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WORLD HERITAGE COMMITTEE

Twenty-fourth session

Cairns, Australia
27 November - 2 December 2000

State of conservation of Kakadu National Park, Australia: Independent Scientific Panel (ISP) of the International Council for Science (ICSU) Report No. 3, September 2000

BACKGROUND

December 1998	22nd session of the World Heritage Committee requested review of scientific issues relating to the development of the Jabiluka uranium mine in an enclave of Kakadu National Park by (i) the Australian Supervising Scientist Group and (ii) an Independent Scientific Panel ((ISP) to be selected by UNESCO in consultation with the International Council for Science (ICSU))
June/July 1999	Presentation of reports to the 23rd session of the Bureau and 3rd extraordinary session of the Committee: - Australian Supervising Scientist (WHC-99/CONF.204/INF.9C and WHC-99/CONF.205/INF.3C) - 1st report of the ISP of ICSU (WHC-99/CONF.204/INF.9E and WHC-99/CONF.205/INF.3E) - Response of Australian Supervising Scientist (WHC-99/CONF.204/INF.9F and WHC-99/CONF.205/INF.3F))
June 2000	2nd report of the ISP of ICSU presented to the 24th session of the Bureau (WHC-2000/CONF.202/INF.7)
July 2000	ISP of ICSU site visit with IUCN in co-operation with the Australian Supervising Scientist
September 2000	3rd report of the ISP of ICSU – **This document**

This document should be read in conjunction with **paragraph I.35 of WHC-2000/CONF.204/10**

ISP OF ICSU REPORT NO. 3 September 2000

EXECUTIVE SUMMARY

In October 1998 the World Heritage Committee [WHC] mission to the Kakadu Park World Heritage site expressed concern over the possible impacts of a proposed scheme to mine uranium at a lease site within the Park Boundaries at Jabiluka [JMA] on the natural and cultural values of the World Heritage site. At the request of the WHC, the Australian Supervising Scientist [SS] reported to the Committee on the scientific concerns raised. The WHC obtained the support of the International Council of Science [ICSU] to form an Independent Science Panel [ISP] to review this SS report.

The ISP concluded that the SS report had reduced the scientific uncertainties but that issues remained which needed additional analysis or clarification. The ISP made 17 principal recommendations but noted that its insights had been limited by lack of time and the need for both a site visit and further information.

In July 1999 the WHC requested ICSU to continue the work of the ISP in co-operation with the SS and the World Conservation Union [IUCN] in an attempt to resolve the remaining scientific issues. A crucial element in this ISP/ICSU activity was a visit to the Kakadu area by representatives of the ISP and IUCN in July 2000, including on site discussions with the SS and representatives of the mining company, the traditional owners and other groups. Prior to this visit other relevant issues had been drawn to the attention of the ISP, including the interim water management scheme at the Jabiluka site, a leakage of tailings water at Ranger mine lease (also lying within the Park Boundaries), and reported leaks of contaminated water from old mines in the Park. The relevance of these issues to Jabiluka was considered in the discussions during the visit and is described in this report.

Following the site visit the ISP and IUCN prepared separate reports of their assessments. These are presented here under one cover, with the IUCN assessment as Annex 4 of the ISP report. There are many points of agreement between the two documents and the four recommendations by IUCN are referred to in the ISP report.

Published papers provided by the SS and others, discussions during the visit and observations on site enabled the ISP to gain a much more detailed insight than formerly into the possible impacts of the proposed mining on the natural values of the World Heritage Park. The ISP found that 10 of their original recommendations had been met. The remaining 7 required further consideration and this is addressed in detail in the report.

Although the ISP considers that the SS has identified and quantified all the principal risks to the natural values of the Kakadu World Heritage site that can presently be perceived to result from the JMA proposal, and has shown these to be very small or negligible, the ISP and IUCN consider that there is still need for a more comprehensive risk assessment of both the freshwater and the terrestrial ecosystem at a landscape – catchment scale. This is because the region is subject to major seasonal or long-term changes unrelated to those which might arise from mining activity.

Comprehensive monitoring programmes with accompanying analyses are therefore needed to distinguish between impacts from these differing causes and unforeseen problems arising from mining. Hopefully such data collection, monitoring and analysis could run for several years before mining starts due to the present delay at Jabiluka but if this is not possible the programme could run in parallel with an operating JMA. The ISP recommends that any risk analysis, whether concerned with the presently approved scheme or some future proposal, be undertaken on the basis of a mine life which may extend to 60 years. The ISP would also wish the Australian authorities to offer a strong statement of intent to provide comprehensive monitoring of the site and adjacent Park areas well beyond the time at which the mining company's obligations cease.

