>Acacia longifolia*<br>Myoporum acuminatum* |
| Water Class 5<br>above 5.5 mS/cm<br>(above 3500 mg/L) | Saltwater couch | Date palm | | Salt sheoaks*<br>(Casuarina spp.)<br>Saltbushes* |

* Plants currently in use for Olympic Dam amenity planting and rehabilitation work.
Source: Hart (1974)

The potential for salt build-up can be estimated from moisture balance and salt balance considerations. The moisture balance of the root zone for an area under irrigation can be represented as follows (FAO/UNESCO, 1973):

$$\underset{\text{(irrigation)}}{I} + \underset{\text{(rainfall)}}{R} = \underset{\text{(evapotranspiration)}}{E} + \underset{\text{(percolation)}}{P} + \underset{\text{(change in soil moisture)}}{dV} \tag{1}$$

where

I = field irrigation supply less surface losses
R = rainfall less interception and surface run-off
E = evaportranspiration from soil and plants
P = deep percolation, drainage or capillary water supply
dV = change in soil moisture in the root zone.

The salt balance associated with irrigation is then (assuming salt from precipitation can be ignored) (FAO/UNESCO, 1973):

$$\underset{\text{(salt into root zone)}}{I\ Ci} = \underset{\text{(salt out of root zone)}}{P\ Cp} + \underset{\text{(change in salt in root zone)}}{dS}$$

where
Ci = salt concentration in irrigation water
Cp = salt concentration in percolation water
dS = variation of quantity of dissolved salts in the root zone.

Two salt balances are provided below for two extreme situations. The first is for the case where only natural percolation to deep groundwater is relied upon to leach salt from the soil. The second examines the case where irrigation of high water use plantings is undertaken and a leaching component is incorporated.

**Case 1: Natural Percolation**

The case examined is the volume of irrigation (I) which can be applied in the long term and which does not increase soil salinity (Cp) above 2,500 mg/l (3.9 mS/cm). The salinity of the irrigation water is in the range 300 - 500 mg/L and an approximate estimate of deep percolation under natural conditions is .006 m/year (Draft EIS p. 6.14). It should be noted that this estimate of percolation is to groundwater at a depth of about 50 m and thus may underestimate percolation from the root zone. In addition, much higher percolation rates will also occur locally where sand extends beneath the root zone. It should be noted that much of the proposed town site is covered by a sand sheet and higher percolation rates will apply.

In the long term, an equilibrium between incoming and outgoing salt is achieved, therefore:

$$I.Ci = P.Cp$$

$$I = \frac{.006 \times 2{,}500}{400}$$

$$= .04 \text{ m/year.}$$

Therefore, only small quantities of water can be applied if reliance is placed on natural percolation to groundwater at depth in order to limit salt accumulation.

**Case 2: Irrigation and Planned Leaching**

The case analyzed here is for the maintenance of a plants which would require intensive irrigation to provide sufficient moisture for plant growth. For this to occur, not only is water required to meet plant needs, but also additional water is required to leach out accumulated salts. For salinity control, it is the salt content of the soil moisture (Cs) in the unsaturated root zone which is important. One approximation is to assume it is the same as the salt concentration in the percolation water (Cp). However, especially in heavy soils, a significant part of the percolation water from irrigation passes through cracks, fissures and relatively large pores without any leaching effect. If the share of the effective water passage to the total percolation is 'k', the leaching coefficient, and the ineffective part is '1-k' the following relationship is valid:

$$Cp = k.Cs + (1-k)\ Ci.$$

Then the yearly quantities at salt balance equilibrium become:

$$I.Ci = P\ (k.Cs + (1-k)\ Ci).$$

The irrigation requirement for high water use plantings is about 0.8 times the yearly evaporation (3 m) less the annual rainfall (0.2 m) and thereby equals 2.2 m. The leaching coefficient (k) is approximately 0.3 for clay soils.

The drainage requirement (P) which is in addition to the irrigation requirement therefore equals:

$$\frac{I.Ci}{k(Cs + (1-k)\ Ci} = \frac{2.2 \times 400}{0.3 \times 2{,}500 + 0.7 \times 400}$$

$$= .85 \text{ m/year.}$$

**Options for Garden Maintenance**

The two cases given above illustrate two options for garden maintenance. First is the 'native garden' option where salt-tolerant plants requiring little moisture form the basis for the garden. Examples of this option can be found at Leigh Creek. In order to minimize irrigation water quantities, drip irrigation is used with individual drippers supplying individual plants. A mulch is provided (in the case of Leigh Creek, stones are used) on the surface to reduce evaporation losses from the soil.

A second option is the 'irrigation and planned leaching' option. If intensive garden development is desired then a system of underdrainage is required beneath the root zone of the plants. This could be achieved by providing drains in the existing soil or by introducing fill over a system of drains. Sufficient water needs to be provided to meet both plant requirements and salt leaching requirements. Saline drainage then needs to be collected and disposed of in a manner which does not involve detention in depressions containing significant native vegetation (refer Draft EIS p. 11.33 and 11.34).

These two options represent two extremes. A wide variety of combinations and intermediate options are available so that individual garden preferences are attainable. Experience from other arid town developments indicates that gardens can be developed with higher salinity irrigation water than is proposed at Olympic Dam. Furthermore, with the gradual nature of salt build-up, monitoring of soil salinity will provide indications of possible problems so that ameliorative action can be implemented.

**Status of Current Studies**

The following studies in relation to plant growth and soil conditions are in progress at Olympic Dam.

- Monitoring of seasonal growth characteristics for selected species in drip irrigated and non-irrigated areas of the temporary housing area and single mens quarters: Measurements of tree height and base circumference have been made at six monthly intervals for fifteen area species since early 1982. Comparisons are being made between results for irrigated and non-irrigated areas. In addition, the overall growth characteristics of tube stock is being compared with more advanced pot size plantings. Soil samples are being taken in the irrigated areas at varying depths but analyses of these have yet to be completed.

- Monitoring of soil chemistry at varying depths in areas under drip irrigation: Soil samples are being taken at six monthly intervals and parameters such as nutrient levels, soil salinity and selected ion concentrations are being measured. Measurements are also being made of irrigation water quantity and quality.

- Monitoring of a western myall grove catchment in the town site: To date soil samples have been collected from both longitudinal and traverse cross-sections of the catchment. The catchment topography has been surveyed. It is also intended to instrument the catchment to measure changes in soil moisture and salinity.

- A soil scientist from the Department of Agriculture has been engaged to examine and report on possible salinity considerations within the town site area. Soil sampling and analysis has been completed for a range of terrain types and a report upon this work is in progress.

## 7.3 INFRASTRUCTURE CORRIDORS

The following comments were raised with respect to the infrastructure corridors associated with the Olympic Dam Project:

- the advisability of having only one infrastructure corridor from Woomera to Olympic Dam instead of the two as proposed;
- the need for the 275 kV transmission line corridor to cross Lake Windabout;
- the location of the transmission line corridor through Port Augusta;
- the width of the transmission line corridor south of Mount Gunson;
- whether the water supply pipeline from the borefields will be above or below ground;
- details of the pump station facilities on the water supply pipeline;
- the environmental requirements associated with borrow pit siting and rehabilitation;
- alternatives to electric power for the pumps at the borefields;
- the vegetation clearance requirements for transmission towers;
- clarification on the use of brackish and saline water;
- the possible use of truck transport to Pimba and rail to Port Adelaide for material transport.

**One Versus Two Corridors**

Public submissions have raised 2 issues in respect of the two corridors south of Olympic Dam. These are:

- increased habitat severance particularly in relation to the proposed rail line, and
- increased accessibility leading to increased likelihood of stock loss or vandalism.

The corridor as proposed in the Draft EIS relates only to transmission lines south of the Project area. As pointed out in Sections 2.6.3 and the Summary of Chapter 10 of the Draft EIS the rail spur is not part of the present proposal outside the Project area and will be subject to further environmental assessment. The track route from the Project area boundary to Pimba has not yet been selected and may not be in the same corridor as the transmission lines. The habitat severance for fauna caused by transmission lines and the access track will be negligible.

The second corridor will not add significantly to the accessibility of the area. The transmission line track will be maintained only as a service track and will be of a standard that will enable 4-wheel drive access only. The Electricity Trust of South Australia (ETSA) maintain a similar policy in respect of the access track along the Port Augusta to Woomera power line.

**Lake Windabout**

The Joint Venturers believe that the crossing of the extreme western end of Lake Windabout by the 275 kV transmission line from Port Augusta will have no significant environmental effect. Section 10.1.4 of the Draft EIS sets out the mitigation measures to be taken in crossing drainage features and notes that the impact is expected to be minimized as roads and transmission lines routinely cross such features and consequently the problems associated with their crossing are well recognized. Western Mining Corporation has constructed extensive causeways and roadworks across Lake Lefroy in Western Australia. The principal potential environmental effect is alteration of water flows and the causeway will be provided with pipes or culverts to maintain such flows. Any towers constructed on the lake bed will be adequately protected against turbulent flows.

**Transmission Line Route Through Port Augusta**

Figures 7.2 and 7.3 in this Supplement show the proposed transmission line route through the Port Augusta area. The transmission line route has been recommended to the Joint Venturers by ETSA and because it so closely parallels the route of the existing 132 kV line to Leigh Creek is expected to have minimum additional impact. The Joint Venturers do not consider that any alternative route offers significant advantage either economic or environmental (refer Section 10.1.2 of the Draft EIS) and therefore will follow the route recommended.

**Southern Corridor Width South of Mount Gunson**

As pointed out in Section 10.1.2 of the Draft EIS the transmission line route from Port Augusta to Mount Gunson will run parallel and immediately adjacent to the existing 132 kV line from Port Augusta to Woomera, and will utilize the existing service track. The transmission line will be separated from the existing line by 60 metres which is the separation required by ETSA. The only significant disturbance that will take place is in a radius around the tower footings of approximately 20 m. As noted in Draft EIS (Section 10.1.4) these disturbed areas will be kept to a minimum and revegetation will be encouraged. There will also be a requirement to remove overhanging branches or trees to facilitate the stringing of the conductors.

**Above/Below Ground Pipelines**

The decision as to whether or not a pipeline should be underground generally relates to its size and material of construction.

Factors influencing whether or not the pipe is buried include:

- corrodability of the pipe material
- the need for mechanical protection of the pipe, as for example PVC or asbestos cement
- size - smaller size pipes can be more economically placed underground
- whether or not water temperature at the delivery point is important. Underground pipes maintain more stable water temperatures than above ground pipes.

The Joint Venturers generally favour the placement of pipes underground but do not wish to eliminate the option of above ground placement if for example concrete lined steel pipes, commonly used by the Engineering and Water Supply Department, are used for pipelines at Olympic Dam.

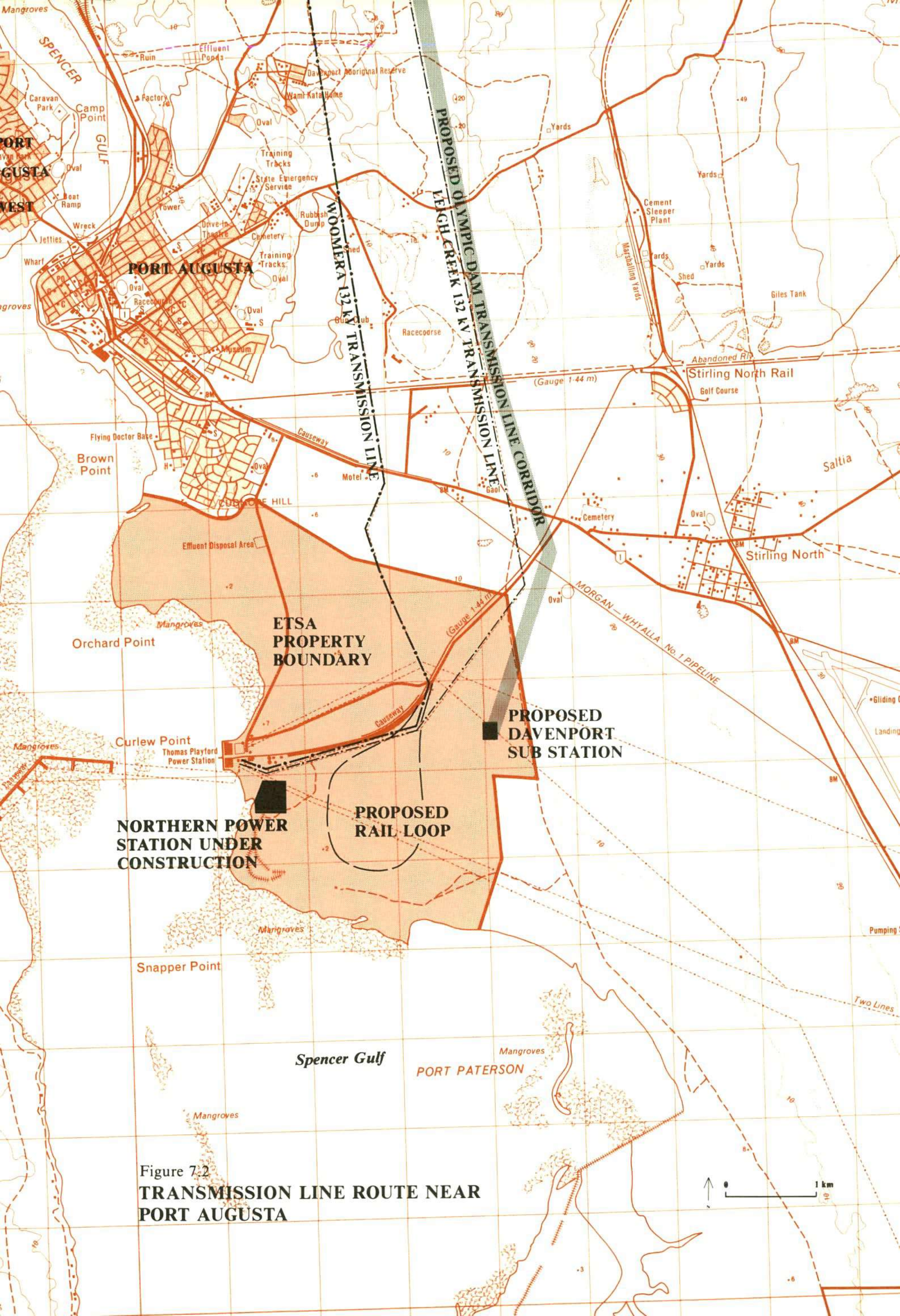



Figure 7.2
**TRANSMISSION LINE ROUTE NEAR PORT AUGUSTA**

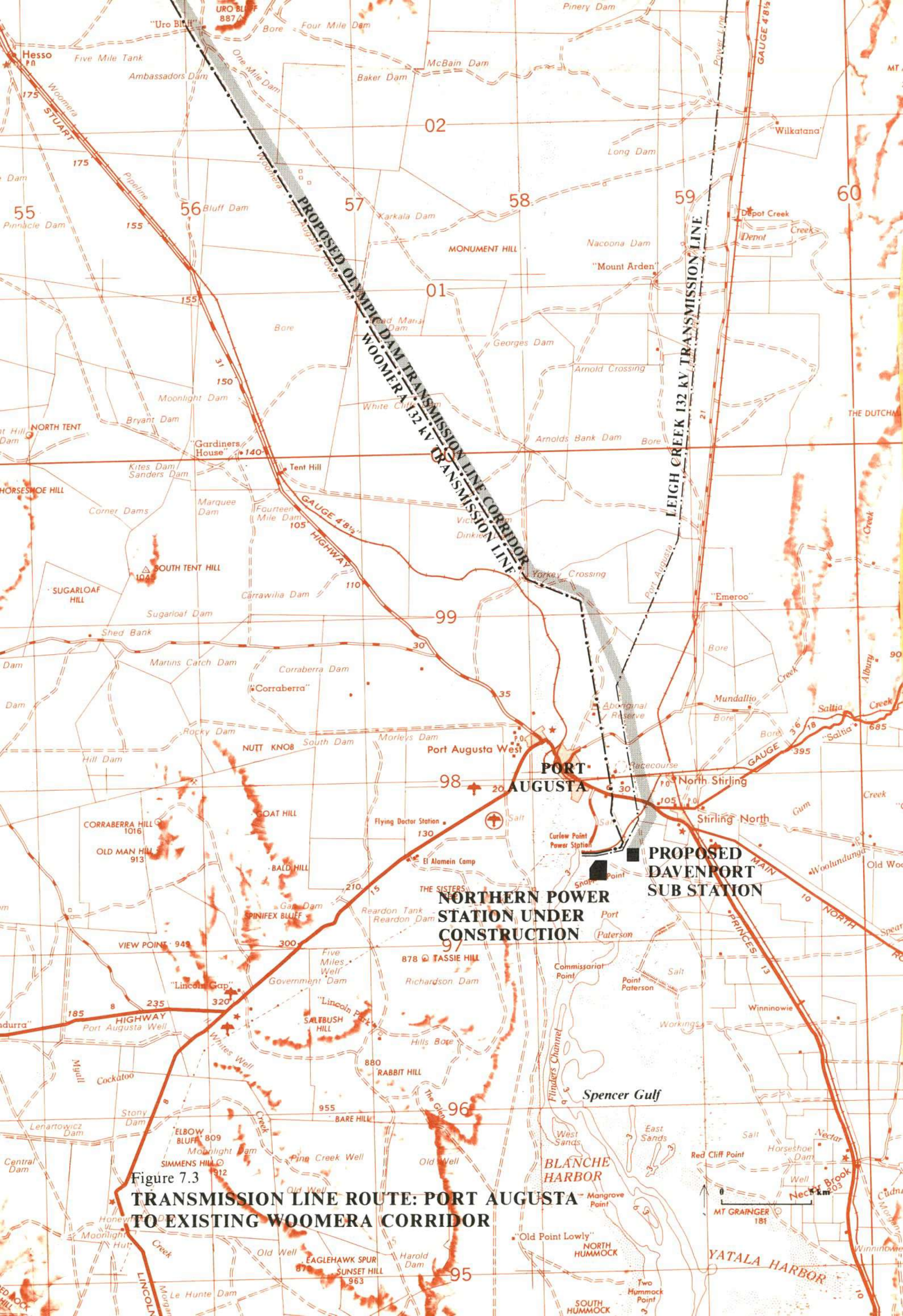



Figure 7.3
**TRANSMISSION LINE ROUTE: PORT AUGUSTA TO EXISTING WOOMERA CORRIDOR**

**Pump Station Facilities**

The pumping stations on the water pipeline will contain the following facilities:

- a building (approximately 10 m x 10 m) to house the pump and associated works
- a transformer compound of approximately 5 m x 5 m
- a tank or pump pond of approximately 15 m x 15 m.

The area will be fenced and will occupy approximately 500 $m^2$ or about the size of an average suburban allotment.

**Borrow Pit Requirements**

It is expected that the frequency of borrow pits on the northern corridor will be approximately each 500 metres. This is of similar frequency to the occurrence on the Woomera-Olympic Dam road. However because the road formation on the pipeline corridor will be smaller, the size of the individual borrow pits will be smaller than those along the southern approach road. The Joint Venturers anticipate that the borrow pits will be sited generally over 50 metres from the road for aesthetic and safety reasons, although for the Woomera-Olympic Dam road, the Government requirement was for much closer distances.

The Joint Venturers will abide by the draft guidelines of the State Government in respect of borrow pit siting and operation and have set down in the Draft EIS (Section 10.2.4) the principles of rehabilitation that will be applied to borrow pits. Examples in practice of the application of these techniques can be seen within the Olympic Dam Project Area.

**Alternative Power at Borefields**

The Joint Venturers propose to use electric pumps both at the borefields and at the pumping and forwarding stations in the belief that there is no viable alternative. The option of installing diesel driven pumps was considered. This has the benefit of a lower capital cost because the transmission line from Olympic Dam to the borefields would no longer be necessary. However the operating costs of this option are very much greater than the option of electric pumps for the following reasons:

- the cost of fuel is in the order of 2 to 3 times as high

- there is a greater requirement for logistic support in supplying diesel fuel to the pumps

- the diesel driven pumps have a much greater maintenance requirement than do electric pumps and lower reliability

- remote control systems are more effective for electric pumps than for diesel pumps.

On balance the Joint Venturers believe that for the economic and technical reasons set out above the electric pumps must be considered the preferred option. However if there is a sufficient change in the relative economic and technical factors then the alternatives will be subject to further evaluation at the final design stage.

**Vegetation Clearance for Transmission Towers**

In the Draft EIS (p. 10.6) it is stated that 'generally an area of less than 1,000 $m^2$ at each tower site ..... will be cleared of vegetation'. The tower structure for a 275 kV transmission line can be up to 12 m x 12 m. Access is required for drilling rigs to prepare foundations and cranes for the erection of the towers and conductors. These activities can be contained within the 1,000 $m^2$ noted in the Draft EIS. For these activities, the amount of clearance required depends upon the density and height of the vegetation present. For much of the length of the transmission line corridor the vegetation structure is low shrubland. For access and erection purposes in areas of low shrubland vegetation clearance is not required although vehicle movement will result in vegetation damage.

**Use of Brackish and Saline Water**

Section 3.3.3 in the Draft EIS details the uses for the piped water from the GAB. The last of the uses given is as follows:

> ". some brackish water will be used for dust control and for vegetation tolerant of this quality of water."

Some clarification of this is considered to be necessary.

The brackish water that will be used for dust control will be untreated borefield water. It will be used instead of the local saline water for dust suppression on roads which may ultimately be sealed, because continued use of saline water may have a detrimental effect on the road seal.

Untreated borefield water will not be used on vegetation watering. It is considered that the carbonate content of the borefield water would clog the soils and in consequence only potable water will be supplied to the townsite. However in areas such as ovals or public gardens, some retreated sewage effluent or collected stormwater will be used as a supplementary supply.

**Transport Alternatives**

The alternative of truck transport to Pimba and consequent rail to Port Adelaide has been considered by the Joint Venturers. It has the following disadvantages:

- it requires goods to be double handled firstly in loading at Olympic Dam and again in unloading and re-loading at Pimba.
- it requires the construction of transhipment facilities at Pimba to receive rail-borne materials which must be stored and then despatched to the site.

In addition certain materials requiring special handling such as tankers or bulk carriers using pneumatic handling will be delivered by road directly to site because of the problems associated with rehandling.

## 7.4 SEISMIC RISK

One public comment queries the superiority of Stewart's 1975 revised formula compared his 1972 formula in relation to the assessment of seismic risk at Olympic Dam (refer Draft EIS Section 6.3). The public comment included an analysis of recurrence relationships using both the 1972 and 1975 formulae for conversion and compared these with historical data converted by both formulae. On the basis of this comparison the public comment asserts that the 1972 coversion is more appropriate, thereby placing Olympic Dam in Zone A rather than Zone Zero as indicated in the Draft EIS.

In response to this comment, a brief historic discussion of the origin of the two formulae is provided. In addition, Stewart (pers. comm.) has examined the comment and responded indicating the limitations of the assumptions and thereby the conclusions in the public submission. It is still considered that Stewart's 1975 formula provides the best conversion for seismic data and that the 1972 formula provides estimates that are too high for larger magnitude events. It should also be noted that even if Olympic Dam was categorized as Zone A, there would be no further impact on design requirements for structures in the area since Zone A is considered a very low risk earthquake area.

**Origin of the Formulae**

The magnitude of an earthquake is a measure of the energy release, and is universally defined in terms of the Richter magnitude scale. In its original definition, the Richter magnitude $M_L$, would be that obtained directly from a standard Wood-Anderson seismograph, having a specific magnification, natural period, and damping coefficient located 100 km from the epicentre of firm ground, as typified in Southern California. Thus any network of seismograph stations set up to monitor local earthquakes in other places in the world using standard Wood-Anderson seismographs, or other instruments from which an equivalent peak Wood-Anderson amplitude could be determined, will yield Richter magnitudes if the attentuation of seismic waves is the same as that for Southern California. This situation is not exactly paralleled in South Australia, where the problem of seismic measurement was further complicated by the addition to the South Australian network in 1968 of a number of high gain instruments with a maximum amplification and a frequency response significantly different from that of the Wood-Anderson seismograph. This problem of relating South Australian observations with world wide criteria was first considered by White (1968), and later Stewart et al (1973) attempted to convert all magnitudes as determined by the South Australian network to Richter magnitudes.

Stewart developed a conversion to a surface wave scale, which he then believed to be continuous with the Richter scale (Stewart, 1981). The conversion took the form

$$M_L = 1.33M_N - 0.73 \qquad (1)$$

where $M_N$ = local scale of magnitude.

Equation (1) has been adopted by the Bureau of Mineral Resources to convert all data from 1969 onwards from local SA magnitudes to Richter magnitudes, and data base for the zoning map of the SAA Earthquake Code relies on the use of this conversion.

To minimize dispersion in local magnitude estimates due to different instrumental bandwidths, Stewart (1975) established a scale to allow for the average source spectrum, geometrical attenuation and frequency dependent absorption. The data used to derive the scale parameters was from surface waves recorded in South Australia over the period from 1967 to the end of 1970, and the equivalent Richter magnitudes (ML) were in the range 1.5 to 3.5. Stewart proposed that his original conversion formula (1) was not correct and that a more realistic relationship would be:

$$M_L = 1.05M_N \qquad (2)$$

Recently Stewart (pers. comm.) has suggested that while the conversion factor given in equation (2) should be investigated further when sufficient data becomes available, the revised formula is probably more generally useful in South Australia than is indicated in the somewhat cautious remarks made in his first publication of this new information in 1975. He further indicated that this relationship should provide a satisfactory guide for all practical purposes, and that it is not expected that the conversion formula will need to be changed appreciably in the future.

