LANDS PLANNING ENVIRONMENT

ASSESSMENT REPORT 22

JABILUKA NUMBER 2 URANIUM MINE PROPOSAL

ENVIRONMENTAL ASSESSMENT REPORT

AND

RECOMMENDATIONS

by the

ENVIRONMENT PROTECTION DIVISION

DEPARTMENT OF LANDS, PLANNING AND ENVIRONMENT

AUGUST 1997

Northern Territory Government

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ABBREVIATIONS AND ACRONYMS

ABS	Australian Bureau of Statistics	U_3O_8	uranium oxide (Yellowcake)
AEA	*Atomic Energy Act*	^0C	degrees Celsius
APC	Aboriginal Project Committee	gm	grams
AS	Australian Standard	gm/t	grams per tonne
Au	Gold	ha	hectares
CRZ	Catchment Runoff Zone	kL	kilo-Litre
DLPE	NT Department of Lands, Planning and Environment	kL/day	kilo-Litre per day
DME	NT Department of Mines and Energy	km	kilometre
Dpp	Draft Jabiluka EIS page number	km/hr	Kilometre per hour
EIS	Environmental Impact Statement	kV	kilo-Volt
EMP	Environmental Management Plan	L	Litre
EPIP	*Environmental Protection (Impact of Proposals) Act* 1974 (Commonwealth)	L/sec	Litre per second
ERA	Energy Resources of Australia Ltd.	m	metre
FML	Flexible Membrane Liner	m^3	cubic metre
ICRP	International Commission on Radiological Protection	m^3/d	cubic metres per day
KNP	Kakadu National Park	Mt	Million tonnes
KRSIS	Kakadu Region Social Impact Study	Mm^3	Million cubic metres
NLC	Northern Land Council	mSv	milli Sevits
NT	Northern Territory	mSv/a	milli Sevits per annum
OSS	Office of the Supervising Scientist	mm	millimetre
PAWA	NT Power and Water Authority	mm/hr	millimetre per hour
pp	page number	mWL	milli Working Levels
RP	Retention Pond	pH	measure of acidity or alkalinity of a solution
RRZ	Restricted Release Zone	ppb	parts per billion
RUEI	Ranger Uranium Environmental Inquiry	t	tonne
SCZ	Sediment Control Zone	t/a	tonnes per annum
SAG	Study Advisory Group	t/m^3	tonnes per cubic metre
Spp	Supplement page number	ug/L	micrograms per litre
TCZ	Total Containment Zone		
THS	NT Territory Health Services		
UMEC	*Uranium Mining (Environmental Control) Act*		
USEPA	United States Environmental Protection Authority		
WMS	Water Management System		

EXECUTIVE SUMMARY

This report assesses the environmental impact of a proposal by Energy Resources of Australia Ltd (ERA) to establish and operate an underground uranium mine at the Jabiluka Number 2 uranium prospect, 230 km east of Darwin and 20 km north of Jabiru, in the Northern Territory.

Current reserves are estimated at 90,400 t of U_3O_8 (at a cut off grade of 0.2%) with a total project life of around 30 years. Ore is proposed to be extracted at Jabiluka and transported by road train along a dedicated haul road to the existing Ranger mill for processing. The process tailings from Jabiluka ore are to be combined with Ranger tailings and deposited within 2 open cut pits at the Ranger mine site. Uranium concentrate will be road transported to Darwin for export, utilising current practices and procedures employed by ERA.

The proponent has given a broad overview of the technical aspects of the proposal on the basis that, within the general parameters of the environmental protection arrangements, specific design and operational measures will be formulated as project planning proceeds. The proponent has outlined in the EIS that much of the baseline work necessary for the project has not been undertaken due to the reluctance of the Northern Land Council and Traditional Owners to grant access to the site for ERA to undertake such surveys.

Major issues associated with the development and operation of the Jabiluka Project raised during the review of the draft EIS, public comments and Supplement to the draft EIS are listed below and are the focus of the contents of this assessment report.

- ***Alternatives to the Proposed Development Option***
- ***Surface and Ground Water Management***
- ***Tailings Management***
- ***Radiation Management***
- ***Transport Management***
- ***Flora and Fauna Management***
- ***Infrastructure Impacts***
- ***Social Impacts***
- ***Heritage and Cultural Values***

This assessment has found that the proposal for an underground uranium mine at Jabiluka with milling of ore at Ranger will significantly reduce potential environmental impacts, compared with other alternatives presented in the final EIS. The assessment also indicates that there should be no significant impacts on the surrounding Kakadu National Park.

The Kakadu Region Social Impact Study, while separate from this assessment, will provide the proponent with additional recommendations to enable further consideration and understanding of the social effects arising from the proposal in the region.

The outcome of this assessment is that the environmental issues raised can be satisfactorily addressed, and that the proposal could proceed in an environmentally acceptable manner provided that undertakings and commitments made in the final EIS, as modified by recommendations in this report, are implemented.

SUMMARY OF RECOMMENDATIONS

Subject to decisions which permit the Jabiluka Project to proceed, the primary recommendations resulting from the assessment are set out below. Unless otherwise stated, additional material (report, study or assessment) required by a recommendation shall be submitted to the Northern Territory Department of Mines and Energy.

It is important, for interpretation purposes, that the highlighted recommendations in this report are not considered in isolation, as the text contains a number of identified concerns, suggestions, and some considerations to assist decision-making.

It is acknowledged that during detailed implementation of proposals outlined in the final EIS, flexibility is necessary and desirable to allow for minor and non-substantial changes to the designs and specifications which have been examined as part of this assessment. It is considered that subsequent statutory approvals for this proposal could make provision for such changes, where it can be shown that the changes are not likely to have a significant effect on the environment.

Recommendation 1

The proponent shall ensure that the proposal is implemented in accordance with the environmental commitments and safeguards identified in the Jabiluka Project draft Environmental Impact Statement, or as modified in the Supplement to the draft EIS, this assessment report and approved Mine and Environmental Management Plans.

A: Alternatives to the Proposed Development Option

Recommendation 2

The proponent shall ensure that if a development alternative to underground mining and milling of Jabiluka ore at Ranger is to be implemented then further information, to reflect the current legislative requirements and mine site design and processes, is to be submitted for assessment.

B: Surface and Ground Water Management

Recommendation 3

Details on the geotechnical information regarding Retention Pond siting and a risk assessment of single versus double liner failure have not been provided. The proponent shall submit the following, prior to committing to a final liner system:

- **a risk analysis of single liner failure;**
- **a risk analysis of double liner failure;**
- **details on the suitability and success or failures of leakage detection systems from similar systems employed elsewhere;**
- **details of proposed geotechnical studies of the Retention Pond site;**
- **a full justification on the selection of the Retention pond site and the appropriate liner system.**

The final approval for the retention pond shall not be made until the above information has been submitted and reviewed.

Recommendation 4

Contingency measures for catastrophic Retention Pond failure have not been clarified in the final EIS. The proponent shall submit for approval detailed procedures for the contingency of Retention Pond failure, including leakage detection and liner repair.

Recommendation 5

The proponent has not detailed contingency plans for unacceptable levels of contaminants within the Sediment Control Zone. The proponent shall prepare and submit for approval a contingency plan to control water containing unacceptable levels of contaminants in the Sediment Control Zone.

Recommendation 6

Silt loads in watercourses will be elevated during the construction activities. These loads are expected to decline during the first few years of mine operation. A study to assess silt loads in watercourses (Magela, North Magela and Swift creeks) along the haul road which may result from the mine site disturbance, the corridor disturbance and road maintenance shall be undertaken. A review of this study shall be undertaken on a yearly basis and results reported in the Jabiluka Annual Report.

Recommendation 7

The proponent shall investigate stabilisation of road side shoulders, fill embankment batters, culverts, mitre and table drains with suitable protective measures to minimise erosion. This study should be extended to include fire breaks and other areas which are required to be kept clear of vegetation such as the power transmission line.

C: Tailings Management

Recommendation 8

Any increase in tailings or modifications to the tailings disposal option as outlined in the final EIS shall be submitted for further assessment.

Recommendation 9

The proponent shall provide the findings of the Best Practice Technology analysis conducted for seepage mitigation at Ranger pit number 3. The proposed method of seepage mitigation must be approved prior to commencement of deposition of tailings into Ranger pit number 3.

D: Radiation Management

Recommendation 10

The continuing modelling of radiation doses to the underground workers, and the associated ventilation requirements, shall be reviewed by an approved consultant with experience in the modelling and operation of underground uranium mines once the final design has been completed. A copy is to be submitted for approval.

Recommendation 11

The proponent shall ensure that recirculation of contaminated air into the mine does not occur.

Recommendation 12

The proponent shall develop an approved radiation protection program which should include, but not be limited to:

- **measurement of radon emanation and gamma dose rates and the effect of waste rock and shotcrete shielding on those emanation rates;**
- **determination of radiation shielding (gamma, dust and radon) provided by the cabins of equipment and other worker protection safeguards;**
- **appraisal of the performance of the mine ventilation design;**
- **regular spot measurements of radon decay product concentrations, the potential alpha energy concentrations of radon progeny and the unattached fraction of radon progeny in workplaces and in air at key sites in the region of the mine; and**
- **measurement of the activity distribution of long lived radionuclides in dust in mine aerosols, in underground workings, and at key sites in the region of the mine.**

Recommendation 13

The technical design and test work to be developed for the enhanced evaporation water disposal system shall be submitted for approval prior to construction. If the quality of air emissions from the mine does not meet the recommended standards, use of the enhanced evaporation system should be suspended until it can be demonstrated that air quality emissions will meet the recommended standards.

Recommendation 14

The proponent shall ensure that radiation emissions from the mine must not exceed levels beyond which members of the public would be potentially exposed to greater than 1 mSv per annum at any site outside the fenced project area as a consequence of additive radiation levels (ie Jabiluka and Ranger combined).

E: Transport Management

Recommendation 15

The proponent shall instigate a study into the design of underflow culverts on the haul road to a higher than 1 in 10 year flood immunity standard prior to construction of the haul road. Details of this study are to be submitted for review and approval.

Recommendation 16

The proponent shall implement a procedure whereby truck operations are curtailed during fires or other events that may restrict driver visibility on the haul road.

Recommendation 17

The proponent shall investigate road design to ensure that crossings suitable to Aboriginal people are provided. This design is to be undertaken in consultation with local Aboriginal communities. Any crossing sites shall be adequately signposted and local Aboriginal communities encouraged to use these. Haul truck drivers are to be suitably educated on these crossings.

F: Flora and Fauna Management

Recommendation 18

The proponent shall prepare and submit a detailed technical design, including test work, for the proposed enhanced evaporation system prior to construction and shall incorporate:

- **alternatives to the enhanced evaporative system if the system fails to operate within acceptable parameters;**
- **a monitoring program which outlines the baseline and ongoing flora studies and infiltration/surface runoff studies;**
- **remedial engineering actions proposed if solute build-up or flora mortality around the exhaust vents reaches an unacceptable level;**
- **a rehabilitation plan for flora surrounding the vents.**

Recommendation 19

The proponent shall complete the study into the dead stand of Eucalypts, as identified in the draft EIS, prior to construction activity commencing. The proponent shall implement a strategy for restricting access into the areas identified in the draft EIS until the completion of this study. Results of this study are to be submitted.

Recommendation 20

The proponent shall ensure that all drivers are fully educated on the potential for fauna road kills. A record of any fauna road deaths shall be kept on-site and included in the Jabiluka Annual Report.

Recommendation 21

In the event that fauna baseline surveys of the project area discover any rare or endangered species or sensitive or critical habitats, the proponent shall implement a management strategy for their protection in consultation with the appropriate bodies. The project design may need to be amended, where appropriate, to ensure the protection of, and minimise impacts on, these species and their habitats.

Recommendation 22

The proponent investigate any bird deaths on the mine site. A record of any bird deaths shall be kept on-site and included in the Jabiluka Annual Report.

Recommendation 23

If significant bird deaths attributable to Retention Pond waters are recorded the proponent shall instigate an appropriate management strategy in consultation with the appropriate bodies.

G: Infrastructure Impacts

Recommendation 24

The proponent shall, if the "Ja Ja" Camp is to be recommissioned, provide a detailed report outlining environmental impacts and mitigation measures with the recommissioning, operation and decommissioning of this camp area.

H: Monitoring

Recommendation 25

Local Aboriginal communities shall be consulted during the development of on-going monitoring programs.

I: Rehabilitation

Recommendation 26

The proponent shall consult with the relevant authorities and the local Aboriginal communities, or their representatives, on the rehabilitation processes, including the haul road throughout the project's life. All rehabilitation programs must be submitted for approval.

J: Other General Issues

Ja: Gold Extraction

Recommendation 27

If at any stage gold is to be extracted, further information regarding the extraction process, potential impacts and safeguards is to be submitted for further assessment.

Jb: Dust, Noise and Vibration

Recommendation 28

The proponent shall monitor dust at Aboriginal sites of significance along the haul road route and provide protection against dust if higher than baseline limits are measured. Details of the protection measures proposed shall be reviewed with local Aboriginal communities and then submitted for approval.

Recommendation 29

The proponent shall instigate trial programs to determine a suitable blasting practice during the construction phase. Results of this program are to be submitted for review.

Recommendation 30

The proponent shall instigate programs for environmental noise level measurement at approved locations adjacent to the mine site to confirm that noise levels remain no higher than those predicted in the final EIS.

Jc: Sewerage and Waste Disposal

Recommendation 31

The proponent shall consult with the Territory Health Services on the design and monitoring program for sewerage disposal by septic tank/leach drain systems for the Jabiluka project.

Recommendation 32

The proponent shall consult with the Department of Mines and Energy and Territory Health Services on design and monitoring requirements if a sewerage treatment plant is to be established on the Jabiluka Mine site.

Jd: Insect Disease Vectors

Recommendation 33

The proponent shall consult with the Territory Health Services to produce a disease vector baseline survey, monitoring program and remedial action plan for the mine site.

Je: Visual Impacts

Recommendation 34

The proponent shall make every effort in ensuring that the project and haul road is visually secluded as much as possible by ensuring that disturbance is kept to a minimum and rehabilitation of disturbed areas is undertaken in accordance with the commitments made within the final EIS.

K: Social, Heritage and Cultural Values

Recommendation 35

The proponent shall include measures to educate and, if necessary, discipline construction workers and sub-contractors for any behavioural breaches during the construction period.

Policies and procedures shall be clearly indicated to all contractors and personnel to ensure any breaches of ERA procedures and commitments will be dealt with in accordance with penalties addressed in the final EIS.

Recommendation 36

The proponent shall instigate a study to identify potential dewatering effects and potential remedial actions in relation to the Boyweg site and other identified soak sites. This study is to include detailed consultation with local Aboriginal communities.

Recommendation 37

The proponent must provide evidence that there is an agreement between the proponent and the Northern Land Council representing the Aboriginal Traditional Owners and other custodians who are the beneficiaries of the relevant land trust. The proponent must set out any conditions for the protection of sacred sites in accordance with that agreement. If there are no such conditions then the proponent must state the manner in which the agreement relates to the protection of sacred sites in the project area.

Recommendation 38

Monitoring of rock art sites in the area surrounding the project area should include monitoring to detect impact from vehicle exhausts.

Recommendation 39

Any significant deviations from baseline data, identified by monitoring of rock art sites, shall be reported to the relevant Northern Territory Government regulatory authorities and Traditional Owners and a course of action agreed and implemented.

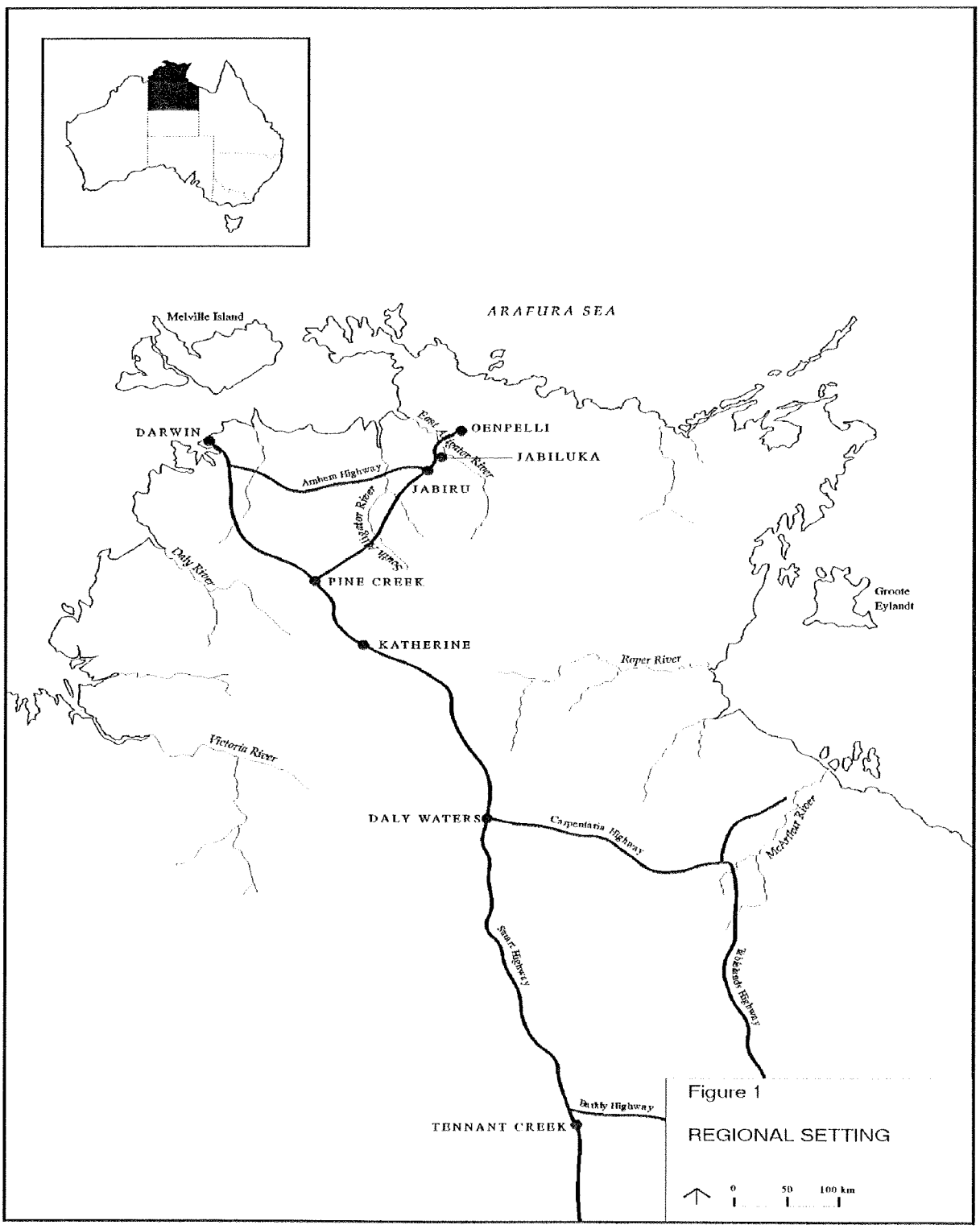
Recommendation 40

ERA and government agencies involved in the regulation and monitoring of this project shall aim for transparency in the reporting of environmental monitoring data. This reporting should be in a form which assists Aboriginal people or their organisations to evaluate the monitoring data.

1. INTRODUCTION AND BACKGROUND

This report assesses the environmental impact of a proposal by Energy Resources of Australia Ltd (ERA) to establish an underground uranium mine with associated infrastructure at the Jabiluka Prospect, approximately 20 km north of Jabiru in the Northern Territory (Figure 1).

Figure 1: Location of the Jabiluka project.



The report reviews the Draft Environmental Impact Statement (draft EIS), public comments on the draft EIS, and the proponent's responses to these comments in the Supplement to the draft EIS (the draft EIS plus the Supplement constitutes the final EIS). It also relies on information, comments and advice provided by Northern Territory (NT) Government agencies and previous studies undertaken in the region.

1.1 Environmental Assessment Process

Environmental impact assessment is predicated on adequately defining those elements of the environment which may be affected by a proposed development, and on quantifying the significance, risks and consequences of the potential impacts of the proposal at a local and regional level.

The final EIS provides a description of the existing environment in the area and the proposed operations, and evaluates the environmental impacts and proposed mitigating measures to minimise the expected impacts.

This report will assess the adequacy of the final EIS in achieving the above objectives, and will evaluate the undertakings and environmental safeguards proposed by the proponent to mitigate the potential impacts. Further safeguards may be recommended as appropriate.

The safeguards may be implemented at various levels within the planning framework of a project. These include, but are not limited to:

* ***Site Selection***
* ***Design and Layout of Facilities***
* ***Processes used in Operations and Facilities (ie. inputs and outputs)***
* ***Management of Operations, Processes and Facilities***
* ***Project Closure and Rehabilitation***

The contents of this report form the basis of advice to the Northern Territory Minister for Lands, Planning and Environment on the environmental issues associated with the project.

1.2 Environmental Assessment History and Legislation

1.2.1 Background

The legislative and administrative basis under which uranium is mined originates from the Ranger Uranium Environmental Inquiry (RUEI, October 1976) which was set up under the Commonwealth's *Environment Protection (Impact of Proposals) Act* 1974 as a result of moves to mine uranium within the Alligator Rivers Region.

The basic framework for environmental control derives from the recommendations of the RUEI. The recommendations were taken up by the Commonwealth and Northern Territory and subsumed as Environmental Requirements within Northern Territory legislation as Schedules 1 and 2 of the Northern Territory *Uranium Mining (Environment Control) Act* (UMEC).

A second Ranger Uranium Environmental Inquiry (May 1977) dealt with the consequences for the natural and social environments of the Alligator Rivers Region, and recommended institutional arrangements to carry out monitoring and supervision of environmental regulations and controls.

Under the terms of the Commonwealth's *Northern Territory (Self Government) Act* the Commonwealth retained ownership of uranium. Working arrangements between the NT Government and the Supervising Scientist for the co-ordination and regulation of environmental aspects of uranium mining in the Alligator Rivers Region were endorsed, through a Memorandum of Understanding, by the Chief Minister for the NT and the Prime Minister in September 1979.

Under the working arrangements the Northern Territory has primary responsibility for setting the requirements and monitoring performances for the protection of the environment using the UMEC Act as the principle legislation in the Northern Territory. This Act is administered by the Department of Mines and Energy and empowers the Northern Territory Minister for Mines and Energy to control the environmental aspects of uranium development.

The *Atomic Energy Act* (AEA) was used to grant an Authority for the Ranger mining operation. The environmental requirements attached to this authority under section 41 of the *Atomic Energy Act* were incorporated as Schedule 1 of the UMEC Act.

The Jabiluka lease, granted under section 64 of the Northern Territory *Mining Act*, included 38 environmental requirements (schedule 3 to the Lease). An authorisation under the UMEC Act will be required before mining at the Jabiluka Lease can commence. Approval is also required under the Northern Territory *Mining Act* as the Lease is granted under this Act.

1.2.2 Jabiluka Assessment Process

Environmental assessment was jointly conducted under a formal agreement between the Northern Territory and the Commonwealth Governments.

The Jabiluka proposal requires a decision under the Commonwealth Government's export licensing legislation. On this basis, and in view of the project's environmental significance, the proposal comes within the provisions of the Commonwealth's *Environment Protection (Impact of Proposals) Act* 1974 (EPIP). The proposal is also subject to impact assessment under the Northern Territory *Environmental Assessment Act* 1982.