Stewart (1982) found that with this revised conversion formula, analyses of recurrence and risk using temporal subsets of the whole data set, which extends from 1883 to 1979, are in reasonable agreement, allowing for some random variation in earthquake occurrence. In addition, and most importantly from the point of view of risk analysis, the new formula indicates that predictions for the felt effects from the larger magnitude events probably require some reduction as a result of reductions in the converted $M_L$ magnitudes from 1969 onwards. Since methods of risk estimation in general require a homogeneous data set, earthquakes from only 1960-1963 onwards have frequently been used for analysis of South Australian sites. It follows that a major portion of the data will have been affected by use of the early conversion formula now known to be incorrect. Thus in the recurrence relationship (McCue, 1975)

$$\log N = a - bM_L \tag{3}$$

for the number N events greater than magnitude $M_L$ where a and b are constants, b found in the analyses by McCue based on data prepared using the older conversion formula was typically between 0.7 and 0.8. With magnitudes based on the revised conversion formula, the value of b is about 1.05, with no significant variations using spatial or temporal subsets of the data.

Since the recurrence rate of large events extrapolated from equation (3) depends on b, a low value of b causes both the number of large events and the risk to be overestimated. For the Olympic Dam site a reduction of the order of one whole zone of risk as defined in the SAA Earthquake Code is possible from variations in data sets between the original and the most recent methods of magnitude conversion.

Some independent confirmation of the most recent conversion formula has been sought from the Bureau of Mineral Resources. The Bureau has advised that the revised Stewart relationship should give better estimates of $M_L$ than those obtained from the earlier relationship, which the Bureau states was based on an error. It is also noted that the Bureau agrees with Stewart's suggestion that the 1.05 conversion factor requires further investigation, which it intends undertaking, and that users of the earthquake data file will be advised that the $M_N$ to $M_L$ conversion is probably incorrect.

The public comment does point to the uncertainty attached to this problem in South Australia. However it must be pointed out that the conclusions of the public comment are based on historic data and there is a great deal of uncertainty regarding the magnitudes of historic earthquake records. It will possibly take years before this problem is fully resolved.

**Limitations of the Analysis Used in the Public Comment**

In the plot included in the public submission, the instrumental data appear to be incomplete for the area considered (most of the state), for the magnitude range (about ML 3 and higher), and for the time interval used (1836-1979). Furthermore, the historic data also tend to have very uneven coverage and quality. Since so many events of even quite moderate size will have been missed over large areas, use of records earlier than 1883, when the BMR data file commenced, is inappropriate. Most of the earlier events were rather vaguely reported and it is difficult to assign magnitudes to them. By 1883, the observation of the larger events at least should have become sufficiently good to be of use in recurrence studies. If too long a time interval is used for reported events, then the regression curve will not accurately reflect the regional seismicity. It is considered fallacious to try to compare the instrumental data from 1966 through 1979 with the historic events without making allowance for the incomplete observation of earthquakes in the region.

## 7.5 SOCIAL EFFECTS AND TOWN DESIGN

A range of comments were made in relation to social effects and town design covering such matters as the continuation of the town, the facilities provided by Government, social characteristics, assumptions and data used in the Draft EIS, and the construction camp. Each of the items raised is addressed under a separate heading below.

**Town Continuation Beyond 30 year Planning Period**

The Joint Venturers have been criticized for not offering options for the continuation of the town after the 30 year period envisaged in the Draft EIS. As pointed out in Section 1.5 of this Supplement the 30 year period was a period discussed by the Joint Venturers and Government to represent a reasonable period over which environmental aspects might be assessed.

However the Draft EIS does note (Sections 2.7.4, 11.1.1, 11.6.3) that provision has been made for continued growth of the town to over 3 times the size anticipated in the Draft EIS. The orebody is of such a size that a continuing mining operation beyond the 30 year period must be considered probable. While the Joint Venturers cannot anticipate what other activities may develop at Olympic Dam, proper provision has been made for the continuation of the town beyond the period envisaged in the Draft EIS.

**State Government Funded Facilities**

Under clause 22 of the Indenture Agreement the State Government is obliged to fund the following facilities in the town:

- Police Station, Lock-up and Court House
- Child-care Centres
- Kindergartens and pre-schools
- Primary schools (including classrooms, administration and amenities blocks, staff facilities, tuck shop and covered or shaded play areas)
- Secondary schools, (including library, administration block, staff facilities and senior centre lecture theatre)
- Hospital (including a general, maternity and children's section, casualty, outpatients and physiotheraphy departments, labour ward, operating theatre and diagnostic X-ray unit)
- Medical and dental centre (including maternal and child care facilities and family planning services)
- Local authority facilities (including municipal offices, meeting room, public toilets, library, civic auditorium, works depot and workshop)
- Swimming pool complex
- Sporting facilities and playing fields with changeroom facilities
- Premises for creative, performing and visual arts
- Fire station and fire tender

- State Government offices

- Ambulance centre and vehicle

- Parks and gardens within the town

- Garbage disposal facilities in the town.

In addition, the Government will fund the necessary plant and equipment, including vehicles, for the provision of State and Municipal services and facilities in the town, the allotment development costs in respect of all the above facilities and the cost of housing (including allotment development costs) for all those personnel connected with the operation and maintenance of the above facilities. The Government will equip, repair and maintain all the above facilities and provide staff to operate them.

It must be noted however that the State's maximum obligation relates to facilities up to a level appropriate to provide for the needs of a town population of 9,000.

**Methodology**

The Joint Venturers have been criticized for the lack of provision in the Indenture Agreement for consultation with town residents as to the municipal boundaries. As it is necessary for planning purposes to define the municipal boundaries before the town is in existence therefore there will be no residents with whom the Joint Venturers and the State Government can consult in respect of municipal boundaries.

**Assurance on Town Size**

The Joint Venturers can give no assurance that the town will not exceed the 9,000 envisaged in the Draft EIS. Provision has in fact been made for a population of 30,000 at the proposed town site. It should be noted that any development in the town will be subject to normal planning controls by the Municipality and such other statutory obligations that may prevail at the time.

**Objectives and Standards are Vague and Unspecified**

The Draft EIS sets out objectives for the development of the town at Olympic Dam and then sets out to demonstrate how these objectives are to be met. They represent statements of intent by the Joint Venturers as to the nature of the town which will be provided. Most of the 'undertakings' are contained in the introductory sections to various aspects of town development and the details setting out specifics as to how the Joint Venturers propose to achieve these objectives follow the introduction.

Specific criticism is raised that there is no indication of the standard or capacity of community facilities to be provided and who defines the standards. The Indenture Agreement is quite clear on this point:

- Clause 21.4 (a) states that the programme for development and construction must be agreed between the Joint Venturers and the State Government.

- Clause 21.5 sets down that the standards and specifications of buildings if not contained in the Building Act are to be agreed by the Joint Venturers and the State Government.

- Clause 21.2 states that buildings owned or occupied by the State or Municipality will be designed by the State Government.

The Joint Venturers thus cannot define details of the standard or capacity of community facilities because they cannot commit the State Government. It is reasonable to assume that the standards will be similar to those that the State will be applying elsewhere at the time of construction of the facilities.

**Previous Experience**

The Joint Venturers believe that operational experience in towns is more significant than design experience alone in understanding the problems and benefits of particular aspects of town design. The individual Joint Venturers have operated the towns of Leinster (since 1978) and Kambalda (since 1967) and have thus gained a considerable depth of experience as stated in the Draft EIS.

**Employment of Females**

There is no ambivalent attitude towards the employment of women at Olympic Dam. Section 11.2.4 states quite clearly 'it is a policy of the Joint Venturers to afford equal opportunity to all people with appropriate skills'. Job training schemes will be introduced by the Joint Venturers (Section 11.2.4) and will be non-discriminatory in this respect. The recruitment of wives has a financial benefit to the Joint Venturers by reducing the numbers of accommodation units that must be provided. Further it is against the law in South Australia (under the Sex Discrimination Act of 1975) to discriminate on the grounds of sex in matters of employment.

**Participation Rates of Females**

Table 11.4 of the Draft EIS has been criticized in public comment for failing to indicate the participation rate of resident females in the towns selected. The purpose of Table 11.4 was to demonstrate the contention advanced in Section 11.2.4 of the Draft EIS that 'mining activity generally involves a greater number of jobs traditionally performed by men'. It is not intended to use these figures as a comment on the participation rate of women in mining towns in the workforce.

**Rationale of Employing Married People**

The statement put forward in public comment that 'certain single members of the workforce may in fact be more likely candidates for long term employment than married employees' is sufficiently generalized to be indisputable. However, the Joint Venturers' experience indicates that the more closely a mining town resembles a long established town in terms of both facilities and demographic structure, the more likely the population is to be stable.

**Desirability of Free Water**

A public comment suggested that free water should be provided to town residents. Under Clause 13 of the Indenture Agreement, the municipality or the State Government will be responsible for the distribution of water in the town. Under Clause 13.21(a) of the Indenture Agreement, the Joint Venturers are obliged to supply water to the distribution authority (up to an amount agreed by the Minister and the Joint Venturers) at a unit rate of $0.32/kL escalated from July 1981 in accordance with statewide increases in water charges. For quantities above the agreed quantity, the Joint Venturers may charge the distribution authority the actual cost, including a component for capital. Clause 13.22 obliges the distribution authority to levy charges to consumers not exceeding unit rate applicable in the agreed quantity plus 20%. The distribution authority is further obliged by this clause to be financially self-sustaining. The Joint Venturers believe that the supply of free water to householders would be inconsistent with their policy of conserving water usage to the extent considered reasonable. The Joint Venturers disagree with the comment that if free water is not supplied the option to establish lawns, gardens and shade trees will be taken up only infrequently. In Kambalda and Leinster and in other mining towns where water is not supplied free of charge, the establishment of attractive gardens has not been seriously inhibited. The Joint Venturers are however committed to encouraging the adoption of garden styles that will allow for the low rainfall characteristics of the area (Draft EIS, Section 11.1.1). This will include community education programmes.

**Rationale for Providing 3/4 Bedroom Houses**

The comments made in a public submission in respect of Paraburdoo, Moranbah and Kambalda are incorrect. It is not necessary for an employee in these towns to have a family of minimum size before a house is allocated. The Joint Venturers believe that their rationale is correct.

**Statement on Size of Families**

The Draft EIS states in Section 11.3.3 that 'generally mining towns have larger family sizes ... than major metropolitan areas'. This has been criticized in public comment in which reference is made to studies of mining towns in the north west of Western Australia compared with other country population centres in Western Australia, the largest comparison town being Geraldton (with a population given as 17,701 persons). The towns used for comparison cannot be considered 'major metropolitan areas' and the Joint Venturers believe that Table 11.7 in the Draft EIS which compares the distribution of household size of selected mining towns and Adelaide to be more relevant to the point being made in the Draft. Household sizes tend to be larger in mining towns that in major metropolitan centres because:

- the pensioner population of mining towns is very low (refer Section 11.3.1 of the Draft EIS)
- most single people in mining towns are resident in the single quarters.

**Overseas Born Residents**

The 25% figure given was based on experience in Kambalda supported by research (Brealey and Newton 1980) and the Joint Venturers acknowledge that more recent work may have indicated a higher proportion. The most important point however is that there have been no significant problems arising from the ethnic composition of the workforce.

**Private Entrepreneurs**

The Joint Venturers accept that it will be necessary in the initial years of township establishment to provide inducements for commercial operations to establish at Olympic Dam (Draft EIS Section 11.5.2). No viable alternative to this is perceived. Following this it is expected that competitive facilities will set up and market forces will ensure the maintenance of competitive pricing. In respect of two-tier shopping, the Joint Venturers believe that this is sustainable at the size of town contemplated.

**Attraction of Cash Target Workers**

The Joint Venturers believe that it will be necessary for inducements to be available to attract people to live and work in the new town at Olympic Dam. Financial inducements such as those set out in Section 11.2.4 of the Draft EIS, and including the increased likelihood of shift work and/or overtime, zone income tax allowances and the likelihood of housing availability on favourable terms are seen as measures that can be expected to attract a suitable workforce.

As pointed out in Section 11.5.3 of the Draft EIS research (Brealey & Newton 1980) indicates that while such financial inducements are important factors in attracting a workforce they are not necessarily significant in the retention of that workforce. The Joint Venturers recognize this and will therefore seek to develop an urban environment at Olympic Dam that will be sufficiently attractive to induce people to remain in the town as permanent residents. The facilities to be provided in the town are set out in Section 11.5 of the Draft EIS, and the proposals for town and accommodation design in Section 11.6. The Joint Venturers believe that such an environment will be sufficiently attractive to maintain a suitable workforce while accepting that a certain proportion of that workforce will always be short term workers attracted solely by the financial inducements.

**Demographic Data Inappropriate**

The selection of Paraburdoo, Moranbah and Kambalda as models for Olympic Dam has been criticized as they are alleged to be 'company' towns whereas Olympic Dam will be an 'open' town. The Joint Venturers dispute the contention that the three towns used for comparison are company towns. They are not fully administered by the companies concerned, and as such are considered appropriate for demographic data.

The relevance of the use of the demographic structure of Kambalda was questioned on the basis that Kambalda in 1976 was 8 years old whereas Olympic Dam would be only 4 years old at the point at which comparisons were drawn. The reason that the 1976 Kambalda figure was used was that between the discovery of the orebody in 1966 and 1971 the operation was expanded rapidly. The effect of this rapid expansion was to modify the demographic characteristics of the town because of the continuing involvement of a significant construction workforce and the expansion of the mine workforce. The Kambalda 1971 census data was not therefore considered to be representative of a town such as Olympic Dam 4 years after construction was completed. The next census (1976) was considered to be more representative of the town at Olympic Dam as Kambalda had then been in a more stable operating (as opposed to construction) situation for about 5 years (Draft EIS Section 11.3.1).

**Rationale for Providing Community Facilities**

The Joint Venturers do not accept that the Draft EIS puts forward the lack of family support as a principle reason for the provision of community facilities. What the Draft EIS said (Section 11.5.3) was:

> "The usual difficulties experienced during the early stages of family formation <u>may also be exacerbated for some families</u> in Olympic Dam because of the lack of extended families (especially grandparents) or long time friends to provide support."

The expected structure of the population - with higher than normal proportions of young families and a lower than normal proportion of older people - clearly dictates that schools, day care centres, pre-schools and child minding facilities will in the initial years of the town's existence be more appropriate social support facilities than elderly citizens' centres.

**Home Ownership**

The reasons for which the Joint Venturers will encourage home ownership are:

- the belief that home ownership encourages a sense of permanence in the community and an improved standard of care for both housing and gardens

- the Joint Venturers accept (Draft EIS Section 11.4.3) that incentives will be necessary in order to encourage home ownership. This may provide an additional financial attraction to employees.

- the Project because of its potential longevity is seen as having significant potential for home ownership.

**Stewardship of Dunes**

A public comment has suggested that housing should be sited on the dune slopes so that the individual householders through management of their own allotments would preserve the dunes. The Joint Venturers believe that the town design as proposed in the Draft EIS provides an appropriate amount of public open space on the dunes and that municipal control is the most appropriate management method.

However, they recognize (Section 11.6.5 of the Draft EIS) that this position may require review in the light of early experience in the town to ensure that affective management and control can be achieved.

**Underground Reticulation of Electricity**

The Joint Venturers have stated their preference to reticulate electricity underground, consistent with other new subdivisions in South Australia (Draft EIS, Section 11.6.6). It is accepted that overhead reticulation may be aesthetically undesirable.

**Solar Water Heaters**

The Joint Venturers have not excluded solar water heaters from their assessment. At the time of commencement of town development solar water heaters will be considered among other options, and the decision will be made on economic and technical grounds (Draft EIS, Section 11.6.6). Periodic re-assessments may take place as additional parts of the town are developed.

**In-situ House Construction**

This will be the subject of detailed evaluation at the time of commencement of construction. The principles to be applied to house design at Olympic Dam are noted in Section 11.6.8 of the Draft EIS.

**Population Projections**

The Joint Venturers accept that population projections for Olympic Dam may differ because the nature of forecasting is such that there are a number of uncertainties associated with it. Section 11.2.2 of the Draft EIS points out some of those uncertainties associated with the non-project workforce. However the Joint Venturers believe that the population forecast in the Draft EIS is sufficiently accurate to permit a proper environmental evaluation to be undertaken.

**Town Site Selection**

The Draft EIS has been written as a stand-alone document for the consumption of informed members of the public. The description of the alternative town sites and the reasons for their selection is considered to be adequate for that purpose. A separate report (see Appendix 2) was provided to Government assessors for a more detailed evaluation, and site visits have been undertaken. Because of the generally homogeneous nature of the Olympic Dam environment and the desire to place the town as close as practicable to the mine-site to reduce commuting distances the Joint Venturers do not consider it appropriate to go beyond the range of distances considered. In a potentially long-life operation with very significant workforce such as Olympic Dam the Joint Venturers do not consider that long commuting distances such as from Woomera are desirable or practical.

The problems identified to date are amenable to management solutions, are relatively insignificant, or common to all of the alternative townsites. None of these would be of sufficient weight to warrant any change in the proposed town location or design.

**Construction Camp**

The Joint Venturers have chosen to utilize the existing village facilities as the first stage of the construction camp and to site the construction camp adjacent to the existing facilities for the following reasons:

- it will be adjacent to existing services and road access
- it will be necessary for a construction workforce to be housed on site prior to the provision of any permanent services in the proposed town site
- the construction workforce will be engaged mainly in the mine and plant area and proximity to the workplace will be much closer than the town site
- the extended hours commonly worked by construction workers make close proximity to their workplace very desirable
- the Joint Venturers for economic reasons wish to utilize the facilities and services already existing in the village and temporary housing area.

The development of the construction camp will be as follows (Section 11.1.4 and 11.4.2 of Draft EIS):

- All construction workers will be housed initially in the existing village single quarters and housing. The single quarters will be expanded to a maximum size of 350 (present capacity is 160). The number of caravan sites will be increased from the present 36 sites to 50 sites. The present houses will be retained to house senior construction personnel.
- The expansions will take place in modules of approximately 500 capacity. On the basis of a 2,500 construction workforce 4 such modules in addition to the expanded village facilities will be required. The modules will have a standard layout and will consist of unit-type accommodation similar to that in the existing village. These will be centred around central canteen and recreation facilities. The existing village can be used as an example of the layout and nature of facilities to be provided in each module (Draft EIS Section 11.1.3).
- Solid waste disposal from the construction camp will utilize the present rubbish tip (Draft EIS Figure 1.4). Sewage disposal will be into self-contained lagoons (the same system as is currently employed at Olympic Dam) and these will be operated in accordance with the regulations set down by the South Australian Health Commission. Stormwater will be collected in a retention basin situated to the west of the camp and will be recycled to vegetated areas where practicable.

- Power will be drawn from an extension to the existing line to the village. Other services will include water, and telephone, including public telephones. There will also be facilities similar to those in the existing village - supermarket, swimming pools, squash and tennis courts, and wet canteen.

Development principles that will apply to the construction camp will also be similar to those that have been applied to the existing village and which are to be applied to the town. These are set out in Section 11.6.2 of the Draft EIS and include:

- generally siting development in swale areas
- maintenance of existing vegetation to the maximum extent practical
- avoiding development in drainage depressions
- avoiding development in dune ridges where possible.

As noted in Section 11.1.4 of the Draft EIS, when construction is completed and suitable accommodation is available in the town, the facilities in the existing village and the construction camp will either be disposed of or relocated in the town. The village and construction camp area will be rehabilitated.

## 7.6 ABORIGINAL ENVIRONMENT

Comments received in relation to archaeology and further developments in relation to anthropological studies are discussed in this section.

### Archaeology

No public comments were received in relation to archaeological matters, however a number of queries were raised in the Government review of the Draft EIS. These queries were in relation to:

- data collection techniques used and their relation to reported results;
- buried archaeological sites in sand dunes;
- mitigation of indirect impacts;
- terminology;
- availability of archaeological reports.

### Data collection techniques and their reporting

As noted in the Draft EIS a number of data collection techniques were adopted for different aspects of archaeological survey work. The Archaeological Baseline Report (one of the background papers) describes in detail how the stratified random sample for the predictive statement was supplemented by a variety of samples, random and non-random, systematic and non-systematic. In comparing the tables in the Draft EIS, particular care has to be taken in noting which survey data was used to compile the tables. The surveys used are included in the table titles. In order to further clarify the data use, Table 7.4 cross refers the surveys undertaken with the data usage in the tables of Chapter 5 of the Draft EIS. For example, Table 5.6 in the Draft EIS is a summary compilation of all baseline information and contains information for more landforms but expressed in general terms while Table 5.1 in the Draft EIS presents summary statistics from only the stratified random sample for the baseline survey. No archaeological sites were found in landform types 1 and 6 in the stratified random sample so no information for these landform types is cited in Table 5.1. However, in the course of other surveys, sites were found in this landform and this information was incorporated in the more generalized summary compilation of Table 5.6. Sites in landform types 1 and 6 are rare and are unlikely to be represented in small sample areas. Those that were recorded were located while driving across country between sample areas. Only one site was recorded on landform 6 in the baseline survey but three others were recorded in the earlier road corridor surveys. All were sparse, separated by large areas with no sites even in areas with good exposure and all were of low richness. In landform type K1, three quarry/knapping floor complexes were recorded in the baseline survey. In the road corridor surveys, two 'rich' campsites on isolated dunes and one quarry/knapping floor complex were also found in K1 terrain. For landform type A1, five campsites were recorded on dunes on the margins of A1 in the road corridor surveys. However, as the areas abutted tracts of A4 and A5, the sites cannot be considered representative of A1. Also note that the frequency of sites for landform type A1 was inadvertently omitted from Table 5.6: frequency of sites is considered 'low' for A1.

The discussion of cairns also warrants some clarification. The Draft EIS states on p. 5.9 that 'only one possible cairn was found in the Study Area and this was at Lake Blanche'. This statement refers to the baseline survey and housing area survey. As noted in Table 5.11, a cairn was identified in the road corridor survey from Purple Downs to Phillips Ponds. The road corridor is also part of the Study Area. No reference in the Draft EIS was made to a cairn identified by Fitzpatrick (1980) as it is considered to be a collection of hearth stones eroding out of a dune.

**Table 7.4** **Archaeological survey data usage in tables of the Draft EIS**

| Survey | Table number | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 5.1 | 5.2 | 5.3 | 5.4 | 5.5 | 5.6 | 5.7 | 5.8 | 5.9 | 5.10 | 5.11 |
| Baseline survey (stratified random sample) | * | * | * | * | * | * | | | | | * |
| Baseline survey (Nonsystematic observation) | | | * | * | * | * | | | | | * |
| Housing area survey | | | * | * | * | * | | | | | * |
| Road corridor Olympic Dam to Purple Downs | | | | | * | * | | | | | * |
| Road corridor Purple Downs to Phillips Ponds | | | | | | * | | | | | * |
| Whenan Shaft survey | | | | | | | | | | | * |
| Regional survey | | | | | | | * | * | | | * |
| Project Area survey (Areas A,B,C) | | | | | | | | | * | * | * |
| Town Site survey (Area D) | | | | | | | | | * | * | * |
| Pipeline survey | | | | | | | | | | | * |

A further point was raised in relation to the impression given in the Draft EIS (p. 5.16) that the predictive model was not confirmed in the Red Lake to Curdlawidny Lagoon area. This also warrants clarification because the predictive model in fact fits well, in that landform 3 should be taken to include the small pans (around which the sites occur) as well as the large features (around which there are fewer sites).

**Buried archaeological sites**

As noted in p. 5.7 of the Draft EIS, 'sites in dunes are usually only exposed in blowouts'. This suggests that some dunes may contain buried archaeological material. The Joint Venturers recognize this and that present legislation imposes a legal obligation to protect buried sites. As a means of minimizing damage the Joint Venturers will advise the appropriate construction personnel of these obligations and educate them in the identification of archaeological sites.

**Mitigation of Impacts**

Two aspects of impact mitigation were raised in comments by Government officers. The first related to the basis of the recommendations proposed for sites of scientific value, while the second concerned measures to minimize indirect impacts.

The sites recommended for salvage or recording (Draft EIS, p. 5.29) all lie in areas which are likely to be cleared in the proposed development. Therefore site retention and protection is not feasible given the present development plans. As noted in the Draft EIS, relocation of development to avoid individual archaeological sites is likely to result in similar sites being affected in the new locations. The work programme outlined in the Draft EIS was designed not only to provide further site information and representative samples of archaeological materials of archival value, but also to provide valuable data for a research hypothesis currently being developed by the archaeologists responsible for the survey work.

The basis for recommending the nine sites referred to in the Draft EIS was also queried. These nine sites were selected on subjective grounds from a continuum of sites ranging from spectacular to very minor, and on the basis that they were within areas which would be heavily impacted. Other similar sites to these nine were observed elsewhere but not recorded.

The Draft EIS does not specifically mention detailed site recording for Site 330. It should be noted that systematic collection (as proposed for Site 330) would in all cases be preceded by systematic recording. However, not all sites or parts of sites which will be systematically recorded warrant collection.

In relation to the potential for indirect impacts upon archaeological sites (i.e. damage to sites not through the proposed development itself but due to activities indirectly associated with the development, such as vehicle damage), the Draft EIS refers to the Joint Venturers restricting access in areas surrounding certain stone features when they have authority to do so. Further action on site protection is awaiting information on the Aboriginal significance of these stone features.