In accordance with the provisions of both acts, ERA was directed to prepare a draft EIS. Following a public review period, final guidelines for the preparation of the EIS were compiled by Environment Australia in conjunction with the Northern Territory Department of Lands, Planning and Environment and provided to ERA.

The draft EIS and Supplement to the draft EIS were prepared by consultants, Kinhill Engineers Pty Ltd of Queensland.

In accordance with Northern Territory and Commonwealth environmental legislation the draft EIS was made available for public review between 17 October 1996 and 9 January 1997. During this period two general public meetings were held, at the Darwin Museum (approximately 100 people) and Jabiru Town Centre (approximately 60 people).

Eighty-five (85) submissions, including the Northern Territory and Commonwealth Government submissions, were received and forwarded to ERA (submissions were accepted until 21 February 1997). Another four submissions were received after this time and were considered too late to be addressed in the preparation of the Supplement; however, these contained issues previously raised. A list of public respondents to the draft EIS is in Appendix 1 and public examination places is in Appendix 2. Appendix 3 is a summary of issues raised in the submissions. Full details of the submissions were incorporated as Appendix A and B of the Supplement.

The final EIS was submitted to the respective Commonwealth and NT Environment Ministers on 17 June 1997. Northern Territory environmental assessment procedures require that the final EIS be distributed to advisory bodies for examination and final comment. These comments are incorporated where relevant in the body of this report.

Under the joint assessment arrangements, a copy of the Northern Territory's assessment report will be provided to the Commonwealth Minister for the Environment.

All recommendations arising from the Commonwealth's assessment are forwarded to the Commonwealth Minister for the Environment, who then considers the assessment and advises the Commonwealth Minister for Resources and Energy of any recommendations and conditions with respect to the project.

The Commonwealth Minister for Resources and Energy, following consideration of the assessment and recommendations, notifies the proponent and the Northern Territory Minister for Mines and Energy of the outcome. The environmental assessment process is then considered complete.

The following table presents a brief history of the Jabiluka project and the associated environmental process.

Table 1: History of the Jabiluka Project

Date	History
1971	Jabiluka uranium deposit (Jabiluka Number 1) discovered by Pancontinental Mining.
1973	Jabiluka Number 2 deposit discovered from step out drilling east of Jabiluka number 1 deposit.
1979	Final Pancontinental Jabiluka Environmental Impact Statement submitted.
1982	Final environmental approval to proceed was given by Commonwealth.
12 August 1982	The Jabiluka Mineral Lease (MLN 1) was granted for 42 years.
1983	The Three Mine policy was adopted by the Commonwealth Government which precluded the start of the Jabiluka Mine development.
21 August 1991	Energy Resources of Australia Ltd purchased the Jabiluka Mineral Lease from Pancontinental.
March 1996	Removal of three mine policy by Commonwealth Government allowed consideration of the Jabiluka Project.
15 March 1996	Notice of Intent to develop Jabiluka mine was submitted for consideration.
14 May 1996	Commonwealth Minister for Resources and Energy determined that the project was environmentally significant and designated ERA under EPIP Act.
28 June 1996	draft EIS Guidelines placed on public view.
28 June 1996	ERA was directed to prepare a draft EIS under EPIP Act.
22 July 1996	Public Meeting held in Darwin to discuss Jabiluka draft EIS guidelines.
23 July 1996	Public Meeting held in Jabiru to discuss Jabiluka draft EIS guidelines.
29 July 1996	Public comment period on Jabiluka draft EIS Guidelines close.
17 September 1996	ERA was directed to prepare a draft Environmental Impact Statement under Northern Territory *Environmental Assessment Act*.
17 October 1996	Submission of ERA Jabiluka draft EIS. Placed on public view.
05 December 1996	Public Meeting held in Darwin to discuss Jabiluka draft EIS.
09 December 1996	Public Meeting held in Jabiru to discuss Jabiluka draft EIS.
09 January 1997	Public comment period closed. (Note: comments accepted until 21 February 1997). A total of 85 submissions were forwarded to ERA. Four submissions were received too late for consideration in the preparation of the Supplement.
17 June 1997	Submission of Supplement for assessment for the Jabiluka Project. (Supplement and draft EIS constitutes the final EIS).
August 1997	Completion of review of final EIS. Report submitted to Northern Territory Minister and subsequently provided to the Commonwealth for consideration.

1.3 Kakadu Regional Social Impact Study

In June 1996 the Commonwealth Environment Minister, Senator Hill, proposed that a Social Impact Study be conducted parallel to, but separate from, the Jabiluka EIS process.

The Kakadu Region Social Impact Study (KRSIS) is funded by the Commonwealth and Northern Territory Governments and Energy Resources of Australia.

The KRSIS is being conducted in two stages:

I. The Aboriginal Project Committee (APC), comprised of local Aboriginal people and chaired by Mr Victor Cooper, is preparing a report on the social impacts of all development, including mining, tourism and park development on Aboriginal people (from an Aboriginal perspective) in Stages 1 and 2 of Kakadu National Park (KNP). The major component of this study is to be a report on the aspirations and concerns of the Aboriginal people.

II. The Study Advisory Group (SAG), comprised of representatives of the major stake holders in the region (Northern Territory Government, Commonwealth Government, Northern Land Council and Energy Resources of Australia) under the chairmanship of Mr Pat Dodson, is to respond to the APC report by preparing a plan of action or recommend strategies to address the issues raised by the APC.

The Aboriginal Project Committee was to submit its final report to the Study Advisory Group on 30 June 1997. The SAG report is due at the end of July 1997.

1.4 Major Issues Raised during the draft EIS Comment Period

By far the major concerns arising from the public review were philosophical, and involved questions related to the compatibility of the proposal with the adjoining KNP. These issues lie outside the scope of this assessment.

Major issues associated with the construction and operation of the Jabiluka mine are listed below and are the focus of the contents of this assessment report.

- ***Alternatives to the Proposed Development Option***
- ***Surface and Ground Water Management***
- ***Tailings Management***
- ***Radiation Management***
- ***Transport Management***
- ***Flora and Fauna Management***
- ***Infrastructure Impacts***
- ***Social Impacts***
- ***Heritage and Cultural Values***

All of the above are discussed in detail within Section 4.

2. THE PROPOSAL

2.1 Objectives of the Project

The objective of the project is to recover and sell approximately 90,400 t of uranium oxide (U_3O_8) over a 28 year mine life, under operating and environmental conditions as stipulated by relevant supervising authorities and utilising "Best Practice" Technology.

2.2 The Need for the Project

Guidelines for the preparation of the EIS specifically required the need for the proposed development to be fully examined.

ERA has identified a shortfall between production and demand for nuclear power generation material which will open significant market opportunities for high grade material. This increased production has been estimated to provide a national economic benefit of some $3.8 billion (equating to around $6.2 billion in real gross domestic product) over the mine's life

2.3 The Mine and Associated Infrastructure

A detailed description of the proposal is presented in Section 4 "*Project Description*" in the draft EIS and Section 5 of the Supplement.

The project will comprise two distinct phases: a construction phase, lasting approximately 18 months, and an operational phase, lasting 28 years.

The Jabiluka Number 2 deposit is estimated by ERA to contain 90,400 t of U_3O_8 within 19.5 Mt of ore at a cut-off grade of 0.2% U_3O_8. Additional ore may be identified through continuing development and exploration. Production of ore will commence at 100,000 t/a (year 1) increasing to 900,000 t/a (year 14) and continue at this level until the end of the mine life (year 28).

The Jabiluka Number 1 deposit, located 400m to the west, is not proposed to be mined. The Number 1 orebody, and extensions to the identified resources of Number 2 orebody, have not been included in this assessment. The proponent has made a commitment not to mine orebody Number 1 as part of this project.

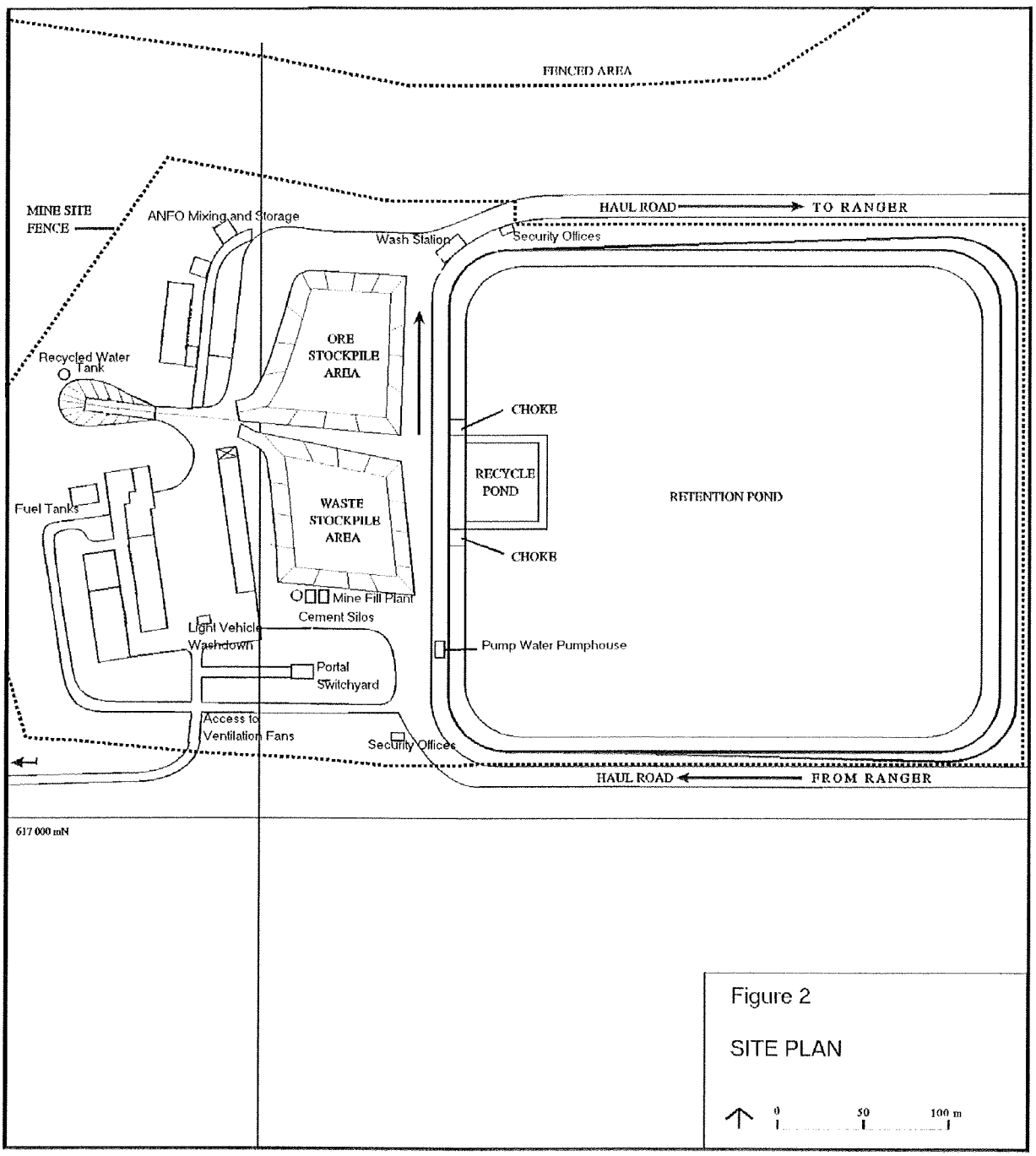
All project mining components will be located within the Jabiluka Mineral Lease, which has a total area of 7,275 ha. The project area covers approximately 90.5 ha and includes a decline development, haul road and surface infrastructure.

The surface facilities at the mine site include (Figure 2):

- a stockpile pad to contain and handle ore and waste rock;
- a Retention Pond for containment of low quality water;
- administration and amenities area;
- storage and hardstand area; and
- access tracks and ventilation fans.

During, and immediately following construction, 15 ha will be rehabilitated, thereby leaving 75.5 ha as the operational area for the project life. These 15 ha are borrow pits, temporary access and other areas disturbed during the construction. Details are presented on page 5-1 of the Supplement.

Figure 2: The project layout and associated infrastructure.



2.3.1 Construction Activities

Construction of the project facilities is proposed to commence as soon as feasible after receiving approval to proceed from the relevant government agencies. Construction includes development of the decline, site earthworks, temporary buildings and site services. The decline is the tunnel used to reach the orebody and to transport ore and waste rock to the surface. Commitments made in the Supplement ([page 11-3 of the Supplement] Spp 11-3) imply that construction will not commence until after negotiations, including change of scope negotiations under the Jabiluka Agreement, are completed with the Northern Land Council (NLC) and Traditional Owners.

In the dry season of the following year, the haul road, site roads and water management system will be installed. After commencement of production the administration building, workshop and change house facilities will be constructed.

Earthworks construction comprises:

- unsealed site roads to ventilation shafts and explosives store;
- surface drainage channels and levee banks;
- building foundations;
- truck parking hardstand and refuelling area;
- ore and waste stockpile hardstands; and
- retention/recycle ponds.

Construction details are as follows:

Sediment traps, culverts and outlet structures will be provided where drainage lines are crossed or surface flows are intercepted. The explosives store requires an earth bund surround stabilised by rip-rap and other non-flammable material due to the risk of fire. The fuel tank and light vehicle car parks will be similarly bunded.

Surface drainage will comprise constructed channels to cut off stormwater flowing towards the surface facilities area and return water to the creeks from the relevant catchment. Drains will be designed to divert a 1 in 10 year storm event. To avoid potential flooding of facilities from a more significant rainfall event, a bund wall between the drain and the facilities will be constructed, where necessary, to accommodate a six minute probable maximum precipitation event. Scour protection will be provided as required.

Construction materials for all hardstand areas will be the same materials as used for the haul road construction. Topsoil will be stockpiled for use on areas requiring rehabilitation. To minimise any runoff leaching through the ore or waste rock pads, each pad grade will have a minimum fall of 1:100 and will be treated with an approved additive to increase pavement density and reduce permeability.

The mine site including the ore and waste pads and hardstand areas form part of the Total Containment Zone (TCZ) where all waters would be collected within the Retention Pond. The Water Management System (WMS) is discussed further in Section 4.5.

The retention and recycle ponds will be constructed by stripping topsoil followed by cut and fill of the pond base area, construction of embankment walls and surface, and the placement of a flexible membrane liner (FML) over a thin layer of sand. Maximum cut will be approximately 5 metres. The FML is required primarily because there are insufficient clay sources available in the lease for preparation of the pond base. The FML will be manufactured to accepted international standards. Because soil surveys have not been conducted at the site, it is uncertain as to whether sufficient material is available to form a compacted base. The Supplement proposes that if investigations indicate unsuitable material, then a double liner with leakage detection would be considered for the pond (Spp 5-9).

The design volume of the pond is 620,000 m^3 with a maximum water depth of 8 metres with 0.5 metre freeboard. The freeboard is within limits calculated as part of the water management system to take account of a 1 in 10,000 year storm event and expected annual rainfall. Within the Retention Pond, an internal embankment wall will be formed for a recycle pond.

2.3.2 Mining

For the underground mine it is proposed to use non-caving mining methods, adapted to the different sizes, attitudes and grades of the orebody. The mining method uses drilling and blasting to break up a large cavity of ore, which is then extracted from a tunnel at the base. Empty stopes will be back-filled with cemented and uncemented waste rock material initially from the Jabiluka mine and then the Ranger mine. No tailings from the processing of Jabiluka ore will be placed underground. Further information and diagrams are provided in the draft EIS (Chapter 4).

Although the orebody has been delineated it is still 'open' at depth, as drilling conducted from the surface has yet to reveal the full extent of the orebody. It is possible that as mining progresses and further drilling can be conducted at depth, additional uranium bearing ore may be discovered. Gold mineralisation also occurs in part of the orebody.

Five air intake and two exhaust ventilation shafts will be drilled to the surface. The ventilation system has been designed to manage and control ventilation in a way that will maintain employee radiation exposure levels below the 20 mSv/a average dose limit proposed by the International Commission on Radiological Protection (ICRP). Each shaft will have a fan at the inlet/outlet point. The ventilation system will provide approximately double the airflow that would be expected in a non-uranium mine. Access to these shafts will be via smaller installation access tracks from the construction access road. Approximately 1 ha of land will be cleared for these smaller tracks.

Mine access ways and working places will be positioned in barren or low grade material, with high grade ore mined by methods designed to reduce radiation exposure of the workers.

The final EIS outlines strategies to be addressed in the development of a health and safety system to ensure safe systems for underground work and support activities ([page 4-56 of the draft EIS] Dpp 4-56).

These mining methods are standard in other underground mines.

Upon commencement of mining, a run of mine ore stockpile will be developed on an impervious pad adjacent to the decline entrance. The maximum size of the stockpile is 20,000 t (approximately 8,000 m^3) with a maximum height of 8 metres. A front end loader will load ore direct into triple trailer road trains for transport to Ranger.

Waste from the Jabiluka mine will be screened via a discriminator prior to placement in the waste stockpile in the same way. The waste stockpile will have a maximum height of 15 metres and a maximum capacity of 150,000 t. Waste for on-site use in the pond embankments or road works will be loaded into construction vehicles and taken to its point of use. During the operating period, waste to be used for backfill will be loaded either directly from the stockpile face or via a backfill plant that will be established. Retention time of ore on the pad will be less than 3 months. No retention times have been indicated for the waste rock.

All trucks leaving the stockpile area will pass through a wash station for removal of any dirt adhering to the outside of the trucks. The surface of the ore load will be wetted and then covered by a tarpaulin to minimise dust emissions during the trip to Ranger.

The mined-out mine stopes will be progressively backfilled with waste rock for the duration of the mine life. Cemented waste rock backfill is not required by the operation until the second year of production. In the proposed backfill plant, cement will be mixed with water pumped from the Retention Pond to form a cement slurry. The slurry will then be sprayed into the mine haulage trucks during loading of waste rock for backfilling.

At the completion of operations the underground mine will be completely sealed, mine surface facilities removed and disturbed areas landscaped and revegetated to approved standards. The haul road may remain if requested by the Traditional Owners.

2.3.3 Ore Processing

The proposed project will utilise existing milling facilities located at the Ranger mine. Ore will be trucked to the Ranger mine site and an estimated total of 936,731 t of Ranger waste rock will be back-hauled for use as fill for stopes.

Uranium oxide, or yellowcake, will be extracted from the ore using the existing acid leaching and solvent extraction methods at the Ranger mill. In comparison to Ranger ore, Jabiluka ore has a higher uranium grade, a significant presence of graphite and the presence of gold within the higher grade uranium ore. Extraction operating parameters for Jabiluka ore will be similar to those for Ranger ore, except that overall recovery will be higher. ERA considers that the integration of Jabiluka ore with Ranger ore is both environmentally and economically beneficial.

The Ranger mill has been upgraded to cater for about a 50% increase in throughput from the additional Ranger Number 3 pit. Processing Jabiluka ore will thus only require the following plant modifications:

- installation of a graphite removal circuit to prevent graphite carry over to the process water and pregnant liquor circuit;
- increased acid and oxidising agent addition making a slightly more aggressive leach regime to optimise uranium recovery;

- increased flocculant addition to assist in settling in the Counter Current Decantation circuit;
- minor increases in amine, ammonia and fuel oil consumption in proportion to the increased feed grade;
- increased solvent extraction strip liquor circuit flow rates to enable processing of the higher feed grades;
- increased capacity of the product calciner when annual production exceeds 4,500 t/a U_3O_8.

The uranium milling process is described in the draft EIS (Dpp 4-61).

The additional Jabiluka ore will require more acid for processing than can be produced at the Ranger site. It is estimated that up to 15,220 t of sulphuric acid will be required from external sources for the combined ore processing.

Current operations require the importation of elemental sulphur and liquid sulphuric acid into Port Darwin. Future storage facilities are proposed to be combined into a new dedicated facility at the new East Arm Port where elemental sulphur, liquid acid and uranium oxide will be stored in a secured facility manned 24 hours per day.

2.3.4 Tailings

Jabiluka tailings will account for approximately 33% of total tailings from the combined processing at Ranger. All tailings will be deposited into pits Number 1 and 3 at the Ranger mine. No tailings will be transported back to the Jabiluka site.

Tailings disposal issues are further discussed in Section 4.5.2.

2.3.5 Infrastructure

The only facilities to be located on site will be administration, warehouse, workshop, an explosives magazine and mixing area, fuel and other storage areas. Any heavy maintenance work will be undertaken at the Ranger facilities. All other infrastructure will be located at Ranger.

Mine staff will be accommodated at Jabiru and transported to the mine on a daily basis via the haul road between Ranger and Jabiluka. The project will employ approximately 164 personnel during construction and approximately 110 during the operational phase of the mine.

During the construction period mine staff and contractors will be transported to the site via the Oenpelli Road. This is dependent upon ERA gaining permission from Parks Australia to ferry workers across the Magela Creek during the wet season. If permission is not granted there is an option to re-commission the "Ja Ja" Camp, which is located on the Magela Creek flood plain. It is proposed to use this as a lay-down area for some supplies and provide camp facilities for drilling and construction personnel for up to two years.

Details of this potential recommissioning of the "Ja Ja" Camp have been provided in the Supplement. Several aspects of the recommissioning appear to be inadequately described, such as the numbers to be accommodated. This is further discussed in Section 4.5.6.

The workshop facility will comprise a four bay workshop that would be used for truck maintenance, servicing, and longer-term maintenance of other equipment such as drills. In addition to the four bays, an additional area will be provided for component overhaul and assembly.

A bunded and fenced fuel storage area will be located near the workshop and is designed to allow for a probable maximum rainfall event. Runoff would be directed to the recycle pond after passing through oil separators.

An ammonium nitrate explosive storage and mixing facility will be located in accordance with statutory requirements and Australian safeguards. All floor surface areas will be drained to the Retention Pond.

A truck wash station will be provided at the point where the Ranger haul road exits the stockpile area. A light vehicle wash down facility will also be provided to enable those vehicles which have travelled underground to be washed down prior to leaving the Jabiluka site. A similar truck wash station will be provided at Ranger. All wash water will be contained within the Total Containment Zones at each mine site and will drain back to Retention Ponds by surface drainage channels. A truck wash facility has been provided at the entrance to Kakadu National Park for mine vehicles entering the park.

Road Infrastructure

Initial access to the site will be via an existing 2.6 km track from the Oenpelli Road. Interruption to drainage lines and sheet flow will be minimised as far as practicable. Detailed design will be carried out following project approval.

It is estimated that construction traffic will add a maximum of 50 vehicles per day to the Oenpelli Road. Current peak usage is less than 600, with design capacity for over 2,000. Sign posting and minor works requirements, on and near the Oenpelli Road, will be subject to approval by the NT Department of Transport and Works.

Haulage of ore and waste rock return will be via a dedicated 22.5 km haul road. The proposed road width of two 3.5 m lanes with 1.5 m shoulders is designed to comply with Australian Standards. Drains, sediment and erosion control structures will be used to control runoff. Bridges will be designed with a 1 in 100 year flood immunity plus one metre of freeboard for debris beneath bridge beams. It is proposed that underflow culverts at smaller streams and drainage lines be designed to a 1 in 10 year capacity. The haul road will then become the only means of access to the site for both road trains and service vehicles and all vehicles will thus need to pass through Ranger prior to travelling to Jabiluka.

Road trains will comprise a prime mover with 16 t capacity and three trailers each of 27 t capacity. There will be a speed limit of 80 km/hr and haulage will not be undertaken when floodwaters cross the road surface or during intense rainfall events that may significantly affect driving safety (see Section 4.6.3).

Following commissioning of the haul road the construction access track would continue to be used only for access from the Jabiluka mine site to meteorological stations, ventilation shafts, and (if necessary) the potable water bore field on the west side of Mine Valley. Following the completion of mining activity at Jabiluka, the construction access track is proposed to be reopened to enable long-term monitoring of the rehabilitated mine site. If the haul road is left open then the construction road may not be required and will require rehabilitation.

2.3.6 Power Systems

For the first 3 years, on-site diesel generators will provide power. Power will then be delivered to the mine site by a 66 kV transmission line running alongside the haul road from the Ranger power station. All lines will be aerial except at major creek crossings where they will be incorporated within bridge structures.

2.3.7 Fencing

The main purpose of the fencing is to delineate the boundaries of the Jabiluka Project Area and haul road corridor so that there is a clear demarcation to mine employees not to enter adjacent lands, particularly the Jabiluka outlier, rather than form a distinct barrier to movement.

The EIS proposes that the location and configuration of fencing around the mine site and haul road will be the subject of negotiations with the Aboriginal landowners. Fencing will be established along the Australian Heritage Commission area boundary as well as most of 'Mine Valley', the mine site and the haul road corridor down to the boundary with the Ranger Project boundary.

2.3.8 Borrow Material

The establishment of facilities at the mine site and haul road necessitate the use of construction material sourced from the general mine area, from Ranger and along the haul road. Materials such as clay, gravels and sand will be sourced from nearby deposits. Field investigations have yet to be carried out to confirm locations, although the draft EIS and the Supplement indicate expected sources (Dpp 4-21; Spp 5-9). The Supplement states that the proposed sources for construction materials will be submitted to statutory authorities for approval prior to construction.

Borrow to fill will be sourced mainly from Ranger inert magnesite waste stockpiles and a small amount of Ranger Number 3 unmineralised sandstone. Gravel borrow pits will need to be established near the road corridor to source approximately 50,000 cubic metres of gravel/road base material. One of the gravel pits, near the midpoint of the haul road, will be utilised for ongoing maintenance.

It has been estimated that approximately 6.0 ha will be required for borrow material during the construction period. After construction, 5.0 ha will be rehabilitated to approved standards.

3. REGIONAL SETTING

3.1 The Region

The Jabiluka mine lies within the Alligator Rivers region and is approximately 230 km east of Darwin, and 20 km north of Jabiru (Figure 1).

The Alligator Rivers Region includes most of Kakadu National Park and part of Arnhem Land and is a major uranium bearing region. There are currently two uranium mines in the region, the Ranger and Nabalek mines. Ranger is still operational, but Nabalek has completed mining operations and is currently being rehabilitated. Significant resources have also been identified at Koongarra, located to the south of Ranger.

The region has a history of uranium and gold exploration and mining, with uranium discovered in 1971 and first mined in 1979 at Nabarlek. Gold exploration occurred mainly to the south of Jabiru, however during 1975 a number of gold leases were pegged to cover gold mineralisation within the Jabiluka Number 2 orebody. No gold has ever been produced from this region.

3.2 Regional and Local Geology

The Alligator Rivers region lies in the north eastern corner of the Pine Creek Geosyncline.

The area is dominated by an Archaean complex, the Nanambu Complex, which is composed of granite, granite gneiss, migmatite, schists and quartzite. This complex is surrounded by facies metasediments of Palaeoproterozoic age comprising the Kakadu Group, Cahill Formation and Mount Partridge and South Alligator Groups.

The uranium ore body is located beneath an outlier of the Kombolgie Sandstone in the Cahill Formation. The bulk of the mineralisation appears to be associated with breccia zones. The Cahill Formation is a formation unconformably overlain by flat lying Middle Proterozoic Kombolgie Sandstone at the Jabiluka project site.

The southern section of the proposed haul road crosses the Koolpin and Nanambu Formations. The underlying rocks are gneisses and schists and are relatively deeply weathered. There is little or no rock outcrop.

The basement rocks are covered with deep sands and silts adjacent to the main streams. Elsewhere the cover is shallow and the surface is generally lateritised with extensive areas of laterite outcrop and shallow sandy lateritic soils, and lesser areas of surface lateritic and siliceous gravel.

The northern section of the haul road is located over the Kombolgie Formation. In this area there are minor outcrops of residual sandstone boulders adjacent to the alignment. Throughout this portion of the proposed route the soils overlying the basement are medium to fine sands of variable depth (2-10 m).

3.3 Land Use

The proposed mine site and associated infrastructure lie within the Jabiluka Lease surrounded by the Kakadu National Park. Major land uses for this region include National Park, recreational fishing, Aboriginal Traditional uses and mining.

At the end of the project the land will revert back to Aboriginal freehold, which was granted under the *Aboriginal Land Rights (NT) Act* 1982.

3.4 Biogeography

The project is situated on the eastern slope of the northern Jabiluka outlier, within the Swift Creek catchment, east of the Magela Creek floodplains. The Magela and Swift Creeks are tributaries of the East Alligator River.

The geomorphic elements in the project area consist of outliers, hill slopes (grading to lower scree slopes) and alluvial flats. Uranium mineralisation to be developed by ERA is hosted under the northern Jabiluka sandstone outlier. The surface infrastructure is located on moderately sloping land on the south eastern part of this outlier in a relatively undisturbed area.

There are three broad terrestrial biogeographic entities within the region which can be described in terms of geomorphologic characteristics and vegetation communities. These have been broadly described as: "The Escarpment Alliance", "The Dryland Plain Alliance" and "The Flood Plain Alliance".

The Escarpment Alliance, consisting of high relief sandstone escarpments and sandstone scree slopes, is not impacted by the project, as no construction or operational activities will be located on or close to this alliance. This alliance has not been surveyed at the request of Traditional Owners, and little vegetation information has been presented.

The Dryland Plain Alliance occupies some 80% of the haul road corridor and 100% of the mine site. It occurs on the fringes of colluviual and alluvial sand deposits below the escarpment and consists predominantly of mixed open woodland and open forest dominated by *Eucalyptus miniata, E. tetrodonta, Petalostigma quadriloculare* and *E. bleeseri* with *E. setosa, Verticordia cunninghamii, Xanthostemon paradoxus, Terminalia ferdinandiana, Pouteria pohlmannia, Planchonia careya* and *Owenia vernicosa* also present. Deep sands that are saturated in the wet season, lateritic red and yellow earths on mica schists, and fluvial material and siliceous sands occur along the transport corridor. Red earths on sandstone occur in the mine facilities area.

The Flood Plain Alliance represents the remaining 20% of the project area. It occurs on creek crossings and immediate surrounds and contains *Melaleuca sp*, riparian woodland and grassland with few emergents. Pockets of rainforest communities may exist along creek lines and associated soaks near the escarpments. Further surveying will delineate these and provide additional information. Soil types similar to the Dryland Alliance have been reported. Finer sediments exist in and near the major watercourses which receive and retain water for longer periods. Soils on the Magela floodplain range from sands overlying deeply weathered laterised saprolites to organic clay loams.

The climate is tropical monsoon with two distinct seasons, the "wet" and "dry", with strongly seasonal rainfall. The wet season generally extends from November to April and the dry from May to October. The project area receives on average in excess of 1,300 mm/year. The nearest recorded average rainfalls are at the communities of Jabiru and Oenpelli, which have annual average records of 1,446 mm and 1,365 mm respectively. Meteorological data has been collected at Oenpelli since 1910 and at Jabiru since 1971.

High intensity periods of storm rainfall is a significant feature of the region and poses a rain splash erosion problem, particularly on cleared areas. Rates of over 100 mm/hr for durations of 5-30 minutes have been recorded at Jabiru. Higher figures of 240 mm/hr for a 5 minute period have also been recorded in the region.

Air temperatures are high and relatively constant throughout the year. Mean maximum temperature at Oenpelli for the period 1963 to 1994 was approximately 38°C in October, with mean minimum temperatures for the same period being 18°C in July. The annual mean evaporation is 2,646 mm, and based on an average year evaporation, exceeds rainfall by approximately 1,200 mm.

At the Jabiru airstrip relative humidities are high throughout the year with a daily average ranging from 54% in July to 80% in January. The wind pattern is distinctive and predictable, with strong variable south east winds in the dry season and predominantly north west in the wet season. Tropical cyclones frequently develop over the seas to the north west, north and east of Arnhem Land. Since 1959 there have been 7 tropical cyclones that have passed sufficiently close to the region to have had some effect.

3.5 Areas of Conservation Significance

Kakadu National Park, managed by Parks Australia, occupies 19,804 square kilometres and possesses an extensive diversity of flora and fauna. Its importance both as a National Park and tourism attraction is renowned, and is subject to a comprehensive Plan of Management.

The Park is listed on the World Heritage Register in recognition of its outstanding natural and cultural values. This listing, as well as requirements under the Kakadu National Park Plan of Management (1991), has made it essential that any developments with the potential to affect the park are undertaken in the most environmentally sensitive way possible. As at March 1996 a total of 683,000 ha of wetlands in Kakadu are listed as being of international importance (RAMSAR Convention).

Kakadu is also currently subject to international treaties for the protection of wildlife and habitats, including:

- the agreement between the Government of Australia and the Government of Japan for the protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA). Forty six of the 76 birds listed under this agreement occur in the park;

- the agreement between the Government of Australia and the Government of the People's Republic of China for the protection of Migratory Birds and Birds in Danger of Extinction and their Environment (CAMBA). Fifty of the 81 birds listed under this agreement occur in the park;

- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention). Twenty-one of the species listed under this convention are found in Kakadu.

Aboriginal archaeological sites and artefacts are also associated with specific geological features of the region. Some 196 Aboriginal art sites, 1 mythological, 29 habitation shelter and 6 burial sites have been identified within the Lease area. The majority of these sites lie at the base and on the scarp of the Jabiluka outlier.

3.6 Demography

The region is sparsely populated, with the township of Jabiru being the focus of social and economic activity. As of 30 June 1996 the population of Jabiru was estimated at 1,403 people, with an additional 714 in the surrounding South Alligator region (source: ABS, Darwin, 1996.

In 1985 approximately 100,000 people visited the Kakadu National Park. This figure increased to around 222,000 in 1996. This increase has stimulated tourism development in Jabiru and surrounds.

The nearest dwellings to the project are Mudginberri (an Aboriginal community), and the semi-permanent camp areas to the west of the project area. The nearest populated zones are Jabiru and Oenpelli. Other populated areas and outstations exist throughout the region.

3.7 Economy

Mining, tourism and recreational fishing are significant contributors to the regional economy. Tourism is highly seasonal. In 1990 monies spent on visits to Kakadu accounted for more than 25% of all money spent on tourism in the Top End of the Northern Territory. Assuming this percentage and using data supplied from the Northern Territory Tourist Commission, approximately $80 million would have been spent on visiting Kakadu during 1996. Mining was worth approximately $106 million during the 1996/97 financial year.

4 ASSESSMENT

4.1 Overview

This section reviews the descriptions of the existing biophysical environment and the predicted impacts, and evaluates the undertakings and environmental safeguards proposed by the proponent to mitigate the potential impacts. In addition, the mining of uranium in Australia is extensively regulated. The Commonwealth and Northern Territory Governments carry out monitoring programs and impose statutory obligations.

The following principal factors are addressed during this assessment:

- ***Alternatives to the Proposed Development Option***
- ***Surface and Ground Water Management***
- ***Tailings Management***
- ***Radiation Management***
- ***Transport Management***
- ***Flora and Fauna Management***
- ***Infrastructure Impacts***
- ***Social Impacts***
- ***Heritage and Cultural Values***

The information provided in the final EIS has been assessed and then used, along with submissions from advisory bodies and public comment on the draft EIS, to determine the adequacy of the information provided by the proponent, the accuracy and acceptability of predicted impacts and safeguards. Specific recommendations for mitigation and monitoring of impacts are made.

It is acknowledged that during the detailed implementation of proposals, flexibility is necessary and desirable to allow for minor and non-substantial changes to the designs and specifications which have been examined as part of this assessment. It is considered that subsequent statutory approvals for this proposal could make provision for such changes, where it can be shown that the changes are not likely to have a significant effect on the environment.

The definition of "project" for this assessment includes all operations associated with the extraction and processing of ore, ore haulage to the Ranger milling facilities, surface and groundwater management, appropriate disposal of wastes, rehabilitation and supporting on-site infrastructure. The definition of "mine site" includes all areas in the immediate works area and includes underground works but excludes the haul road (after exiting the mine site) and the Ranger mill and associated processes.

Subject to decisions which permit the Jabiluka Project to proceed, the primary recommendation resulting from this assessment is:

Recommendation 1

The proponent shall ensure that the proposal is implemented in accordance with the environmental commitments and safeguards identified in the Jabiluka Project draft Environmental Impact Statement, or as modified in the Supplement to the draft EIS, this assessment report and approved Mine and Environmental Management Plans.

4.2 Issues Raised in Submissions

The Supplement to the draft EIS contains ERA's response to the issues raised in the 85 submissions (refer Section 1.2.2). It also includes updated sections on the social impacts of the proposal and radiation management at the mine.

The Supplement published a summary of the comments received, and ERA responded in detail to the issues that were raised. Matters of specific concern included:

- the impact of the project on the local social environment;
- radiation aspects of the proposal;
- a lack of certain environmental baseline data;
- aesthetic problems caused by the presence of mining activities in the midst of a national park;
- contamination of watercourses and consequential hazards to human health;
- disturbance of flora and fauna;
- usage of uranium;
- disposal of uranium wastes; and
- adequacy of Ranger water and tailings management.

A summary of major issues has been included at Appendix 3 of this report. A more detailed table of the issues raised in these submissions can be found in Appendix A and B of the Jabiluka Project Supplement (1997).

The majority of the submissions were highly critical of both the proposal and the information presented in the draft EIS. About 50% were generally concerned with the undesirability of mining and potential usage of uranium for nuclear weapons. These issues are beyond the scope of the environmental assessment process.

Other main concerns included inadequate consideration of suitable alternatives, the tailings and water management systems at Ranger, social and cultural issues as they relate to the Aboriginal population of the region, and the importance of the surrounding World Heritage Area.

Submissions were also concerned with the inadequate environmental data base, and inadequate discussion or identification of ecological impacts. Several submissions raised doubts about the proponent's ability to comply with environmental safeguards and monitoring programs. Twenty-one written comments indicated concern over environmental management at Ranger and how the Jabiluka mine could affect the Ranger project.

An assessment of the adequacy of the proponent's response is an important aspect of the overall assessment of the project because the public review phase provides all interested parties with opportunities to raise issues that concern them. The proponent's response to the issues identified in the submissions has been indexed in the Supplement for easy cross-referencing. Responses to the comments take the form of either answering a query, resolving a conflict or proposing suitable management methods and are considered to be satisfactory. Comments not directly quoted in the appendices have been incorporated in other main comments.

Northern Territory mining legislation requires that auditable Mine and Environmental Management Plans be developed. These will detail the safeguards to minimise and manage potential impacts arising from the project, and outline proposed monitoring programs and additional baseline studies to be undertaken.

4.3 Project Baseline Information

Baseline data is important for the best practice evaluation of, and planning for, potential impacts upon the area concerned, and for comparison with monitoring results if the project commences. It is important that baseline data is collected over a suitable time period (at least a year to capture seasonal variability, and preferably longer to account for variations in rainfall events) prior to any development. This will enable comparisons between pre and post development measurements. The use of modelling based on incomplete baseline data and extrapolation from distant areas leaves open the possibility that there could be adverse impacts that have not been identified and which therefore have not been addressed.

Submissions focussed on the paucity of baseline information about aquatic ecology, terrestrial fauna, aquatic and terrestrial flora, hydrology (including water quality and quantity), hydrogeology, air quality, soils, archaeology and cultural heritage. The proponent has acknowledged this but points out that there have been restrictions on accessing several areas to conduct many of the required surveys. The final EIS acknowledges the need for additional detailed survey work, and ERA proposes to undertake baseline studies immediately after access has been approved by the Traditional Owners

4.4 Project Alternatives

The proponent was required to give consideration to alternatives to the project and to the means of carrying out the project. A detailed description of the alternatives, is presented in Section 5 "*Alternatives to the Project*" in the draft EIS and Section 6 of the Supplement.

The final EIS describes a preferred option, an underground mine with milling at Ranger, for the development of the Jabiluka Project.

Criteria used by the proponent in evaluating alternatives included:

- using "Best Practice" Technology;
- using best possible operating practices;
- ensuring compatibility and technical feasibility, particularly with Ranger operations;
- maintaining high health and safety standards;
- minimising environmental impact;
- compliance with all regulations, Australian Standards and codes;
- maintaining realistic economic cost and return; and
- accord with the findings of the Ranger Inquiry (1977).

Four alternatives were presented in the final EIS (Table 2).

Table 2: Alternatives to the Jabiluka Development, NT

Alternative	Description	Estimated Area of Disturbance
Pancontinental Proposal (1979)	An underground mine with associated ore treatment, similar to Ranger, recovery of gold from the uranium tailings and disposal of tailings as cemented fill to the mine and to a tailings pond. This mine proposal obtained agreement and approvals in 1982 (granting of Mineral Lease Number 1 and signed agreements with the Aboriginal community).	819 ha
Jabiluka Mill alternative	Milling and processing within the Jabiluka Lease. Adjacent Ranger facilities such as the sulphuric acid plant, power supply etc would be utilised.	126 ha
ERA Proposal (1996)	An underground mine with no on-site treatment. All treatment and milling would occur at the Ranger uranium Mine.	Construction: 90.5 ha Operation: 75.5 ha
Do Nothing	No development of the proposed mine.	0 ha

Studies undertaken by Pancontinental in 1979 considered both open-cut and underground mining methods. The underground mining alternative, as preferred by ERA, offers a number of advantages over open cut including:

- reduction in the environmental impacts associated with the physical disturbance of the surface area;
- no large waste dumps or tailings dams;
- no major mining pits;
- visual effects will be minimised;
- a no-release water management policy is considered practicable and achievable;
- reduction in the overall potential social effects, due to low worker numbers;
- complete rehabilitation will be practicable and achievable.

The current ERA 1996 proposal offers substantial advantages over other mining alternatives with respect to minimising environmental and social impacts. A large development such as the Pancontinental proposal which includes on-site processing would result in extensive impacts attributable to additional staff, additional land clearing, additional waste disposal, ore processing (ie chemical inputs and emissions) and product transportation. Given that over 15 years of data has been obtained from the Ranger operation it is considered that the design data used in the earlier proposal requires review to incorporate new technology and Best Practice Technology.

The final EIS lacks specific technical and background data in its discussion of the Jabiluka Mill alternative. Submissions have cited lack of technical data, tailings dam seepage and hydrogeological modelling as inadequate. It is therefore appropriate that this option, if adopted, be subject to further assessment due to its significant divergence from the current alternative being assessed.

In the event that mining the Jabiluka number 2 deposit is approved then the ERA proposal (1996) is preferred. However, if ERA decides to implement the Pancontinental proposal (1979) or the Jabiluka Mill alternative, then updated information will be required to assess potential impacts. The remainder of this report assesses the ERA proposal (1996).

Recommendation 2

The proponent shall ensure that if a development alternative to underground mining and milling of Jabiluka ore at Ranger is to be implemented then further information, to reflect the current legislative requirements and mine site design and processes, is to be submitted for assessment.

4.5 Major Environmental Issues, Potential Impacts and Safeguards

The Jabiluka Mineral Lease encompasses a portion of the Magela Creek floodplain, which forms a crucial component of the World Heritage values of Kakadu National Park and is of major significance to the overall ecological and biological value of the Park. The wetlands of Kakadu were a primary reason why the region was placed on the World Heritage List, yet it is their proximity to the proposed Jabiluka mine which makes the protection of water quality and quantity a major ecological issue. Because of the environmental sensitivity of the area surrounding the lease, Jabiluka needs to be managed so that there will be minimal risk of impacts which may diminish the values of the floodplains and associated ecosystems, and the species which utilise these habitats.

4.5.1 Water Management

4.5.1.1 Surface Water Management

The main objective of surface water management is to contain waters which may be of unacceptable quality for release to the environment. Other important objectives are to control storm water runoff, surface erosion and sedimentation.

Many of the submissions expressed concern over the water management system in place at the Ranger site but only 6 expressed some concern directly related to the Jabiluka mine site and associated haul road. The issues included water quality, hydrology and the lack of baseline data.

The major streams of this region arise in the highly leached sandstone of the Arnhem Land plateau and consequently their waters contain low concentrations of solutes (Humphrey *et al* 1990). The marked seasonal flows along the catchment areas predominantly occur from January to May.

While there is substantial hydrological data for the Magela Creek catchment, aspects of upstream catchments of the Swift, North Magela and 7J Creeks were not presented in the final EIS. A monitoring program to obtain baseline data on Swift Creek hydrology and water quality commenced in 1997.

The proponent describes the existing surface water hydrology based on estimates of average and extreme events for rainfall and known data on stream and river flows of the region. The final EIS has characterised water quality dynamics within the Magela Creek regime based upon 20 years of monitoring for the Ranger operation. Specific data related to the Jabiluka mine project area has not been presented but is considered that there will be little variation from the dynamics of the Magela system.

Mine Site

The water management system (WMS), at the mine site, is designed to operate on a "no release" basis by containing potentially contaminated waters on-site and operating on the principle of segregation and management of waters according to catchment origin and water quality. Water may enter the mine site as fresh supply from external bore fields, potable water supplies, run-off from the project catchments and as mine water pumped to the surface. Water will leave the system entrained in truck dust suppression, by seepage from water catchment devices and as evaporation.

For this project the WMS consists of:

- Catchment Runoff Zone (CRZ): These waters are in contact with undisturbed catchment in the project area. They will be intercepted by cut-off drains and diverted away from mine facilities back to natural drainage lines.

- Sediment Control Zone (SCZ): These waters comprise turbid runoff from non-mineralised areas such as roads and surface facilities at the mine site. These waters will be directed to silt traps to remove readily settleable solids ahead of free release to natural drainage.

- Total Containment Zone (TCZ): The TCZ includes all sub-catchment and storage units which are likely to generate or store contaminated runoff resulting from mine-related activities. This effectively means any area where material containing more than 0.02% uranium is mined, stockpiled, stored or handled, or any catchment draining such an area. Runoff from the TCZ will not be released to the environment but rather directed to sumps and then directed to and stored in the Retention Pond, capable of holding 620,000 m^3, where it will be recycled for use or evaporated. This pond has been designed to allow a storage capacity sufficient to contain a 1 in 10,000 year storm event.

External catchment flows will be prevented from entering the SCZ and TCZ by diversion drains and bunds on the northern and southern sides of these zones which will be sized to accommodate the probable maximum precipitation (PMP) event. Bunds will be designed so that PMP events cannot enter the TCZ from the SCZ, or vice versa. SCZ areas will additionally contain internal bunding and drainage designed to handle a 1 in 10 year rainfall event.

Water from the Retention Pond will be required for underground use, truck washing, dust suppression, backfill plant and general wash down requirements. All recycle water will drain back to the Retention Pond. Water captured during underground operations will be pumped directly to the Retention Pond.

Concerns were raised over the suitability and reliability of the proposed lining technique to be used in the Retention Pond. It was highlighted that the USEPA normally require a double liner with an alarm system to detect leakage between membranes and suggests that the Jabiluka Retention Pond does not provide adequate safeguards against leakage.