As noted in the Draft EIS (p 5.33), despite an invitation to be present during archaeological survey work, Aboriginal groups who claim a traditional link with the area did not take the opportunity to be present. The Joint Venturers will continue to seek information on Aboriginal interest in such sites and the steps taken since the release of the Draft EIS are discussed below in the section on anthropology. As noted above on buried sites, the Joint Venturers have a legal obligation to protect sites in the Project Area. More specific mitigation measures will be formulated as part of future environmental management programmes (refer Chapter 8 below).

**Terminology**

Revised descriptions of a number of technical terms are provided below in order to clarify their meaning in relation to the Draft EIS:

- tula: flakes retouched steeply at the distal end, with convex ventral faces and steep angles between the ventral surface and the platform;
- horsehoof cores: single platform cores with step-terminating flake scars emanating from the platform;
- grindstones: the ground pieces found were mostly sand fragments (generally less than 10 cm) of local quartzite slabs and nearly all of these were very lightly ground.

It should be noted numerous quartzite slabs were found at many sites and these have been considered by others to be grindstones. However, hundreds of these were examined but they were definitely not ground - the 'polish' is natural patina.

**Availability of Archaeology Reports**

The background reports on archaeology were submitted on a confidential basis to the Heritage Conservation Branch of the Department of Environment and Planning. This was done as a means of protecting sites. This is considered unduly restrictive by the Department. Therefore the Joint Venturers are prepared at the Department's request to make the reports (but not site locations) available to responsible interested parties except in the case of the information on stone features. This is because it has not been possible to date, to determine if these features have mythological significance.

**Anthropology**

**Site identification:** At the time of writing the Draft EIS, a satisfactory basis for the exchange of anthropological information was still being sought with the Kokatha People's Committee. Further discussions have failed to reach agreement in relation to the principles for the conduct of anthropological surveys and exchange of information. Consequently Roxby Management Services (RMS) has advised the South Australian Government and the Kokatha People's Committee that in accordance with the guidelines, no further anthropological information can be included in the Final EIS.

However as noted in Section 5.2.6 of the Draft EIS, RMS wish to locate and take steps to protect verified anthropological sites. In order to achieve this objective RMS proposed that a one month field trial on a 'no prejudice' basis be undertaken at RMS expense adopting the information restriction requirements which were acceptable to the Kokatha People's Committee. RMS would review the results of the trial to determine if this method provided anthropological information which met professional standards for verification. Field work for the trial has now been completed. Following assessment against proper professional anthropological standards, protection of all verified sites within the Project Area is proposed in accordance with the procedures set out below.

**Verification of sites:** The basis on site verification will be in accordance with proper and professional anthropological standards. It is proposed that in the event of a dispute between the State or Federal Governments and the proponent in respect of the verification of any anthropological site, the dispute will be resolved by reference to arbitration in accordance with the procedures contained in Clause 49 of the Indenture Agreement. Any such resolution will be final and binding on the parties.

**Protection of verified sites:** It is proposed that verified sites of anthropological significance within the area of the Special Mining Lease (to be granted pursuant to the Indenture Agreement), within the area of land set aside for township purposes pursuant to the Indenture Agreement, or within the area of any Special Buffer zones granted pursuant to the Indenture Agreement will be placed under the direct control and management of the State Government. The mechanisms for achieving this are:

- Special Mining Lease Area

  Any such sites within the perimeter of the Special Mining Lease will either:

  - be specifically excluded from the area in respect of which application is made for a Special Mining Lease: or

  - be surrendered from such title if identified subsequent to the tenement being granted.

  In both cases the exclusion will be to a depth of 50 m from the surface and appropriate rights of access to the areas will be negotiated.

- Townsite Area

  The Joint Venturers will ensure that such sites will be excluded from any application for freehold title so that ownership of the land remains with the Crown. Access rights if necessary will be negotiated.

- Special Buffer Zones

  The Joint Venturers will ensure that such sites:

  - are excluded from the area in respect of which any Special Buffer Zone is granted.

  - will be surrendered from such title if identified subsequent to the tenement being granted.

  - access rights if necessary will be negotiated and the exclusion will be to a depth of 50 m.

  Any sites other than in these areas are outside the control of the Joint Venturers and their protection is a matter for the State Government.

# 8 ENVIRONMENTAL MANAGEMENT

This section describes the Joint Venturers' approach to environmental management of the Olympic Dam environment. The topics discussed include current practices, staffing, responses to specific aspects of monitoring programmes, and community education programmes.

The programmes outlined in the following sections are so designed that they meet the Joint Venturers' objectives and commitments of having an integrated environmental management programme that ensures that all aspects of Project research, monitoring and rehabilitation are co-ordinated.

In addition the programme has to be sufficiently flexible to accommodate the changes that will occur. This philosophy is embodied in Clause 11 of the Indenture Agreement which commits the Joint Venturers to obtaining Government approval for the proposed management programme and stipulates the reporting framework.

## 8.1 CURRENT PRACTICES

Physical and biological monitoring at Olympic Dam is designed to allow early recognition of undesirable environmental impacts, assess the success of rehabilitation programmes and reduce impacts where economically feasible. Monitoring studies in areas for which previous baseline work has shown potential impacts are likely to occur, have commenced with ongoing studies continuing in disciplines such as erosion, soil salt storage, meteorology, hydrogeology, avifauna and vegetation. Rehabilitation programmes for the mine area and the townsite are to provide for re-establishment of self-propogating vegetation which is characteristic to the area.

**Vegetation monitoring**

The vegetation monitoring programme described in section 3.4.4 of the Draft EIS has been in operation since 1981. This programme will continue with the field work being undertaken by environmental staff to permit adequate comparison with baseline data. The programme has been so designed to enable flexibility in the event that changes occur in plant and infrastructure design or location. Results of the monitoring will be reported where appropriate on an annual basis as outlined in clause 11 of the Indenture Agreement.

**Climatological monitoring**

A network of 6 meteorological stations was established for baseline studies. The instruments have been removed from all site stations with the exception of the main Sandhill station which contains mechanical instrumentation (Siap 2000) to measure and record continuously wind speed/direction/run, relative humidity, rainfall and temperature. A separate high volume dust sampler measures ambient dust levels. Regional climatological data is available from Woomera and Andamooka and should the need arise for any specialized studies, (e.g. pilot tailings retention area), additional recording equipment will be used where appropriate to supplement existing instrumentation.

**Fauna monitoring**

Baseline studies have demonstrated that no rare or endangered mammal or regionally unique mammal habitats will suffer as a result of habitat destruction associated with the

Project's development. Furthermore, it is almost inconceivable that any such species could be present, given the known ecological requirement of possible candidates (Aitken, 1982). Under these circumstances faunal monitoring will be conducted at regular intervals to assess what actions are required to control both native and feral animal populations. In addition selected species of small mammals and amphibians will be sampled from designated control sites to monitor any changes in levels of pollutants, particularly heavy metals, in the environment.

The locations of these trap sites within the Project Area will also enable information to be collected on the re-establishment of small mammals in the rehabilitated areas.

**Avifaunal monitoring**

It is likely that the densities of certain species of native birds will be reduced in the Project Area as a result of development while others will benefit to some degree. Population variations due to severe drought conditions have already been noted in the ongoing monitoring of selected smaller passerines and these natural variations must be taken into account when assessing development impacts. Banding of some of the local Hooded Robin and Splendid Fairy-Wren populations, when conditions are appropriate, will allow a more detailed analysis of population changes and structures.

**Erosion monitoring**

Within the Study Area a combination of the terrain types present, their low relief, relatively high infiltration potential, and the intermittent low precipitation events result in little natural water erosion. Wind induced erosion does occur on a limited scale, particularly during prolonged dry periods. The potential for sand movement and erosion and their impacts have been examined in Section 3.2.4 of the Draft EIS. Dust and erosion control within the Project area is considered an integral part of Project development and rehabilitation practice. Ongoing monitoring programmes will be regularly reviewed to evaluate the efficiency of control programmes.

**Rehabilitation**

Natural environmental constraints on the re-establishment of self sustaining indigenous vegetation in arid land demands that land and vegetation disturbance during construction phases be carefully controlled and minimized. This objective has been followed in the rehabilitation, to various stages of approximately 160 drill sites, borrow pits and disused access roads. However, the overall success of the programme cannot be evaluated until the area has received rain.

Although rehabilitation techniques vary according to drill pad location within the differing terrain types most of the following general guidelines apply:

- avoidance of unnecessary soil disturbance and conservation of selected top soil where appropriate during pad construction;
- removal of drilling surface contaminants (oils, muds, grease, sludge etc.), to waste storage following hole completion;
- reconstruction of landforms, ripping of hardstanding and respreading of stockpiled surface material;
- re-establishment by artificial seeding of selected vegetation species characteristic of the local terrain types;

- regular monitoring of growth performance.

**Research**

The Joint Venturers support the principle of environmental research on the basis that this work in addition to increasing awareness of the region's ecological relationships provides feedback that will enable the regular updating and improvement of monitoring and management programmes. To remain cost effective this work requires effective communication links with research organizations and Government Departments and to this end the Joint Venturers believe that in some areas joint participation and funding may be desirable. Research may be directed at:

- providing facilities and personnel for experimental germination studies on selected vegetation of the region particularly ground cover and ephemerals;

- extension of studies on soil salt storage, its movement and effect on vegetation;

- further studies on plant water balance requirements and adaptability studies particularly on the western myall (Acacia papyrocarpa), an important shade tree in drainage catchments in the townsite;

- studies on bird deterrent mechanisms associated with the tailings retention system;

- studies associated with endemic aquatic invertebrate fauna associated with the mound springs (see Section 6.3 above).

## 8.2 STAFFING

**Radiation Safety Officer**

The Joint Venturers already employ a professional person on site with qualifications in radiation protection. This person also provides professional expertise in other areas of occupational hygiene and hazard control.

His responsibilities include:

- the development and maintenance of the Project radiation monitoring system

- the regular reporting of results to Government regulatory authorities

- the regular auditing and reporting on radiation matters to RMS and Joint Venture management

- the provision of input into the design of Project facilities

- the development and monitoring of occupational health and safety standards for Project operation

- the ongoing education programme in respect of radiation matters for employees and the community at Olympic Dam.

**Environmental Officer**

Roxby Management Services has, on behalf of the Joint Venturers, maintained a high level of professional environmental input from the commencement of the intensified drilling programme late in 1979. Following the completion of the EIS, this input may be undertaken by an environmental specialist employed by RMS or by the continuing use of appropriate consultants. The responsibility for environmental management will continue as a line management function within RMS. The following responsibilities and tasks outlined should not be seen as an exhaustive list rather as an indication of the type of work currently performed or planned by the environmental section. The programme needs to be sufficiently flexible to accommodate Project status changes from exploration through feasibility assessment, pre-construction, construction and operation stages.

Responsibilities would include:

- ensuring that all site personnel understand and comply with the Joint Venturers' approach to environmental management;

- formulating, implementing and evaluating ongoing programmes in areas such as revegetation programmes in disturbed areas, vermin and weed control, soil and salinity studies, local seed collection experimental amenity planting and floristic water requirements;

- monitoring of air and surficial water quality, avifauna, fauna, vegetation, erosion, soil salt storage levels and effectiveness of rehabilitation programmes;

- consulting with land use planners to ensure that adverse impacts to the environment are minimized;

- liaising with relevant consultants, contractors, State and Federal authorities, pastoralists and other land users in respect of environmental matters;

- establishing and maintaining a site nursery;

- maintainance of site meteorological stations and supervision of data collection;

- encouraging a positive, knowledgeable and concerned attitude towards the environment through induction and education among all site personnel.

## 8.3 ASPECTS OF MONITORING PROGRAMMES

Comments were made in relation to the following monitoring aspects:

- the approach to monitoring the tailings retention system
- clarification of the term 'environmental water quality'
- the availability of results of monitoring.

### TRS Monitoring

The need for and extent and method of monitoring any seepage from the TRS will be decided in consultation with the regulatory authorities and in the light of the results obtained from the pilot tailings retention system referred to in section 3.2 of this document. Because of the nature of the topography and foundation conditions at Olympic Dam, seepage from the tailings storage and the evaporation ponds will tend to travel vertically downwards toward the water table. The detection and measurement of small volumes of seepage under such conditions is a complex task as non-saturated ground conditions will exist and the influence of seepage from one location will be largely confined to the area directly below that point.

Two possible methods of detection of seepage beneath the evaporation pond are proposed. The first would be to install resistivity type detectors at selected locations beneath the pond. These would enable changes in the resistivity below the evaporation pond to be measured and provide a qualitative indication of the changes in the moisture content of the ground. The detectors being of simple design would have a long functional life expectancy. The second method would be to install standpipe type piezometers into the water table adjacent to the evaporation pond embankments to enable changes in level and chemical content of the water table to be observed. Both methods would provide a qualitative assessment of the presence of escaping liquor. A quantitative assessment of liquor losses in the form of seepage would only be possible if an accurate water balance calculation could be carried out.

The detection of seepage from the tailings storage will be hampered by the same difficulties discussed when considering seepage from the evaporation pond. The deep ground water together with permeable underlying strata and minimal potential seepage of liquor will not allow the build up of a saturated zone beneath the embankment.

It will, therefore, be extremely difficult to collect quantitative data and only detection will be possible. Resistivity type gauges could be positioned around the central decant area with a reading station mounted at the top of the structure. Standpipe piezometers could be installed below the decant to enable level monitoring and sampling of the ground water table to be carried out.

It should be stressed that seepage from the central areas of the storage will be minimal due to the proposed foundation treatment and the impermeable nature of the tailings. Ponded liquor will be minimized at all times to permit the development of high densities in the deposited tailings thus further reducing the potential for the seepage of liquor to occur.

**Regional Water Quality**

Clarification was requested of the term monitoring of 'environmental water quality' in section 6.2.3. The Joint Venturers intend to monitor regional water quality through a system of bores close to areas of possible contamination, monitoring bores around the Project area boundary, and monitoring of water quality in selected existing bores and wells outside the Project area. Section 6.2.3 of the Draft EIS sets out the proposed groundwater monitoring programme. The nature of this programme will be decided after discussion with the relevant regulatory authorities.

**Availability of Monitoring Results**

Results must be made available to the Minister as set out in Clause 13(8) of the Indenture Agreement. All information supplied under the Indenture Agreement may not be disclosed without consent as specified in Clause 35 of the Indenture Agreement.

The Joint Venturers will report to government bodies as required by law.

## 8.4 COMMUNITY EDUCATION PROGRAMME

A public submission requested the establishment of an education programme for residents of Olympic Dam in respect of radiation and uranium mining. Such a programme is already underway at Olympic Dam and consists of illustrated talks given by the Radiation and Safety Superintendent, a qualified health physicist, to both employees and their families. The programme will continue.

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## APPENDIX 1

## SUMMARY OF PUBLIC COMMENTS

| | Author of public submission<br>Summary of points raised | Reference to response made in in supplement |
|---|---|---|
| **1** | **United Farmers and Stockowners of SA Inc** | |
| 1.1 | livestock production difficult adjacent to centres of population; livestock raising affected by dogs, human movement, vandalism and traffic movement | 5.1 |
| 1.2 | difficulty in retaining rural workforce because of more attractive opportunities at Olympic Dam | 5.1 |
| 1.3 | queries in relation to pipeline water supply to pastoralists | 5.2 |
| 1.4 | road building could affect water runoff to dams | 5.1 |
| 1.5 | request for GAB monitoring results to be made available to pastoralists in the area | 8.3 |
| 1.6 | who will maintain roads: will they be private or public and the implications for access control: will rural transports be able to use roads | 5.6 |
| 1.7 | request for Joint Venturers to fence the road to Woomera subject to appropriate water supply provisions | 5.1 |
| 1.8 | penalties for vandalism; education programme for town population | 5.1 |
| 1.9 | problem of dogs | 5.1 |
| 1.10 | availability of power to pastoralists | 5.2 |
| 1.11 | favour power lines following transport corridor | 5.1 |
| 1.12 | asking RMS to assist in negotiations with Telecom and ensure pastoralists have access to lines | 5.2 |
| **2** | **B.R. Durman** | |
| 2.1 | damage due to feral dogs, cats and vandalism | 5.1 |
| 2.2 | compensation for airport from area around Coorlay Lagoon | 5.2 |
| 2.3 | double fencing of road to Andamooka (problems of stock accidents at 12 Mile Dam and Phillips Ridge) | 5.1 |
| 2.4 | wish to discuss access to watering points off the proposed pipeline | 5.2 |

| | Author of public submission<br>Summary of points raised | Reference to response made in in supplement |
|---|---|---|
| 3 | **D.G. Rossiter** | |
| 3.1 | insufficient evidence to revise SAA Earthquake Code zonings | 7.4 |
| 4 | **F. Mollenmans** | |
| 4.1 | large quarry required for mine fill - why can't tailings be used | 2.3, 3.4 |
| 4.2 | how will tailings dam and related structures be affected by 50 mm rainfall | 3.1 |
| 4.3 | information on vegetation very general in relation to infrastructure corridors | 7.1 |
| 4.4 | Acacia linophylla incorrectly classified | 7.1 |
| 4.5 | public education programme requested on mine functioning and dangers of uranium mining | 8.4 |
| 4.6 | need for on-site person to monitor dangers associated with uranium mining | 8.2 |
| 4.7 | need for trained biologist for biological monitoring | 8.2 |
| 5 | **The South Australian Ornithological Association** | |
| 5.1 | effect of drawdown of mound springs on avifauna; important as drought refuge area; recommends intensive survey be carried out | 6.3 |
| 5.2 | recreational impact on birds; controls on recreational impacts | 5.3 |
| 6 | **Friends of the Earth (Victoria)** | |
| 6.1 | Indenture could pre-empt environmental assessment procedures | 1.5 |
| 6.2 | suggestion of parliamentary hearings on the Project | 1.5 |
| 6.3 | detailed feasibility study of copper/gold/silver extraction only desired | 2.2 |

| | Author of public submission<br><br>Summary of points raised | Reference to response made in in supplement |
|---|---|---|
| **7** | **David Symon (Waite Agricultural Research Institute)** | |
| 7.1 | concern in relation to impact of drawing water from Great Artesian Basin | 6.3 |
| 7.2 | concern over survival of <u>Eriocaulon</u> <u>carsoni</u> known to occur at Hermit Hill (which is still in a reasonable state) | 6.3 |
| **8** | **Campaign Against Nuclear Energy (SA) Inc** | |
| 8.1 | no opportunity for public comment via an EIS on exploration phase | 1.5 |
| 8.2 | need perceived to critically assess economic viability | 2.2 |
| 8.3 | the long time period associated with feasibility study and commitment to proceed means that exploration activity with its associated impacts will continue for a longer period than necessary | 1.5 |
| 8.4 | lower uranium price and demand considered more appropriate | 2.2 |
| 8.5 | no account of toxicity and carcinogenicity of solvents, radio-toxicity and solubility of ammonium diuranate | 4.1 |
| 8.6 | inadequate attention to transport of toxic and radioactive materials on workers' clothing | 4.3 |
| 8.7 | risk assessment on increases rather than total exposure | 4.1 |
| 8.8 | finance an independent anthropologist | 7.6 |
| 8.9 | significant public investment in Project through cost of power generating plant | 5.2 |
| 8.10 | ETSA should have other priorities than providing fossil fuel powered generating plant | 5.2 |
| 8.11 | more hydrogeological information required on effects of drawing water supply from the GAB | 6.3 |
| 8.12 | build-up of radon gas from tailings on windless days, need for water cover | 3.3 |
| 8.13 | comparability of US EPA regulations | 3.2 |
| 8.14 | security in relation to yellowcake transport | 4.5 |
| 8.15 | unions and environmental groups should be given access to routine radiation monitoring | 8.3 |

| | Author of public submission<br><br>Summary of points raised | Reference to response made in in supplement |
|---|---|---|
| **9** | **Wolfgang Zeidler (S.A. Museum)** | |
| 9.1 | concern about the siting of bores and their effect on the mound springs | 6.3 |
| 9.2 | fauna has not been studied in sufficient detail for ecological assessment | 6.3 |
| 9.3 | constant seepage is essential to maintain fauna | 6.1 |
| 9.4 | species vary from top of mound to bottom | 6.1 |
| 9.5 | species vary from mound to mound | 6.1 |
| 9.6 | requests consideration of alternative bore sites | 6.5 |
| 9.7 | Hermit Hill to be preserved | 6.4 |
| **10** | **Nature Conservation Society of South Australia Inc** | |
| 10.1 | concern about localized effect of Borefield A on mound springs | 6.3 |
| 10.2 | lack of adequate baseline data with respect to mound springs | 6.1, 6.3 |
| 10.3 | computer model fails to account for characteristics peculiar to the springs | 6.3 |
| 10.4 | fauna depend on flow rather than ponding, therefore maintenance of flow rates is essential to survival | 6.1 |
| 10.5 | concern about possible damage to Hermit Hill and need for its protection | 6.3, 6.4 |
| 10.6 | note that 9 ML/d available from Port Augusta | 6.5 |
| 10.7 | mitigation measures for the mound springs require closer attention | 6.2 |
| 10.8 | insufficient justification for Borefield A in particular | 6.5 |
| 10.9 | who is responsible for control of withdrawal of water from GAB | 6.5 |
| 10.10 | inadequate consideration of impacts beyond the town site | 5.3 |
| 10.11 | failure to accept a greater responsibility for indirect impacts | 5.6 |
| 10.12 | failure to investigate means of investigating ways of minimizing indirect impacts | 5.3 |
| 10.13 | failure to address responsibility for staff and equipment for management strategies to protect environmentally significant features as well as providing for recreation needs and demands of increased population | 5,3, 5.6 |

| | Author of public submission<br><br>Summary of points raised | Reference to response made in in supplement |
|---|---|---|
| 10.14 | suggested need for reserves in this area | 5.6 |
| 10.15 | additional data requested on sources of resources | 5.5 |
| 10.16 | single corridor for rail and road route to minimize habitat severance | 7.3 |
| 10.17 | measures to prevent birds using acid liquor evaporation pond required | 3.4 |
| 10.18 | recommends consulting specialists | 6.1, 6.3 |
| **11** | **W.A. Wabeke** | |
| 11.1 | Joint Venturers should use more labour intensive mining methods | 2.1 |
| 11.2 | mining methods proposed are prone to rockfall, especially when unsupported | 2.3 |
| 11.3 | Joint Venturers should use more 'orthodox' methods, e.g. shrink stoping, square set | 2.1 |
| 11.4 | build up of radon gases in orepasses, dead-ends etc. | 4.4 |
| 11.5 | 'secondary' ventilation will be required to disperse radioactive matter | 2.3 |
| 11.6 | danger of radioactive dust particles in mine air | refer Draft EIS |
| 11.7 | air velocity inadequate to disperse radon products | 2.3 |
| 11.8 | concern at the use of the decline as a transport route for explosives | 2.3 |
| 11.9 | danger to mine workers in clearing blocked ore-passes and drawpoints because ore will settle like concrete | 2.3 |
| 11.10 | shock effects of blasting and effects on groundwater movement | 2.3 |
| 11.11 | security of tailings base | 3.1 |
| 11.12 | tailings liquor seepage to groundwater | 3.1 |
| 11.13 | leakage from TRS | 3.1 |
| 11.14 | NIOSH findings supercede ICRP | 4.1 |
| 11.15 | Carcinogenic effects of low levels of radiation | 4.1 |
| 11.16 | no opportunity for town people/local council to participate in decisions on town boundaries | 7.5 |

| | Author of public submission<br>Summary of points raised | Reference to response made in in supplement |
|---|---|---|
| **12** | **J. Wilkinson** | |
| 12.1 | concern about proximity of transmission line to airstrip | 5.1 |
| **13** | **C.J.M. Glover (S.A. Museum)** | |
| 13.1 | mound springs are habitat for indigenous and endemic Australian fishes | 6.1 |
| 13.2 | mound springs important as avifauna habitat | 6.3 |
| 13.3 | good examples of a particular geologic formation | 6.3 |
| 13.4 | has physical data on file | 6.1 |
| 13.5 | preservation of certain springs desired | 6.4 |
| **14** | **Friends of the Earth (South Australia) Inc** | |
| 14.1 | question the need for uranium to be extracted | 2.2 |
| 14.2 | relationship of Olympic Dam to nuclear war | 2.2 |
| 14.3 | no assurance that Olympic Dam will not have adverse health effects on miners and townspeople and adversely affect regional water quality | refer Draft EIS |
| 14.4 | workers compensation issues | 4.5 |
| 14.5 | emission of radon from TRS after decommissioning | 3.3 |
| **15** | **Kokatha People's Committee Inc** | |
| 15.1 | indicating interest in anthropology | 7.6 |
| 15.2 | intention to prepare reports | 7.6 |
| 15.3 | RMS are aware of traditional interest at Olympic Dam | 7.6 |
| **16** | **W.D. Williams** | |
| 16.1 | concern about effects on mound springs | 6.3 |
| 16.2 | endangered aquatic environments | 6.1, 6.3 |
| 16.3 | need for research and investigation | 6.3 |
| 16.4 | specific mitigation measures mentioned to be undertaken before decision to proceed | 6.2 |