There is some uncertainty about the geotechnical suitability of the Retention Pond site and liner system to prevent or contain leaks. Consequently there may be impacts resulting from release of contaminated water, but this will depend on the temporal and spatial extent of any leak, the degree of contamination, and the sensitivity of any biota exposed to the water.

The proponent has acknowledged (Spp 9-2) that a double liner is less susceptible to leakage from liner damage and is able to incorporate leak detection equipment in the sand sandwich layer. However, to achieve these advantages the proponent considers that the significantly higher capital cost (approx. 35% higher) is not warranted. Instead, ERA believes that the installation of a single liner above a thin sand layer over compacted sub-base provides sufficient confidence that the leaks will not occur. ERA will, however, only adopt the single liner system if geotechnical investigations determine that site conditions and construction materials available are suitable for the purpose. ERA has not provided data relating to risks of liner leakage.

It is considered that geotechnical data relating to the Retention Pond should be reviewed to assess the need for a double liner with an alarm system to detect leakage between membranes, as is the standard adopted by the USEPA. While operations of the pond can be managed to minimise the potential for damage to the liner, a contingency plan needs to be developed for this site to be consistent with the proposed no water release policy.

Recommendation 3

Details on the geotechnical information regarding Retention Pond siting and a risk assessment of single versus double liner failure have not been provided. The proponent shall submit the following, prior to committing to a final liner system:

- **a risk analysis of single liner failure;**
- **a risk analysis of double liner failure;**
- **details on the suitability and success or failures of leakage detection systems from similar systems employed elsewhere;**
- **details of proposed geotechnical studies of the Retention Pond site;**
- **a full justification on the selection of the Retention pond site and the appropriate liner system.**

The final approval for the retention pond shall not be made until the above information has been submitted and reviewed.

The water management system at the mine site adequately addresses the issues of separating and controlling water over the mine site, however specific design issues, such as contingency procedures for catastrophic Retention Pond failure, still require clarification. While alternatives were presented for the distribution of pond waters, no engineering details or procedures were presented in the final EIS.

Recommendation 4

Contingency measures for catastrophic Retention Pond failure have not been clarified in the final EIS. The proponent shall submit for approval detailed procedures for the contingency of Retention Pond failure, including leakage detection and liner repair.

Submissions also raised issues relating to poor quality water with potentially high contaminant levels (particularly trace elements, nitrates and oily contaminants from the explosives and fuel storage areas) entering the natural system. The proponent has redesigned the SCZ in the final EIS to ensure any potentially contaminated water from these areas is contained within the TCZ.

Other potential contaminants, such as acid and sulphates from the ore stockpiles, are also to be contained within the TCZ. Testing on representative ore samples indicate that approximately 15% of ore could yield acid if exposed to oxidising conditions for more than 6 months. To minimise the potential acid generation of ore it will be stockpiled for less than 3 months. Any pyritic waste generated from decline development will be temporarily stockpiled within the TCZ and later disposed of underground as cemented backfill.

Turbid runoff from the mine site will be managed through designated water management systems including sumps, drains and bunding. Runoff water entering the system, such as waters from waste rock and ore dumps, may be expected to show a cyclic annual fluctuation in dissolved load but little systematic change once the mine is established and atmospheric fall-out reaches a steady state. These waters will be contained within the TCZ.

The proposed erosion control measures, drains, diversion bunds and sediment traps detailed by the proponent are adequately described, however their detailed design will require approval. The design will need to ensure the structures contain and direct surface flow and suspended solids as outlined in the water management system.

Recommendation 5

The proponent has not detailed contingency plans for unacceptable levels of contaminants within the Sediment Control Zone. The proponent shall prepare and submit for approval a contingency plan to control water containing unacceptable levels of contaminants in the Sediment Control Zone.

Provided that the water management system is operated, as described in the final EIS, there is a low risk of entry of contaminants from the mine site into surface waters of the Magela and Swift Creeks.

Haul Road

Comments relating to the potential impacts of the haul road, namely increased silt loads in watercourses, increased erosion potential due to road design, the water classification scheme, culvert design, potential water contamination and disturbance of aquatic species have been raised in submissions.

The final EIS fails to note that disturbance to the catchment of a watercourse, such as clearing of vegetation, can produce a change in water quality even if hydrological patterns are little changed. Silt loads in runoff from newly cleared areas will inevitably be higher than for vegetated catchment areas. As the haul road is proposed to be sealed, silt loads can be expected to reduced over the first few years of the project's life.

The level of turbidity in water can have both direct and indirect effects on aquatic flora and fauna communities. The end result of chronic turbidity may be that the growth of plants will be limited, fish breeding and distribution will be affected, and macroinvertebrate abundance and diversity will be reduced and/or significantly altered in species make-up.

ERA has not provided estimates of silt loads on creeks that the haul road crosses. Measures to reduce silt loads include sedimentation traps on either sides of the bridges and at culverts.

The draft EIS outlines procedures for vegetation clearing, topsoil management and erosion control strategies (eg., buffer strips and temporary sediment traps). Creek crossings will be priority areas for mitigation measures and immediate stabilisation. The proponent has undertaken to regularly review these strategies in consultation with relevant government agencies over the life of the operation. ERA has stated that contractors conducting clearing operations will be subject to significant penalties should unwarranted clearing occur, although the nature of these penalties have not been outlined in EIS documentation (Spp 5-11).

Recommendation 6

Silt loads in watercourses will be elevated during the construction activities. These loads are expected to decline during the first few years of mine operation. A study to assess silt loads in watercourses (Magela, North Magela and Swift creeks) along the haul road which may result from the mine site disturbance, the corridor disturbance and road maintenance shall be undertaken. A review of this study shall be undertaken on a yearly basis and results reported in the Jabiluka Annual Report.

The sealed haul road has the potential to cause sheet and rill erosion on the unsealed shoulders and embankment batters, and to a lesser extent at culverts. It is unclear whether the proponent intends to monitor silt loads along the haul road.

To reduce potential for soil erosion, the proponent should undertake suitable investigations for stabilisation of road side shoulders, fill embankment batters, mitre and table drains with suitable protective measures to minimise erosion. Measures including stabilisation using suitable grasses and slashing rather than grading as part of the annual maintenance program should be investigated.

There are some concerns about the adequacy of culvert design in relation to surface water management. Impedance of water flows upslope of the road could lead to changes in vegetation. Water flow in excess of the culvert design could cause build-up of water at the side of the road, possible water flow over the road surface, and downslope scouring. While the 1 in 10 year flood design may be in excess of the normal design standards for normal rural roads, the haul road does not fall into this category. See Section 4.5.4.1 for further discussion of design standards.

Recommendation 7

The proponent shall investigate stabilisation of road side shoulders, fill embankment batters, culverts, mitre and table drains with suitable protective measures to minimise erosion. This study should be extended to include fire breaks and other areas which are required to be kept clear of vegetation such as the power transmission line.

Ranger

Many submissions on the draft EIS questioned the ability of the Ranger WMS to accommodate any additional load incurred through processing Jabiluka ore at Ranger mine. Submissions also drew attention to the performance of Ranger's WMS since commencement of mining at Ranger in 1979. The impact of milling Jabiluka ore at Ranger on the WMS is essentially one of an extension of life of existing arrangements rather than imposing additional loads. The environmental performance of the Ranger operation is under constant review by the Office of the Supervising Scientist and the Northern Territory Department of Mines and Energy. The WMS for Ranger has undergone appropriate assessment and subsequently has been approved as meeting environmental requirements.

While the overall method of water management at Ranger will not change with the addition of Jabiluka ore, the timeframe of operation will be extended from approximately 12 years to about 30 years. The Ranger WMS was based on recommendations of the RUEI Second Fox Report. Subsequently the principles of applying "Best Practice" Technology have resulted in continuous major improvements during the operation of the mine.

Acid production from ore stockpiles is another issue of concern in submissions. Ore from Jabiluka may be stockpiled for periods in excess of 6 months. The proponent proposes to install a system for the collection and treatment of acid leachate. Waters, if found to contain unacceptable levels of acid leachate, will be treated with conventional lime dosing or transferred direct to the Ranger mill for use in the sulphuric acid leachate circuit. Leachate waters of lower acid levels will be collected in sumps and transferred to Retention Pond 2 which is part of the Restricted Release Zone (RRZ) at Ranger.

Issues centering upon Magela Creek contamination caused by soluble uranium from Ranger operations were raised. This is discussed in Section 4.5.2.

The major impact of the Jabiluka mine on the WMS at Ranger will be the systems' extension for 17 years.

4.5.1.2 Groundwater Management

There are two important aspects of groundwater management:

- alteration of the groundwater regime on or near the mine site; and
- groundwater pollution from seepage water and mine processes (including water storage).

Hydrogeological investigations in 1992 attempted to identify the groundwater regime in the project area.

The aquifers in the region consist of a shallow aquifer associated with the unconsolidated sediments overlying the bedrock, and a deeper fractured rock aquifer in the underlying bedrock. Groundwater investigations in the Jabiluka area have shown that structural features such as faulting (ie Hegge fault) are important controls in the groundwater flow through the deeper fractured rock aquifer. The initial investigations also confirmed that the surrounding deeper aquifer rocks have low transmissivity and permeability.

The deeper aquifer is extensive in area and likely to be associated with local and regional groundwater flow systems. Recharge to this aquifer is expected to occur in the elevated outcrop areas and the groundwater flow is likely to follow the topography. The shallow aquifer associated with the alluvial sediment is restricted in extent to the valleys and is likely to form a local groundwater flow system.

While limited pumping results from the deeper aquifer inferred a connection between the deep and shallow aquifer systems, the proponent was unable to define the magnitude of this connection from the available data. Therefore further investigation during baseline studies is required.

The hydraulic gradient in the region of the mine site has not been presented. The proponent indicates that groundwater movement generally follows the same broad drainage pattern as dictated by topographical features, placing the mine "upstream" of possible shallower aquifer system connections. Given sub-surface stratigraphy and the known hydrogeological parameters in the Alligators River Region, it is likely that this assumption is correct with sub-surface flows directed towards surface features such as Swift Creek.

Conclusions regarding groundwater hydraulics were based upon drill holes situated on the western side of the Hegge fault. On the eastern side of the fault there is a lack of information on the effects that pumping may have on surrounding soaks, flora and areas reliant on groundwater.

The proponent has recognised the lack of data and is committed to carry out further investigations.

Potable water and make-up water is available to the west of the Jabiluka ore deposit. Expected consumption of potable water (maximum of 9.0 m^3/d) and make-up water in droughts (170 m^3/d) is within the bore's determined long term yield of 260 m^3/d. Initial testing show that the water is of a high quality and suitable for human consumption, and further testing to verify chemical, bacteriological and radiological water quality parameters will be undertaken prior to construction. Water will be piped to the mine site facilities by a 150 mm pipeline resting on the ground and requiring minimal ground disturbance and no additional clearing.

During mine start-up, approximately 1,300 m^3 (year 1) rising to 16,000 m^3 (year 15) of make-up water will be required, based on an average wet season. In a drought situation some 82,500 m^3 would be required.

Concerns were expressed that the draw down of the regional groundwater table to form a cone of depression may affect the availability of water to vegetation in or near the mine project area.

Long term pumping details and calculations on drawdown and transmissivity have not been provided by the proponent. However, short term test information suggest that a 0.05m lowering of the ground water table at a distance of 300 m from the bore may occur. The proponent agrees that these results are at best estimates and do not take into account variations in aquifer parameters and recharge levels. This raises a level of uncertainty in regards to if, when and how much the shallower and the deeper aquifers would be affected. Localised drawdown of the groundwater due to underground extraction operations is not expected to adversely impact on the proximal vegetation or fauna due to the deep nature of the groundwater affected and its estimated low transmissivity rates. Information regarding this effect, particularly during the dry season, is required.

The proponent has not fully investigated the groundwater regime for the mine site or surrounds, but has provided a reasonable scenario based upon available data. Drawdown estimates, hydraulic gradients, transmissivities and general groundwater movements for the bore field will need to be submitted and verified to the satisfaction of the regulatory agency.

The proponent has committed to undertake further detailed studies into groundwater volumes and quality (Spp 11-2). A set of observation bores to monitor groundwater both at the mine site and at the potable water bore field will be established. Bores established for monitoring groundwater quality on and off the mine site will also measure water table levels. The proposed monitoring program has not been detailed in the final EIS but will be refined in the mine's Environmental Management Plan.

Of particular importance to local Aboriginal communities is a soak named "*Boywreg*" located to the west of the project mine site. Shallow and deep groundwater drawdown may have an effect on this site through the potential to lower the water table causing the soak to dry up. This is further discussed in Section 5.2 and recommendation 36.

4.5.2 Tailings Management

Uranium mine tailings have the potential to emit radon for a considerable period of time (for example, the radioactive half life of uranium-238 is 4,800 million years). Its leachate is likely to contain heavy metals which have the potential to impact on the surrounding biological systems.

Many submissions outlined concerns over tailings disposal and the potential for tailings contaminants to enter the surrounding water systems through groundwater ingress/egress.

Jabiluka tailings disposal alternatives were canvassed in the draft EIS and included underground disposal, the construction of surface tailings dams at Jabiluka, and the disposal of tailings within mined out pits at Ranger.

Underground disposal is not a preferred option due to engineering problems with potential surface subsidence once the tailings settle in void spaces, and possible heavy metal and radiation emission via groundwater seepage.

Surface disposal at the Jabiluka mine site would require land clearance in excess of 70 ha and would result in substantial alterations to surface hydrology of the project area. This is not a preferred alternative due to long term storage issues. No detailed information has been presented with respect to engineering design.

Disposal of tailings in the Ranger pits provides potentially fewer engineering problems. Under this alternative ERA intends to place all combined tails from Ranger and Jabiluka into pit numbers 1 and 3 at the Ranger mine. The additional Jabiluka tails will necessitate the use of pit number 3 as a repository. Tailings deposition into pit number 1 will continue whether Jabiluka proceeds or not.

The Environmental Requirements appended to *the Uranium Mining (Environmental Control) Act* 1979 require that all tailings at Ranger must be deposited in or transferred to the mine pits unless an alternative disposal process is proposed and will protect the environment equally well. Since August 1996, tailings have been deposited in the mined out Ranger pit 1. No further tailings will be deposited into the tailings dam.

Using a pit that would otherwise remain open or existing facilities for tailings disposal is considered preferable to additional disturbance by the alternatives. The option of using Ranger pit 3 for Jabiluka tailings is therefore supported.

The three alternatives have the potential for groundwater seepage. The impacts associated with using pit number 3 is further addressed in this section.

Volume available in pits 1 and 3 total 59 million cubic metres (Mm^3) based upon a settled density of 1.2 tonnes per cubic metre (t/m^3). Current estimates of requirements from Ranger and Jabiluka ore processing (including the transfer of existing tailings dam tails) is 49.3 Mm^3 which is well within the storage capacity of the two pits.

Both the Jabiluka ore body and Ranger number 3 ore body are undefined at depth. If additional deposits were mined and processed, then it is possible that more tailings would be produced than could be contained in Ranger pits 1 and 3. The proponent acknowledges this possibility and recognises that it would be likely to have a significant impact on the volume of tailings generated, thus raising significant environmental issues.

There is currently some uncertainty as to the depth to which ore will be mined from Ranger pit number 3. This will influence the amount of tailings that could be deposited in the pit and could also influence the time at which pit 3 is available for tailings deposition. ERA has made a commitment to continue mining pit number 3 to provide sufficient tailings space for tailings produced from the milling of Ranger and Jabiluka ore (including tails currently in the Ranger tailings dam if required).

It is possible that disposal of additional tailings would involve above ground storage facilities. It is not possible for this assessment report to provide advice on possible impacts or recommendations on remediation required in such circumstances. Further environmental impact assessment under the relevant Commonwealth and Northern Territory legislation may be required if a proposal was made to mine and process more ore from Jabiluka than is specified in the EIS.

Recommendation 8

Any increase in tailings or modifications to the tailings disposal option outlined in the final EIS shall be submitted to further assessment.

The hydrogeology of pit 3 and surrounds have been investigated since the feasibility stage of the Ranger project in the 1970's. The Supplement outlines the results of these investigations. However, the extent of connection between various hydrogeological zones and the connection between the pit wall aquifer system and Magela creek has yet to be completely characterised. The EIS indicates that further hydrogeological studies will have to be made to complete the picture.

Existing studies have not identified significant aquifers in the 200m above the expected base of the pit. If tailings were deposited above this point there is the potential for tailings contaminants to seep into groundwater at certain points adjacent to the pit. If tailings from Jabiluka ore were not deposited in pit 3, it is unlikely that the tailings deposited would reach the level at which there is the potential for seepage. As such there is a linkage between disposal of Jabiluka tailings at Ranger and the potential for increased impacts.

Extensive investigation work was carried out into hydraulic connections and tailings management prior to the approval for tailings deposition in pit number 1. Similar preliminary investigation work has been undertaken for orebody number 3, and a more definitive understanding of hydrogeology will be achieved as mining of the orebody progresses. This work was, and will be, extensively reviewed by Northern Territory Government agencies.

If seepage were to occur, it is likely that seepage water would contribute amounts of salts such as sulphate, magnesium and sodium and acid to Magela creek water.

The Supplement cites movement of uranium from the Koongarra deposit of 80m in one million years, and used this information as evidence for negligible impact arising from the movement of uranium in groundwater to the surface water system. However, the uranium and other radionuclides present in tailings are in very different chemical forms to those in the Koongarra orebody, and it would appear to be more appropriate to use information derived from studies at the Ranger tailings dam. For example, tailings samples at Ranger have been found to have a soluble uranium component of 0.5%. The Supervising Scientist estimates that about 6 t of soluble uranium will be present in pit number 3 (ie. about 12 Mt of water @ 0.5% soluble uranium). The proponent was asked for further information on this issue.

The Australian Drinking Water Guidelines recommend a maximum level of 8 ppb (roughly equivalent to 8 micrograms per litre) of uranium. The Northern Territory's maximum allowable addition of uranium to the Magela Creek system is currently set at 3.8 micrograms per litre.

ERA has estimated that the possible concentration of uranium in Magela Creek will be 0.36 micrograms per litre. Seepage could be expected to occur for about 15 years, although it is possible that seepage could occur for longer periods at lower levels. The concentration is based on the assumption that there will be no dilution or sorption of uranium before reaching the creek, whereas it is likely that these factors could prevent some of the uranium from reaching the creek.

ERA states that it is committed to intervene to reduce seepage to levels that will not cause any impact. The EIS outlines a number of techniques by which the impact of seepage from tailings placed below the groundwater table can be mitigated (Spp 5-41). These include, but are not limited to:

- lining or grouting the sides of pits to prevent seepage in or out of the tailings;
- placement of a zone of high permeability around the deposited tailings to divert groundwater and discourage mixing of groundwater and tailings water;
- the creation of a low-permeability tailings 'plug' to decrease seepage.

A Best Practice Technology analysis will be conducted to determine the most appropriate means of mitigating seepage from the zones of higher permeability. It is unlikely that any technique would fully prevent seepage; rather it would reduce seepage speed and attenuate the peak amount.

Current authorisation requires ongoing ground water monitoring at Ranger. ERA proposes to conduct further hydrogeological studies and monitoring to detect any failures in the containment system. The monitoring regime is based upon historical data and perceived risk.

As the mining of orebody number 3 will continue for at least the next ten years, there is sufficient time to carry out geotechnical investigation and work such as grouting or sealing prior to tailings deposition if required. Further information that will become available during mining will allow for the determination of the appropriate method of tailings management at pit 3.

Recommendation 9

The proponent shall provide the findings of the Best Practice Technology analysis conducted for seepage mitigation at Ranger pit number 3. The proposed method of seepage mitigation must be approved prior to commencement of deposition of tailings into Ranger pit number 3.

Ranger pit 3 will require rehabilitation measures whether or not Jabiluka tailings are deposited in it. The Supplement outlines two measures which ERA proposes to investigate further for rehabilitation to natural surface level:

- to cap the tailings in Ranger pit 3 with an impermeable layer of non-acid forming tailings overlain by 2-3 m of waste rock sourced from the Ranger stockpiles;
- to cover the pits with waste rock to ground level.

The Supplement (Spp 10-9) states that cover materials will be selected to perform several functions:

- minimise infiltration of rain water (and thus reduce seepage);
- minimise erosion of the batters;
- minimise escape of radon and radon decay products;
- minimise the potential for intrusion by plants or animals;
- retain optimal moisture content.

Both measures will provide cover thick enough to prevent direct gamma radiation exposure. Radon emission is discussed in Section 4.5.3.2.

ERA is required by the Northern Territory to submit plans for the rehabilitation of tailings impoundment annually. The Ranger Rehabilitation Plan is revised every five years and the EIS acknowledges that the plan would be revised to accommodate the changes due to mining of Jabiluka.

4.5.3 Radiation Management

Concerns were raised regarding human and environmental exposure to radiation, in particular the low dose level estimates and lack of safeguards. The key element of the final EIS in respect to radiological matters is to demonstrate that dose limits do not exceed published guidelines.

Radiation dose limits for workers are set by the Northern Territory Government in the form of legislation which is derived from the *Code of Practice on Radiation Protection in the Mining and Milling of Radioactive Ores 1987* issued by the Commonwealth Government (Code 87).

The latest recommended worker and public exposure limits, from the International Commission on Radiological Protection (ICRP) and adopted by the National Health and Medical Research Council (NHMRC), have been used in the proponent's analysis of worker and public maximum dose exposures. These recommendations include:

- Dose to designated workers is limited to 100 mSv in any 5 year period, which is an average of 20 mSv per annum with a subsidiary limit of 50 mSv in any one year; and
- Dose to members of the public must be less than 1 mSv per annum, both during operation and, to the extent foreseeable, after mine closure.

Radiation hazards from this project may arise from:

- exposure to external radiation, namely alpha, beta and gamma radiation;
- inhalation of radon and radon daughters; and
- ingestion or inhalation of radioactive dusts.

Alpha radiation does not penetrate the skin and is only a risk when an alpha emitter is ingested or inhaled. Substances which are potentially dangerous in this way are radon gas and its daughters, and radioactive dust. Radon concentration will depend upon the amount and grade of ore exposed.

There is comparably little risk associated with beta radiation. Doses are only dangerous when a high concentration beta emitter comes into contact with the skin or radioactive dusts inhaled. Risks from this source can be minimised with adequate clothing when dealing with high grade ore.

Gamma radiation will be the main type of external radiation to which mine workers are exposed, and can affect human tissue from a distance.

4.5.3.1 Worker Exposure

Some 12% of all mine development is in ore which is classed as high i.e. > 0.2% U_3O_8. High ore grades of up to 0.65% U_3O_8 may expose underground workers to gamma ray doses that approach recommended limits.

The final EIS has given estimates of total radiation exposure based upon worker categories (Spp: 10-3) and a model by Auty (1993) revised by Leach and Mitchell (1997). The highest doses would be for development and production miners, particularly during the first seven years of operation where they would be exposed to totals of approximately 9.5 to 14 mSv per annum. Around 90% of this dose is expected to come from gamma exposures with doses from radon decay products (radon progeny) and dust in the range of 0.5 to 0.75 mSv per annum.

The Australian Radiation Laboratories (ARL) and Territory Health Services (THS) indicated that the report from which these estimates were derived provided data from the computer model of radon concentrations which contained errors. THS has indicated that these errors have been corrected in the Supplement.

Radon gas is released from the ore and may entrain itself in air, water and surrounding rock. After the radon is released it decays into its radon progeny (radon and radon daughters). The exposure of worker to radon progeny is thus dependent upon the efficiency of the mine ventilation system.