| | Author of public submission<br>Summary of points raised | Reference to response made in in supplement |
|---|---|---|
| **17** | **R.S. Beckwith** | |
| 17.1 | concerns in relation to EIS procedures | 1.5 |
| 17.2 | no justification for production target | 2.2 |
| 17.3 | diversion of public resources to Olympic Dam not justifiable | 5.2 |
| 17.4 | upgrading of copper in Australia to provide greater benefit to South Australians | 2.2 |
| 17.5 | queries uranium demand forecasts | 2.2 |
| 17.6 | no consideration of new technological developments - robotic mining, Dextec techniques, solar energy | 2.1, 7.5 |
| 17.7 | questions the assertion that the GAB can supply the projected water requirements indefinitely | 6.5 |
| 17.8 | might require additional water for tailings retention area to control dusting | 3.1 |
| 17.9 | slower build-up recommended to establish feasibility | 1.5 |
| **18** | **Conservation Council of the SE Region and Canberra Inc** | |
| 18.1 | opposed to nuclear fuel cycle, radioactivity of tailings, plutonium, nuclear proliferation and disposal of nuclear wastes | 2.2 |
| **19** | **M. Davies** | |
| 19.1 | period of public comment inadequate | 1.5 |
| 19.2 | calling it Olympic Dam Project seen as discouraging public input | 1.5 |
| 19.3 | use of uranium for military technology | 2.2 |
| **20** | **E. Davies** | |
| 20.1 | wishes Joint Venturers to start baseline hydrological and ecological studies of mound springs | 6.3 |
| 20.2 | actions by Joint Venturers re mound spring effects | 6.4 |
| 20.3 | have alternative areas been considered | 6.5 |

| | Author of public submission<br><br>Summary of points raised | Reference to response made in in supplement |
|---|---|---|
| **21** | **W.F. Ponder (Australian Museum)** | |
| 21.1 | expressed concern about effect of Borefield A and possibly Borefield B | 6.3 |
| 21.2 | provides details of results to date of mound spring research<br>. localized species<br>. fauna from groups of springs varies<br>. within spring each species is habitat specific<br>. species do not colonize bore outflows<br>. cattle damage reduced fauna<br>. unique geology | 6.1 |
| 21.3 | consequences<br>. need to retain flow for species to survive<br>. difficult to maintain habitat artificially<br>. springs still of value despite degradation due to cattle | 6.2 |
| 21.4 | fauna composition understated in EIS | 6.1 |
| 21.5 | mound springs a unique habitat containing variety of organisms found nowhere else | 6.1 |
| **22** | **R. Pimlott** | |
| 22.1 | military use of uranium not mentioned | 2.2 |
| **23** | **Environmental Protection Council** | |
| 23.1 | concern re mound springs | 6.2 |
| 23.2 | urges implementation of baseline studies, control of bores, conservation of springs, definition of state/proponent responsibilities | 6.3 |
| **24** | **M.E. Piercy** | |
| 24.1 | insufficient detail on water and power supplies | |
| | . concern re mound springs impacts; suggest Joint Venturers undertake studies and absorb cost of mitigation | 6.3 |
| | . alternative water supplies considered; justification for 33 ML/d (need for water conservation) | 6.5 |
| | . need for anthropological surveys | 7.6 |

| Author of public submission<br><br>Summary of points raised | | Reference to response made in in supplement |
|---|---|---|
| **25** | **T.N. Swindon (Australian Radiation Laboratory)** | |
| 25.1 | no reference to other examples of subaerial tailings disposal in Australia; need to evaluate before operation | 3.2 |
| 25.2 | problems with plastic membrane | 3.2 |
| 25.3 | need for monitoring boreholes in TRS | 8.3 |
| 25.4 | elaboration on procedure for wind tunnel tests | 3.1 |
| 25.5 | queries on air quality estimates methodology | 4.4 |
| 25.6 | information desired on equilibrium conditions in relation to radon emissions under inversion conditions | 4.4 |
| 25.7 | not possible to estimate radon recirculation by intake vent from exhaust vent under inversion conditions | 4.4 |
| 25.8 | typographical errors noted | App. 5 |
| **26** | **M.A. Robertson** | |
| 26.1 | weeds effects on:<br>. conservation of native flora and fauna<br>. town amenity<br>. pastoral activity | 5.4 |
| 26.2 | recreation impact on distinctive features (wishes to know nature of impacts, mitigation measures and responsibility for implementation) | 5.3 |
| 26.3 | assurance desired that population will not exceed 9,000 people | 7.5 |
| 26.4 | mound springs - undertaking to protect areas from grazing and human impacts and to carry out studies | 6.3 |

| | Author of public submission<br>Summary of points raised | Reference to response made in in supplement |
|---|---|---|
| **27** | **T.B. Brealey (CSIRO)** | |
| 27.1 | objectives of town development are vague and non-specific | 7.5 |
| 27.2 | no indication of standard or capacity of community facilities | 7.5 |
| 27.3 | no residual experience from the design of Leinster within Seltrust | 7.5 |
| 27.4 | ambivalent attitude towards employment of women | 7.5 |
| 27.5 | no mention of participation rates of resident females | 7.5 |
| 27.6 | question the rationale to encourage married people; queries assumption that this is necessarily required for population stability | 7.5 |
| 27.7 | desirability of free water to householders to support gardens to mitigate climate effects | 7.5 |
| 27.8 | desirability of education programme and providing plant species compatible with low rainfall for residents | 7.5 |
| 27.9 | rationale leading to conclusion that 3/4 bedroomed houses are desirable is fallacious | 7.5 |
| 27.10 | statement on size of families is incorrect | 7.5 |
| 27.11 | percentage of overseas born is too low | 7.5 |
| 27.12 | no basis for suggesting that foreign born residents will have no family ties in Australia | 7.5 |
| 27.13 | adverse effects of single retailer policy | 7.5 |
| 27.14 | two level shopping hierachy not sustainable at 9,000 population | 7.5 |
| 27.15 | conditions are likely to attract short term cash target workers | 7.5 |
| 27.16 | demographic data inappropriate | 7.5 |
| 27.17 | no reason to separate construction workforce from town | 7.5 |
| 27.18 | queries assumption that separation from kin is a serious problem - affects need for community facilities | 7.5 |
| 27.19 | no statement as to why home ownership will be encouraged | 7.5 |

| | Author of public submission<br>Summary of points raised | Reference to response made in in supplement |
|---|---|---|
| 27.20 | stewardship of the dunes | 7.5 |
| 27.21 | in-situ construction of houses should be avoided | 7.5 |
| 27.22 | overhead electricity is aesthetically undesirable | 7.5 |
| 27.23 | irresponsible not to install solar water heaters | 7.5 |
| 27.24 | population forecasts methodology is inadequate and too low | 7.5 |
| 27.25 | data on town site selection inadequate | 7.5 |
| **28** | **Friends of the Earth (Victoria)** | |
| 28.1 | no basis for comparison of options | App. 7 |
| 28.2 | inadequate discussion and evaluation of 'no uranium' option | 2.2 |
| 28.3 | no discussion of risks involved in mining methods proposed | 2.3 |
| 28.4 | tailings disposal method is risky; alternatives are inadequately discussed | 3.1, 3.2 |
| 28.5 | risks of liquor seepage from TRS to limestone | 3.1 |
| 28.6 | risks of radon emanation from TRS (cracking and drying) | 3.3 |
| 28.7 | economic benefits may not be realised | 2.2 |
| 28.8 | format contravenes DEP guidelines | 1.5 |
| 28.9 | fails to supply detailed plans of orebody | 2.3 |
| 28.10 | draft EIS is premature - should have preceded Indenture | 1.5 |
| 28.11 | commencement date not specified | 1.5 |
| 28.12 | uranium market data is inadequate | 2.2 |
| 28.13 | need for detailed cost/return/feasibility study figures | 2.2 |
| 28.14 | copper market data is inadequate | 2.2 |
| 28.15 | use of tailings as fill | 3.4 |
| 28.16 | use of diesel equipment underground is dangerous to health | refer Draft EIS |
| 28.17 | acid run-off and radon emanation from stockpiles | 4.7 |
| 28.18 | Project layout is too widely dispersed | 2.4 |
| 28.19 | no justification for excluding electro-refining step | 2.2 |

| | Author of public submission<br><br>Summary of points raised | Reference to response made in in supplement |
|---|---|---|
| 28.20 | capital costs are inaccurate and therefore economic analysis is suspect | 2.2 |
| 28.21 | need to neutralize tailings | 3.2 |
| **29** | **Friends of the Earth/Great Australian Artesian Basin Association** | |
| 29.1 | questions Project viability | 2.2 |
| 29.2 | health risks to underground workers | refer Draft EIS |
| 29.3 | radioactivity risk from stockpiles and tailings | 4.3 |
| 29.4 | health risk of toxic process chemicals (cyanide and ammonia) | 4.1 |
| 29.5 | detrimental effects on other bores and mound springs | 6.3 |
| 29.6 | inadequacy of GABHYD model | 6.3 |
| 29.7 | alternatives required to ensure long-term survival of the town | 7.5 |
| **30** | **Nature Conservation Council of NSW** | |
| 30.1 | mound springs support unique biota | 6.1, 6.3 |
| 30.2 | opposes the development of Borefield A considering the unusual nature of the mound springs | 6.5 |

## APPENDIX 2

## LIST OF SUPPORTING DOCUMENTS FOR EIS

The following list of documents together with the Draft EIS and Supplement represent the documentation comprising the Final EIS for the Olympic Dam Project. Reports indicated with an asterisk (*) were made available to the public during the Draft EIS public comment period. The other documents have been submitted to Government officers to assist their environmental assessment of the Project. The documents are listed in the order of presentation of the Draft EIS.

### TERRESTRIAL ENVIRONMENT

**Terrain**

| | |
|---|---|
| * Terrain Analysis (1981) | Baseline Report - Terrain Description. Olympic Dam Project, Draft Environmental Impact Statement, Background Papers, Terrain. Kinhill-Stearns Roger Joint Venture, Adelaide. |
| * Terrain Analysis (1982) | Impact Assessment - Terrain. Olympic Dam Project, Draft Environmental Impact Statement, Background Papers, Terrain. Kinhill-Stearns Roger Joint Venture, Adelaide. |
| * Kinhill Pty Ltd (1982) | Dune history and sand movement. Olympic Dam Project, Draft Environmental Impact Statement, Background Papers, Terrain. Kinhill-Stearns Roger Joint Venture, Adelaide. |

**Surface Hydrology**

| | |
|---|---|
| * Kinhill Pty Ltd (1982) | Baseline Report and Impact Assessment -Hydrology. Olympic Dam Project Draft. Environmental Impact Statement, Background Papers, Hydrology/ Hydrogeology. Kinhill-Stearns Roger Joint Venture, Adelaide. |

**Flora**

| | |
|---|---|
| * Dames & Moore (1981) | Baseline Report - Vegetation. Olympic Dam Project Draft Environmental Impact Statement. Background Papers, Flora, Volume I, Baseline Study Area. Kinhill-Stearns Roger Joint Venture, Adelaide. |
| * T.J. Fatchen and Associates (1982) | Impact Assessment - Vegetation. Olympic Dam Project Draft Environmental Impact Statement, Background Papers, Flora, Volume I, Baseline Study Area. Kinhill-Stearns Roger Joint Venture, Adelaide. |

**Fauna**

- Mammals

| | |
|---|---|
| * Aitken, P.F. (1982) | Baseline Report - Mammals. Olympic Dam Project Draft Environmental Impact Statement, Background Papers, Fauna. Kinhill-Stearns Roger Joint Venture, Adelaide. |
| Downard, R.J. (1980) | Report on rabbit infestation in the Olympic Dam area of Roxby Downs and recommendations relating to the control of the problem. Roxby Management Services. |

- Avifauna

| | |
|---|---|
| * Reid, N.C.H. (1982) | Baseline Report - Avifauna. Olympic Dam Project, Draft Environmental Impact Statement, Background Papers, Avifauna. Kinhill-Stearns Roger Joint Venture, Adelaide. |
| * Reid, N.C.H. and Paton P.A. (1982) | Impact Assessment - Avifauna. Olympic Dam Project, Draft Environmental Impact Statement, Background Papers, Avifauna, Kinhill-Stearns Roger Joint Venture, Adelaide. |

- Reptiles

| | |
|---|---|
| * White, J. (1982) | Baseline Report and Impact Assessment - Herpetology. Olympic Dam Project, Draft Environmental Impact Statement, Background Papers, Fauna. Kinhill-Stearns Roger Joint Venture, Adelaide. |

- Amphibians

| | |
|---|---|
| * Tyler, M.J. (1982) | Baseline Report - Amphibians. Olympic Dam Project, Draft Environmental Impact Statement, Background Papers, Fauna. Kinhill-Stearns Roger Joint Venture, Adelaide. |
| * Tyler, M.J. (1982) | Impact Assessment Report - Amphibians. Olympic Dam Project, Draft Environmental Impact Statement, Background Papers, Fauna. Kinhill-Stearns Roger Joint Venture, Adelaide. |

**LAND USE**

| | |
|---|---|
| David Price & Associates (1982) | Agricultural and economic assessment of surrounding properties. Kinhill-Stearns Roger Joint Venture, Adelaide. |

## ABORIGINAL ENVIRONMENT

### Archaeology


| | |
|---|---|
| Hughes, P.J. (1981) | Olympic Dam Project. Regional Testing of the Baseline Archaeology Predictive Statement. Kinhill Pty Ltd, Adelaide. |
| Hughes, P.J., Hiscock, P. and Rhoads J. (1982) | Olympic Dam Project Archaeology Study: The 1982 Project Area, Townsite and Pipeline Corridor Surveys - Methodology and Results. Volumes I and II. Kinhill Pty Ltd, Adelaide. |
| Hughes, P.J. (1981) | Olympic Dam Project: Stone Features. Kinhill Pty Ltd, Adelaide. |
| Hughes, P.J. and Hiscock, P. (1981) | Olympic Dam Project: Baseline Archaeology Study. Kinhill Pty Ltd, Adelaide. |
| McBryde, I. (1982) | Report on the archaeological features of some mythological sites in the Lake Eyre South area. Kinhill Pty Ltd, Adelaide. |


### Anthropology


| | |
|---|---|
| Sutton Partners (1981) | Anthropological Baseline Studies Literature Review. Olympic Dam Project Environmental Studies. Kinhill-Stearns Roger Joint Venture, Adelaide. |
| Hercus, L. (1982) | Regional survey of aboriginal sites in the vicinity of the proposed Great Artesian Basin water supply system for the Olympic Dam project. Kinhill Pty Ltd, Adelaide. |


## UNDERGROUND ENVIRONMENT


| | |
|---|---|
| Roberts, D.E. and Hudson G.R.T., (1982) | The Olympic Dam Copper-Uranium-Gold Deposit - Roxby Downs, South Australia. Roxby Management Services. |
| Australian Groundwater Consultants Pty Ltd (1982) | Hydrogeology of the Olympic Dam area and impact of mining on the groundwater regime. Rpt. 642/2. Roxby Management Services. |


## TAILINGS RETENTION SYSTEM


| | |
|---|---|
| WLPU Consultants (Australia) Pty Ltd (1982) | Olympic Dam Project tailings & disposal - model and laboratory tests on tailings. WLPU Rpt. No. 506/15. Roxby Management Services. |
| University of Sydney - School of Mining & Civil Engineering (1982) | Wind Tunnel Tests on Specimens of Olympic Dam Tailings for Dusting Potential. Investigation Report S417. WLPU Consultants (Australia) Pty Ltd. |

WLPU Consultants (Aust) Pty Ltd (1982) — Olympic Dam Project Tailings Disposal - Report on Conceptual Design of the Tailings Retention System. WLPU Rpt. No. 506/17. Roxby Management Services.

Bureau of Meteorology (1983) — Estimation of Probable Maximum Precipitation - Woomera Area South Australia. WLPU Consultants (Australia) Pty Ltd.


## OTHER WASTES AND EMISSIONS


* R.K. Steedman and Associates (1982) — Air Quality. Olympic Dam Project, Draft Environmental Impact Statement, Background Papers. Kinhill-Stearns Roger Joint Venture, Adelaide.

* Vipac and Partners Pty Ltd (1982) — Impact Assessment - Noise Level Prediction. Olympic Dam Project, Draft Environmental Impact Statement, Background Papers. Kinhill-Stearns Roger Joint Venture, Adelaide.


## RADIATION ASSESSMENT


Dickson, B.L. (1982) — Uranium series disequilibrium in some samples from the Roxby Downs uranium project. CSIRO Rpt. No. 1292 R.

* T.J. Fatchen & Associates (1982) — Forage intake by sheep, kangaroos and cattle in the Olympic Dam Area. Olympic Dam Project, Draft Environmental Impact Statement, Background Papers, Flora, Volume I, Baseline Study Area. Kinhill-Stearns Roger Joint Venture, Adelaide.


## PROJECT INFRASTRUCTURE


* T.J. Fatchen & Associates (1982) — Ecological description and impact assessment. Infrastructure Corridors - vegetation. Olympic Dam Project, Draft Environmental Impact Statement, Background Papers, Flora, Volume II, Infrastructure Corridors. Kinhill-Stearns Roger Joint Venture, Adelaide.

* Terrain Analysis (1982) — Terrain description and impact assessment - Infrastructure Corridors. Olympic Dam Project, Draft Environmental Impact Statement, Background Papers, Infrastructure Corridors. Kinhill-Stearns Roger Joint Venture, Adelaide.

* Australian Groundwater Consultants Pty Ltd (1982) — Baseline Report and Impact Assessment. Hydrogeology of the Water Supply Borefields. Olympic Dam Project, Draft Environmental Impact Statement, Background Papers, Hydrology/ Hydrogeology, Kinhill-Stearns Roger Joint Venture, Adelaide.

| | |
|---|---|
| Australian Groundwater Consultants Pty Ltd (1982) | Olympic Dam Project: Groundwater supply investigations - technical data. Roxby Management Services. |
| John Connell Consulting Group (1981) | Olympic Dam Project: Preliminary Study of Airstrip Location. Roxby Management Services. |

## SOCIAL EFFECTS AND TOWN DESIGN

| | |
|---|---|
| Ullman & Nolan (1981) | Olympic Dam Project - Town Site Selection preliminary report. Roxby Management Services. |
| Ullman & Nolan (1981) | Olympic Dam Project - Town Development outline report. Roxby Management Services. |

## APPENDIX 3

## ACTS AND OTHER PROVISIONS RELEVANT TO ENVIRONMENTAL CONSIDERATIONS

This appendix lists a number of Acts, codes and other provisions with which the Project must comply and which are related to environmental considerations. Specific requests for compliance with these Acts were made as part of Government comments in relation to the Draft EIS. It does not represent an exhaustive list of all relevant legislation. However, the Joint Venturers are subject to and will observe all relevant statutory requirements.

### Occupational Health and Safety

The following Acts contain provisions relating to occupational health and safety which will apply to the Olympic Dam Project and will be adhered to by the Joint Venturers:

- Health Act
- Industrial Safety, Health and Welfare Act
- Mines and Works Inspection Act
- Noise Control Act.

### Air Emissions

The plant will be required to comply with:

- the Clean Air Regulations, 1972 under the Health Act.

### Water Quality

All of the potable water supply and sewerage facilities constructed within the township or for town purposes are to be constructed and maintained to standards normally adopted by the Engineering and Water Supply Department and the quality of the water supplied for town purposes shall be to standards reasonably acceptable to the South Australian Health Commission.

### Toxic Chemicals

Legislation regulating the keeping, handling, conveyance, and use of toxic chemicals comes within the ambit of the following Acts:

- Dangerous Substances Act
- Industrial Safety, Health and Walfare Act
- Mines and Works Inspection Act
- Health Act.

The relevant provisions of these Acts will be adhered to.

### Radiation

Under Clause 10 of the Indenture Agreement, the Joint Venturers are obliged to comply with the most stringent of the codes, standards or recommendations of the following:

- the Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores, 1980

- codes or recommendations of the ICRP, in particular Publication No. 26 of 1977

- codes or recommendations of the IAEA, in particular the 'Regulations for the Safe Transport of Radioactive Materials'
- codes based on studies or assessments by the NHMRC.

If any of the above are amended, the Joint Venturers must then comply with the amended or future new codes, standards or recommendations. Since the signing of the Indenture Agreement, the following additional provisions have come into being:

- the Radiation Protection and Control Act
- the Code of Practice for the Safe Transport of Radioactive Substances
- the Code of Practice on the Management of Radioactive Wastes from the Mining and Milling of Radioactive Ores.

It is anticipated that further amendments and provisions will be issued. As noted above, the Joint Venturers are obliged to comply with future amendments. For example, the decommissioning of tailings will be in compliance with legislation or regulations applicable at the time of decommissioning and this may be at variance with the method proposed in the Draft EIS.

**Borrow Pit Siting**

The Joint Venturers will abide by the draft guidelines provided to them by the State Government in respect of borrow pit siting and operation.

**On-Site Sand Extraction**

The Joint Venturers will abide by the requirements of the Special Mining Lease and the Mines and Works Inspection Act in the establishment and operation of sand extraction operations on the Lease area.

**Quarry Vibrations**

The Joint Venturers will operate the mine fill quarry so as to meet the requirements of AS 2187, Part 1 - Storage and Land Transport of Explosives and Part 2 - Use of Explosives.

## APPENDIX 4 COMMITMENTS TO UNDERTAKE MITIGATION MEASURES

The following is a summary of commitments made by the Joint Venturers in respect of mitigation measures to limit the environmental impact of the Project operations. They are listed in chapter order, first from the Draft EIS and then from the Supplement.

## DRAFT EIS

## CHAPTER 2

### Use of Tailings as Mine Fill

A test programme to evaluate the suitability of various types of fill for use at Olympic Dam which has been under way since March 1981, will be continued in order to refine proposed filling techniques (p. 2.15).

### Rehabilitation of Quarry for Mine Fill

Rehabilitation of the quarry will be undertaken on a progressive basis as part of the environmental management programme (p. 2.16).

### Below-Ore-Grade-Material Stockpile

The stockpile will be bunded to contain any particulates which might be washed off by rain (p. 2.16).

### Control of Emissions to Air

Dust generated from conveyors to ore storage and grinding mills will be controlled by covering conveyors, by using water sprays or dust collection at transfer points, and by enclosing live ore storage bins at the mine and plant (p. 2.39).

For the RLE circuit, the tail gas from the acid plant, minor acid mist from the electrowinning tankhouse, and in addition for the PLE option, the gases evolved from the autoclaves will be passed through a wet scrubber and the liquid effluent returned to the uranium leach circuit (p. 2.39, 2.40).

In the SC option, off-gas from the fluid bed dryer will be passed through a baghouse and electrostatic precipitator with the dust collected returned to the process, while fugitive dust from the furnace will be collected in a high efficiency dust collection system and returned to the process (p. 2.40).

In both the AL and PL circuits, the combustion gases from the calciner will be passed through a wet scrubber with the spent liquor being fed to the uranium solvent extraction circuit; dust from the yellowcake bin and yellowcake packaging area will be collected in a baghouse and returned to the bin; for the PL option gases evolved from the autoclaves will be scrubbed (p. 2.40).

### Control of Wastewater Emissions

For all process options, nearly all the liquid effluents will be recycled back to the process; the washed solids residue from the CIP adsorption process will be pumped to a well ventilated agitated tank (for decomposition of complexed cyanides) before being pumped to the TRS; the reject carbon slurry from the recycling of the barren carbon solids is diverted to a slop tank then pumped to the tailings surge tank for storage in the TRS (p. 2.40).

Each area within the plant will have a wastewater containment system to ensure that wastewater generated from events such as maintenance flushing and accidental spillages will be contained, drained to a sump within the area and pumped back into that section of the process (p. 2.41).

**Control of Solid Waste**

Uncontaminated waste considered salvageable such as scrap metal, will be sold, while uncontaminated materials not considered salvageable will be disposed of in the mine landfill tip. Material considered contaminated will either be decontaminated or drummed; salvageable material will be sold and non-salvageable material will be disposed of in the mine landfill (p. 2.41, 2.42).

**Control of Noise Sources**

The Joint Venturers will specify that the noise level from individual items of equipment must not exceed 85 dBA at 1 m (p. 2.42).

**Boundary Fencing**

The operations area will be enclosed by a 1.8 m high vermin-proof security fence. The vermin-proof fence will be extended to enclose the airstrip and town (p. 2.49).

## CHAPTER 3 TERRESTRIAL ENVIRONMENT

**Terrain**

Potential terrain-related impacts are amenable to mitigation either through suitable planning and design of development or through control of construction activities (p. 3.19).

Potential sand movement will be controlled by limiting the degree of disturbance on sand dunes, by retention of vegetative cover where possible, and by early stabilization of any areas which show sand drift or which require disturbance of dune ridges (p. 3.19).

Alterations to surface drainage and sediment movement will be accommodated by appropriate engineering design (p. 3.19).

Dust generation due to surface breakdown of trafficked areas on tablelands will be controlled either by sheeting or watering (p. 3.20).

Any development within a swale area will have access closely controlled and the vegetation upslope safeguarded (p. 3.22).

Run-off waters from pavements, buildings, and other impermeable surfaces will be directed into lined channels where necessary to avoid scour (p. 3.22).

Any development involving the removal of dune ridges will include stabilization measures such as mulching, brush spreading or hard surfacing (p. 3.22).

Where appropriate, disturbed areas likely to erode will either be ripped to promote revegetation, or stabilized with surfacing or mulching. Excavated areas in clayey silty soil will be deep-ripped to encourage natural revegetation (p. 3.23).

Cleared vegetation with its associated topsoil will be retained for brush spreading. Where possible, larger tree trunks will be chipped for spreading (p. 3.23).

**Hydrology**

Where necessary to avoid inundation, facilities will be built on raised pads or compensating basins created to receive storm run-off (p. 3.26).

Where appropriate, run-off water will be collected for irrigation (p. 3.26).

Run-off from areas liable to contamintion by ore or plant spillage will be collected in sumps of adequate capacity to receive design storms, and passed to the plant circuit as process water or to the tailings retention system for evaporation (p. 3.26).