Dr M J Howes, an internationally recognised expert consultant in the specific field of uranium mine ventilation, has reviewed the Underground Ventilation and Radiation Dose Assessment Study for the Jabiluka proposal on behalf of the Supervising Scientist. The review highlighted several issues associated with the ventilation design, and gives rise to differences in opinion regarding radiation dose predictions. However, much of the differences of opinion relate to assumptions made by modelling techniques regarding the radiation environment which will exist in the mine. Their validity cannot be definitively confirmed without comprehensive investigations into the actual radiation environment during development and operation. This view is supported by the Australian Radiation Laboratory which considers that "ERA will need to continuously evaluate occupational exposure impacts as the project develops, as in our experience it is not possible at this stage to predict them better than their present estimates".

The proponent has outlined safeguards to protect workers against radiation hazards including, but not limited to:

- providing adequate ventilation to remove emitted radon from exposed and broken ore;
- shielding provided by shotcrete;
- the steel cabins of the mobile equipment;
- siting the access ways and working places in rock of low grade ore; and
- reduction of worker exposure through multi-skilling.

Radon and radon decay product exposure will be minimised through the avoidance of mine development through high grade ore zones. The proposed ventilation system, which consists of five air intake and two exhaust ventilation shafts, has been designed to manage and control ventilation in a way that will maintain employee radiation exposure levels below the 20 mSv per annum. The ventilation system is proposed to provide approximately double the airflow of that expected in a non-uranium mine.

Data from other operating underground uranium mines has confirmed ventilation rates influence the dose rates resultant from exposure to radon progeny and the inhalation of radioactive dusts. Ventilation rates of 570 cubic meters per second have been used for the models in this project. The Office of the Supervising Scientist (OSS) and THS agree that this ventilation rate is achievable and provides a suitable means of extracting contaminated air from stopes. The general layout of the proposed underground mine and the positioning of intake and exhaust airways is considered to provide a suitable basis upon which to design and operate a ventilation system which will keep radon levels within allowable limits.

The Supplement indicates that micro-climate conditions, such as experienced at Olympic Dam, can influence the radon progeny exposure. These micro-climate conditions can occur when seals are ineffective (broken and imperfections in seals) or when ventilation control doors are not closed. Similar systems are to be put in place for the Jabiluka mine but will be designed to avoid micro-climate development. The radiation exposure model neglects to make allowance for the practical difficulties that will arise due to micro-climates. The final EIS agrees that these micro-climates are very large, if not dominant, factors controlling the radon doses. Regular maintenance and inspection of all ventilation doors and parachute seals should minimise the risk of this occurring. The final EIS notes that monitoring will be undertaken at "strategic locations" which may need to be reviewed to ensure that the micro-climate effects are well measured.

While radon progeny exposure may be higher than that quoted in the draft EIS, the expected total dose will still be within the 20 mSv per annum limit.

Recommendation 10

The continuing modelling of radiation doses to the underground workers, and the associated ventilation requirements, shall be reviewed by an approved consultant with experience in the modelling and operation of underground uranium mines once the final design has been completed. A copy is to be submitted for approval.

During their review, Leach and Mitchell (1997) raised the possibility that air intake may be contaminated by exhaust air in certain atmospheric conditions. This has not been discussed in detail in the final EIS but will be the subject of further studies by ERA during the review of the mine ventilation design prior to construction.

Recommendation 11

The proponent shall ensure that recirculation of contaminated air into the mine does not occur.

If respirable dusts are inhaled then alpha and beta radiation could pose a potential health risk. To minimise this ERA proposes to ensure that workers are suitably protected by enclosed air-conditioned cabins on all mobile equipment and by directly forcing air from stopes to exhaust vents. Water entering the decline as seepage will also reduce potential for dust disturbance.

Given that the largest predicted annual radiation doses approach the relevant annual dose limit, it is essential that an exhaustive radiation protection program be planned and implemented to verify the methodologies employed to estimate effective doses to mine workers, and to accurately quantify the radiation doses incurred as a result of each work function at the mine.

The radiation protection program should be divided into two components: radiation environment characterisation, and radiation monitoring and dosimetry. Both components should operate concurrently through all phases of mine development, operation and decommissioning. All facets of the program, including planning, methodology and implementation, should be agreed by the Supervising Scientist, Northern Territory Department of Mines and Energy, and Territory Health Services. Further, verification of the outcomes of the program through a comprehensive regime of check monitoring and scrutiny should be undertaken by independent government auditors. It would be appropriate for OSS, in conjunction with Northern Territory agencies with the required skills, to fulfil this role.

Recommendation 12

The proponent shall develop an approved radiation protection program which should include, but not be limited to:

- **measurement of radon emanation and gamma dose rates and the effect of waste rock and shotcrete shielding on those emanation rates;**
- **determination of radiation shielding (gamma, dust and radon) provided by the cabins of equipment and other worker protection safeguards;**
- **appraisal of the performance of the mine ventilation design;**
- **regular spot measurements of radon decay product concentrations, the potential alpha energy concentrations of radon progeny and the unattached fraction of radon progeny in workplaces and in air at key sites in the region of the mine; and**
- **measurement of the activity distribution of long lived radionuclides in dust in mine aerosols, in underground workings and at key sites in the region of the mine.**

4.5.3.2 Public Exposure

Direct gamma radiation exposure by inhalation of ore and tailings dust and exposure to atmospheric radon progeny have been highlighted in submissions as pathways for potential public radiation exposure.

The final EIS has indicated that gamma dose rates above natural background levels will only be detectable in the immediate vicinity of the Jabiluka mine, from ore contained on haulage trucks, and tailings at the Ranger mine site.

Dust can be generated from:

a) fugitive emissions from haulage vehicles;

b) truck spillage;

c) stockpile dusts;

d) wind blown dusts from tailings; and

e) dust from the mine ventilation system.

Access by the general public to the mine site, haul road, stockpiles and tailings repositories will be restricted and strictly controlled. However, local Aboriginal groups will be able to cross the haul road, but this will be controlled via specific crossing sites (Section 4.5.4.1). Exposure to this population will only result from fugitive haul truck dust emissions and possible spillage along the haul road corridor.

To overcome potential wind blown dusts emanating from haulage trucks, all ore will be wetted and trailers covered. A regular maintenance and inspection program of trucks and coverings will ensure that dust emissions from these vehicles will be minimised. To remove exterior dusts, all haul trucks leaving the Jabiluka site will be washed.

The risk of exposure to direct gamma irradiation from fugitive dust emissions from these trucks is considered to be negligible.

The potential for ore spillage due to road accidents along the haul road was raised as a concern. The risk analysis of spill frequency along the haul road adopts a conservative approach and is considered adequate. This is further discussed in Section 4.5.4.1. The proponent has committed to a series of measures to mitigate this risk. These include limiting truck speeds to 80 km/hr, driver education, restricting driving to daylight hours only, regular inspection and maintenance of haulage trucks, road design (surface sealing and extended visibility of oncoming traffic, signage) and suitably trained clean-up crews.

Many of the submissions also raised concerns regarding inadequate measures for clean-up of spills in watercourses, particularly during the wet season. The proponent has calculated the risk of a spill into watercourses to be in the order of 1 every 300 years. The proponent has also revised a contingency plan to ensure the containment of potential spillage. The mitigating measures include the design and location of bridge structures ensuring at least 1 km of visibility either side of the bridge, emergency response team clean-up training, and signage. Bridge structures are also wider (8.8 m as opposed to the haul road of 7 m), which further reduces the risk of truck accidents.

Consequently, the risk of public exposure to radiation from ore spillage due to road accident is considered to be minimal.

Relatively small quantities of dust will become airborne during tipping at stockpiles, as is the case for Ranger. Environmental dust monitoring and studies into ore and tailings at Ranger demonstrate that radiation doses to members of the public from this pathway are negligible in comparison to doses caused by radon progeny inhalation. Measurements at the township of Jabiru show that residents received less than 0.003 mSv per annum from the inhalation of all dusts generated at the Ranger operation (which included the tailings dam).

The amount of dust generated at Jabiluka is expected to be small due to factors such as water sprays on stockpiles, small tonnages being moved and the relatively coarse nature of the dust (>20 microns) allowing fast settling.

Tailings at Ranger are currently deposited into pit number 1 in saturated (wet) form and is not considered to contribute to dust levels within the region. The same management regime applies to the pit as does the tailings dam.

Consequently dusts from the stockpile operations and tailings repositories are not expected to contribute to the overall public exposure.

The dominant radiation exposure pathway for the public in relation to this proposal is the inhalation of radon progeny. Effectively all the radon progeny that will be attributable to the mine will originate from the underground workings and be expelled to the atmosphere via the mine ventilation system. Only a very small proportion of the total radon progeny concentration will be derived from ore stockpiles and haulage operations.

Increased radon progeny emissions can arise from extra tailings at Ranger and by dispersion from the mine ventilation system onto the adjacent land.

Jabiluka tailings will be deposited into Ranger mine pits together with Ranger tailings. Because the radon emission rate is dependent on the surface area of the tailings repository once the depth exceeds 3 metres, and because the surface area is fixed by the dimensions of the pits, the addition of Jabiluka tailings to Ranger tailings will not significantly increase the total environmental load of radon in the area.

The proponent has used a detailed atmospheric dispersion model and established methodology to calculate the predicted average annual radon progeny concentration attributable to Jabiluka in the region surrounding the mine. Background radon progeny and gamma dose rate readings have been measured around the mine site to assist in both atmospheric dispersion determinations and worker dose exposures. The atmospheric dispersion model has been summarised and results presented, but full details, including all assumptions, were not contained within the final EIS.

Emanation rates used in the model have been derived from uranium samples from Nabarlek and Ranger and an additional quantity of radon (50%) was added to account for broken rock within the stopes.

Concerns were raised about radionuclide concentrations in mine water being expelled from ventilation outlets. Water entering the mine through seepage is pumped to the surface Retention Pond and then recycled into the exhaust vent misting system to assist in water evaporation. Radon gas may become entrained in water and as such may be expelled via the misting process particularly if droplets are formed within the ventilation shafts.

In response ERA stated that, provided an evaporative process occurs, (ie. there is no physical carry over of water droplets or aerosols) then there could be no possible loss of contaminants, including salts and radionuclides, through this process. All contaminants contained in the water would remain at the point of evaporation inside the mine. ERA's response also indicated that the actual mechanism and process has yet to be selected and could include a water curtain or saturated mat system.

ERA gave a commitment to:

- complete technical design and test work and obtain approval for the proposed enhanced evaporation system prior to construction; and
- modifying the water management system to enhance evaporation if the system cannot be demonstrated to operate as an evaporative system.

Additionally, intensive monitoring would be implemented in the vicinity of the exhaust vents for any deposition or carry over of water or contaminants from the underground operations. This would include baseline and ongoing flora studies as well as infiltration/surface runoff studies. This is a critical issue because if the system were to fail, it would be a failure of the total containment zone and the no release policy which is a key element of the Jabiluka proposal.

On the basis that misting of water into mine ventilation outlets does not occur, it is considered that there will be no releases of potentially contaminated water to the environment at Jabiluka and that any exposure pathway for ingestion of radionuclides in water or biota by members of the public will be removed.

Recommendation 13

The technical design and test work to be developed for the enhanced evaporation water disposal system shall be submitted for approval prior to construction. If the quality of air emissions from the mine does not meet the recommended standards, use of the enhanced evaporation system should be suspended until it can be demonstrated that air quality emissions will meet the recommended standards.

The group chosen for radiation dosimetry modelling is the occupants of Mudginberri, a permanently occupied site approximately 10 km south of the mine. This site has the highest predicted radon progeny concentration. Other sites are predicted to be subject to lower radon progeny concentrations and/or have lower levels of occupancy The annual radiation dose attributable to Jabiluka is 0.12 mSv, or 12% of the 1 mSv dose limit. Combined with the existing Ranger operation, the annual radiation dose to occupants at Mudginberri is predicted to be approximately 0.25 mSv or 25% of the limit.

There is some uncertainty about the radon source levels, due to the lack of data presented on broken ore influences on radon progeny within the stopes, and levels may be markedly higher than those cited in the final EIS. However, if the level used in the model is increased by a factor of three, the permanent occupants of Mudginberri would still receive only a predicted radiation dose of 0.49-0.50 mSv, well below the existing dose limit. As there are still uncertainties, there may be regions within the vicinity of the Jabiluka lease where the annual radiation dose of 1 mSv limit may be exceeded. This will therefore need verification and appropriate remedial measures implemented to maintain the 1 mSv per annum limit for any permanent human occupants.

The proponent has agreed to carry out further investigations using a refined topographically modified dispersion model.

The proponent should also obtain data from areas outside the mine site to confirm background levels and then undertake monitoring to confirm predicted radiation levels as presented in the final EIS. One monitoring station is currently located at Jabiru. The proponent should install an additional monitoring station at Jabiluka to enable the integration of regional data on cumulative radon progeny from the Jabiluka and the Ranger mines. The location of monitoring site/s should be based upon meteorological conditions prevailing within this region.

Recommendation 14

The proponent shall ensure that radiation emissions from the mine must not exceed levels beyond which members of the public would be potentially exposed to greater than 1 mSv per annum at any site outside the fenced project area as a consequence of additive radiation levels (ie Jabiluka and Ranger combined).

In summary, the radon attributable to this project will primarily originate from the underground workings through the ventilation system. No existing permanently populated locations will be subjected to radon progeny concentrations above the limit of 1 mSv per annum.

4.5.4 Transport Management

Ore transport alternatives were addressed in detail with respect to economics and the environmental impacts (Chapter 5 of the draft EIS and Section 6.6 of the Supplement). Other than road, all involved additional vegetation clearance, increase water management systems, increased power requirements, higher ore spillage risks, higher accident rates and lower flexibility in operations, and proved economic only at substantially higher production rates.

The rail alternative may be a viable option if production levels increased above 1.2 Mt per year. The proponent has made a commitment to undertake further studies if this alternative becomes economic. All alternatives would required a road to cater for mine vehicles and service/material supplies which would be of similar configuration to that of the preferred haul road alternative.

Road corridors to the east and west of the Jabiluka outlier were the subject of detailed reviews in the 1979 Pancontinental draft EIS and in a 1978 Pancontinental Study on the extension of the Arnhem Highway.

The corridor on the western side of the Jabiluka Outlier is considered unsatisfactory due to the close proximity of the Magela wetlands and Oenpelli Road. This would result in higher intrusive environmental impacts both on flora/fauna and the aesthetic tourism quality of the area. It was also determined that this alternative would pass close to significant Aboriginal art sites thus affording little or no protection to public intrusion without substantial fencing and monitoring. Based on this information and discussions with local Aboriginal representatives, the final EIS opted for the eastern route.

Ore haulage by a sealed road east of the Jabiluka outlier is considered an acceptable option which would minimise potential bio-physical impacts.

4.5.4.1 Haul Road

Issues raised over the road transport of ore material from Jabiluka to Ranger include the haul road design, the possibility of contaminants entering surface waters through ore spillage, and impeded access to cultural and food gathering sites by local Aboriginal communities.

The original design has been upgraded to a two coat sealed pavement over its entire length. This will minimise dust levels from the haul road, minimise the likelihood of erosion of the pavement and associated downstream turbidity, and lead to increased vehicle safety and reduced requirements for ongoing maintenance. There may be a small comparative increase in the potential for pollutant transport from the surface by water. Should future use of the road not be required by the Traditional Owners, the sealed surface would be removed after closure of the mine and disposed of in the Jabiluka underground workings or Ranger pit number 3, and the surface area rehabilitated.

The draft EIS commits to the construction of bridges only during the dry season and to install sediment traps in the event of an early wet season. This will avoid erosion and increased sedimentation in the streams.

The proponent has indicated that the proposed 1 in 10 year flood immunity for underflow culverts is in excess of the requirements of the normal design standards for rural roads. However, water flow in excess of the current culvert design would cause build-up of water at the side of the road, possible water flow over the road surface and downslope scouring. While the design may be in excess of the design standards for rural roads, the haul road does not fall into this category. Table and mitre drains should be designed to have a flat, broad cross section in preference to the standard "V" cross-section. By using flat cross-section drains, capacity will be increased and down drain scouring will be reduced thereby minimising annual maintenance costs. The proponent has undertaken to review the cost-benefits of providing culverts with a higher capacity during the detailed design phase (Spp 5-5). Although monitoring could be undertaken after construction, remediation if adverse impacts were detected would be difficult.

Recommendation 15

The proponent shall instigate a study into the design of underflow culverts on the haul road to a higher than 1 in 10 year flood immunity standard prior to construction of the haul road. Details of this study are to be submitted for review and approval.

Ore Spillage

A number of submissions suggested extending the TCZ to include the haul road based upon the assumption that ore may be spilt during ore transport. Spillage of ore could occur during transport through truck accidents and a resultant spill, or by fugitive emissions from the trucks.

Fugitive emissions have been discussed in Section 4.5.3.2.

A risk assessment study on truck accidents was conducted for the final EIS. The study indicated that the average number of accidents involving spills would be 0.08 per million vehicle-kilometres (1 spill every 30 years or 0.034 accidents per year) and that the expected number of tonnes spilt from a laden single vehicle collision can range up to 97 t or, in the worse case, up to 194 t if two road trains were involved in the accident.

The Supplement outlines contingency measures to be undertaken in the event of a spillage (Spp 11-28). Drivers and an emergency response team would be trained in clean-up procedures. Actions would include the establishment of emergency, covering the spill with a waterproof sheet to prevent rainwater contact, removal of bulk material and a radiological survey to determine the area where surface material needs to be removed, prior to a second survey to ensure complete clean-up.

It was considered that the draft EIS did not adequately address the possibility of ore being spilt into a water course, which was seen as potentially having greater impact than spillage upon the ground and be more difficult to clean up. The Supplement describes the risk of spillage from each of the three bridges as approximately 1 spill every 300 years (0.0034 per year).

An investigation has now been conducted into the potential for uranium release from such a spillage (Supplement Appendix F). Geochemical modelling and static laboratory leach techniques were used to estimate the amount of uranium that would be released following the accidental spill of ore into one of the three creeks that intersect the haul road. The studies found that the overall leachability of the uranium is very low when compared to the natural background levels found in the Magela Creek system. On the basis of the static leach tests it is expected that approximately 200g of uranium would be leached if all 97 t of a load were discharged into a creek system and not recovered. It has been estimated that the Magela creek system carries an annual background load of 130 kg of uranium (Noeller, 1989). Given the background load of the Magela system, the estimated total release from a spill is not considered to pose a significant risk to downstream biota provided that rapid clean-up occurs.

The Supplement makes a commitment to train emergency crews in the rapid clean-up of spillage, with clean-up exercises conducted at least once a year. Monitoring of drivers' performance in the safe handling of vehicles through regular checks will also assist in minimising this risk.

Adequate precautions such as ore wetting, tray coverage, speed limitations, driver training and movement restrictions are all considered satisfactory to mitigate any ore spillage risk. Reclassification of the haul road to a TCZ will not reduce risk and provide additional protection. Any reclassification would require substantial land clearance for sediment control devices, thus increasing siltation potential. By placing streams within the TCZ, substantial engineering works would result in surface hydrology changes which have the potential to affect downstream wetland areas.

The spillage contingency plans outlined in the EIS adequately provide for appropriate measures to be taken to reduce spillage risks to an acceptable level and to implement appropriate corrective actions.

It is feasible that smoke and hot embers may pose an impediment to driving operations and increase the risk of truck accidents even if fires are not adjacent to the road alignment. The proponent has made a commitment to halt haulage activities in such circumstances but the visibility threshold for this has not been established.

Recommendation 16

The proponent shall implement a procedure whereby truck operations are curtailed during fires or other events that may restrict driver visibility on the haul road.

Access impediment along the Haul Road

Concerns were raised that the haul road may obstruct access to the area by the Aboriginal community. No physical barriers will preclude access across the road, and haul truck traffic will only occur at a frequency of one road train in each direction every 15-20 minutes with speed limited to 80 km/hr and good sight distance along the road.

The Supplement states that should there be specific areas where Aboriginal people are likely to cross, special measures such as signposting and possible modifications to the road design would be evaluated and implemented. Given that the submission by the Northern Land Council identified that the haul road would stop Aboriginals from utilising a track that runs along the north east bank of the Magela creek which provides access to the Mikinj Valley and the Magela headwaters, there is a need for consultation on this issue prior to construction.

Recommendation 17

The proponent shall investigate road design to ensure that crossings suitable to Aboriginal people are provided. This design is to be undertaken in consultation with local Aboriginal communities. Any crossing sites shall be adequately signposted and local Aboriginal communities encouraged to use these. Haul truck drivers are to be suitably educated on these crossings.

4.5.4.2 Construction Access Road

It is proposed to construct an access road from the Oenpelli Road to the mine site (refer Section 2.4.8) by upgrading an existing track.

This access will only be utilised during the construction phase and for monitoring during the rehabilitation phase. Impacts expected include vegetation clearance, surface water drainage alteration, increased turbidity in surface waters and disturbance to fauna.

The proponent has briefly addressed each of these concerns and has made a commitment to provide full design details once permission is granted to access the project area (Dpp 4-16). These measures include vehicular speed restrictions, the provision of sediment traps, concrete or rock aprons to minimise erosion, sealing on steep sections and regular maintenance. The turn-off from the Oenpelli Road will also be sealed. While the proponent estimates minimal dust emission, there is no mention of dust mitigation measures other than grading and regular maintenance.

Dust monitoring is proposed for nearby Aboriginal sites of significance (ie rock art sites). Safeguards such as protective covering for these sites and sealing steeper sections of the road have been outlined.

As this access track is to be used for the first 2 years impacts are expected only during this period and should diminish once the surrounding surface system stabilises.

It is considered that long term effects on fauna and flora from this road will be minimal.

4.5.4.3 Product Transport

The transport and handling of uranium oxide from the Ranger site to international destinations is covered by the *Nuclear Non-Proliferation Safeguards Act* 1987 and regulated by the Australian Safeguards Office. The Northern Territory also has requirements for uranium producers which include licensing and transport regulations.

The existing arrangements for transport of uranium oxide from Ranger to Darwin will not change with the increased output associated with Jabiluka, although there will be an increased movement of haulage trucks and ships from the Port. At present there is an average of five shipments per year of 30-35 containers each. At peak production there will be 6 or 7 shipments per year, with each shipment comprising an estimated 45 containers.

Accidents involving product transport to Darwin could result in uranium oxide being spilt. The transport procedure and a contingency plan is outlined in the Supplement (Spp 11-29) which includes the establishment of temporary bunding, cover with a waterproof sheet, collection of material by personnel wearing protective clothing and using special purpose industrial vacuum cleaners, and detailed test work to ensure complete clean-up.

The heavy vehicle accident data and the quantitative risk assessment of transportation of uranium and acid between Ranger and Darwin indicate that the risk of an accident for uranium oxide transport trucks is equivalent to 1 every 91 years and that the risk of a spillage as a result of an accident is 1 every 500 years. This takes into account that the uranium oxide is secured in drums which act as a secondary containment to spillage.

This interpretation appears sound, and it is considered that product spillage risks are low. It is noted that no incidents have occurred in the 15 years of transport of the product from Ranger to Port Darwin.

The procedures for transport and storage of the product are considered adequate.

4.5.5 Flora and Fauna Management

The Kakadu Region possesses an extensive diversity of species that make it a region of major conservation significance. Studies show that the region is biologically rich and diverse, containing some rare and unique flora and fauna species.