**Vegetation Retention and Rehabilitation**

Operation Area:

Loss of vegetation leading to increased sand movement is probably the main environmental concern. In detailed site planning, high priority will be given to the retention of vegetation, particularly on dunefields, by locating development and roads where practicable in interdune corridors and by limiting cross-dune connections. Careful rehabilitation and land management will ensure that areas which are cleared or damaged will be adequately restored (p. 3.50).

The exclusion of stock from the area, the control of rabbits, the creation of buffer zones, and garden and amenity planting will assist in mitigating adverse effects on vegetation (pp. 3.50, 3.51).

To compensate for possible loss of protected plant species, they will be incorporated in general amenity plantings (p. 3.52).

Town:

The maintenance of existing vegetation where practicable, particularly drainage-related vegetation such as mulga and canegrass swamps (p. 3.53).

The avoidance where practicable of dune areas sensitive to disturbance or likely to be present sand drift problems and, where not practicable, the protection of such areas by surface treatment (p. 3.53).

The general siting of most roads parallel to dunes in swale areas, and the minimization of cross-dune roading (p. 3.53).

The alignment of roads, where possible, to avoid stands of western myalls (p. 3.53).

The siting of development primarily in swale areas (p. 3.53).

The siting of houses near, or between, individual trees, but not in place of them (p. 3.53).

Ensuring that an adequate water supply is available to western myalls, either by avoiding interception of run-off to myall groves or, alternatively, providing water to compensate for interception loss (p. 3.53).

### Fauna

Where practicable, rain collecting depressions will be kept away from roadsides (p. 3.60).

The Joint Venturers will examine the factors involved in creating 'breeding islands' in water storages (p. 3.65).

The Joint Venturers will consider various techniques to distract birds from the acid liquor evaporation pond (p. 3.66).

## CHAPTER 4 LAND USE

Where practicable, the Joint Venturers will consider the requirements of development plans in the location, design and construction of Project facilities (p. 4.16).

The Indenture Agreement makes provision for third party usage of water obtained from the borefields (p. 4.20).

The Joint Venturers are responsible for payment of reasonable compensation for loss of land and for the loss of production from any land required for the purposes of the Project (p. 4.21).

The Indenture Agreement (Clause 25) provides for the creation of special buffer zones surrounding the town and mine areas in which development will generally be restricted (p. 4.20).

The Joint Venturers will continue their programme of identifying issues of concern to the pastoralists and informing Project personnel of these concerns to minimize vandalism and stock danger. The Environmental Officer will provide a communication link between pastoralists and Project personnel (p. 4.22).

The Indenture Agreement protects the rights of opal miners in the Andamooka Precious Stones Field to a depth of 50 m (p. 4.22).

The Joint Venturers will conform to the appropriate legislation prevailing at the time of Project abandonment and will use best industry practices in their abandonment procedures (p. 4.23).

## CHAPTER 5 ABORIGINAL ENVIRONMENT

### Archaeology

Damage to archaeological sites will be minimized by the restriction of heavy machinery movement where practicable - particularly the dunes and the floors and margins of pans (p. 5.28).

Recording, salvage and excavation work will be undertaken where required at nine archaeological sites which are considered to be of special scientific value (p. 5.29).

### Anthropology

The Joint Venturers are obliged to conduct their activities with reference to Aboriginal site protection legislation. The Indenture Agreement confirms legal responsibility for site protection that would apply under the Aboriginal Heritage Act, 1979 and retains penalty provisions relating to site damage. A modification of the 1979 Act contained in the Indenture relates to the declaration of protected areas. In the first instance, declaration of protected areas is confined to significant sites identified during EIS preparation and assessment. The Joint Venturers will not withold consent to the subsequent declaration of protected areas under the Act unless such a declaration impedes or disrupt operations or endangers the health or safety of any person (p. 5.40).

The Joint Venturers will take steps to protect verified sites that are determined to be significant and will continue their existing programmes to inform key on-site personnel about the types of aboriginal sites and their responsibility for protecting these sites (p. 5.42).

## CHAPTER 6 UNDERGROUND ENVIRONMENT

### Mine dewatering

The Joint Venturers will investigate the possible use of groundwater pumped from the mine for process make-up water after suitable treatment. If this use is not possible then the water will be pumped to the tailings retention system for evaporation (p. 6.21).

### Groundwater Monitoring

A groundwater monitoring programme will be established to monitor the mine dewatering system to ensure that mining requirements are met, to monitor the cone of depression resulting from aquifer dewatering, and to detect any changes that may result. This monitoring programme will include monitoring of dewatering pumpage and water levels, collection of samples from bores close to areas of possible surface contamination for analysis, construction of monitoring bores around the Project Area boundary, and regular quality monitoring of existing bores and wells outside the Project Area. For monitoring of mine water, the location and amount of inflows will be noted, samples taken for analysis and measurements and analysis taken of water pumped from the mine (pp. 6.22, 6.23).

## CHAPTER 7 TAILINGS RETENTION SYSTEM (TRS)

### Construction

The earthworks for the construction of the first stage of tailings embankments will be balanced so that no external borrowing will be necessary (p. 7.4).

The crest of the tailings embankments will be covered by a wearing zone to prevent erosion and will be sloped inwards to direct rainfall into the storage basin (p. 7.4).

The inward facing zone of the tailings embankments will be constructed from swale material to provide an erosion resistant face with low permeability. The outside face of the embankments will be covered with 1 m of selected rockfill to provide protection from erosion to all exterior faces of the storage (p. 7.4).

### Spillage Leakage Safeguards

A low bund will be constructed around the periphery of the embankments to control any accidental spillage and to divert and pond stream flow from the small catchments outside the tailings storage. The bund will be capped with a wearing surface to permit vehicle access (p. 7.4).

The last 100 m of the four internal embankments dividing the tailing storage into four separate cells will be constructed of swale material to minimise the possibility of ponded liquor seeping through the internal embankments into the underlying foundation zones (p. 7.4).

To ensure that a competent layer of soil is in place between the tailings and the dolomitic limestone underlying the tailings area, the Joint Venturers will locate the soil/limestone interface by a programme of seismic refraction and shallow bores, excavate the limestone (if necessary) so that a sufficient depth of compacted fill can be placed to achieve the desired soil cover, conduct a geophysical survey to locate dolines in the limestone which if present will be back-filled and sealed, ensure a sound base for the concrete decant structure by excavating into the rock after proof-drilling and plugging, and compact the entire surface of the TRS with heavy compaction equipment. In addition to reduce permeability in the base underlying areas where ponding may occur, use will be made of available clays to provide a barrier (pp. 7.4-5).

The tailings delivery pipeline will be bunded to confine any accidental spills. The channel formed by the bunds will be cross-bunded every 200 m to minimise the spread of any spillage and to facilitate clean-up. Close monitoring, instrumentation and fail-safe procedures will be adopted for the corridor. Any soil contaminated as a result of spillage will be removed with the tailings during clean-up and deposited within the confines of the tailings storage (p. 7.5).

**Decant Structure**

The height of the stop logs which will be used at each weir to maintain a crest above the level of the tailings will be kept sufficiently low to minimize any ponding of decant liquor (p. 7.5).

The central pump will be equipped with forced ventilation and a sump pump and instrumentation will be provided to monitor pump performance (p. 7.6).

**Evaporation Ponds**

A list programme will be carried out to evaluate the available type of synthetic liner which might be used to line the decant liquor pond (p. 7.6).

The saline water evaporation pond will be clay lined to provide a low permeability base and the inside face of the pond embankment will be constructed as a low permeability zone (p. 7.6).

Rip rap protection will be provided for both evaporation ponds to prevent erosion by wave action (p. 7.6).

As each stage of storage construction is completed, the 10 m strip between the inside crest of the external embankments and the toe of the new embankments to be built will be decommissioned in accordance with the techniques approved for final tailings decommissioning (p. 7.6).

The saline evaporation pond will be operated independently of the decant liquor evaporation pond after production begins and will be used for saline water only (p. 7.12).

The additional evaporation capacity of the tailings storage during hot periods will be utilized to ensure that a build-up of liquor does not occur in the decant liquor pond and liquor will be pumped back to the tailings storage (p. 7.15).

A deepened hopper section will be provided in the decant liquor pond for the settlement of fines that might carry over from the tailings storage. Any build-up of settled fines which would lower the capacity of the pond will be pumped back to the tailings storage (p. 7.15).

Allowances will be made in design of the evaporation ponds for the loss of effective pond depth due to build up of salts during the evaporation process (p. 7.16).

The concentrated salt solution that will build up in the cell construction of the evaporation ponds will be pumped back to the tailings storage to minimize salt accumulation and effective loss of depth (p. 7.17).

Provision will be made for saline aquifer water to be pumped to the decant liquor pond to maintain a minimum moisture content within the deposited salts (p. 7.17).

**Other Items**

Monitoring of the in situ moisture content of tailings will be carried out to avoid excessive drying of the tailings (p. 7.18).

The condition of the tailings delivery and tailings distribution pipelines will be regularly monitored to minimize the possibility of pipe breaks and spillage (p. 7.19).

The pipeline carrying decant liquor from the storage to the decant liquor pond will be placed in a semi-circular culvert to channel any spillage to the decant pond (p. 7.19).

If the membrane lining of the decant evaporation pond is perforated, then the cell affected will be taken out of action, dewatered and the perforation repaired (p. 7.19).

**Tailings Decommissioning**

The present Project planning is based on placing an average of 1.5 m of swale material over the tailings surface (corresponding to a minimum of 1 m at any point) with a further 0.5 m of quarried rock over the swale material. This will serve to attenuate radon gas emanation, gamma radiation, and protect the tailings from erosion (p. 7.21).

The surface of the swale material will be contoured to provide a more even ponding of run-off percolating through the rock cover. This will prevent a concentration of water in the centre of the storage while still containing any run-off water within the storage area (p. 7.21).

The evaporation ponds will be decommissioned and any contained salts, together with any contaminated soil or embankment material, will be placed in the tailings storage. The synthetic liner will be destroyed or buried or placed in the tailings storage. The areas occupied by the ponds will be rehabilitated (p. 7.21).

**Tailings Storage Monitoring**

A monitoring system of tailings storage performance will form an integral part of the operating procedure. The details of this programme are set out in Section 7.6 of the Draft EIS, but the programme will generally monitor moisture content in the tailings, radon emanation and gamma radiation at various points on and around the TRS, dust generation and groundwater movement below and around the tailings storage. The programme will be approved by the regulatory authorities (p. 7.22).

## CHAPTER 8 OTHER EMISSIONS

### Gaseous Emissions

The emissions indicated by final plant design will be confirmed with the Air Quality Branch of the S.A. Department of Environment and Planning to ensure compliance with the Clean Air Regulations. There are several options whereby this can be achieved (p. 8.18).

### Other Emissions

Protective measures for safety and contaminant control will be built in at the design stage (p. 8.24).

### Process Material Stockpiles

Process material stockpiles other than sand will be situated on concrete pads with concrete bunds around the perimeter to trap particles removed by saltation. Unloading and handling points will be equipped with dust control, suppression or collection devices. Pyrolusite will be reclaimed by underfeed conveyor to minimize dust. All areas of handling will be monitored periodically to ensure adherence to NHMRC recommended limits and corrective measures will be taken if NHMRC limits are approached (pp. 8.30-31).

### Quarry

Dust suppression, control or collection devices will be used on conveyors, transfer points, crushers and screens. Water will be used in drilling, and blasting methods will be carefully controlled. Worker exposure will be maintained to within the NHMRC recommended limit (p. 8.31).

### Roads

Primary roads will be sealed and unsealed roads will be watered to minimize dust (p. 8.32).

### Process Chemicals

Attention will be paid at design stage to the layout of clear access and escape routes. Safety equipment such as showers, eyewash stations and breathing apparatus will be provided where necessary. Access to hazardous areas will be restricted. A register of toxic substances will be prepared and employees instructed in its use. NHMRC recommended values will be followed (p. 8.32).

### Noise

Buffer zones will be provided under the Indenture Agreement which will assist in minimizing possible noise annoyance to town residents from trucks or trains (p. 8.40).

A review of manufacturers' noise data will be undertaken as a selection criterion for air conditioners installed in homes by the Joint Venturers (p. 8.41).

Sites for industry will be located in areas separated from residential areas in the town (p. 8.41).

**Solid Waste**

The design and construction of the town solid waste disposal facility will be located at a sufficient distance from built-up areas to avoid offensive odours but near enough to discourage roadside littering. It will also be at sufficient distance from the airstrip to minimize bird strike problems. It will be progressively covered and will be sited in an area not subject to flooding. Surface drainage will be directed away from the site and covered areas contoured to shed run-off away from landfill areas in use (p. 8.42).

The mine solid waste disposal tip will be operated in similar manner to the town landfill. Contaminated material will be decontaminated where possible prior to disposal. Where possible, contaminated material will be secured in steel drums prior to disposal in a separate area of the tip. The area will be progressively covered with an average 1 m of swale material (p. 8.43).

## CHAPTER 9 RADIATION ASSESSMENT

Project planning has taken into account the Joint Venturers' obligations under the Indenture Agreement to adhere to the radiological protection standards required by the Commonwealth of Australia's Code of Practice on Radiation Protection in the Mining and Milling of Uranium Ores 1980 (Code of Practice), and the codes or recommendations of the International Commission on Radiological Protection (ICRP), the International Atomic Energy Agency (IAEA) and the National Health and Medical Research Council (NHMRC). These standards relate to the control of exposure to radiation above naturally occurring background levels both for employees and for members of the public. Three mechanisms of exposure have been considered in relation to uranium mining and processing: external exposure to gamma radiation, inhalation and retention of radon decay products (radon daughters), and inhalation or ingestion of radioactive particulates (p. 9.1)

**Environmental Radiation Levels**

A baseline survey is being undertaken to provide data on the radioactivity present in the natural environment. This baseline information can then be compared with radiation measurements taken during Project operations in order to detect any changes in radioactivity brought about by the Project. Data will continue to be collected on the various natural radiation sources (p. 9.4).

**Legislation**

Under Clause 10 of the Indenture Agreement, the Joint Venturers are obliged to comply with the most stringent of the codes, standards or recommendations of the following:

- the Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores, 1980
- codes or recommendations of the ICRP, particularly publication no. 26 of 1977
- codes or recommendations of the IAEA, in particular the 'Regulations for the Safe Transport of Radioactive Materials'
- codes based on studies or assessments by the NHMRC (p. 9.13).

If any of the above are amended, the Joint Venturers must then comply with the amended codes, standards or recommendations (p. 9.13).

The Joint Venturers are required by the Code of Practice and by Clause 10 of the Indenture Agreement to ensure, not only that the appropriate limits are observed, but that the human exposure is reduced to the lowest reasonably achievable level, economic and social factors being taken into account (p. 9.14).

**Dose Limitation Criteria**

The Joint Venturers propose to limit the overall exposure of employees to radiation by limiting the contribution from all mechanisms, taken together, in a coherent manner. This includes exposure from gamma, radon daughters and airborne radionuclides (p. 9.13).

A similar approach will be adopted with regard to members of the public (p. 9.18).

The design level commitment in the underground mine is based on a radon daughter exposure to 1 WLM/a. This commitment will ensure exposure averages considerably below that figure because of the statistical spread of results (p. 9.14).

**Dust Control**

Mine Dust Control:

Water will be used for dust suppression. This will include water injection during drilling, water sprays after blasting, washing down of walls, and wetting of piles of broken ore before moving. Sprays will also be used at ore passes and chutes and at the crushers. Ventilation of ore passes will be designed to remove dust produced during tipping of ore, while dust confinement will be provided by enclosures and exhaust ventilation at the crushers and conveyors (p. 9.20).

An assessment of the amount of dust emitted from the underground crusher prior to release to the atmosphere will be assessed by a series of trials which will be carried out in consultation with the Department of Mines and Energy (p. 9.20).

Dust from infrequent large scale blastings will be allowed to settle for an adequate time prior to the recommencement of local full scale ventilation (p. 9.20).

Metallurgical Plant Dust Control:

Dust emissions from the uranium circuit will occur during ore conveying and yellowcake drying and packing. Design criteria for the dust extraction systems will be as specified in the 'Industrial Ventilation Manual of Recommended Practice' (American Conference of Governmental Industrial Hygienists, 1980) (p. 9.21).

Provision will be made in the general design and layout of treatment plant areas for the containment of spillages of material and for ease of subsequent clean-up. Concreted and bunded areas will be provided wherever liquid or slurry spillages are likely, with high pressure hose connection points for washdown and sumps from which clean-up slurry will be pumped back to the appropriate parts of the process circuits. Areas where solid spillages are likely will be concreted, to provide for ease of clean-up by small skid-steered loaders. Areas available for dust resuspension will also be minimized. Vehicles and equipment will be subject to inspection and, where directed, washed down on a drained pad prior to leaving the Controlled Access Area (p. 9.21).

Dust extraction systems will be designed to pick up all dust particles of less than 20 um which become airborne at transfer points, crushers and screens, by the use of enclosures and air velocities which prevent sedimentation. Ducting will be run from pick-up points at an angle greater than the angle of repose of deposited dust, to enable deposited material to slip back to the collection point. Flow velocities in ducts will be 20 m/s in general, and 30 m/s wherever very fine, dry, dusty material is to be handled (p. 9.22).

**Radon Daughter Exposure and Control in the Mine**

The basic commitment of the Joint Venturers is to provide a ventilation design in which the air velocity in occupied workplaces and air transit times through workings will be such as to give normally not more than 0.1 WL. This, in conjunction with operational safeguards will limit the total design exposure to radon daughters for mine workers to 1 WLM per year (p. 9.25).

The ventilation design philosophy has been developed to include as a numerical design criterion a maximum air transit time from intake to last occupied workplace of fifteen minutes. Stripping of pillars in room-and-pillar stopes will always be carried out by retreating into fresh air. Mined out stopes will be sealed from intake airways and provided with a leakage path to exhaust airways (p. 9.25).

**Radioactivity Dose Estimates**

Radionuclide exposure:

Minimization of exposure to long-lived radionuclides in ore dust follows from the dust suppression criterion required in respect to silica, where continuous average dust concentrations of less than 1 $mg/m^3$ will be maintained in general working zones (p. 9.35).

Crib and washroom areas will be regularly cleaned, and those areas together with personnel will be regularly monitored to ensure high standards of personal radiation hygiene as laid down by the Code of Practice (p. 9.36).

Radionuclide Content in Grazing Animals:

Contaminant levels in grazing animals will be regularly monitored, and grazing will be regulated accordingly in the immediate vicinity of the operations area (p. 9.39).

**Yellowcake Handling, Packaging and Transport**

Handling and Packaging:

Exposure of workers involved in yellowcake handling and packaging within the plant will be controlled by engineering design aimed at minimizing the release of dust into the air and maximizing containment of spillage (p. 9.42).

Spillages of uranium concentrate within the plant area will be handled either by washing the material to sumps from which it will be pumped back into the circuit, or by vacuuming. In the event of any spillage outside the calcining or packaging area, or of a severe spillage inside, the spillage will be isolated, operators will be clothed in overalls and equipped with powered respirators, and clean-up will proceed until monitoring by the Radiation Safety Officer or his deputy indicates an acceptable level of decontamination as defined in the Code of Practice. The clean-up crew will change and shower after the completion of clean-up (p. 9.42).

Transport Regulations:

Yellowcake product will be packed into steel drums, which will limit the radiation sources to external radiation only. The drums will then be packed in export shipping containers for transport (p. 9.42).

The Joint Venturers will be responsible for the entire transport operation up to and including off-loading at the port storage area (p. 9.42).

Transportation Safeguards and Monitoring:

The Joint Venturers are committed to accident action planning as part of their operations programme (p. 9.42)

**Monitoring**

Environmental Monitoring:

Environmental monitoring to be undertaken during the operational phase will thus continue the monitoring presently being undertaken as part of the baseline studies. In all aspects of the development of this monitoring programme there will continue to be full consultation with the Department of Mines and Energy and with the South Australian Health Commission (p. 9.43).

Meteorological data collection and high volume air sampling for dust will continue into the operational period, with analysis of filters by gravimetric and gross alpha counting methods to give three-monthly airborne uranium and radium time-weighted average concentrations (p. 9.43).

In the operational period, monitoring of atmospheric radon and radon daughter levels will be performed at the town and at other public locations as part of the continuing environmental monitoring programme. Some of this work will be performed using continuous-running samplers already on site and operational, while some will be by grab sampling at a frequency to be determined following consultation with the Department of Mines and Energy and the Health Commission (p. 9.43).

Vegetation will be sampled on a yearly basis for radionuclides using the same species and the same locations as those used in the baseline study. Details of other biological monitoring will also be compatible with pre-operational baseline studies in terms of sampling location and species selection (p. 9.44).

All new designated employees as defined by the Code of Practice are at present individually instructed soon after appointment, although once operations commence on a larger scale more formal group lectures will be given. Periodic follow-up discussions are being held with core farm workers, underground miners, and staff groups (p. 9.45).

Occupational Monitoring Programme During Production:

Regular operational monitoring of radioactive and non-radioactive contaminant levels will be carried out by the Joint Venturers to enable adherence to commitments to limit exposure agreed with the statutory authorities. Independent checking procedures will also be regularly conducted by the South Australian Department of Mines and Energy and the South Australian Health Commission (p. 9.45).

One of the aims of the radiation monitoring programme is to generate data to serve as a basis for management decision-making. Thus the programme will specifically incorporate 'trigger points' (i.e. radiation levels below the Code levels) which, when exceeded for a specified time, will require a specific programme of actions to be undertaken within a set time scale. It is the explicit policy of the Joint Venturers to develop an appropriate series of responses designed specifically for each aspect of the operation. Action to be taken as a result of information provided by the monitoring plan will be in the nature of a graded response, depending on the level of radiation monitored and on whether radiation levels are decreasing or increasing. This action can be based on:

- the Code guideline suggesting 'protective action levels' which, when exceeded, trigger clearly defined responses;

- 'internal reporting levels' set by management, which provide operational supervisors with early warning to enable corrective action to be taken before operations are affected (p. 9.45).

The reporting of radiation hygiene hazards, contaminant sources, and excursions above PALs will be by formal written report, and will explicitly transfer responsibility for corrective action to the operational department involved (p. 9.45).

The monitoring programme is set out in detail in Section 9.7.4 of the Draft EIS.

In the monitoring programme for gamma radiation, instrument surveys will be carried out as underground headings are opened up. The general workforce will be monitored by monthly TLD badge readings (p. 9.46).

The major radon daughter survey work will consist of weekly surveys of workplaces and transport ways. These surveys will completely cover all mine working areas to identify radon sources, and the intervals at which these will be repeated will be dependent on the readings and as approved by the Department of Mines and Energy and the South Australian Health Commission. Personal radon daughter monitors have not yet been proven in the field, although they are in an advanced stage of development. These will be used once they have been proven in extended field trials (p. 9.46).

For dust control, there will be regular patrolling with instantaneous dust monitors to check the efficiency of engineering control systems, for example by spot readings to check dust extraction systems and for investigation of dust concentration variations while operations are in progress. Full shift gravimetric dust samples will also be taken at regular intervals for free silica determinations (p. 9.46).

Those personnel working for periods in areas where higher than average mine dust arisings can occur (e.g. rock bolting in recently blasted zones) will be subject to regular monitoring with full shift personnel dust samplers. The filters will be analysed by gravimetric and radiometric methods (p. 9.46).

There will be continuously-running high volume air sampling stations at strategic locations at the mine upcast shafts and ore treatment plant. These samplers will be read weekly and will provide data for engineering control procedures feedback and for environmental monitoring (p. 9.46).

Surface contamination surveys will be performed at weekly intervals in mine offices, mine workshops, cribrooms and changerooms and in other workplaces as required, and also on the skin and clothes of employees. Hand alpha contamination monitors will be installed in the treatment plant changerooms and crib rooms, and at the yellowcake calciner and packaging station (p. 9.47).

Personal dose and exposure results will be updated at regular intervals, and will be made available for inspection by each employee on request. The results of the routine monitoring programme will be reported to the regulatory authorities at approved intervals (p. 9.47).

## CHAPTER 10 PROJECT INFRASTRUCTURE

**Pipeline Alignment**

The pipeline alignment to the borefields has been chosen as the most direct route which takes account of environmental constraints such as significant drainage depressions, gullies, escarpments and mound springs (p. 10.2).

**Pastoral Impacts**

If an above ground pipeline is selected, stock and vehicle crossings will be provided in appropriate locations to minimize severence of pastoral lands (p 10.2, see also p. 10.37).

Five archaeological sites considered to be of some scientific significance were identified in the northern corridor and will be subject to further recording (p. 10.2, see also p. 10.44).

Off-road vehicle movement by employees and contractors will be limited during construction and operation to minimize environmental damage (p. 10.2).

**Borefield Development**

Rights of Existing Water Users/Maintenance of Flow:

The terms of the Indenture Agreement protect the rights of existing users and the Joint Venturers must either make alternative supplies available or come to other suitable arrangements with users who are adversely affected (p. 10.3, see also p. 10.66).

Mound Springs:

Mound springs are of environmental, archaeological, anthropological, historical and scientific importance as some support rare vegetation and aquatic invertebrate fauna. Pumping will reduce the flows in eight springs. Further studies of mound springs and the development of measures to mitigate the effects on significant mound springs will be conducted in conjunction with the relevant government Department (p. 10.3, see also p. 10.67).

**Southern Transmission Line Corridor**

Access/Disturbance/Revegetation Approach:

Access will generally be along the corridor and gates or grids will be installed in all fences unless there is an existing gate in close proximity (p. 10.4).