There are a number of areas of potential impact on flora and fauna, including weed management, flora and fauna mortalities and the general effects of air and liquid emissions from the project.

The descriptions of the flora and fauna are generic, have not been systematically ground-truthed, and are not considered comprehensive given the diverse range of habitats traversed by the mine site and haul road. Additionally the significance of Kakadu National Park as a conservation area and World Heritage Site is not considered to be adequately reflected in the level of information presented. All data presented in the final EIS appear to have been compiled from a combination of local knowledge, casual observation and existing data from previous Jabiluka and Ranger studies. Without more systematic investigations there are insufficient grounds for the proponent to infer that no rare or endangered species will be adversely affected (Supplement; Figure 13.1).

Therefore protection of these species, if found, is paramount to maintain the diversity of the flora and fauna. The proponent has recognised the need to undertake systematic baseline studies and has committed to do so.

4.5.5.1 Flora Management

The project may have impacts upon the region's flora in three ways:

- destruction of flora by land clearing;
- effects on flora by mine processes; and
- effects through the introduction of exotic flora.

No species of conservation significance were found in the survey conducted for the draft EIS. However, Leach *et al.* (1992) identified nine species of conservation significance in the vicinity of the Jabiluka project area (Dpp 6-46, Table 6.14). None of these species are cited by ANZECC (1993) on the List of Threatened Australian Flora nor are they listed as endangered or vulnerable under the *Endangered Species Protection Act 1992*. Of these nine species, five occur in escarpment communities away from the proposed transport corridor and mine site.

Any clearance creates disturbance, not only to the remaining plants whose light, water, wind and competitive environments are modified, but to regenerating plants which may have to cope with the problems of soil erosion or compaction.

Direct impacts will result from the clearance of 90.5 ha for the mine and haul road. Disturbance of this land is unavoidable if the project is to proceed. The company has committed to rehabilitate some 15 ha of land immediately following (and during) construction activities.

To minimise the impact of land clearing, the proponent should take all practicable steps to protect from damage or disturbance all vegetation which need not be removed.

Two processes which may impact on flora are the emission of radionuclides (discussed in Section 4.2) and solute emissions from the ventilation shafts.

Water from the Retention Pond will be sprayed as a mist into the ventilation outlets as part of the WMS. The solutes contained in the water may become entrained in the airflow and ejected into the atmosphere in water droplets..

The proponent has specifically addressed this concern with the design, monitoring and maintenance programs. The jets used for misting are ultra fine, operating in a constant velocity airstream, and misting will take place at selected temperature and humidity levels which are constantly monitored. Consequently any solutes should remain at the point of evaporation although this will require periodic cleaning to remove any accumulated salts. Given the Retention Pond salinity is not expected to buildup until after year 12 of operation, there is adequate time to monitor potential effects around the vents and for the proponent to instigate any remedial actions necessary (see also Section 4.5.3.2).

Recommendation 18

The proponent shall prepare and submit a detailed technical design, including test work, for the proposed enhanced evaporation system prior to construction and shall incorporate:

- **alternatives to the enhanced evaporative system if the system fails to operate within acceptable parameters;**
- **a monitoring program which outlines the baseline and ongoing flora studies and infiltration/surface runoff studies;**
- **remedial engineering actions proposed if solute build-up or flora mortality around the exhaust vents reaches an unacceptable level;**
- **a rehabilitation plan for flora surrounding the vents.**

Fuel and oil spills have the potential for impacts on areas adjacent to the haul road and watercourses. The proponent has in place a regular maintenance and inspection program on all the haulage vehicles.

It is considered that this will minimise the risk of chronic leakages from vehicles, and that adequate measures will be in place to clean-up at any accidents.

Weed Management

The disturbance created by vegetation clearance and vehicular traffic during construction and operation will open a corridor for invasion by weed species. These species may be further spread by fauna attracted to the haul road corridor, due to increased grass coverage rather than forest canopy and ease of movement from one area to another. It is considered that the potential for weed invasion and plant diseases is significant.

Parks Australia has recorded 32 weed species and 5 cultivated species. *Passiflora foetida* (wild passionfruit) has been recorded on the haul road corridor and perennial grasses such as *Pennisetum polystachion* (mission grass) and *Andropogon gayanus* (gamba grass) have been recorded along the Arnhem Highway. Other species including *Sida acuta* (spiny head sida) and *Hyptis suaveolens* (hyptis) also favour disturbed areas. A study by Lonsdale and Lane (1994) has also shown that seeds of undesirable species can be transported into Kakadu National Park via tourist vehicles.

Mimosa pigra (mimosa) presently covers some 800 square kilometre of wetlands throughout the Northern Territory. An infestation of mimosa near Oenpelli has been the object of an extensive eradication program. No mimosa has been recorded in the Jabiluka or Ranger lease areas. *Salvinia molesta* is a major pest plant on the Magela floodplain and is the subject of an intensive control program by Parks Australia. Parks Australia currently requires that all vehicles, plant and equipment to be used in the park are free of weeds.

The proponent has undertaken to minimise the risk of weed infestation through a program outlined in the final EIS, including a baseline survey with periodic inspections, developing preventive and control measures, and an employee education program. The proposed program will be similar to that in place for the Ranger mine operations, which includes vehicle wash down prior to park entry and random inspection.

Flora Mortality

Section 6.11.4 of the draft EIS states that up to 3 ha of mainly Eucalyptus species have died in an area about 200m south-west of the portal. The cause of the tree mortality is as yet unknown. Suggested causal agents include: plant pathogens; insect damage; local hydrology changes; fire regimes; seasonal water regime alteration leading to plant stress; and human interference.

Mortality of *Eucalyptus tetrodonta* has been the subject of studies by the Department of Primary Industries and Fisheries in areas associated with disturbances from development of the Nhulunbuy townsite. It has been postulated that mortality in these areas at Gove is linked to soil disturbance and hydrology changes, and may involve a plant fungal pathogen such as *Phytophthora*. While these studies have not definitively identified the cause, caution must be used to restrict the spread of any potential plant pathogens. Due to potential risk of impacts on Kakadu National Park values, it is required that further studies be conducted and isolation techniques employed to minimise the potential for spread of plant mortality.

A commitment from ERA to further study this phenomenon has been made in the Supplement. The study should be undertaken prior to any construction work commencing and a quarantine strategy prepared for the affected area if plant pathogens are implicated in Eucalypt mortality.

Recommendation 19

The proponent shall complete the study into the dead stand of Eucalypts, as identified in the draft EIS, prior to construction activity commencing. The proponent shall implement a strategy for restricting access into the areas identified in the draft EIS until the completion of this study. Results of this study are to be submitted.

4.5.5.2 Fauna Management

Studies throughout the Alligator Rivers Region demonstrate that the fauna is very diverse. Pancontinental's studies of the reptiles, mammals, birds, amphibians, invertebrates and fish occurring in and around the project area gave a qualitative estimate of population sizes and described the habitats. ERA has provided updated information based on studies conducted in 1981 and 1992.

Field surveys specifically for fauna within the Jabiluka lease were conducted by Macquarie University in 1978-80 and ERA in 1992. However, restrictions due to wet season flooding and access constraints imposed by the Traditional Owners prevented a field survey being conducted for the EIS. Instead, a literature review was conducted and field monitoring of these areas has been proposed.

The draft EIS contains a table of ERA's estimation of potentially threatened species in the region, their habitat and likely presence (Dpp 6-58, Table 6-17). It does not cover aquatic insects. Additionally, aquatic fauna are the biota most susceptible to mine impacts due to their restricted habitats and the sensitivity of some species to heavy metal concentrations.

It is considered that the fauna surveys are not sufficiently detailed or up-to-date to identify potentially endangered or rare species which may reside within the project area. For example the EIS did not mention a rare dragonfly species (*Indolestis obiri*) which has been identified as being resident on the Jabiluka outlier, and which may be conservation dependant for survival. Some details of the species have been documented in the *Zoological Catalogue of Australia, Volume 6.*

A lack of adequate data on aquatic macroinvertebrates in the streams near the proposed mine site and along the haul road needs to be redressed before the commencement of construction to ensure that a suitable biological monitoring program can be designed and implemented. Because species such as the dragonfly have not been identified elsewhere, ERA will need to undertake further survey work to better define spatial distribution.

The project's main impacts on the fauna in the area may arise from:

- displacement or alteration of movement patterns due to land clearing and mine operations;
- possible introduction of exotic species; and
- mortality from construction and operational activities.

One important effect of this proposal will be the disturbance of natural habitat. The impact on fauna in adjacent areas depends largely on the amount and type of vegetative cover remaining. For this reason it is likely that after initial clearing the movements of small animals which avoid cleared areas will be disrupted.

Noise, lighting, vibration and, to a lesser extent, dust from operations and haulage vehicles may either drive some animals from the vicinity of the project or attract other animals.

These effects will continue until mine decommissioning and rehabilitation, and it is considered that these present a very low risk of long term impacts on regional biodiversity.

The haul road could act as either a barrier or a corridor for some terrestrial animals and could fragment the area into discrete populations. The proponent has investigated fully fencing the project, including the haul road, and considered it inappropriate as this may hinder normal migratory paths and require substantial clearing.

ERA now proposes to install dry culverts to assist fauna movement across the road corridor. These culverts would be placed in areas between wet drainage culverts that are 1 km or more apart. The proponent has indicated that there will be positive and negative effects. Negative effects will include the attraction of fauna to a cooler shaded area as opposed to vegetation cover. This in turn may attract more predatory fauna and result in an increase in the number of road kills. The final locations need to be confirmed during the project design phase.

The haul road bridges may influence predation on migratory fishes around pylons close to the embankment. The proponent proposes that for each of the major creek crossings a series of culverts would be incorporated on either side of the main channel at various levels to assist migratory species in avoiding attacks. The culverts would have slopes similar to the gradients of the natural surroundings and contain permanent structures such as rocks to provide refuge and less exposure to predators.

Haulage operations have the potential for direct impacts on fauna.

The proponent has indicated that haulage operations will only occur during daylight hours which will significantly reduce the risk to native wildlife which move mainly during the dawn/dusk periods. The road kill rate is directly related to vehicle speed, and the proposed maximum of 80 km/hr is considered reasonable to minimise road kills. Road kills can often attract other predatory species, particularly raptors which feed off the dead animal carcases, and therefore any animals killed should be removed from the road surface as soon as possible to further reduce the potential for road deaths.

Recommendation 20

The proponent shall ensure that all drivers are fully educated on the potential for fauna road kills. A record of any fauna road deaths shall be kept on-site and included in the Jabiluka Annual Report.

The introduction of exotic animals, such as dogs, cats, cane toads, mice, fish or other non-endemic fauna could disturb or displace the existing native animal population. ERA prohibits the introduction of animals into the Ranger mine and will do so at Jabiluka.

The township of Jabiru also has strict guidelines on animal importation which are those for the National Park. The washing and inspection of vehicles at the entrance to the National Park will mitigate the potential for introducing exotic animals by heavy vehicles used in the project.

There are possible alterations to migratory patterns and bird movements. Specific details on migratory patterns and seasonal movements of fauna, particularly birds, have not been included in the final EIS due to access restrictions.

Studies (Malcolm 1982; McNeil et al 1985; Faanes 1987, Rusz 1990) have shown that bird mortality from collisions with power lines can be quite significant for some species. The major factor in these collisions has been found to be the groundwire or earthwire, which is higher and less visible than the conductors. Birds appear to see or sense the electrical field of the conductors, bank to avoid them and collide with the earthwire causing serious injury or death.

Mitigation measures are proposed to reduce the risks of collision. Main bird movements follow major water courses and it is considered that bird collisions with power lines will be reduced given the redesign and relocation of the transmission lines. It is intended to incorporate the power lines in the bridge structures and to keep the conductors in the shadow of tree lines elsewhere.

Fauna Species of Conservation Significance

Work carried out previously has indicated that there are no species of birds, mammals, reptiles or frogs restricted to the project area, however a number of species of conservation significance were observed. The proponent contends that the loss of habitat due to the mine operation is expected to be minimal and will not have a significant effect on the conservation status of any fauna.

Previous studies undertaken throughout the Kakadu National Park have found that fauna respond to seasonal variability through nomadism and migration, such that the faunal composition of any particular area is continually changing. A corollary is that particular small areas may be critical at some time of the year for fauna which normally occur well beyond that area. Hooded Parrots and Gouldian Finches provide clear examples of this characteristic: both may need to disperse widely in the non-breeding season in order to find water and food and to track locally occurring fires or rainstorms.

It appears very unlikely that the project site is critical habitat for nomadic or migratory species, unlike the South Alligator River and associated riparian vegetation which is a major dispersal route for wildlife. In the event that faunal baseline surveys of the mine site and haul road discover any endangered or rare species, or sensitive or critical habitats, the proponent will need to implement a management strategy in consultation with the appropriate bodies.

Recommendation 21

In the event that fauna baseline surveys of the project area discover any rare or endangered species or sensitive or critical habitats, the proponent shall implement a management strategy for their protection in consultation with the appropriate bodies. The project design may need to be amended, where appropriate, to ensure the protection of, and minimise impacts on, these species and their habitats.

Bird Deaths on or near the Retention Pond

During the public comment phase on the draft EIS, further information was requested on the possible hazards to birdlife posed by the Retention Pond. It was noted that birdlife contributes significantly to the Park World Heritage values, and may be at risk if using water in the Jabiluka storage. The draft EIS stated that the pond "is not acutely toxic to birdlife" but did not discuss chronic effects. In the Supplement, the proponent points to experience at Ranger over 15 years, where no significant bird deaths have been recorded apart from the death of 40 birds caused by a diesel oil spill.

While acknowledging that relatively higher numbers of waterbirds might be expected at Jabiluka because of its proximity to the Magela floodplain, the proponent notes that waterbirds have been observed to rarely visit the tailings dam at Ranger. An ERA commissioned study by Corbett (1996) also noted that relatively fewer birds are attracted to constructed water bodies compared to natural water bodies. The EIS concludes that there is a low potential for waterbirds, especially those used as food by Aborigines, to be impacted by chronic, sublethal poisoning. To assist in the reduction of this potential the Retention Pond is to be kept clear of any vegetation.

However, during prolonged dry periods the Retention Pond may attract birds if there is intense competition for food, water and space at the permanent waterholes on the Magela flood plain.

To address the potential hazards to birdlife, ERA has undertaken to monitor the potential toxic effects of the water contained in the proposed Retention Pond from the perspective of individual contaminants present as well as possible synergistic effects of the total load. Potential exposure pathways will be established by observing waterbird behaviour, and bioaccumulation of heavy metals in a range of aquatic organisms utilised by birds will be monitored.

The proponent expects that elevated heavy metal levels in prey organisms are likely to be an early warning indicator of potential bioaccumulation in waterbirds. Waterbirds are the main concern because of mobility, but other fauna will be excluded by measures including high pond walls and an enclosure fence which will impede large terrestrial vertebrates such as wallabies and crocodiles. Although small terrestrial vertebrates such as turtles, quolls and rodents will be able to pass through the fence, experience at Ranger suggests that these species are not attracted to such areas probably because it is not suitable habitat.

ERA has an active monitoring program for heavy metal contamination at Ranger and proposes a similar program for Jabiluka.

The water in the Jabiluka Retention Pond will be of similar quality to that of Ranger Retention Pond 2 (RP2).

It is considered that regular monitoring of aquatic fauna and Retention Pond water is satisfactory to assess the risk of bioaccumulation and provide early indications of potential bioaccumulation in waterbirds. If bird deaths attributable to Retention Pond water emerges as a significant and operational issue, ERA will be required to implement a strategy to manage the situation.

Recommendation 22

The proponent shall investigate any bird deaths on the mine site. A record of any bird deaths shall be kept on-site and included in the Jabiluka Annual Report.

Recommendation 23

If significant bird deaths attributable to Retention Pond waters are recorded the proponent shall instigate an appropriate management strategy in consultation with the appropriate bodies.

4.5.6 Infrastructure Impacts

The implementation of the project will have a direct impact on Ranger by extending operational life by up to 17 years. No new infrastructure is required at Ranger to handle the additional ore processing from Jabiluka.

The option of recommissioning "Ja Ja" camp was not detailed in the draft EIS but the Supplement states ERA may do so. This camp was used during the exploration phase in the 1980's and was decommissioned in 1991. It is partially rehabilitated although some buildings remain.

This camp, while still within the Jabiluka Lease, is immediately adjacent to the Magela wetlands in the Kakadu National Park and within 15 km of Mudginberri and East Alligator area Aboriginal living areas. The Supplement stated that it will be a "low key" operation.

The Supplement proposes to put temporary demountable accommodation, ablution and messing facilities for approximately 30 people on site with associated infrastructure and a mine equipment storage area. Insufficient information was provided in the Supplement to enable a full assessment of the "Ja Ja" option.

Further information would be required if this option is utilised. No rehabilitation or ongoing monitoring programs have been incorporated. No quantitative predictions are offered for impacts resulting from water usage from Ja Ja Billabong, sewerage system, weed encroachment and so on.

Recommendation 24

The proponent shall, if the "Ja Ja" Camp is to be recommissioned, provide a detailed report outlining environmental impacts and mitigation measures with the recommissioning, operation and decommissioning of this camp area.

4.5.7 Monitoring

Submissions on the draft EIS raised concern over ERA's record of monitoring and environmental performance, and the level of consultation with local Aboriginal communities concerning the design of monitoring programs.

The management of impacts of the project on the biophysical environment is dependent upon adequate monitoring of interactions before, during and after the mine's operation. The objective of such monitoring should be to confirm the predictions of impacts and outcomes of management strategies which are being implemented and to detect environmental changes so that remedial measures may be taken.

The final EIS proposes a monitoring program for all facets of the biophysical environment and includes meteorology, climatology, air and water quality (including dust and radiation), aquatic biology, soil erosion, hydrology, and terrestrial flora and fauna. It is noted that the development of specific monitoring strategies is dependent upon the findings of the baseline studies proposed in the final EIS, finalisation of detailed mine design, and further consultation with relevant authorities.

An accepted practice for the management of predicted environmental impacts is to implement an Environmental Management Plan (EMP) which is regularly reviewed in the light of operational experience and monitoring results. The Northern Territory Government has set in place an appropriate process for requiring an Environmental Management Plan and its ongoing assessment.

Consultation is essential with local Aboriginal communities for input into management strategies and monitoring programs that may affect their traditional lifestyles.

Recommendation 25

Aboriginal communities shall be consulted during the development of on-going monitoring programs.

4.5.8 Rehabilitation

Rehabilitation of the project areas was of concern in many submissions on the draft EIS.

Rehabilitation proposals are aimed at stabilisation and revegetation of the land surface, the treatment or remedy of alien land-forms, and the removal or immobilisation of chemical pollutants.

ERA has proposed a sequential form of rehabilitation starting with borrow areas and culminating in the mine site proper. The rehabilitation of the haulage road has not been determined as there are two options currently available: complete rehabilitation; or leave the road as access for the local Aboriginal communities.

ERA has proposed to return all waste rock from the mining operation at Jabiluka and 4.8 Mt from Ranger back into the underground stopes. This will reduce rehabilitation requirements at both mine sites and reduce the long term visual impacts of the Ranger project.

A detailed rehabilitation plan will be developed by the proponent in consultation with appropriate authorities and should incorporate provision for long term monitoring of rehabilitation.

Recommendation 26

The proponent shall consult with the relevant authorities and the local Aboriginal communities, or their representatives, on the rehabilitation processes, including the haul road, throughout the project's life. All rehabilitation programs must be submitted for approval.

4.6 Other Issues

4.6.1 Gold Resource

Gold is associated with the uranium ore at Jabiluka Number 2 orebody. A mineable reserve of gold ore has been calculated at approximately 1 Mt at an average grade of 2.6 gm/t of gold. The draft EIS stated that due to economic considerations and existing environmental issues associated with its recovery, gold would not be produced as part of this proposal. The Draft EIS stated that this situation would only change if economic conditions were to change markedly, and if new gold extraction technology was to become available that did not have the attendant environmental concerns associated with present methods.

Current technology suggests that a cyanide process would be required to extract this gold. The additional impacts of a gold extraction facility at Ranger would require further review.

Recommendation 27

If at any stage gold is to be extracted, further information regarding the extraction process, potential impacts and safeguards is to be submitted for further assessment.

4.6.2 Management of Hazardous Substances and Dangerous Goods

The transport, handling, storage and use of chemicals at Ranger, Jabiluka and Darwin has been recognised as possibly having an impact on the surrounding environment in the event of accidental spillage, both within the lease areas and during transport.

The draft EIS provided a comprehensive outline of such substances and goods, their classification, transportation, storage, handling, contingency procedures and emergency response. The proponent recognises the requirement to adhere to the relevant Dangerous Goods and Mine Management Regulations for the transport and storage of dangerous chemicals.

Spillage of ore has been discussed in Section 4.5.4.1. Other chemicals used in substantial amounts at this mine site, and transported to either Ranger or Jabiluka, include fuel, elemental sulphur, liquid acid and explosives.

ERA has stated that an additional 5,000 t/a of liquid acid is required at the Ranger site due to the addition of Jabiluka ore. While some acid is produced on site at Ranger, up to 10,000 t/a of acid is transported from Darwin. The risk of an acid vehicle accident, based upon a maximum acid cartage figure of 15,000 t/a, has been calculated as 1 every 33 years and the risk of spillage is equivalent to 1 every 185 years. Acid is contained in stainless steel tanks constructed to International Standards Organisation standards designed to withstand rough conditions, and are fitted with rigid outer metal frames to provide protection in the event of a rollover. Contingency plans for acid spillage are provided in the Supplement (Spp 11-29).

It is considered that the increased risk of acid spillage attributable to the Jabiluka project is acceptable.

4.6.3 Fire Management

The proponent has been practising controlled fuel-reduction burning in the region for a number of years and has undertaken to continue the formal fire management and control plan for this operation. The plan will operate and form part of the overall Environmental Management Plan. Fire management will also include input from the NT Fire Service, Parks Australia and the Bush Fires Council.

It is considered that the fire management plan is adequate.

4.6.4 Dust, Noise and Vibration

The generation of dust will be unavoidable with maximum levels expected during the construction and mining operations. Dust from mine operations may locally affect flora and fauna within both the mine site and, to a lesser extent, along the haul road. It also has the potential to affect local Aboriginal art sites. Respirable dust may be a problem in the immediate mine site.

No estimates of dust levels were presented by the proponent but given the meteorological conditions, extreme dust generation would only occur during the dry season and dispersal would be restricted to the mine site vicinity by the terrain.

The impact upon vegetation and fauna is difficult to quantify but it is not expected to be significant. The settling of air-borne dust may impact upon significant cultural and heritage sites if wind velocities are higher than normal.

Dust suppression measures to protect human health at the mine site will significantly reduce the volume of dust generated.

Dust from unsealed road verges may be evident throughout the life of the operation, caused primarily by vehicular movement creating elevated wind conditions on the verges. It is expected that these levels would decrease after the first few years of operation. However it has been noted that some significant sites lie close to the road corridor and must be afforded adequate protection. To identify the impacts, monitoring should be considered for the first few years of operation to ensure dust build-up will not pose any potential problems to these significant sites. Suggestions such as verge grassing and slashing rather than grading may assist in dust reduction and should be investigated by the proponent.

The commitments and procedures outlined in the final EIS are expected to minimise the potential for excess dust. The proponent should instigate mitigation measures when monitoring indicates problems arising.

Recommendation 28

The proponent shall monitor dust at Aboriginal sites of significance along the haul road route and provide protection against dust if higher than baseline limits are measured. Details of the protection measures proposed shall be reviewed with local Aboriginal communities and then submitted for approval.

With the exception of local thunderstorms, noise levels at the site are low. Noises of new character and significantly higher intensity will be associated with the initial establishment of the project, and to a different degree with operation and rehabilitation.

Two noise surveys were conducted at locations adjacent to the project area and investigated total expected noise levels associated with operations and impacts these may have on nearby communities. Results indicated that current noise levels would not unduly increase in these communities. Noises associated with occasional use of mobile machinery may, by its random nature, show more potential for annoyance than any fixed sources at the project. These noises are expected to only affect personnel immediately working within the mine area.

Blasting noise and vibration may be important and although the size and frequency of proposed blasts are within acceptable limits, small adverse impacts on fauna and local art sites is a possibility.

Appropriate trials and the setting of suitable blasting practices should be carried out early in the project life to minimise these potential impacts. Low frequency noise from blasting operations may travel to surrounding areas outside the mine site and cause some concern to both tourists and local Aboriginal communities. Any such communities should be advised of blasting operations prior to their beginning.

Recommendation 29

The proponent shall instigate trial programs to determine a suitable blasting practice during the construction phase. Results of this program are to be submitted for review.

Because the project is located adjacent to a national park, any man made noise could be held to detract from the quality of the park. It will be necessary that all operations be monitored and that action be taken to ensure that noise levels remain no higher than those predicted in the final EIS.

Recommendation 30

The proponent shall instigate programs for environmental noise level measurement at approved locations adjacent to the mine site to confirm that noise levels remain no higher than those predicted in the final EIS.

4.6.5 Sewerage and Waste disposal

Sewage is a major source of nutrients and can cause eutrophication in waters receiving nutrient enrichment.

The location of the septic tanks and the absorption/transpiration trenches are subject to the site assessment criteria for sewage disposal systems as defined by Territory Health Services. The proponent noted in the Supplement that the septic tank and leach drain system will be located above the Magela flood levels, although no indication is given as to what level this is in relation to rainfall Annual Exceedance Probabilities.

No calculations on sewerage nutrient levels were presented to allow estimation of potential pollutants entering the existing water systems, however the proponent has undertaken to adhere to the ANZECC recommendations, namely the National Water Quality Water Management Strategy, *Guidelines for Groundwater Protection* and *Australian Water Quality Guidelines for Fresh and Marine Waters.*

The proponent has committed to undertake site specific tests to ensure that nutrient export levels do not encourage undesirable plant growth in nearby streams.

The proponent has stated that if the workforce exceeds 200 then a sewerage treatment plant may be considered. No details have been provided by the proponent on this proposal and further design details will be required to enable assessment.

Garbage and other waste (such as equipment parts, batteries, waste oils etc) will be disposed in accordance with a Jabiluka waste management policy and will not be disposed of within the Jabiluka project area. Liquid, metal and putrescible wastes will be collected and disposed of by an external contractor in the same way as that currently undertaken at Ranger. Contaminated wastes will be disposed of in existing waste trenches at Ranger.

The proponent should note that the proposed Waste Management and Pollution Control Act will control the disposal of certain wastes outside mining tenements, and will require the licensing of contractors who handle hazardous wastes.

The waste management policy is considered to be appropriate.

Recommendation 31

The proponent shall consult with the Territory Health Services on the design and monitoring program for sewerage disposal by septic tank/leach drain systems for the Jabiluka project.

Recommendation 32

The proponent shall consult with the Northern Territory Department of Mines and Energy and Territory Health Services on the design and monitoring requirements if a sewerage treatment plant is to be established on the Jabiluka Mine site.

4.6.6 Insect Disease Vectors

Severe problems are associated with biting insects, particularly those which act as vectors for malaria, Ross River virus, dengue fever and Australian encephalitis. The fact that the mine site is isolated and the population is low does not reduce the potential severity of the diseases on mine personnel if problematic biting insects are allowed to breed.

The proponent has identified a number of general safeguards to be incorporated in the design of project facilities to minimise the possibility of insect breeding. The proponent did not however identify the need for a baseline survey or monitoring program and did not fully recognise the issues associated with biting insects on the mine site, including smaller drains and ponds. This is important as project surface water drainage and other catchment systems may contain sites for biting insects to breed.

Recommendation 33

The proponent shall consult with the Territory Health Services to produce a disease vector baseline survey, monitoring program and remedial action plan for the mine site.

4.6.7 Visual Impacts

The project will only be visible to tourists undertaking scenic flights.

As the project activities will be restricted to the eastern side of the Jabiluka outlier, ground based tourists will not see the major portion of the project or associated activities from the Oenpelli Road or nearby wetlands.

There is a possibility that the ventilation shafts may be seen during the latter part of the dry season. Provided that vegetation clearance is kept to a minimum it is anticipated that these would be difficult to see from popular tourist vantage points.

Recommendation 34

The proponent shall make every effort in ensuring that the project and haul road is visually secluded as much as possible by ensuring that disturbance is kept to a minimum and rehabilitation of these disturbed areas are undertaken in accordance with the commitments made within the final EIS.

5 Social Issues and Potential Impacts

Over 50% of submissions on the draft EIS, including those from the Northern Land Council (NLC) and some Government Agencies, expressed concern over the direct and indirect impacts of the proposal on Aboriginal culture, including impacts on natural resources, lifestyle and sacred sites. Respondents were also critical of the adequacy of the draft EIS assessment of these issues. ERA has attempted to answer these concerns within the Supplement.

Many submissions have stated that the Traditional Owners of the area should be provided with an opportunity to make an informed decision about the mine as many have been excluded from the process. Some of the Traditional Owners of the Jabiluka Lease land have publicly stated their opposition to this project proceeding and are refusing to participate in consultations. The Northern Land Council on behalf of the Traditional Owners has restricted access to the lease area by the proponent to undertake specific cultural and bio-physical studies which has meant that the EIS has not been able to present sufficient or reliable information on some impacts on Aboriginal people.

Many submissions raised issues related to broader social issues which will be addressed in Kakadu Region Social Impact Study (KRSIS).

In conjunction with the importance of the natural environment of the region surrounding Jabiluka, the area is also significant for the living cultural heritage of the Aboriginal community. In more recent times, the influence of activities associated with mining, urban development, tourism and national park management have added new aspects to the social and cultural environment of the area.

The Mirrar Gundjehmi people are the traditional owners of the land upon which the Jabiluka mine is proposed. The Mirrar Gundjehmi clan have a cultural responsibility to look after the country and at the same time to take account of the interests of others in the region that may be affected by developments on Mirrar Gundjehmi land.

The Mirrar Gundjehmi people's traditional land also includes the Ranger mine site and the town site of Jabiru. The NLC submission on the draft EIS notes that these developments take up a large proportion of the traditional estate of the clan.

The EIS presents information on the Aboriginal community drawn largely from discussions with relevant agencies and secondary sources. No field based research has been undertaken with the Aboriginal community in the Jabiru area.

There are approximately 300 Aboriginal people in the Kakadu National Park area with the 1991 census indicating 133 Aboriginal residing in Jabiru.

The information provided in the Supplement enables a picture to be drawn of the Aboriginal community which is subject to a number of advantages and disadvantages. Disadvantages, particularly in relation to health, education and employment were noted. Advantages through Ranger royalty income enabling involvement in tourism and representation, through land ownership, and through participation in many decision making processes (ie Kakadu Board of Management) have been discussed. The Supplement notes that these are being examined by KRSIS in which ERA, the Commonwealth and the Northern Territory Governments are active participants.

The Traditional Owners and broader Aboriginal community have been faced with a variety of changes to their social circumstances which are derived from a number of sources including mining, tourism, park management and urban development. The Supplement notes that there were existing social problems in the area before uranium mining commenced in the late 1970's, and that many of these have continued since the introduction of mining and tourism to the area.

The Supplement presents baseline information derived from the results of the 1994 National Aboriginal and Torres Strait Islander Survey conducted by the Australian Bureau of Statistics (ABS) which extended over the top end of the Northern Territory. While this analysis provides some idea of social conditions in the relevant region (an area of 114,200 square kilometres with an estimated Aboriginal and Torres Strait Islander population of 8,490 in 1994), the survey data is naturally somewhat generalised in relation to the area surrounding the Jabiru lease. The information is also of doubtful relevance unless linked to the dynamics of social change and cumulative impacts occurring in the region.

The Aboriginal people, individually and in communities, have become subject to increasing pressures to change and to information overload so there is often sufficient stress to cause social disruption. The people are currently receiving complex information on many topics from a variety of sources, but the information they receive is often incomplete and conflicting. Added to this there are time pressures to make a rapid decision in a manner not consistent with Aboriginal approaches, which requires a high degree of consensus arising from considered discussion from all parties concerned.

5.1 Social Impacts

Two issue of concern to local Aboriginal communities are (1) local Aboriginal people will be excluded from locations traditionally used, including those still used for food gathering; and (2) that recreation areas will be contaminated.

ERA has indicated that access would only be restricted to areas along the haul road and around the mine site where personal risk is high due to traffic and mining operations. This restriction will take the form of fencing around the mine site and along part of the haul road (a detailed description is provided in Figure 1.3 of the draft EIS). Should there be specific areas where Aboriginal people are likely to cross, special measures will be investigated which includes signposting and modifications to road design.

Adverse effects on food gathering and recreation areas may occur through a number of mechanisms including surface and ground water contaminants, airborne contaminants, human interactions and the introduction of non-endemic weeds to the region.

The potential for groundwater contamination is minimal provided all the safeguards as detailed in the final EIS or as modified by this report are implemented. Adequate monitoring mechanisms will ensure that the low risk of groundwater contamination is maintained.

Human interaction is to be restricted on the lease area and is not considered to be problematic. Weed encroachment has been considered in Section 4.5.5.1. Airborne contaminants have been considered in Section 4.5.3.2.

Submissions highlighted that many of the Aboriginal people in the region are concerned over the potential contamination of bush tucker and bush medicine. While not founded in scientific analysis, the risk perception still remains.

Perception of risk may exist after an issue has been demonstrably dealt with to the satisfaction of the company and regulatory agencies, and may remain due to issues of trust in scientific data collection and in the company, or because measures taken to minimise risk have not been communicated successfully. The Jabiluka proposal may lead to increased perception of risk associated with contamination of the food chain or the dangers of increased amounts of radioactive tailings stored at Ranger. The impacts of these fears have not been well documented, other than reports (including in the Northern Land Council submission) of reduced usage of the Magela floodplain. Possible social impacts of these fears can include the psychological and health effects of suffering fear, reduced use of the area concerned and of species normally hunted from it. Over a very long period there is a risk of gradual attrition of knowledge of these areas if they become less frequented and children are taken there less often for socialisation into traditional ecological knowledge. The Supplement in part acknowledges this impact and commits to cooperation and communication with community groups to increase mutual trust and cooperation. While this may reduce the impact of perceived risk, such perceptions have continued despite the history of mining at Ranger and it is unlikely that they could be easily overcome.

A number of submissions have highlighted potential difficulties that could arise, particularly with the influx of workers during the construction and operation phases leading to the intrusion of non-Aboriginals into sacred areas, increased liquor related problems and other increased cultural stresses.

Commencement of operations for the project will result in an approximate 10% to 15% increase in the population of this region. During the construction period the workforce is expected to peak at about 180, including visitors. A permanent workforce of 110 will be associated with the operation of the mine. This would be reached during year 14 of the mine operational life. A statement in the Supplement (Spp 5-13) indicates that the workforce may be higher than stated and may exceed 200.

The Ranger Uranium Environmental Inquiry examined in detail the development of uranium in the region. On the basis of information presented by the mining industry the Inquiry found that a maximum town population limit of 3,500 was applicable. The inquiry also envisaged the town of Jabiru would have a finite life with a long term preference of having no permanent town in this region. Presently there are 1,403 residing in Jabiru (ABS, June 1996 census). The population recorded at Jabiru has been fairly constant (Table 3).

Table 3: Jabiru population vs Direct ERA employment

(**Source** Supplement to Jabiluka draft EIS , 1997; ABS, 1996).

Year	Jabiru Population	Direct ERA Employees
1991	1450	310 (reduced to 167 during 1991)
1995	1370	Not stated
1996	1403	233 (April 1997)

An additional 110 people plus families is considered achievable for the longer term, without undue stress on either the township or the region's physical and social capacity.

The extension of the town's life from 30 years to 48 years may contribute to both positive and negative social impacts. These can include an increase in opportunities for Aboriginal investments, an increase in the availability of Aboriginal services, increased employment opportunities, perceived marginalisation, and the cumulative effect of non-Aboriginal intrusion within the region.

While there is substantial intrusion through tourism, tourists are largely restricted to areas normally frequented by tourism operators. The permanent town population often has opportunities to visit other parts of the park considered significant to the Aboriginal communities. This is a matter to be further refined in association with Parks Australia and the local Aboriginal communities. Intrusion into significant areas around the Jabiluka mine will be restricted through both physical barriers, worker education and penalties if workers depart from operating sites and transport routes. It is also an issue that Parks Australia may need to consider.

Recommendation 35

The proponent shall include measures to educate and, if necessary, discipline construction workers and sub-contractors for any behavioural breaches during the construction period.

Policies and procedures shall be clearly indicated to all contractors and personnel to ensure any breaches of ERA procedures and commitments will be dealt with in accordance with penalties addressed in the final EIS.

Under the "do-nothing" option the life of Ranger's operations would be approximately 15 to 17 years. After this time the town of Jabiru would experience changes due to the reduced interaction and services provided by ERA. These changes would flow to other services and eventually cause a significant increase in isolation and impacts on self-sufficiency. The possible extension of the township's life to around 2023 will result in sufficient support to maintain, if not expand, the levels of services provided.

If ERA terminates operations then a previous commitment to rehabilitate the town will take effect, requiring all of the residents and services to either move or renegotiate with the relevant authorities for a continuance of the town. It is not part of the consideration for this assessment.

Aboriginal employment within ERA's operations has been between 5% and 10%. Submissions have indicated that this is not sufficient and should be higher as was indicated in the previous Pancontinental mining proposal. ERA has committed to maximising Aboriginal employment and assistance in setting up contractual business for local Aboriginal communities if they desire.

ERA has made commitments to accommodate Aboriginal wishes and to further undertake investigations arising from the KRSIS report.

5.2 Heritage and Cultural Values

As a signatory to the World Heritage Convention, Australia is obliged to identify, protect, conserve, present and transmit to future generations the World Heritage on its territory. Australia's obligations under the Convention apply not only to actions which take place within areas on the World Heritage List, but also to actions outside a listed property which have the potential to adversely affect World Heritage values. This is of particular relevance for the proposed Jabiluka uranium mine given that the Jabiluka Mineral Lease is completely surrounded by land on the World Heritage List.

Kakadu National Park contains a collection of places which have significance to the Aboriginal people. Traditional beliefs and practices remain very important to daily life, and rites and ceremonies continue to be practised. Such sites associated with traditional beliefs can include a waterhole or soak, a cave, a hill or gorge or a rock formation. The Jabiluka Lease contains such places.

The proponent has undertaken literature searches regarding prehistoric (Aboriginal) archaeology within the Jabiluka project area to identify sites which may be affected by exploration and mine development. The methods and results were reported in the draft EIS activities but did not address the significance of these sites in a regional context. A survey was also undertaken by Pancontinental for the 1979 draft EIS. Archaeological and four sacred sites have been located along escarpments, outliers and along creek lines.

While known sites are not within the project area, the proximity of these sites to the proposed development indicates the need for up-to-date archaeological and anthropological studies for adequate assessment of Aboriginal cultural heritage values, including rock art, dreaming and ceremonial sites and present day significance of sites.

Baseline anthropological and archaeological surveys have not been undertaken for the specific purpose of this project due to access restrictions by the Northern Land Council and Traditional Owners. The Traditional Owners have also refused to be consulted for the purposes of preparing the final EIS and thus first hand knowledge of sacred sites has not been available.

The Jabiluka Lease area contains significant religious sites, stone quarries, burial sites and at least 196 art sites, and a range of archaeological sites including the site known as Malakunanja II. Two National Estate sites are adjacent to the proposed Jabiluka mine site. These are the:

- Kakadu National Park, including the former Gimbat and Goodparla Leases National Estate place (interim listed 17 November 1986); and
- two archaeological site complexes: the Ngarradj Warde Djobkeng Sites Complex (interim listed 19 December 1978), and the Djawumbu-Madjawarna Sites Complex (interim listed 19 December 1978).

The Djawumbu-Madjawarna complex is important for its mythological associations and the wide range of Aboriginal activities represented at sites there. More than 100 painting sites have been found around its escarpment. Subjects identified include sorcery figures, X-ray motifs, hunter figures, stencil motifs, some figures made of native beeswax pressed into the rock, and contact motifs. Quarry sites are also found in this area, along with debris from the manufacture of stone artefacts. Burial sites are present in this area as well.

The Malakunanja II site is one of the most important within this group, preserving a deep, well-stratified archaeological sequence. Within its deposits are found some of the oldest dated grindstones in Australia. Its lowest occupation deposits, which have been dated using thermoluminescence techniques, could be some of the oldest in Australia, and may be as old as 50- 60,000 years before present.

While these do not form part of the Jabiluka project proposal, other parts of the Jabiluka lease may contain indigenous heritage values of National Estate significance. Establishing whether these values occur in the Jabiluka area will depend on professional archaeological and anthropological surveys.

Of particular importance is the "Boyweg" sacred site, which has been referred to as a soak within the final EIS. It appears this site may be affected by potential changes in ground and surface water regimes. The proponent propose a monitoring strategy to identify any potential water drawdown effects from mining activities. This strategy has been questioned by the local Aboriginal communities because the nature of the monitoring itself may have potential impacts upon the site (ie placing a monitoring hole on or near this site).

Recommendation 36

The proponent shall instigate a study to identify potential dewatering effects and potential remedial actions, dealing with the Boyweg site and other identified soak sites. This study is to include detailed consultation with local Aboriginal communities.

Only one European historical site has been identified in the project area. This site was identified as "Camp 38" of John McKinlay in 1866. This site is not expected to be disturbed as a result of the Jabiluka mining activities.

Respondents to the draft EIS have reported that the survey and results presented in the draft EIS did not provide sufficient data to fully assess the level of impact the project may have on Aboriginal archaeological sites in the prospect. The proponent has argued that the survey reported in the draft EIS was complete but due to the importance of these sites to the Traditional Owners much of the detail was omitted. Details are available to relevant authorities.

The Aboriginal Areas Protection Authority has stated that they have not issued any Authority Certificates for this proposal under the current legislation. While ERA has previously stated that it has obtained a sites avoidance agreement from the NLC, no evidence has been provided to the relevant Government authorities.

Recommendation 37

The proponent must provide evidence that there is an agreement between the proponent and the Northern Land Council representing the Aboriginal Traditional Owners and other custodians who are the beneficiaries of the relevant land trust. The proponent must set out any conditions for the protection of sacred sites in accordance with that agreement. If there are no such conditions then the proponent must state the manner in which the agreement relates to the protection of sacred sites in the project area.

The final EIS acknowledges that dust generation and vibrations from mine operations are a potential threat to two archaeological sites. The potential for dust to be generated by the haul road has been minimised by ERA's decision to seal the road, however dust may arise from other access tracks including the construction access road. If necessary ERA has proposed that dust at these sites would be carefully contained and protective measures (eg plastic protective sheeting) used to protect art work. Any protection measures should be discussed with the local Aboriginal custodians.

The final EIS notes that blasting may marginally exceed the recommended peak criteria for archaeological sites of 3 mm per second. Similarly the final EIS describes the risk of any effect upon the sandstone escarpment as negligible. Specific strategies would include vibration analysis during the initial phase to assist in determining appropriate charges. Monitoring would include locations near heritage sites and nearby escarpment areas with ongoing monitoring at key locations.

Also associated with vehicle use is the potential for site damage from carbon emissions from vehicle exhausts. While ERA has acknowledged this possibility in the Supplement (Spp 8-17), it concludes that distances from known sites would suggest that it is unlikely to be a concern. The Australian Heritage Commission recommended that monitoring of carbon emissions from vehicle exhausts should be incorporated into the management of rock art sites in the area.

Recommendation 38

Monitoring of rock art sites in the area surrounding the project area should include monitoring to detect impact from vehicle exhausts.

Recommendation 39

Any significant deviations from baseline data, identified by monitoring of rock art sites, shall be reported to the relevant Government regulatory authorities and Traditional Owners and a course of action agreed and implemented.

As indicated previously in this report, access to the haul road will be restricted to the general public. ERA has, however, recognised the probability that local Aboriginal people may need to cross the road to access sites within the lease. In order to fully evaluate the requirements to access these sites the proponent should discuss the maintenance of rights of access with the relevant traditional owners and others. There may be other sites which the Aboriginal people wish to be prohibited to all persons. Full consultation with local Aboriginal communities will clarify this situation.

The proponent has made an undertaking to conduct a detailed archaeological survey on the haul road corridor and on the mine site. To mitigate site disturbance the proponent has included measures such as induction for all employees and exclusion measures such as fencing to prevent access from the haul road and mine site.

6 Conclusion

This assessment has found that the proposal for an underground uranium mine at Jabiluka with milling of ore at Ranger will significantly reduce potential environmental impact, compared with other alternatives presented in the final EIS. The assessment also indicates that there should be no significant impacts on the surrounding Kakadu National Park.

ERA has indicated that consultation with the Traditional Owners, through the Northern Land Council, will occur on this proposal. In addition it will be necessary for consultation to occur on monitoring programs to assist and provide surrounding Aboriginal communities with an opportunity to have an input into monitoring programs.

Recommendation 40

ERA and government agencies involved in the regulation and monitoring of this project shall aim for transparency in the reporting of environmental monitoring data. This reporting should be in a form which assists Aboriginal people or their organisations to evaluate the monitoring data.

The Kakadu Region Social Impact Study, while separate from this assessment, will provide the proponent with additional recommendations to enable further consideration and understanding of the social effects arising from the proposal in the region.

The outcome of this assessment is that the environmental issues raised can be satisfactorily addressed, and that the proposal could proceed in an environmentally acceptable manner provided the undertakings and commitments made in the final EIS, as modified by recommendations in this report, are implemented.

The requirements of the *Environmental Assessment Act* and its Administrative Procedures have been met by the proponent.