Clearing of vegetation or disturbance will not take place over the full width of the corridor as it is the Joint Venturers policy to clear only the minimum area required for construction and to encourage revegetation of disturbed areas where appropriate (p. 10.4).

Tableland Terrain Impacts/Mitigation Measures:

Erosion can be initiated on the undulating plateau surfaces if the gibber strewn surface is broken resulting in surface waters being channelled. The following mitigation measure will be adopted:

- off-road movement of vehicles during construction and operation will be limited,

- where practicable, the removal of gibber will be avoided in the construction of the access track and transmission towers,

- construction traffic movements will be restricted in wet weather, to ensure that scars are not produced which could initiate runoff and erosion (p. 10.16).

Dissection Slopes:

These slopes have been formed by the erosion of the tableland surface and adoption of the following mitigation measures will provide protection against the effects of continuing erosion.

- off-road movement of construction and operation vehicles will be limited,

- culverts, pipes or inverted crossings will be provided at all major drainage lines, streams and creeks,

- sediment movement and accretion will be allowed for in the design of any drainage structures (p. 10.16).

Drainage Depressions and Stream Channels:

The problems associated with crossing drainage lines are recognized and accepted engineering design measures will be adopted to minimize environmental effects on the surrounding country. To reduce impacts the following mitigation measures will be adopted:

- construction will be avoided in large swamps,

- sediment movement and accretion will be allowed for in design of drainage structures,

- embankments will be protected against large turbulent flows,

- culverts, pipes or inverted crossings will be provided to maintain the current pattern of surface water flows (p. 10.17).

Dune Fields:

The route direction of the transmission line corridor is generally perpendicular to the trend in the dune ridges. This will allow crossings to be made at the most favourable angle with a reduction in potentional impacts. Mitigation measures to be adopted for the dune fields are:

- avoidance of development in the more sensitive dune areas where practicable,

- the access track will be surfaced with compacted local borrow material where it crosses dune ridges and sand sheets,

- deep cuttings in dunes will be avoided where possible,

- bare faces on cuttings will be stabilized where appropriate,

- track formation will be designed to ensure that it does not alter swale catchment boundaries in such a way that surface runoff is transferred to adjacent swales,

- a pad of stabilized material will be provided where towers will be constructed on dune ridges,

- off-road movement of construction and operations vehicles will be limited (p. 10.17).

Vegetation Retention/Rehabilitation:

In the siting of towers and access track vegetation clearance will be minimized and where possible vegetation of botanical significance will be avoided. For areas disturbed during construction the following measures will be adopted:

- Profiles of borrow pits and other disturbed areas will be rounded.

- Where applicable, top soil and other loose material will be respread.

- Disturbed surfaces will be lightly contoured and ripped to create seed traps and to reduce surface wind velocity (p. 10.19).

Archaeological Sites:

Further archaeological work is proposed following tower sites and alignment of the new access track. The work will consist of:

- Where the corridor parallels the existing transmission line within the Arden, Hesso, Mount Gunson and Oakden environmental associations, an archaeological survey of the transmission tower sites will be undertaken.

- Within the Simmens environmental association, the tower sites will be inspected.

- The tower sites and access track alignment within the Oakden environmental association, where the corridor diverges from the existing transmission line, and in the Woomera environmental association, will be surveyed.

- A systematic survey of the access track alignment and sites will be undertaken within the Moondiepitchnie environmental association. If any sites of special scientific importance are located, the service track will be rerouted, or the tower sites relocated, to avoid damaging the site and to obviate the need for salvage work (p. 10.21).

**Project Water Supply**

The pipeline corridor to the borefields will be 50 m wide and it will be necessary to clear vegetation for a road, pipeline, transmission pole sites and conductor stringing. Excavations of a limited number of borrow pits will occur away from the road verges to minimize the effects on visual amenity and restrict the development of stock and fauna watering points adjacent to the road (p. 10.25).

**Pipeline Corridor Mitigation Measures**

Tableland Surface/Dissection Slopes:

Where the pipeline is buried, trench construction could initiate erosion through overfilling or underfilling of trenches. The following mitigation measures will be adopted:

- ensuring that all backfill material is properly compacted

- providing an erosion resistant cover to trenches in any sloping tableland areas (p. 10.40).

Dune Fields:

The access road from Olympic Dam to Canegrass Dam is perpendicular to the dunes which allows the dune crossings to be made at the most favourable point with the avoidance of potentionally unstable dunes where practicable (p 10.41).

**Vegetation Impacts and Mitigation**

Uncommon Vegetation:

Sarcostemma australe has only an isolated and restricted occurrence with one known stand of this species along the traverse. Construction and operation activity will be confined to the corridor right-of-way to avoid further damage (p. 10.41).

**Rehabilitation of Disturbed Areas**

Pipeline Access Corridor:

The following measures will be adopted to rehabilitate areas disturbed during the construction of the water supply facilities:

- Profiles of borrow pits and other disturbed areas will be rounded.

- Top soil and other loose material will be respread.

- Light contour ripping of disturbed surfaces will be carried out to create seed traps and to reduce surface wind velocity.

- Trenches and back-fill will be compacted and profiles shaped to prevent water erosion.

- Certain areas will be watered once, to assist the establishment of vegetative cover (p. 10.42).

**Terrain Impacts Mitigation Measures**

Terrain features are in many respects similar to those documented for southern corridors and adoption of the terrain mitigation measures outlined previously will minimize any erosion resulting from vegetation removal (p. 10.43, see also pp. 10.41, 10.19, 10.17).

Archaeological Sites:

The five sites consisted of scientific significance will be subject to further recording (p. 10.44).

Water Supply Provisions:

The water supply from the borefields will be developed in accordance with the requirements of Clause 13 of the Indenture Agreement. The State will grant a Special Water Licence or Licences, under which the Joint Venturers may draw underground water from borefields to satisfy all or part of the Project water requirements. This Licence will be subject to a number of conditions, including:

- the installation and maintenance of a monitoring system, approved by the State, which will provide data on total water quantities withdrawn, water pressures and levels, and water qualities;

- the provision of an annual report to the State, defining aquifer response to water production, the ability of the resource to maintain the supply, a strategy for future water production and management, and the need for further development of, or use of, additional water sources. This annual report is intended to provide one of the mechanisms by which the State will be able to ensure that the resource is used responsibly (p. 10.44).

Mound Springs:

A number of the mound springs are considered to be of scientific, historical, archaeological and anthropological signifance.

To develop specific measures for the mitigation of any impact upon the mound springs, the Joint Venturers will undertake the following programme:

- establish, in consultation with the Department of Environment and Planning, which springs require study;

- undertake a range of environmental studies related to these springs, including vegetation, limnology, fauna and avifauna. These studies will gather baseline data, assess the impact of the borefield development and recommend any necessary mitigation measures;

- develop and implement measures to protect and conserve significant mound springs in conjunction with the Department of Environment and Planning's ongoing mound spring survey and the current rehabilitation and bore capping programme of the Department of Mines and Energy. Such joint measures might include the provision of alternative water supplies to springs, the restoration of troughs and fences to exclude stock, and the rehabilitation and capping of bores. Certain of these measures could be implemented as a continuation or an extension of existing government programmes, and as such would not be the responsibility of the Joint Venturers (p. 10.67).

This programme is discussed in detail in Section 6.3 of the Supplement.

## CHAPTER 11 SOCIAL EFFECTS AND TOWN DESIGN

### Provision of Community Facilities

Community facilities will be provided to a standard comparable with similar towns elsewhere in Australia (p. 11.2, see also p. 11.9, p. 11.23).

### Town Development/Construction

The Joint Venturers will fund most of the cost of initial construction (while the State Government will fund certain community facilities) (p. 11.2).

### Joint Venturers Vegetation Policy

A policy of retaining existing trees and vegetation to the maximum extent possible is being followed at Olympic Dam (p. 11.2, see also p. 11.18).

**Housing Standards/Living Environment**

A high standard of family housing, long stay caravan accommodation and permanent accommodation for single employees will all be provided in the 'open' town (p. 11.2).

**Construction Village/Rehabilitation**

The construction village will continue to be used during the early years of production until all necessary accommodation is available in the town. Following this the single quarters and caravan accommodation in the village will be dismantled, the existing housing will be relocated to the town and the village area will then be rehabilitated (p. 11.4).

**Single Person Accommodation in Town**

A flexible accommodation policy for single status production employees will be considered and, where appropriate single accommodation will be integrated with other housing throughout the town (p. 11.18).

**Street Design Objective/Road Hierarchy**

The objective of street design has been to provide ease of access and to maintain safety and privacy in residential neighbourhoods. Where appropriate, off road links will be provided for cyclists and pedestrians. Provision will be made in the road width for on street parking, and verge widths will be the minimum consistent with the need for the installation of services and planting of shade trees (p. 11.29).

Water Supply

The Joint Venturers will be responsible for providing potable water (under Clause 13(3) of Indenture Agreement) (p. 11.30).

## CHAPTER 12 ECONOMIC EFFECTS

**Labour Requirements/Training Policy**

The Joint Venturer's policy is to provide a manpower training programme designed to facilitate the employment of semi-skilled and unskilled labour within the region, of females where practicable and of apprentices to a level compatible with the project's workforce (p. 12.21, see also p. 11.9).

SUPPLEMENT

## CHAPTER 2 PROJECT DESCRIPTION

### Occupational Safety

The Joint Venturers will abide by the provision of the legislation relating to occupational health and safety except where new technical developments or performance standards have yet to be incorporated in current regulations and are accepted by the relevant regulatory authorities (p. 13).

### Quarry Noise

The Joint Venturer will use best industry practice to reduce quarry noise to the maximum extent practicable (p. 14).

## CHAPTER 3 TAILINGS RETENTION SYSTEM

A minimum freeboard of 1.5 m will be maintained between the crest of the retaining embankments and the tailings surface (p. 17).

### Short or Medium Term Cessation of Operations

In the event of such a cessation of operations the Joint Venturers will maintain personnel on site to ensure control of access, will continue to dewater the mine and if necessary will add water from mine dewatering to the tailings storage (p. 21).

### Pilot Tailings Retention System

As part of the pilot plant the Joint Venturers will set up a pilot tailings retention system to confirm the suitability of the sub-aerial deposition method and to confirm the results and concepts set out in the Draft EIS. The objectives of the pilot TRS have been determined in conjunction with the SA Department of Environment and Planning. The details of the objectives and measurements to be taken are set out in Section 3.2 of the Supplement and further detail is supplied in Appendix 7 of the Supplement (p. 22).

### Tailings Spillage

In the event of tailings spillage between the embankment walls and the peripheral bund, it will be contained and contaminated soil together with any tailings will be removed and deposited within the confines of the tailings storage (p. 23).

### Associated Facilities

The saline evaporation pond will be designed with adequate freeboard to ensure that under conditions of maximum pumping from the mine and above average rainfall no overtopping will occur (p. 24).

The dispersivity of the proposed clay base will be tested prior to final design of the saline evaporation pond (p. 25).

The Joint Venturers will conduct further literature reviews on the subject of the deterence of birds from the acid liquor pond and will experiment with deterent trials when suitable water bodies are available (p. 26).

## CHAPTER 4 RADIATION AND OTHER EMISSIONS

**Dust from Copper Roasting**

In the event of a positive pressure being created in the copper roaster the facility would be temporarily closed to avoid an occupational health hazard (p. 30).

**Drinking Water**

Under the Indenture Agreement the Joint Venturers must supply the town with water of acceptable quality to the S.A. Health Commission (p. 31).

**Dust from Stockpiles**

When loading to the shaft bin from the temporary ore stockpile, if there is an occupational health hazard to the operator then measures such as the provision of respiratory equipment will be taken. If the responsible authorities perceive an environmental hazard then appropriate dust suppression measures will be taken (p. 31).

**Higher Grade Ore Effects**

If extended areas of high-grade uranium mineralization are encountered in production conditions then active control measures will be taken as necessary (p. 32).

**Spillages**

Contingency plans for clean up of spillage of uranium product or toxic chemicals will be drawn up for approval by relevant authorities before production commences (p. 33).

**Baseline Radiation Monitoring**

The present baseline radiation monitoring programme with certain modifications (detailed in Section 4.6) of the Supplement will be continued. The present meteorological station will continue to operate (p. 33).

**Gaseous Emissions**

The Joint Venturers will discuss with the Air Quality Branch of the SA Department of Environment and Planning the necessary measures to ensure continued compliance with Clean Air Regulations in the event of both production units in the acid plant going off line simultaneously (p. 34).

**Sulphur Stockpile**

The Joint Venturer will take preventative measures including good housekeeping practices, limitation of vehicular traffic on the stockpile and if necessary sealing of the stockpile to minimize fire risk (p. 35).

**Ore Stockpiles**

The Joint Venturers will collect runoff water from stockpiles containing mineralized material for use as plant make-up water (p. 35).

## CHAPTER 5 INDIRECT EFFECTS

**Effects on Pastoral Activity**

The vermin-proof fence around the Project area will effectively prevent any movement of dogs from the town to adjacent grazing areas (p. 37).

The Environmental Officer will liaise with nearby landholders to enable quick identification of problems (p. 37).

The community education for town residents and the employee induction programme will address the maintenance of 'good neighbour' relationships with pastoralists (p. 37).

Fencing of roads will be consistent with the policies of other authorities responsible for road construction in the area (p. 38).

Drainage will be provided under roads to maintain flows to stock dams (p. 38).

The transmission line alignment avoids conflicts with existing airstrips (p. 38).

The transmission line access track will be maintained in a condition that will make it impassable to all but 4 wheel drive vehicles (p. 38).

The Joint Venturers will discuss the availability of water from the pipeline with pastoralists prior to its construction and will provide assistance to pastoralists in negotiations with Telecom on access to telephone lines (p. 39).

**Weed Invasion**

The present programme of vegetation monitoring, destocking and restrictions on off-road use of company vehicles will continue to reduce the risk of undesirable seed transport and provide warning of unnatural increases in weeds (p. 47).

**Source Requirements**

The Joint Venturers in selecting dumes for sand extraction will select dunes that are suitable for metallurgical use, and will use low or devegetated dunes and remove whole dunes in preference to parts of dunes. Maximum use will be made of sand removed from developed areas (such as the plant site) (p. 48).

## CHAPTER 6 MOUND SPRINGS

**Study Programme**

The Joint Venturers will undertake a study programme, parts of which have already commenced, to gather further baseline data on the mound springs, assess the impact of borefield development, provide a basis for future monitoring and recommend any necessary mitigation measures or modifications to the proposed borefield development programme. The elements of the programme are set out in Section 6.3 of the Supplement and relate to vegetation, limnology, fauna, avifauna, geology and hydrology (p. 58).

A consultative committee will be set up in relation to the study programme and ecological management of the mound springs. This has yet to be formalized but will include representation from relevant Government Departments (p. 59).

**Monitoring and Control of Water Abstraction**

Under the Indenture Agreement, the Joint Venturers must satisfy certain criteria before a Special Water Licence can be granted and install a monitoring programme which is subject to the Minister's approval (pp. 60).

## CHAPTER 7 OTHER ISSUES

**Hydrologic Studies of Catchments**

As part of the town design phase of the Project, the Joint Venturers will undertake detailed engineering studies of catchments for drainage design purposes (p. 64).

**Sulphur Dioxide Effects**

The flora monitoring programme will include plant examination for signs of air pollutant damage (p. 68).

**Soil Salinity**

A series of studies in relation to plant growth and soil conditions are currently being undertaken (see Section 7.2 of the Supplement). They involve monitoring of seasonal growth characteristics for selected species, monitoring of soil chemistry, monitoring of a western myall grove in the town site, and salinity considerations in the town site (p. 74).

**Borrow Pits**

The Joint Venturers will abide by the draft guidelines supplied to them by the State Government in respect of borrow pit siting and operation (p. 79).

**Use of Brackish Water**

Untreated borefield water will not be used for vegetation watering because of its carbonate content (p. 80).

**Employment of Females**

Job training programmes will be non-discriminatory as required by law (p. 85).

**In situ House Construction**

This will be evaluated at the time of commencement of construction (p. 88).

**Construction Camps**

Section 7.5 sets out a number of commitments by the Joint Venturers in relation to the construction camp. These relate to the timing and nature of its development, the nature of services and facilities to be provided, the methods of disposal for solid waste, sewage and stormwater and development principles. When the camp has no further use, it will be removed and the area rehabilitated (p. 89).

**Archaeology**

To minimize damage to buried sites, the Joint Venturers will advise appropriate construction personnel of their legal obligations in respect of sites and educate them in identification of archaeological sites (p. 92).

At the request of the Department of Environment and Planning, the Joint Venturers will make archaeological background reports (but not site locations) available to responsible interested parties except in the case of information on stone features (p. 93).

**Anthropology**

RMS will protect anthropological sites in the Project area that have been verified against proper professional anthropological standards. The procedures proposed are set out in Section 7.6 of the Supplement (pp. 93).

## CHAPTER 8 ENVIRONMENTAL MANAGEMENT

**Monitoring**

The Joint Venturers are committed to an integrated environmental monitoring programme to ensure that all aspects of Project research, monitoring and rehabilitation are co-ordinated (p. 95).

Results of the monitoring programme will be reported to the Government as required by the Indenture Agreement (p. 95).

Details of the specific aspects of the monitoring programme are set out in Section 8.1 of the Supplement (pp. 95).

The Joint Venturers support the principle of environmental research (p. 97).

The responsibility for environmental management will continue as a line management function (p. 98).

The community education programme currently underway at Olympic Dam in respect of radiation monitoring and uranium mining will continue (p. 99).

## APPENDIX 7 PILOT PROCESSING PLANT AT OLYMPIC DAM

The pilot plant will be monitored for radiation, airborne dust and occupational hygiene hazards. The data collected will be used as input to the final design and monitoring programme for the full scale plant (p. G-1).

The entire pilot plant area and tailings retention area will be enclosed by a security fence (p. G-4).

Off-gases from the smelter or roaster will be scrubbed to control emissions (p. G-8).

Material impounded in the pilot TRS will be removed from the site on completion of construction of the main TRS and will either be disposed of in the main TRS or treated through the metallurgical plant (p. G-10).

Spillages or wash-down water in the pilot plant will be controlled by bunding and diverted to individual sumps within each section of the plant for recycle to that section (p. G-11).

Other measures taken to contain wastes and emissions from the pilot plant are detailed in Section 5.2 of Appendix 7 to the Supplement (p. G-13).

**APPENDIX 5**

**ERRATA TO THE DRAFT EIS**

| | |
|---|---|
| Page 2.43 | First paragraph<br>'Risks from acute exposure' and 'Risks from chronic exposure'<br><br>should read<br>'Hazards from acute exposure' and 'Hazards from chronic exposure' respectively. |
| Page 3.9 | Figure 3.3<br>Area of K (Cretaceous Siltstone) west of Myall Dam is labelled correctly but coloured as Qs (Quaternary Deposits Superimposed on Low Stony Rises). |
| Page 3.14 | Paragraph 1<br>'Wasson (per. comm.) has found this sand to range from 750 to 2,500 years old from carbon-14 dating of carbonates.'<br><br>should read<br>'Wasson (per. comm.) has found for equivalent dunes in western NSW that from charcoal dating, an age of dune movement between 2,500 and 650 years B.P. was established. The dune caps at Olympic Dam do not contain soil carbonate, suggesting that they are young. The caps contain microliths demonstrating a late Holocene age of less than 5,000 years. These data together suggest a late-Holocene phase of dune mobility which probably correlates with that documented in western NSW.' |
| Page 3.20 | Table 3.6<br>'A4, K4, P4, Qs4' and 'A6, K6, Q6, Qs6'<br><br>should read<br>'A4, K4, P4, Q4, Qs4' and 'A6, K6, P6, Q6, Qs6' respectively. |
| Page 5.20 | Paragraph 5. Delete 'as well as results of the Whenan Shaft survey'. These results were provided in Table 5.11 not Table 5.9. |
| Page 6.13 | Figure 6.8<br>Colour coding of geological units was incorrect in a few instances. See revised Figure 6.8. |
| Page 7.11 | Table 7.2 under 'Solids' column<br>Radium 226 content listed as '4.5 - 6.0 Bq/L'<br><br>should read<br>'4.5 - 6.0 Bq/g'. |
| Page 7.5 | Section 7.13<br>Section heading 'Pipeline corridor'<br><br>should read<br>'Tailings pipeline corridor'. |

| | |
|---|---|
| Page 8.8 | Line 6 under 'Winds'<br>'During the winter months, winds from the north-west quadrant dominated.'<br><br>should read<br>'During the winter months about 70% of the winds had a westerly component, i.e. blew from the south-west to north sector.' |
| Page 8.12 | Line 3 of third paragraph<br>'Throughout the year, the morning temperature at Sandhill generally exceeded that at Shaft Head, while during the afternoon and evening, the Shaft Head temperature generally exceeded that at Sandhill'<br><br>should read<br>'Throughout the year, the temperature at Sandhill generally exceeded that at Shaft Head during most of the the daylight hours, while during the night the Shaft Head temperature generally exceeded that at Sandhill'. |
| Page 8.29 | Under 'Mines and Works Inspection Act'<br>'nitric oxides'<br><br>should read<br>'higher oxides of nitrogen'. |
| Page 9.2 | Last sentence fourth paragraph<br>'... contingency plans for cleaning up and monitoring spillage will be prepared.'<br><br>should read<br>'... contingency plans for cleaning up and monitoring spillage will be prepared to the satisfaction of the appropriate authority.' |
| Page 9.8 | Under 'Airborne Dust'<br>'20 ug/m'<br><br>should read<br>'20 ug/$m^3$.' |
| Page 9.8 | Table 9.3<br>'Treated Olympic Dam drinking water'<br><br>should read<br>'Treated drinking water from the Olympic Dam'. |
| Page 9.9 | Line 6, paragraph 2<br>'Kochia sedifolia'<br><br>should read<br>'Maireana sedifolia'. |
| Page 9.16 | Last sentence of first paragraph<br>'... the two sets are deemed compatible'<br><br>should read<br>'... the two sets are deemed comparable'. |

Page 9.21

Note to Table 9.10
'Ore grade taken as 0.5% $U_3O_8$'
should read
'Ore grade taken as 0.05% $U_3O_8$'.

Page 9.22

Last line of third paragraph
'$1.5 \times 10^{-5}$ Bq/$m^3$.s'
should read
'$1.5 \times 10^{-5}$ Bq/$m^2$.s'.

Page 9.32

Under 'Radon Daughters'
'WL = $2.7 \times 10^{-4}$ x (Rn) x t for t   90 minutes'
should read
'WL = $2.7 \times 10^{-4}$ x (Rn) for t   90 minutes'.

Page 9.38

Lines 5 and 6
'$1.8 \times 10^{-5}$ Bq/m'
should read
'$1.8 \times 10^{-5}$ Bq/$m^3$'.

Page 9.39

Last line of first paragraph
'$7.4 \times 10^{-4}$ Bq/m'
should read
'$7.4 \times 10^{-4}$ Bq/$m^3$'.

Page 9.39

Under 'Radionuclide ingestion through consumption of local vegetables and fruit
'$1.8 \times 10^{-5}$ Bq/m' and '$1.6 \times 10^{-5}$ Bq/m'
should read
'$1.8 \times 10^{-5}$ Bq/$m^3$' and '$1.6 \times 10^{-5}$ Bq/$m^3$' respectively.

Page 9.46

Last sentence paragraph 6
'These (i.e. radon daughter monitors) will be used once they have been proven in extended field trials.'
should read
'These will be used once they have been proven in extended field trials and approved by the appropriate authority.'

Page 10.48

Table 10.7
Results for Venable Spring should be revised from column 1 figures to column 2 figures.

| | (1) | (2) |
|---|---|---|
| Calcium (mg/L) | 34 | 35 |
| Magnesium (mg/L) | 35 | 33 |
| Sodium (mg/L) | 1,250 | 1,190 |
| Potassium (mg/L) | 19 | 17 |
| Bicarbonate (mg/L) | 1,100 | 1,042 |
| Sulphate (mg/L) | 360 | 235 |
| Chloride (mg/L) | 135 | 1,250 |
| Fluoride (mg/L) | 0.7 | 3.2 |
| Total dissolved solids (mg/L) | 3,700 | 3,275 |
| pH | 7.7 | 7.3 |
| Electrical conductivity | 7,150 | 5,000 |
| Total hardness | 220 | 223 |

Results of GAB 2 for total dissolved solids was indicated as '2,465 mg/L'

should read
'2,730 mg/L'.

Page 10.51 First line, paragraph 3
'Table 10.8 summarizes the groundwater quality in Borefield B'

should read
'Table 10.8 summarizes the groundwater quality data for bores in the vicinity of Borefield B'.

Page 10.53 Table 10.10
The following footnote should be added
'In the 1981 survey only flows from the discharge points were measured. In the SADME 1974 survey, discharges were measured either by current meter, bucket, visual estimate or estimation from potential evapotranspiration. The estimate of discharge from potential evapotranspiration was made by measuring the area of water and green vegetation (from aerial photographs taken in February, 1973) and assuming an evapotranspiration of 7 mm/day for that time of the year.'