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Appendix 1

List of Public Respondents to the Jabiluka draft EIS

List of Public Respondents to the Jabiluka draft EIS

No.	Name	Organisation	City	State	Postcode
1	J E Nove &M R Howard	Environmental Excellence	Willoughby	NSW	2068
2	G C Richards	Greg Richards and Associates	Belconnen	ACT	2617
3	Sarah Phillips	Wilderness Society (Tasmania)	Hobart	TAS	7000
4	Herbert Compton	Personal	Darwin	NT	0800
5	John Ward	Personal	North Albury	NSW	2640
6	Sharee Hutchison	Personal	North Albury	NSW	2640
7	Gary Brooker	Personal	Strathfield	NSW	2135
8	Jo Reid	Personal	Bomaderry	NSW	2541
9	W R Maynara	Personal	Woy Woy	NSW	2256
10	Jennifer Hughes	Personal	Glenorie	NSW	2157
11	Dr John Lea	University of Sydney	Sydney	NSW	2006
12	Vic Little	Brunswich Progress Association	East Brunswich	VIC	3057
13	Doug McFadden	Personal	The Channon	NSW	2048
14	S Edwards	People for Nuclear Disarmament (WA)	Perth	WA	6765
15	M Barsony	Personal	Casino	NSW	2470
16	Carmel Young	Personal	Darwin	NT	0801
17	Tania Davey	Personal	Rapid Creek	NT	0810
18	Carol Boomma	Personal	Coffee Camp	NSW	2480
19	John Hallam	Friends of the Earth, Sydney	Sydney	NSW	1235
20	Sashia Kouwenbug	Personal	Ninbin	NSW	2480
21	L M Barry	Personal	Goonellabah	NSW	2480
22	L Taylor	Personal	Unknown	---	----
23	Cate Allan	Personal	Crossley	VIC	3283
24	Jane Alexander	Personal	Booyong	NSW	2480
25	Cindy Jordan	Personal	Dorroughby	NSW	2480
26	Penelope Coleing	Total Environment Centre	Sydney	NSW	2000
27	Keith Muir	Colong Foundation	Sydney	NSW	2000
28	John Hepburn	Personal	Indooropilly	QLD	4068
29	Kevin G Gall	Personal	Brisbane	QLD	4054
30	Dr Geoff Williams	Australian Radiation Laboratories	Yallamble	VIC	3085
31	Bob Barrowcliff	Jabiru Town Council	Jabiru	NT	0886
32	Richard Howitt	Macquarie University	Sydney	NSW	2109
33	Richard Smart	Australian Radiation Protection Society	Parkville	VIC	3052
34	Joy Gough	Personal	Dodges Ferry	TAS	7173
35	Stuart Pearson	University of Newcastle	Callaghan	NSW	2308
36	Lou GugenBerger/Michael Froemmcke	Coalition Against Mining and Export of Uranium	Paddington	NSW	4064
37	David L Allen	Personal	Sydney	NSW	2001
38	Kylie Hosie	Personal	Lismore	NSW	2480
39	Steve Hale	Personal	Nimbin	NSW	2480
40	Helena Combe	Personal	Blackheath	NSW	2785
41	Simon Ridgley	Personal	Lismore	NSW	2486
42	Lyn Allen	Personal	Rapid Creek	NT	0801
43	The Nuclear Issues Coalition	The Nuclear Issues Coalition	Adelaide	SA	5000
44	J Gerard	Byron Bay Environment Centre	Byron Bay	NSW	2481
45	Steve Duthy	Big Scrub Environment Centre	Lismore	NSW	2480
46	Susanna Murtinger	Personal	Anula	NT	0812
47	Peter Schnelbogl	Personal (with supplemental)	Lismore	NSW	2480

48	Malcolm Hughes	Personal	Springwood	NSW	2777
49	Serannon Barr	Personal	Brisbane	QLD	4601
50	Elise Dorahy-Hill	Personal	Dunoon	NSW	2480
51	Celeste Barr	Personal	Dunoon	NSW	2480
52	James Johnson	Johnson Hydromap	Cooma	NSW	2630
53	Robert Levitus	Aboriginal Project Committee (KRSIS)	Jabiru	NT	0886
54	Lynne Zihrul	Willoughby Environmental Protection Association	Chatswood	NSW	2067
55	Grusha Leeman	Personal	Parap	NT	0820
56	Friends Of the Earth Fitzroy	Friends Of The Earth Fitzroy	Fitzroy	VIC	3065
57	Jayne Weepers	The Environment Centre (NT)	Darwin	NT	0801
58	J Katona	Gundjehmi Aboriginal Corporation	Jabiru	NT	0886
59	Ophelia Cowell	Australian Conservation Foundation	Sydney	NSW	2000
60	Hamish Barr	Personal	Dunoon	NSW	2480
61	David Thomas	Public Health Association of Australia	Alice Springs	NT	0871
62	Martin Oliver/Jennifer Ellis	Personal	Lismore	NSW	2480
63	Northern Territory Government	Department of Lands, Planning and Environment	Darwin	NT	0801
64	Galarrwuy Yunupingu	Northern Land Council (and supplemental)	Casuarina	NT	0811
65	Jeremy Tager	North Queensland Conservation Council	Townsville	QLD	4810
66	A Kington	Personal	Kalamunda	WA	6076
67	Stuart Sutton	Personal	Lismore	NSW	2480
68	Russell Willis	Willis's Walkabout	Millner	NT	0801
69	Don Owers	Personal	Dudley	NSW	2290
70	Mick Alderson	Kakadu Board of Management	Jabiru	NT	0886
71	Uranium Research Group	The Uranium Research Group	Parap	NT	0804
72	Beryl Brugmans	ENuFF	Darwin	NT	0801
73	Geoff Williams	Australian Radiation Laboratory	Yallambie	VIC	3085
74	Jodie Clarkson	Personal	Alice Springs	NT	0870
75	Carol Drake	Personal	Epping	NSW	2121
76	Charles Allen	Personal	Tamworth	NSW	2340
77	Robin Dyall	Environmental Defenders Office, NT	Darwin	NT	0800
78	Jeff Richardson	Personal	Larrakeyah	NT	0820
79	Penelope Coleing	Total Environment Centre	Sydney	NSW	2000
80	John Drake	Personal	Epping	NSW	2121
81	Breanna Barr	Personal	Dunoon	NSW	2480
82	Ken Devereux	Personal	Melville	WA	6156
83	Unknown	Personal	Rapid Creek	NT	0810
85	Commonwealth Government	Environment Australia	Canberra	ACT	2600

Appendix 2

Public Examination Places for the Jabiluka draft EIS

Public Examination Places for the Jabiluka draft EIS

State Library of New South Wales	Sydney
State Library of South Australia	Adelaide
State Library of Victoria	Melbourne
Northern Territory Library	Darwin
Queensland State Reference Library	Brisbane
State Library of Tasmania	Hobart
State Library of Western Australia	Perth
Jabiru Library	Jabiru (NT)
EPA Library	Canberra
Environment Protection Division	Darwin (NT)
The Internet (Summaries Only)	www.north.com.au/era

Appendix 3

Issues raised in submissions on the Jabiluka draft EIS

Issues raised in submissions on the Jabiluka draft EIS

The following tables present a compilation of issues raised in submissions on the Jabiluka draft Environmental Impact Statement. It has been summarised to be concise rather than convey the language and tone of each submission. They are in the form of questions or statements which have attempted to encompass concerns.

The following table represents a summary of the number of comments/issues raised:

Category	Number of issues raised within submissions
Development Proposal and Alternatives	**162**
Water Management	**22**
Tailings and Waste Rock Management	**38**
Radiation Management	**58**
Transport Management	**15**
Flora and Fauna Management	**23**
Infrastructure Impacts	**32**
Social Impacts	**142**
Heritage and Cultural	**18**
Other General Issues	**143**

Development Proposal and Alternatives

The draft EIS should be a stand alone document not relying on Pancontinental's proposal for justifying the project.
The assessment of project alternatives should be thorough providing more economic, social and environmental costs/benefit analyses: • If the price of uranium falls/rises considerably what implication would this have on the mining schedule. • The economic benefits section does not address the impact or effect any delay would have on the viability of this project. ERA refer to a window of opportunity but have neglected to adequately define same. What is the effect on this project if other large mines start? What would be the effect on the Ranger project? The economics modelling is therefore considered incomplete. • Indirect costs associated with the project have not been discussed. • Social costs have not been incorporated into the economic analysis. • Environmental monitoring costs have not been defined or incorporated in the economic analysis. • The analysis of the "Do Nothing" option has not been adequately addressed.
The option of development, using the Mill alternative, is considered inappropriate and data provided for this alternative is not complete. The proponent has indicated that they may proceed with this option. Considerable information is needed.
The extent of ore bodies within Ranger Number 3 pit and at Jabiluka Number 2 deposits have not been fully defined suggesting that more ore may be mined. What implications would there be on the Jabiluka and Ranger facilities, the township of Jabiru and the surrounding environment?
Substantial gold mineralisation is considered an important resource and should be further assessed. Alternatives for future gold extraction are not considered.
The areas quoted for disturbance are in question. A total disturbance of around 80.5 ha was quoted. Disturbance areas may be in excess of this figure.
The draft EIS did not fully address the impacts at the Ranger site.
The impacts from this project are based upon impacts from the Ranger operations and are therefore inaccurate given the different nature of the mines.
Concerns over the Environmental Record at Ranger.
The draft EIS lacks information on the long term environmental risks and impacts.

Concerns were raised over rehabilitation of the mine and project areas.
The flexible Membrane Liner (FML/HDPE) is guaranteed for 30 years whereas any contaminants will be in the pond for a substantially longer period of time. The breakdown of this liner may result in both surface and ground water contamination. Monitoring mechanisms to be in place for leak detection and subsequent repair of the FML were not adequately discussed. What effect will acid water have on this liner?
Rehabilitation has been covered, however a commitment for long term monitoring and rehabilitation is not addressed.
No details on mine power reliability and stability have been presented.
The power line deviates from the haulage road near the mine decline. This requires further clearing above that quoted.
Alternatives to overhead power supply to the mine site have not been adequately discussed.
Fences are to be built in the lease areas. Details on design, clearing requirements, maintenance requirements etc were not discussed.
Tipping operations onto stockpiles will generate dust and cause radon progeny dispersion and dust dispersion.
The draft EIS states that construction material will be obtained from a number of sources. Clarification is required to enable a determination of erosion and other possible localised effects. Details on borrow rehabilitation is not given.
Information on the sources of clay for the pond lining are not identified.
Proponent should discuss the environmental effects of not proceeding with the project
Further design details were requested to identify further impacts.
Concerns over the occupational health and safety of workers in an underground uranium mine.
Concerns over the construction material and its acid producing potential.
Concerns over the potential release of contaminants and their impacts resultant from the ventilation shafts. No modelling information was presented in the draft EIS.

Water Management

Surface Water Management

There is no water quality data presented for Swift Creek or any other creeks crossed by the haul road or potentially affected by the project activities.
No details have been presented on heavy metals that are potentially released and their effects.
The data used for comparative purposes is considered selective and needs to be qualified. Equipment and measurement techniques were not of a high quality as compared to today. The 1970's data is considered to be of poor quality. Sampling sites for these samples are not fully identified.
Water quality, particularly from waterholes and billabongs in the 1970's (used for comparison) is considered non-representative due to the effects of feral animals and buffalo in the 70's. This coupled with high season fluctuations in water quality results questions the validity of data for comparative purposes.
The construction activities may cause turbid waters and contain other contaminants to be released into surface drainage systems which do not normally contain high suspended solid material or other contaminants (ie fuels).
Drainage from fuel storage and explosive storage and handling areas are currently directed to a sediment control mechanism rather than to the total containment zone. High levels of nitrates etc may cause environmental concerns if not adequately addressed in the design of the facility layout and the water management system.
Water wastes from laundry facilities and sewerage effluent will need to be further addressed with respect to location and contaminant emissions.
The safety design of the water retention structures has been questioned.
The commitment to "no release" is in doubt given the record of both Nabalek and Ranger.
The build up of contaminants in the natural wetlands, billabongs etc may be passed on through food chains (ie birds drinking water or eating fish). The question of wetland contaminant saturation is also raised. Uptake occurs in wetland; what are the ramifications on the Magela System and surround when the wetlands cannot function effectively and contaminants enter the surface water systems? Wetland filters may approach saturation levels and plumes may develop. New areas would then be required at the Ranger site (expansion of disturbance).
The question of the Water Management System at Ranger has been questioned.
The effect of possible contamination uptake by waterbirds from the Retention Pond.

The possible evaporation from Retention Pond may be contaminated. Also the issue of potential acid rain was raised.
Water Management at Ranger may be altered to allow incorporation of the Jabiluka ore. No plans for any changes have been presented.
The design of water retention systems at Jabiluka are in question, particularly the 1 in 10,000 year scenario. The figure used for extreme rainfall is 2450mm (1 in 10,000) yet within the last 20 years a figure of 2223 mm was reached.
The Net Acid Generation testing for use in the field has not been fully developed for testing material that may be used in construction of roads etc.
Questions related to erosion controls throughout the project areas were raised and in particular along the haul road, and during the construction period.
Monitoring of the Sediment Control Zones was not adequately addressed.
Some facilities did not appear to be contained within the Total Containment Zone and as such the Water Management System needed further reviews.
Concerns over the Annual Exceedance Probabilities for the surface water management system.
Concerns over possible water seepage into the surface waters systems and ultimately into the Ramsar wetlands and the effects this may have.
The issue of surface water contamination from radioactivity not adequately discussed.
The contingency plans for structural failures of TCZ bunding/pond have not been detailed.

Ground Water Management

There is not enough baseline hydrogeological data or detailed modelling presented. This included details on the connectivity between aquifers and surface water bodies. The groundwater analysis presented in the draft EIS is for dry season and does not represent yearly fluctuations and as such requires further clarification.
The information presented on groundwater inflow to the mine may be higher than quoted.
The construction of raised ventilation shafts may encounter ground water which needs to be accounted for. This ground water may be in contact with "ore" and would necessitate proper engineering design to prevent water ingress and other appropriate measures to capture and contain these waters as part of the total containment system. The droplets of water from the mine exhaust vents possibly being brought to the surface must be addressed.
Potable ground water may be obtained from other sources than discussed in the draft EIS. Due to the presence of high quantities of uranium ore throughout the region a requirement to test for selenium, radium 226 and 228 in potable water must be undertaken to ensure the health and well being of workers.
Water bores for make-up and potable water have not been adequately addressed (ie location, design etc).
A number of vegetation types rely upon natural springs and seeps in the area. Continual high volume pumping may affect the groundwater levels and ultimately alter vegetation patterns. No information has been presented. A number of "Significant Soaks" exist in the area (ie. Boyweg) which may be affected by groundwater pumping (ie drawdown of water table or recharge to the site). Not enough detail was presented in the draft EIS.
Information regarding groundwater aquifers has not been adequately discussed, in particular those intersecting the tailings structures, the exhaust vents and the mine decline. It is believed that contamination of groundwater will occur over time.

Tailings and Waste Rock Management

Mercury associated with gold at Jabiluka has not been addressed.
Figures of reserves at 0.05% U^3O^8 cutoff indicate ore reserve of 52 Mt and at cutoff of 0.1% U^3O^8 of 19.5 Mt. It has been suggested that tailings volumes are not adequately calculated. Some submissions suggest that tailings volume may be as high as 2.5 times that suggested in the Draft.
Concern about the effects of termites in terms of bringing tailings fines to the surface.
Cumulative effects of tailings at one locality and of greater volumes than originally predicted has not been addressed.
The tailings dam are inappropriate with costs of monitoring and repair of structures not addressed.
Acid generation of waste rock and in tailings is of concern.
Questions the tailings management system in place at Ranger and its adequacy to cater for the Jabiluka tailings.
The extra load of tailings, resultant from Jabiluka, will require special management at Ranger.
The effects of dust from fine tailings (wind borne) have not been adequately addressed.
Consideration of the rehabilitation of the tailings areas (long term) is lacking and in particular the company's responsibility and commitment to rehabilitation of these areas.

Radiation Management

Considers there is not enough baseline data on radiation, in particular worker exposure and environmental modelling.
Issues involving the assumption and inputs into the radiological model have not been adequately presented and therefore the model is not justifiable.
Details on worker protection in the workshops etc (those that may show effects from scale buildup and gypsum precipitation), need to be included.
Details on monitoring programs have not been presented in enough detail.
Radiological and other monitoring programs have focussed on acute rather than chronic effects.
Because higher grade ore will be mined in the first years of production the average figure quoted for radiation exposure may not be average for a short term employee.
Pathways of radiation have not been adequately addressed (ie. draft EIS looked at inhalation only and neglected information on ingestion of dusts).
No modelling on exhaust air from the vents has been presented. What will be the composition of exhausted air and what effects will be expected.
Details on the environmental model are required. Environmental pathways also need more detail. Considers that the environmental exposures are underestimated (some believe this exposure already too high).
Concerns regarding dose limits and threshold levels. Concerns also raised over the radiation protection of workers in mine.
Questions the job-rotation methodology to reduce worker exposure.
The draft EIS did not adequately address bioaccumulation of radiation contamination.
No data on permissible inhaled dust in the draft EIS.
No assessment of radiological consequences of any accident scenarios
General concerns over radiation exposure.

Transport Management

A raised haul road will impede terrestrial animal movement particularly towards the wet lands. Not enough detail has been placed on animal movements over the haul road.
The draft EIS does not adequately cover contingency plans for accidents on public roads, both within and outside of Kakadu National Park.
The design of the wet and dry culverts were raised primarily dealing with flood event and culvert design for a 1 in 10 rather than a 1 in 25 year event.
The draft EIS should also cover transportation and shipping of sulphuric acid and other chemicals.
The width of the haul road is considered too narrow and the option of haul road sealing was not adequately covered.
Concern over the amount and impacts of construction traffic and product/chemical transport on the Oenpelli Road and Arnhem Highway.
Concern over transportation of construction personnel over the Magela Creek during the wet season and that alternatives were not adequately presented.
Bridge construction over major watercourses is considered inadequate for normal flood conditions (ie Magela Creek expands to several hundred meters). Bridge design and construction will need to ensure that flooding does not result in runoff in a direction opposite to normal watercourse flows and would not increase scour effects either side of the bridges.
Radioactive dust emanating from loading facilities and subsequent haulage operations may result in dust/water leaving the facility which contain elevated levels of contaminants and ultimately settle in areas outside the containment zones.
The alternatives to loading haulage trucks have not been addressed (ie loading plant as opposed to front end loaders). The use of front end loading may increase exterior contamination.
The alternatives to the haul road (ie rail, pipe transport etc) have not been considered.
A commitment to wash all vehicles (including light vehicles and empty trucks) from/to Jabiluka is required. It is currently unclear.
Structural engineering aspects of bridges are in question particularly when they intend to use large capacity trucks at 80 km/hr.

Flora and Fauna Management

There is no up-to-date flora and fauna baseline data presented. This includes both aquatic and terrestrial species. Flora and fauna, their conservation significance and their persistence has not been detailed in the draft EIS. A summary of macroinvertabrates has not been included.
The identification of threatened species is not up-to-date and neglects to identify the impacts on these (ie Gouldian Finch).
Long term chronic effects (or acute) on birds which congregate around the tailings dam (Ranger) and Retention Ponds (Ranger and Jabiluka) needs to be further addressed (ie toxic effects).
Many land and soil types have been identified but their significance to the area is not well discussed, particularly for the interactions. Some are more vulnerable to weed infestation and erosion but details were not presented in the draft EIS on how these would be managed.
Weed management has been questioned. No previous management has been in place for the exploration activities in the Jabiluka area. The effects are unknown and surveys should identify weeds not normally found in this region (ie those that have been transported to the are over the last 20 years).Also of concern is the resources to be allocated to this management plan.
Concerns on the cumulative effects on flora and fauna from this project (water, radiation) as well as from Ranger. Frog abnormalities may be genetically linked and associated to mining in the region.
Baseline data on biting insects has not been presented. Monitoring/control programs for biting insects have not been detailed.

Infrastructure Impacts

The upgrading of the Ranger milling plant was commenced prior to formal approval from regulatory bodies. The confidence of regulating authorities has now been questioned.
The seepage plume under the tailings dam has been suggested as moving and expanding and could cause problems in the future.
Groundwater contamination may develop to the north of the tailings dam. Groundwater models are not presented or well understood in the Ranger area.
The current EIS utilises power via an overhead power line. Alternatives including underground placement have not adequately been assessed.
The current power line configuration does not conform with guidelines of the Australian power supply industry.
The record of tailing and water management is poor at the Ranger facility. Therefore submissions have indicated it may be the same at Jabiluka and continuing at Ranger.
The capacity of Ranger's tailings dam to contain extra tailings from Jabiluka ore is in question. Excess water has been released from the Restricted Release Zone into the pits. If the pits are used for tailings storage what will happen to this excess water?
The draft EIS does not adequately discuss the impacts of traffic using public roads.
The continuing development of this area will require further infrastructure at Jabiru which may have further impacts on the Kakadu National Park.
The continual development of Jabiru may result in Jabiru becoming a permanent township which may bring special contaminant pollution to the KNP.

Social Impacts

Social impacts upon Aboriginal landowners have not been adequately addressed namely: the lack of discussion of Tradition Owners views; more white people entering the area; Aboriginals have not provided approvals for the ERA proposal; details in the draft EIS is ERA's views only; the new proposal restricts Aboriginal employment and business operations; benefits to Aboriginal people will reduce by 50%; no gold extraction also reduces benefit; failure of Government and ERA to monitor or address negative impacts from Ranger mine; cumulative impacts on people have not been addressed (ie through food chains); impacts on Archaeological sites and mythical areas, and to the culture of Aboriginals, have not been adequately addressed; the rehabilitation of Jabiru township is in question.
The draft EIS fails to recognise that Aboriginals should have a greater input to the mine processes and be involved more heavily in discussions.
The project is contrary to the wishes of the Traditional Owners.
General objections to mining on Aboriginal Land.
The description of the socio-economic environment is lacking (ie alcohol, housing, health).
The draft EIS does not address the KRSIS and its relationship to the EIS.
The draft EIS does not provide for monitoring of social impacts (in the Environmental Management Plan).
The Jabiru town designed as a temporary accommodation town will become a permanent fixture rather than rehabilitated at a later stage. Benefits and costs associated with non-mining lacks detail.
Problems associated with towns involve pollution, erosion, alteration of land patterns, illegal activities by residents, alcohol sales to aboriginal people etc. This has not been discussed in the draft EIS.
Areas to be specifically restricted to public access (ie broken stone country) have not been described. Areas used by Traditional Owners will be restricted to them.
There is no discussion on socio-economic issues based upon cumulative effects.
Believes that the environmental impact assessment process should be delayed until after the KRSIS report is finalised and released.

Heritage and Cultural Values

The land is of particular spiritual and cultural significant to the traditional owners.
While only one historic/heritage site has been identified there is a lack of surveying over this project area. The NLC has a number of recorded sacred sites which were not used in the draft EIS.
Information on specific aboriginal significant sites is scant as no details on archaeological site surveys have been provided.
There are a number of significant sites which may be affected by vibration, dust, groundwater, surface water etc from mine activities. Details on monitoring proposed for the construction period have not been presented.
The lease is interlaced by tracks of cultural significance which will be destroyed by mining activities.
A sacred sites certificate was issued but only for a small section of the project.
There is a general lack of discussion on sacred sites significance.
Concerns that the haul road will open access and allow sacred site disturbance.

Other General Issues raised

Mining within the bounds of a National Park (or World Heritage Property) goes against the World Heritage Conservation Act 1983 where activities are likely to damage the values of the property (ie the mine is not compatible with the values and will risk tourism activities).
Ramsar wetlands will be adversely affected.
Uranium mining is not safe, creates radioactive wastes and is not the most cost-efficient energy source. Australia should adopt a anti-nuclear stance.
General objections to uranium mining.
The long term effects of uranium mining has not been discussed.
The mine is situated within a national park (a lease which predated the park). Any contaminants would enter the park if a release occurred.
The environmental impact assessment process provides a mechanism for project approval.
Obligations of obtaining uranium from areas outside of World Heritage Areas first.
Does not consider that the mining method at Jabiluka is Best Practicable Technology.
Considers that the guidelines for this project were too narrow.
Considers the guidelines do not account for end-use of the products.
The draft EIS does not consider the cumulative effect of development within the Kakadu National Park.
The draft EIS should have been produced in the language of Traditional Owners.
The draft EIS does not adequately cover the adverse effects on tourist perceptions.