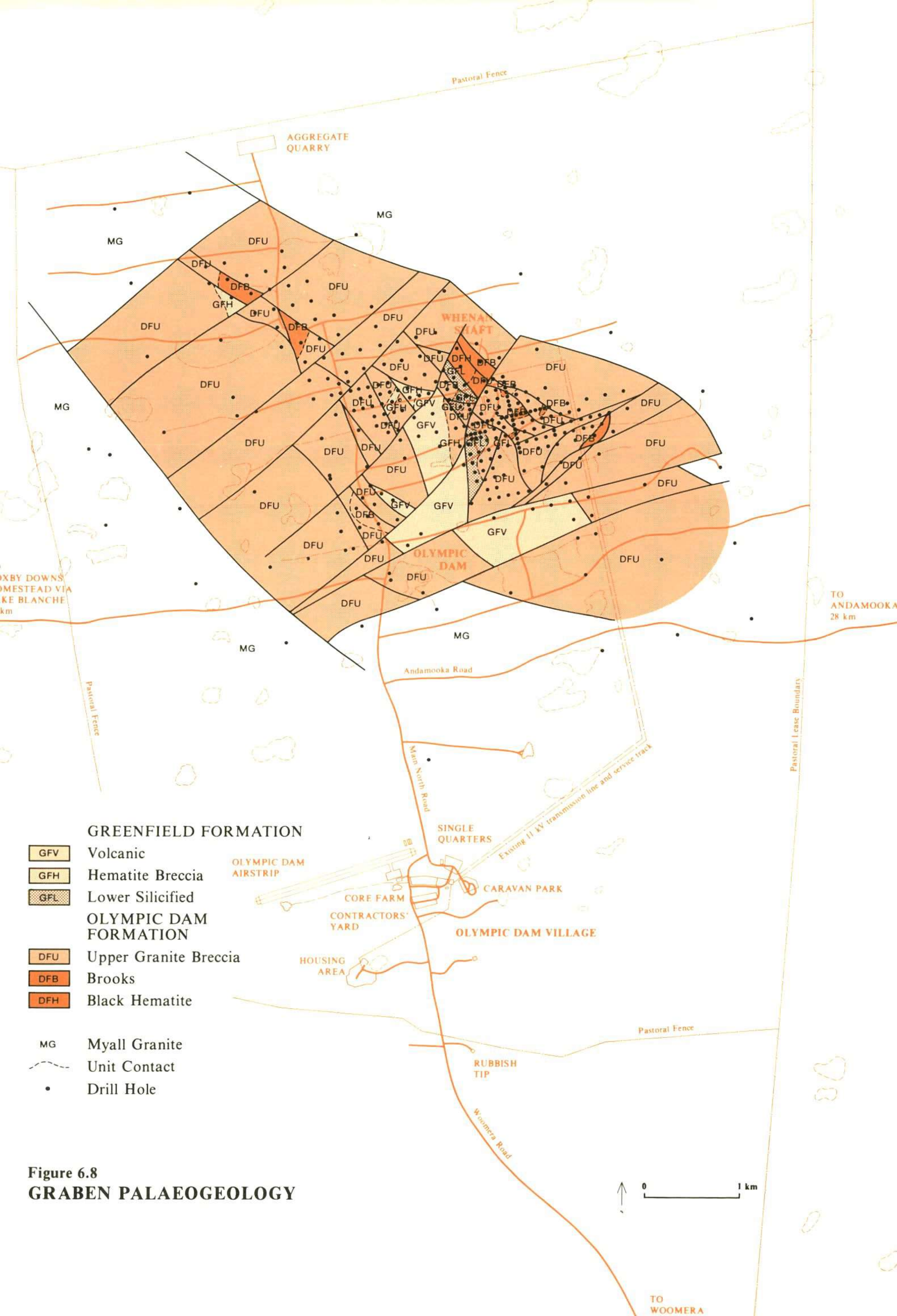


**Figure 6.8**
**GRABEN PALAEOGEOLOGY**

**APPENDIX 6**

**PROPOSED DEVELOPMENT FOR WHICH ENVIRONMENTAL APPROVAL IS SOUGHT**

Approval is now sought by the Joint Venturers for all aspects of the Project addressed in the EIS including the following principle items:

**1 MINE DEVELOPMENT**

(a) Surface Development

(b) Underground Development and Operations

Option to use one or more of the following mining methods and associated equipment:

- Open Stoping
- Room and Pillar
- Post-pillar Cut and Fill.

(c) Underground Transportation

(d) Ore Handling

(e) Ventilation

(f) Mine Dewatering and Groundwater Disposal

(g) Backfilling of Mine.

**2 ORE PROCESSING**

(a) Conveying and trucking to processing facilities

(b) Concentrator - comminution and flotation system

(c) Concentrate Processing Circuit

Option to use one or more of the following processing routes:

- Roast/Leach/Electrowin to produce 'electrowon copper cathode' and 'gold and silver bullion'
- Pressure Leach/Electrowin to produce 'electrowon copper cathode' and 'gold and silver bullion'
- Smelt/Convert to produce 'blister copper' with gold and silver impurities (note: subsequent refining stages are not part of present proposal).

(d) Flotation Tailings Processing Circuit

Option to use one or both of the following processing routes:

- Atmospheric Leach to produce yellowcake
- Pressure Leach to produce yellowcake.

- Approval to construct and operate the pilot plant and all associated facilities.

## 3 TAILINGS RETENTION SYSTEM

Approval for:

- sufficient area for tailings from 30 years production of 150,000 t of copper
- proposed tailings retention concept, construction and operation
- borrow materials for retention system walls
- approach proposed for decommissioning.

## 4 MINE/PROCESSING SERVICE FACILITIES

Approval for facilities required to service mine and processing operations including:

- central workshop
- main store
- administration offices
- medical/first aid centre
- Project fire station
- change houses
- miscellaneous service buildings.

## 5 PROJECT INFRASTRUCTURE

(a) Water Supply

- Borefield A area
- Borefield B area
- Pipeline Corridor - Borefield B to Borefield A to Olympic Dam for pipelines, power supply and service road (subject to additional information on corridor from Borefield A to Borefield B)
- Water treatment and storage at Olympic Dam
- Water distribution system.

(b) Power Supply

- 132 kV line from Woomera to Olympic Dam including transmission line easement, switchyards, associated facilities and on site reticulation

- 275 kV line from Port Augusta to Olympic Dam including transmission line easement, switchyards, associated facilities and on site reticulation.

(c) Roads

- roads internal to Project area (excluding those within the town site)

(d) Airport

- on-site airstrip and associated airport facilities

(e) Rail Spur

- approval not required at this stage except as indicated in Draft EIS for Project area

(f) Boundary Fences

- approval to construct security and vermin-proof fences

(g) Communications

- public telephone exchange and associated facilities

(h) Transportation

- approval to transport all required materials into the site and off the site

- approval to transport mine product to wharf storage.

## 6 TOWNSHIP

(a) Land Area for town to accommodate 30,000 people

(b) Conceptual Town Design to accommodate 9,000 people

(c) General Approach to Subdivision

(d) General Approach to House Design

(e) Approach to Municipal Management

APPENDIX 7

# PILOT PROCESSING PLANT AT OLYMPIC DAM

## 1 PROPOSAL

It is proposed to construct and to operate for approximately 12 months at Olympic Dam, a pilot processing plant which will incorporate processes envisaged for a commercial sized operation. The pilot plant will use bulk samples of ore produced from underground development. The capacity of the pilot plant will be approximately one two-hundredth (0.5%) of the size of the commercial plant outlined in the Draft EIS. It will cost about $15 million to $20 million to construct and employ about 70 people. Figure A7.1 shows the development schedule for the pilot plant and associated facilities.

## 2 OBJECTIVES

The objectives of the pilot plant operation are to:

- confirm the performance of processes indicated by the laboratory and small scale continuous tests which have been conducted to date,
- confirm process design criteria for a commercial plant,
- confirm scale up and engineering design criteria,
- produce quantities of product for quality assessment for marketing purposes,
- produce quantities of residues for operation of a pilot tailings retention system using subaerial deposition,
- assess the required properties of construction materials,
- produce quantities of copper concentrates for smelting tests overseas by process licensors.

The plant may also be used for the training of operators before start-up of the commercial plant and for further testing once the commercial plant has started production.

The plant will be intensively monitored for radiation parameters, airborne dust and other occupational hygiene related hazards. The monitoring programme will be subject to approval of the relevant regulatory authorities. The data collected will be explicitly used as input for full scale plant design and will also enable clearer planning of monitoring to be provided in the full scale plant.

## 3 PROPOSED DEVELOPMENT

### 3.1 Location

The pilot plant and associated on-site infrastructure facilities will be located within the area of Exploration Licence 783 at Olympic Dam (Figure A7.2). The pilot plant, which will be on a Miscellaneous Purposes Licence granted for this purpose, is located in a broad swale to the north of and adjacent to the area proposed for the commercial processing plant.

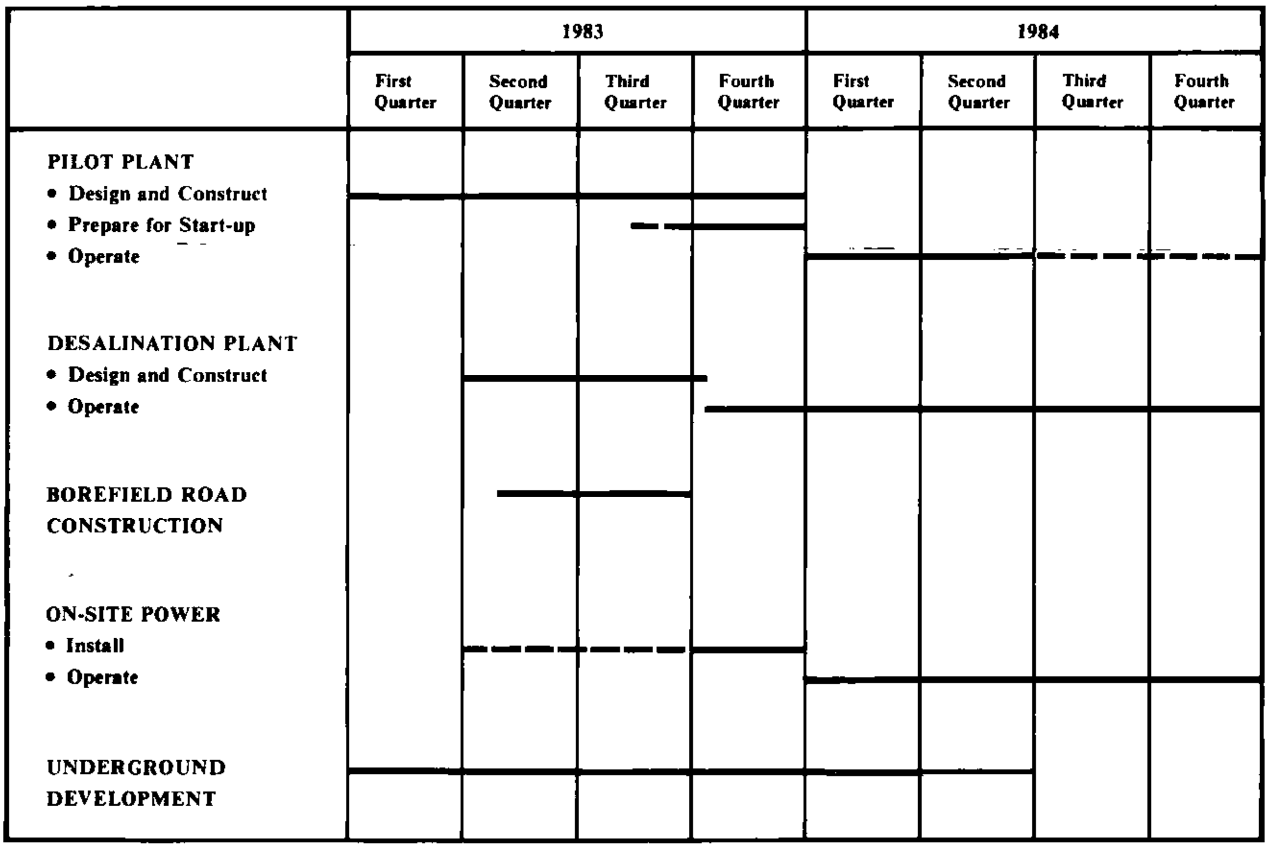


Figure A7.1
**PILOT PLANT DEVELOPMENT SCHEDULE**

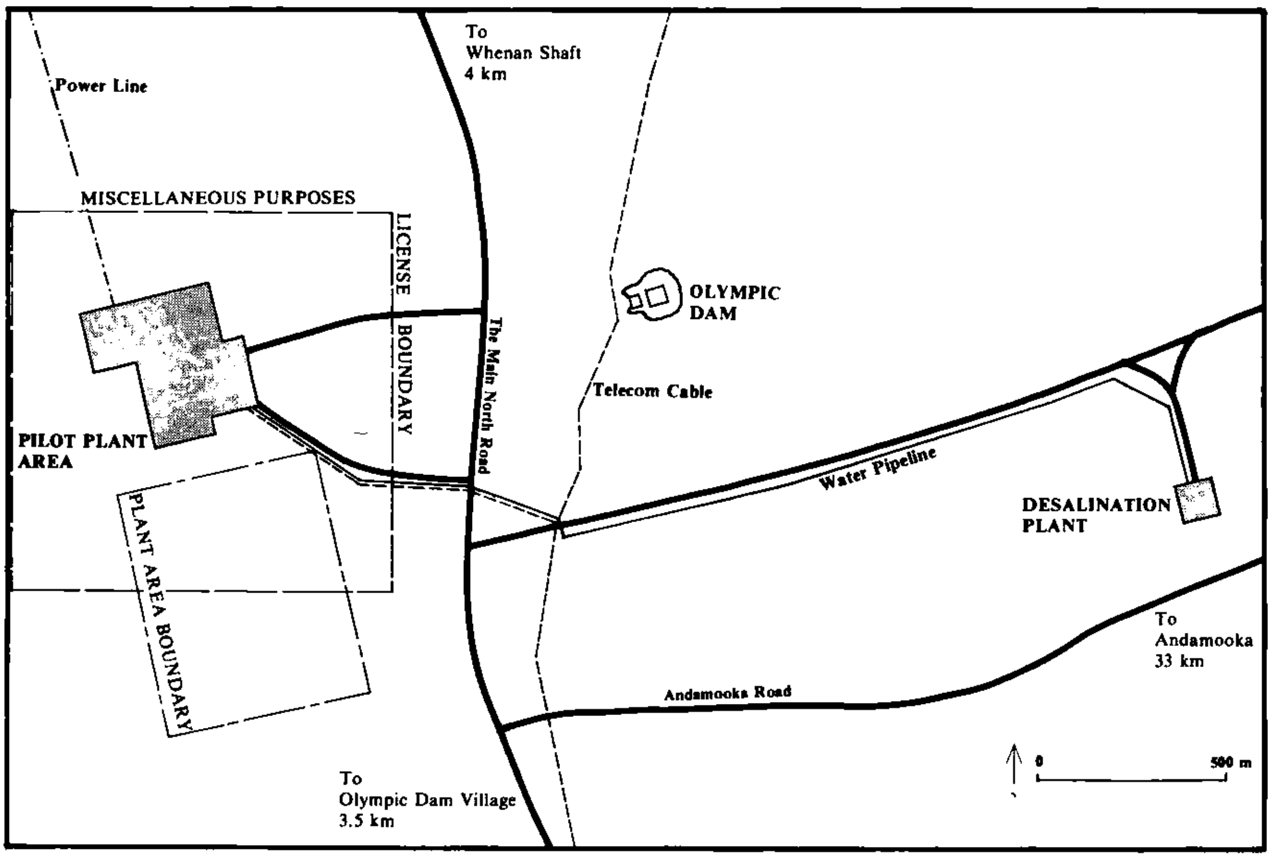


Figure A7.2
**PILOT PLANT LOCATION**

### 3.2 Scope

The general arrangement of pilot plant facilities is shown in Figure A7.3 and the detail of the plant is shown in Figure A7.4. The following facilities are included in the pilot plant:

- stockpile area for ore receival and reclaim,
- primary and secondary crushers for the preparation of ore from underground development for the plant and for bulk sample analysis,
- ore bins for plant feed and metallurgical samples,
- a rod mill and ball mill grinding section to prepare feed for the concentrating section, and a facility for testing autogenous grinding and variations thereof on a test programme basis,
- a concentrator comprising flotation cells to produce sulphide concentrates and tailings,
- thickener and acid leach tanks for flotation tailings,
- counter current decantation (CCD) thickeners for washing slurry discharge from the leach tanks,

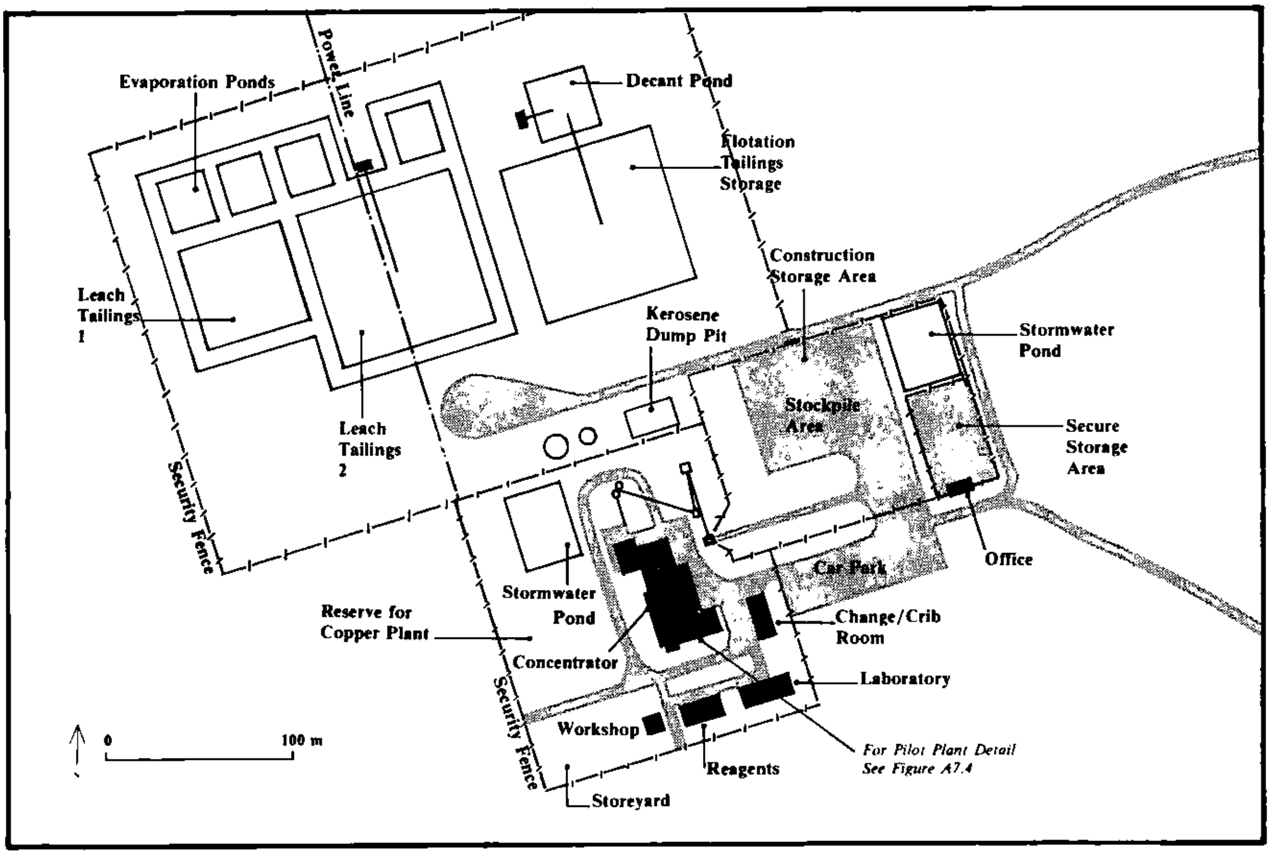


Figure A7.3
**PILOT PLANT GENERAL LAYOUT**

- clarification tanks and solvent extraction mixer-settlers for solution clarification and solvent extraction (SX) of the uranium content,
- yellowcake processing and handling facilities for the precipitation and washing of ammonium diuranate and storage of the final uranium-bearing product,
- a prototype leach tailings retention system,
- a flotation tailings storage system,
- a reserve for copper plant designed to contain a concentrates storage area, a smelting facility to produce slag and matte and a slag treatment circuit,
- a laboratory which includes sample preparation and analytical facilities,
- support facilities including:
  - offices
  - change/crib room and laundry
  - small workshop and store
  - reagent storage and preparation.

Following a comparison of possible processes for the treatment of copper concentrates in April-May 1983, the decision may be taken to include a roast/leach/electrowinning (RLE) section in the pilot plant which would be included in the reserve for copper plant. This would involve:

- fluid bed roasting of copper concentrates,
- a calcine leach circuit,
- clarification of leach solutions and recovery of the copper by solvent extraction,
- final recovery of the copper by electrowinning,
- treatment of the calcine leach residue by cyanidation and recovery of precious metals by carbon-in-pulp techniques.

The whole of the proposed pilot plant and tailings retention area will be enclosed by a security fence and will occupy a total area of approximately 3 ha.

## 3.3 Capacity

The capacities of the main elements of the pilot plant are:

| | |
|---|---|
| Crushing | - approximately 45 tonnes of ore/hour nominally 8 hours/day, 5 days/week |
| Concentrator (grinding & flotation) | - 5 tonnes of ore feed/hour, 24 hours/day, 5 days/week |
| Uranium Leach and Recovery (leach, CCD, SX, precipitation) | - 3 tonnes of flotation tailings/hour, 24 hours/day, 5 days/week |

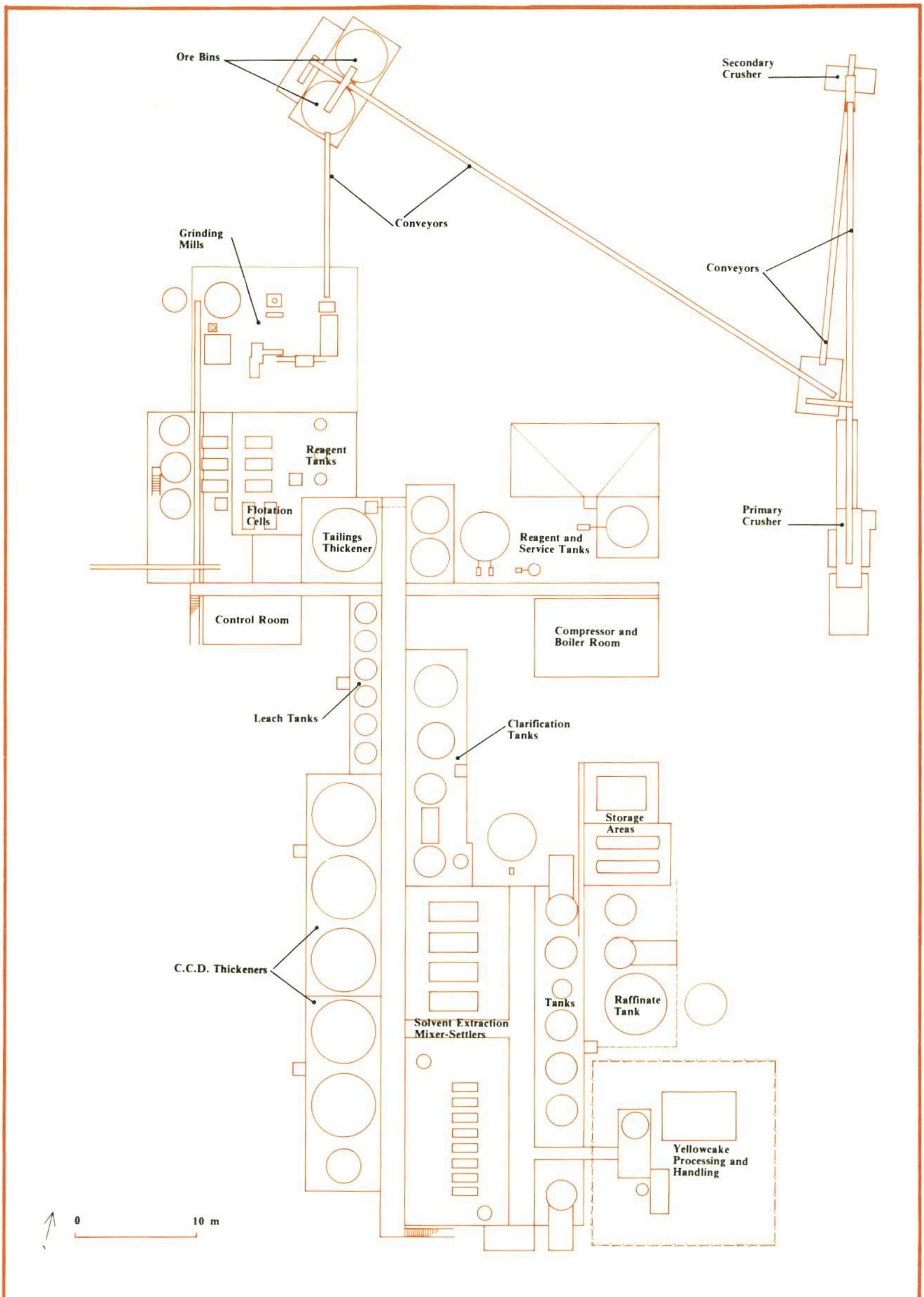


Figure A7.4
**PILOT PLANT LAYOUT DETAIL**

| | | |
|---|---|---|
| Concentrates Processing (slag production, slag treatment, RLE) | - | equivalent to approx. 300 kg/hour of concentrates |
| Concentrates Storage | - | to 500 tonnes of concentrates |
| Leached Tailings Retention System | - | to accommodate 3 tonnes/hour for 12 months operation |
| Flotation Tailings Storage | - | to accommodate 1.5 tonnes of tailings per hour for 12 month's operation. |

### 3.4 Underground development

An underground development programme from the Whenan Shaft is being undertaken to supply ore to the pilot plant as well as to provide geological and other data necessary for feasibility study purposes. Development is currently proceeding on two 4.5 m x 6 m headings, one to the east and south-east of the shaft of approximately 1,000 m in length and the second to the north-west of the shaft and approximately 1,500 m in length. The development will include the necessary crib-rooms, workshops, fuel bays, electrical sub-station, and ventilation raises. The appropriate regulatory authorities have approved the programme.

## 4 OPERATION

### 4.1 Crushing

Bulk samples of ore produced from underground development will be selected from the present stockpile area adjacent to the Whenan Shaft (refer Draft EIS Figure 1.5) and transported by truck to the pilot plant where they will be either dumped into a receiving dump hopper or onto an adjacent pad from which they will be reclaimed to the dump hopper using a front end loader.

The crushing section will reduce the size of the ore to minus 12 mm in two stages of crushing in closed circuit with a vibrating screen. The minus 12 mm product will be delivered by conveyor belt into a covered fine ore storage bin of 75 tonnes live capacity. The crushing plant will have the capacity to produce the pilot plant's daily requirements in less than 8 hours. The other duty of the crushing plant will be to process bulk samples from underground development to obtain an accurate assessment of metal content.

Bulk samples of up to 300 tonnes will be crushed to minus 12 mm and the final product stream will be sampled automatically at frequent intervals. The sample collected will be analysed for an accurate determination of the metal content which will be compared with the results of other sampling methods used underground, e.g. grab, drill core, chip, sludge sampling. If the product from such bulk samples is not used in the pilot plant it will be diverted into a separate bin and returned by truck to the existing Whenan shaft stockpile area.

There will be no reagents required for this section.

### 4.2 Concentrating

The concentrator will operate at 5 tonnes of ground ore/hour for a nominal 120 hours/week. Fine ore (minus 12 mm) from the fine ore storage bin will be wet ground in a rod mill and ball mill circuit to approximately minus 75 microns. The ground ore as a slurry at 30% solids will pass to a flotation section where a sulphide concentrate will be separated from a tailing. The 0.5 tph of concentrates will be thickened, filtered and stored in bays under cover for use either in a slag production and treatment section or for licensor smelting tests. Flotation tailings will be split with 3 tph proceeding to the tailings leach section and 1.5 tph proceeding to a flotation tailings retention system.

Reagents used in this section will be:

- sodium ethyl xanthate
- sodium dithiophosphate
- methyl isobutyl carbonyl
- frother A65
- flocculant.

These materials will be received in either drums or bags, will be stored under cover adjacent to the concentrating section and will be prepared as dilute solutions for usage in the process.

### 4.3 Uranium Leach and Recovery

This section will operate at 3 tph for a nominal 120 hours/week. Thickened tailings will be acid leached in air agitated pachuca tanks at 60% solids. Leached tailings will be washed in a five stage counter current decantation (CCD) section. Residue from the fifth thickener will be pumped to the leached tailings retention system. Pregnant solution from the CCD section will be clarified and will pass to solvent extraction where uranium will be recovered by contacting the aqueous pregnant solution with an organic reagent in four stages of mixer settlers. Barren raffinate will be directed to the fifth stage of the CCD as the washing solution. The uranium containing organic stream will be scrubbed with a solution containing ammonia and then stripped organic will be regenerated by contact with a sodium carbonate solution. The uranium containing solution from the strip circuit will pass to precipitation where uranium will be recovered as ammonium diuranate by the addition of ammonia. Ammonium diuranate will be washed, filtered, and stored in drums. A portion of the ammonium diuranate will be calcined to yellowcake on a test campaign basis to confirm the chemical analysis of the final product.

Reagents used in this section will be:

- sulphuric acid
- oxidants - pyrolusite, sodium chlorate, Caro's acid
- air
- polyethylene oxide
- flocculant
- tertiary amines
- sodium chloride, ammonium sulphate
- sodium carbonate
- ammonia.

### 4.4 Concentrates Processing

Concentrates after filtration will contain 6-10% moisture and will be stockpiled. A portion of the stockpiled concentrate will be accumulated for shipment overseas for licensor smelting tests. Another portion of the stockpiled concentrate (equivalent to the production from 3 tph ore) will be smelted to produce a slag and matte. The smelting process to be used has not been selected but could be:

- a type of electric furnace
- the CSIRO submerged combusion smelting 'Sirosmelt' process.

Off gas from the smelting process will be collected and passed through a gas cleaning and scrubbing system to control emissions from this section. Slag produced will be treated for the recovery of contained copper and uranium by grinding and flotation and leaching of the slag flotation tailing. The leached slag residue will join the main flotation tailing leach residue for pumping to the leached residue retention system. The liquor from slag leaching will join the liquor from tailings leaching for extraction of uranium.

In the event that a decision is made to test the RLE circuit, concentrates will be roasted in a fluid bed roaster. Off gases will pass through a gas cleaning and scrubbing section to control emission levels. Calcine from the roaster will be leached to extract copper and uranium and the pregnant solution will pass to a solvent extraction section for the recovery of copper. Copper will be stripped from the loaded organic by stripping with spent electrolyte from the electrowinning cells. The final copper product will be electrowon copper cathode.

Uranium will be transferred to the tailings leach section by solution interchange. Residues from the copper calcine leach will be washed and will pass to cyanidation for the recovery of precious metals. A carbon-in-pulp circuit will be used for the recovery of precious metals from the cyanide leach solutions in the form of bullion.

Reagents used in this section are:

Smelting fluxes

| | | |
|---|---|---|
| . silica sand | - | hematite |
| | - | limestone |
| . fuel | - | fuel oil |
| | - | oxygen |

Slag treatment

| | | |
|---|---|---|
| . flotation | - | sodium ethyl xanthate |
| | - | sodium dithiophosphate |
| | - | frother - methyl iso butyl carbonyl |
| . leach | - | sulphuric acid |
| | - | oxygen |
| . thickening | - | flocculant |
| | - | polyethylene oxide |
| RLE | - | fuel oil |
| | - | sulphur |
| | - | sulphuric acid |
| | - | organic (P5100 or equivalent) |
| | - | lime or sodium carbonate. |

## 4.5 Tailings Retention System

Leached residues from the tailings leach section will be pumped to a pilot tailings retention system (Figure A7.5). The tailings will be discharged on a cyclic basis in the retention areas and the system will be operated to demonstrate performance and to confirm design criteria. The pilot TRS site has been selected because the near proximity to the pilot plant will permit ease of supervision and because of the difficulties inherent in pumping small slurry volumes over greater distances.

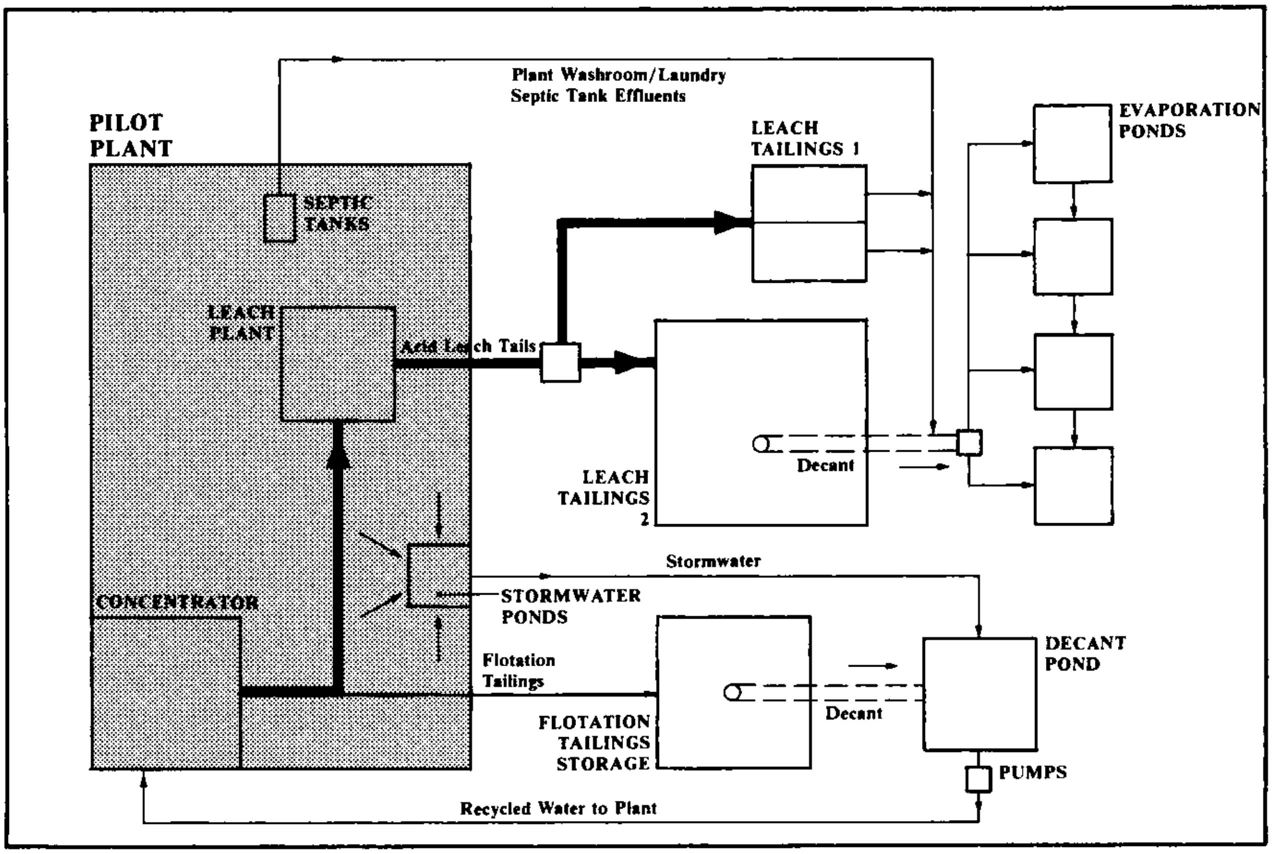


Figure A7.5

**FLOW CHART FOR LIQUID EFFLUENTS**

The objectives in the design and operation of this section will be to demonstrate the sub-aerial deposition method for tailings impoundment under the climatic conditions of Olympic Dam and in doing so measure parameters of interest for the design of a full scale installation and for monitoring purposes. The nature of the objectives and measurements proposed are set out in Section 3.2 of the Supplement.

The measurements proposed are as follows:

- liquor balance for the system, i.e. supernatant, underdrainage, evaporation;
- moisture profiles during the deposition cycle;
- seasonal variations in required cycle time;
- bulk densities of tailings deposited;
- geo-mechanical properties of deposited tailings;
- pond and beach evaporation rates;
- surface properties and propensity to dust;
- radon emanation and variations during the deposition cycle;
- alternative cover materials and depths of cover for decommissioning;
- composition of liquors;
- profile of chemical reaction of liquor with underlying strata;
- evaluation of alternative lining materials for evaporation ponds;
- alternatives for disposal of concentrated liquor from evaporation ponds;
- composition of any salts derived from liquor from evaporation ponds.

The proposed system will be designed to store both the unleached and leached tailings and will receive all other contaminated liquid wastes from the plant area for disposal by evaporation or re-cycling. It provides separate storage for each tailings stream with associated evaporation ponds for excess liquor and liquid plant wastes. It will comprise the following components:

- Two acid leach tailings storages. The first of these will be used to build up successive tailings layers, dried to about 90% of saturation under sub-aerial deposition. This will permit evaluation of seasonal variations in drying time and also determination of geo-technical parameters such as final density. The storage will be divided into 2 sections, one of which will be lined to enable accurate water balance calculations to be done. Excess liquor will be decanted.

  The second storage will also operate on a sub-aerial basis and will receive the tailings flow that will be produced during the time that tailings in the first storage are drying. A decant will remove excess liquor which will be directed to a series of evaporation ponds. Some minor ponding of excess liquor around the decant will occur in operation. This will enable measurement of tailings permeability and the determination of possible seepage.

- Four evaporation ponds with alternative base preparations to receive the excess acid liquor from the two acid leach tailings storages. These ponds will also receive other contaminated plant liquid wastes including septic tank effluent and waste water from the pilot plant laundry and washrooms.

- A single storage with a decant system to store unleached flotation tailings. The decant liquor in this case will be ponded and re-cycled back to the plant. The decant pond will be used to receive non-acid wash down water, settled storm-water run-off from the pilot plant area and other clean liquid wastes all of which will be re-cycled to the plant.

On completion of construction of the main TRS, the material impounded in the pilot tailings retention system (approximately 18,000 t/a) will be reclaimed and transported to the main tailings retention system area. Flotation tailings (approximately 1.5 tph) will be likewise reclaimed and treated through the main metallurgical plant for recovery of uranium.

## 5 WASTES AND EMISSIONS

### 5.1 Nature of Wastes and Emissions

The principal emissions from the pilot plant will be as follows:

**Tailings**

As described in Section 4.5 above the plant will generate two types of tailings. The first, unleached flotation tailings, will be generated at a rate of 1.5 tph or a total of approximately 9,000 t in the proposed 12 month operating period. These tailings will be contained in the manner described in Section 4.5 of this Appendix.

The second type of tailings which will be generated at a rate of 3 tph or 18,000 t/a will be acid leach tailings. The expected characteristics of these tailings is described in Section 7.2.4 of the Draft EIS. Containment of them will be as described in Section 4.5 of this Appendix.

**Air Emissions**

The two principal gaseous emissions will be sulphur dioxide and nitrogen oxides, which will be emitted only in very small quantities.

Based on the processing of 300 kg/day of sulphide concentrates containing 20% sulphur, the emission of sulphur dioxide in the gas stream following scrubbing will be approximately 0.10 g/sec at a concentration of 10 ppm. This emission rate will apply to both the smelting or RLE circuits. This compares with 239 g/s of sulphur oxides referred to in Table 8.18 of the Draft EIS which will be emitted by the commercial processing plant.

The main source of nitrogen oxides will be the emission from two boilers used for steam generation and fuelled by distillate. Based on fuel requirements and United States Environmental Protection Agency (USEPA 1977) emission factors, the expected emission rate will be about 0.03 g/s.

If the smelting circuit is installed, there will be additional nitrogen oxide emissions from the concentrate dryer. Based on the factors noted above, the expected emission rate will be about 0.02 g/s nitrogen oxides.

Thus total nitrogen oxides emission will be about 0.05 g/s. This compares with the expected emission rate of 9.7 g/s referred to in Table 8.18 of the Draft EIS.

**Liquid Effluents**

Figure A7.5 shows schematically the flow of liquid effluents from the pilot plant. The principal passage for process liquid effluent disposal is via the tailings retention system which is discussed above. Other liquid wastes will come from the plant gas scrubbing, sewerage and washroom water which will be disposed of by evaporation via the pilot tailings retention system. Any spillages or wash-down water from the plant will be diverted to sumps within each individual section and will be recycled to that section of the circuit. Other than in the case of spillage or washdown water, there are no points of significant liquid effluent discharge in the treatment circuit.

All the emissions and wastes mentioned above will be subject to statutory controls in their disposal. The principal regulatory body responsible will be the Department of Mines and Energy.

**Stormwater Runoff**

Runoff from the whole pilot plant area (approx. 3 ha) will be collected in two storm water ponds and returned to the plant at a controlled rate through the decant pond. The areas beneath and adjacent to plant sections will be paved and drained to individual internal sumps to contain spillage and to facilitate cleanup. The liquor content of slurry flows pumped to the Tailings Retention System areas will be evaporated. There will be no discharge of liquid effluents from the pilot tailings retention areas.

**Radiation**

The pathways available for delivery of radiation dose to workers are as discussed in the Draft EIS, Chapter 9.

The Joint Venturers have direct access to operating experience on the Kalgoorlie Metallurgical Test Plant. This plant, with a capacity to treat ore at the rate of 1 tph has been successfully processing uranium ore of up to 0.2% grade and higher for 18 months.

It is subject to regular checking for radiation and other occupational health standards by the statutory authorities.

In addition, experience in uranium treatment plants in Queensland and Northern Territory has shown that radon daughter concentrations will be very low. It is expected that radon daughter concentrations will be in the order of $10^{-3}$ WL with higher levels only inside enclosed volumes such as the fine ore storage bins. Gamma radiation dose rates will also be very low (Marshman 1982). It is expected that gamma dose rates will be in the order of 1 to 10 uSv/h throughout the plant. Airborne dust control will require application of specific features of engineering, i.e. dust extraction hoods and scrubbers, sprays at ore handling locations and so forth. With these features in place and operational, respirable dust concentrations should average less than 0.5 ug/$m^2$. Regular and frequent monitoring of airborne dust will feedback information for control and future design.

Surface contamination, i.e. ore dust deposited on surfaces, is a further potential pathway for dose delivery, in that material can be either resuspended into the air or subsequently inhaled or transferred to food or hands and thence to mouth and ingested. Surface contamination is controlled by maintaining good area cleanliness and good personal hygiene. There is no reason why surface contamination levels in the ore handling sections of the pilot plant should be any different from the levels found to date in the facilities either at the corefarm or at the Whenan shaft. These levels have been very small fractions of the Code of Practice, Schedule 7, normally 1 to 5%. The final stage of the pilot plant uranium extraction circuit is seen from 4.3 above to be production of ammonium diuranate filtercake with a small test campaign producing $U_3O_8$ (calcined product).

Thus for the most part there will be no opportunity for dust production in the uranium circuit. The production of calcined product ($U_3O_8$) will present a potential hazard in respect of $U_3O_8$ spillages and possible $U_3O_8$ airborne dust. The monitoring programme, which will include the use of portable battery-powered air sampling pumps at possible contaminant release points and occasionally on operating personnel, will obtain sufficient data to enable metallurgical and operator personnel to take any necessary corrective action.

The tailings as a source of radiation will not be different in nature from the ore which will be stockpiled on the surface, and will certainly be quantitatively much less (i.e. in terms of dust and radon emission). As noted in Section 4.5 above, measurements of dust and radon emissions will be undertaken and analysis of dissolved radium 226 and thorium 230 in tailings liquor will be performed.

**Toxic Processing Chemicals**

Certain of the reagents to be used in the pilot plant are considered toxic to humans. The reagent store will be situated within the pilot plant security fence (Figure A7.3). It will be a dry storage area on a concrete floor. The reagents are generally in a dry form and are mixed and despatched to the plant in a very dilute form (generally in the order of a 1% solution). The reagents are consumed in the processing and the residual reagent in the process waste water will be disposed of either to the pilot tailings retention system where it will either be evaporated or recycled to the plant for re-use (Figure A7.5). Empty drums will be washed out and disposed of in the existing rubbish tip.

## 5.2 Control of Other Wastes and Emissions

The following measures will be incorporated in the main pilot plant facilities to control other wastes and emissions:

**Crushers**

- Ore stockpiles and reclaim will be on paved areas with drainage into the plant runoff collection system.

- Transfer points, hoppers and bins will be equipped with dust collection/suppression devices where appropriate.

**Grinding mills**

- Area will be paved and bunded to contain spillage and facilitate clean up.

- No air emission points as the process is conducted as a slurry.

**Flotation cells**

- As for grinding.

**Leach and recovery tanks**

- As for grinding and flotation.

- Safety showers will be installed where acid is distributed.

- Organic handling plant will be bunded for fire containment and control.

**Concentrates processing plant**

- Smelting and slag treatment

  - collection and scrubbing of offgas
  - clean up as in other areas.

- RLE

  - collection and scrubbing of offgas
  - clean up as in other areas.

## 6 RESOURCE AND INFRASTRUCTURE REQUIREMENTS

The Draft EIS has already dealt with the impacts of those items of infrastructure that will be required as a result of the pilot plant construction and operation. The only changes to the descriptions as covered in the Draft EIS will generally be an advance in the timing (refer Figure A7.1 above) and a staging of the development of particular items. The principal infrastructure items required for the pilot proposal are:

- accommodation facilities
- roads
- water supply
- power supply.

The resources required are similar but smaller in magnitude to those indicated in the Draft EIS for the full scale plant.

## 6.1 Accommodation

**Existing village single quarters**

The present 174 room camp would be expanded to 220 rooms as a first stage of the increase to 350 as described in the EIS.

**Caravan park**

Additional 'en-suite' type sites would be provided on the present location to enlarge the park to the ultimate 50 sites.

## 6.2 Roads

**Project roads**

Minor extensions to the Project road system to service the pilot plant would be along alignments suited to the permanent road layout.

**Road to Borefield A**

The road to Borefield A would be constructed along the pipeline corridor as detailed in Section 10.2 of the Draft EIS. Construction would be by progressive upgrading along the final alignment. The road will be a dry weather only road, generally 4 m wide but increased to 8 m width for sand dune crossings for safety purposes. This is a lesser standard than the final road required for pipeline and powerline construction and maintenance. Surfacing with gravel would be added as required to maintain the water tanker traffic required for delivery of borefield water for pilot plant process use and desalination for domestic supplies. All of these necessary works will be carried out in accord with the principles set out in Section 10.2.4 of the Draft EIS.

## 6.3 Water Supplies

Initially potable water for Project use would continue to be transported from Woomera. However, GAB water is required for pilot plant process use together with additional supplies of potable standard. These potable supplies are in excess of the freely available quantities from Woomera and, with road access to the GAB, can be transported and desalinated at slightly less cost than water from Woomera. A desalination plant of up to 400 kL/day capacity will be installed at Olympic Dam at the permanent site (see Figure A7.2) together with small capacity raw and potable water storages. Operation of this small pilot scale plant will enable optimization of the desalination method and provide comparative data with alternative methods. The method presently favoured is the electrodialysis reversal process which is not widely used in Australia.

Electrodialysis is a membrane process which operates almost at atmospheric pressure. An electric field is applied across the saline solution, causing cations to migrate toward the negatively charged cathode and anions towards the positively charged anode. A stack of membranes, alternatively cation and anion selective, is placed between the cathode and anode. The solution between one pair of membranes becomes depleted in ions, while the solutions on either side become enriched.

Distribution will be in existing pipelines with minor extensions and relocation of pumping units to supply the village, pilot plant and mine.

It should be noted that concurrently with the operation of the pilot plant, the Joint Venturers will be undertaking long-term pump tests on bores in the Borefield A area of the GAB as part of the hydrogeological programme referred to in Section 6.3 of this Supplement. The requirements for the pilot plant and potable supply (estimated at 300-400 kL/day) will constitute only a minor proportion of the water extracted in the pump tests.

The desalination plant reject stream (saline) will be added to process supply, used for road watering, or injected into the Arcoona Quartzite saline aquifer.

### 6.4 Power Supply

The power demand for the pilot plant is approximately 0.8 MW.

The increased power supply required will be met by the installation of additional 'on-site' diesel generating sets. On-site powerline extensions would be required in 11 kV construction to the pilot plant and desalination plant.

### 6.5 Resource Requirements

Based on twelve months operation, the pilot plant will process about 30,000 tonnes of ore through the concentrator and 18,000 tonnes through the leach section. This will result in the production of 750 tonnes of copper matte, 700 tonnes of slag and 40 tonnes of uranium oxide ($U_3O_8$). The estimated resources consumed in the course of this production is set out in Table A7.1.

**Table A7.1 Operational inputs for the pilot plant**

| Stores consumed | Quantity | Source |
|---|---|---|
| Steel rods | 15 tonnes | Australia |
| Steel balls | 30 tonnes | Australia |
| Sodium ethyl xanthate | 1 tonne | Australia |
| Sodium dithiophosphate | 1 tonne | Imported |
| Methyl isobutyl carbonyl | 1 tonne | Imported |
| Flocculant | 7 tonnes | Imported |
| Organic (Acorga P51000) | 2 $m^3$ | Imported |
| Kerosene | 15 $m^3$ | S. Australia |
| Sodium chloride | 45 tonnes | S. Australia |
| Ammonia | 30 tonnes | Australia |
| Sodium carbonate | 43 tonnes | S. Australia |
| Sulphuric acid | 850 tonnes | S. Australia |
| Oxidant ($MnO_2$) | 50 tonnes | Australia |
| Polyethylene oxide | 5 tonnes | Imported |
| Sodium hydroxide | 43 tonnes | S. Australia |
| Lime | 150 tonnes | S. Australia |
| Tertiary amine | 0.5 $m^3$ | Imported |
| Isodecanol | 0.5 $m^3$ | Imported |

## 7 DECOMMISSIONING OF PILOT PLANT

As noted in Section 2 above, the Joint Venturers' intent is to continue to use the pilot plant as an experimental facility for ongoing metallurgical testing after the commercial plant has commenced production. It is for that reason that it has been situated adjacent to the area where the commercial plant will be constructed.

Decommissioning would therefore only be necessary in the event of the Joint Venturers not proceeding with the Project development.

In this event, the extent of decommissioning would go beyond the pilot plant itself and would involve a decomissioning of the entire Project. As pointed out in Section 9.8 of the Draft EIS, the decommissioning and final use of any facilities on the site would depend on the outcome of discussions between the Joint Venturers and the State Government. Therefore, while no detailed statement can be made on decommissioning, the anticipated principles that are set out in Section 9.8 of the Draft EIS may be repeated.

- Mine openings would be sealed.
- Equipment and facilities would be sold and those which are not saleable disposed of as directed by the State Government.
- All Project monitoring data would be reviewed to finalize the location of a controlled access area boundary (if necessary).
- Placement of cover on the pilot tailings retention area would be completed in accordance with the manner described in Section 7.5 of the Draft EIS.