The delay in proceeding with the mining activity at Jabiluka has enabled new designs, which may further improve environmental aspects of the system, to be considered. This is welcomed by the ISP provided there are full discussions on these with stakeholder groups, particularly the traditional owners, a rigorous environmental assessment and independent review.

Arising from the leakage incident at Ranger and the consequent recommendations from the SS for improvements to the existing monitoring and review systems there is a clear need to strengthen and extend the on-site monitoring responsibilities of the SS at Jabiluka. The ISP found the staff of the Office of the Supervising Scientist and those undertaking research at *eriss* to be of high quality and to have good working relationships with the Park management, however the Office is under resourced. Additional commitment in terms of further protecting the natural values of Kakadu would change management procedures and require extra staff.

The present review arrangements lack transparency and an independent perspective. The ISP also perceived that the traditional owners feel excluded from the decision making process. There is a pressing need for an Independent Science Advisory Committee to regularly review activity at the Jabiluka site in the context of protecting the natural values of the Kakadu World Heritage site. Recommendations for its membership and Terms of Reference are given in the report.

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1. Introduction

1.1. Background

In October 1998 the World Heritage Committee's mission visited Kakadu to examine possible impacts of the proposed Jabiluka uranium mine on the natural and cultural values of the World Heritage Site. With respect to the natural values, the Mission recognised uncertainties relating to the Jabiluka mine proposals [Ref.1]. Somewhat similar concerns had been expressed by a number of eminent Australian scientists [Ref. 2]. In November 1998 the World Heritage Committee [WHC], at its Kyoto meeting, requested the Australian Supervising Scientist to report to the Committee on the scientific concerns that had been identified. The Committee also required the Australian report to be reviewed by a panel of independent scientists.

The Australian Supervising Scientist provided the requested report on 9 April 1999 [Ref. 3]. UNESCO obtained the support of the International Council for Science [ICSU] in forming an Independent Science Panel [ISP] to undertake the review. Membership of the ISP is given in Annex 1. The ISP undertook its review during the period 22 April to 13 May 1999 and submitted its report to the Committee on 15 May 1999 [Ref. 4].

The ISP review was restricted by the WHC Terms of Reference to assessing the impact of the Jabiluka Mill Alternative [JMA] on the natural values of the Kakadu World Heritage Site. A proposal to mine at Jabiluka but to transport to and mill the ore at the Ranger uranium mine, some 20 km to the south, [this is known as the Ranger Mill Alternative (RMA)], was referred to in the Supervising Scientist's Report. Because the traditional owners of the land had not given their approval to the RMA its potential impacts were not considered in any detail in the report of the Supervising Scientist and were deemed to lie outside the brief of the ISP during its first and subsequent assessments.

The ISP's first report [Ref.4] concluded that the Supervising Scientist's report [Ref.3] had reduced the scientific uncertainties in some areas but that scientific issues remained which required additional analyses and/or information. Seventeen principal recommendations were made. In its report the ISP noted that its review period had been very short and that its insights had been restricted by the absence of some information and the lack of a site visit.

1.2 ISP Terms of Reference – Second Stage Assessment

Prior to the meeting of the World Heritage Committee on the 12 July 1999 the Supervising Scientist had prepared a 'Response to the ICSU Review of the Supervising Scientist's report to the World Heritage Committee' [Ref. 5]. However, given time constraints, it was not possible for the ISP to consider this response in advance of the July meeting. At its meeting the World Heritage Committee noted that it 'continues to have significant reservations concerning the scientific uncertainties relating to mining and milling at Jabiluka'; and ' to resolve the remaining scientific issues' asked 'ICSU to continue the work of the ISP…' 'to

assess, in co-operation with the Supervising Scientist and the World Conservation Union [IUCN], the Supervising Scientist's Response to the ISP Report.'

ICSU re-established the ISP, which was to undertake its further work in two stages, as follows:

(i) Offer preliminary considerations on the Response of the Supervising Scientist to the ISP's First Report, presenting these considerations as a succinct Progress Report for examination by the 24th Session of the World Heritage Bureau in June 2000.

(ii) ISP and IUCN representatives to make a field inspection at the Kakadu National Park and at the Jabiluka Site in July 2000 and prepare a final assessment in a Report to be submitted by 15 September 2000 for examination by the Bureau at the 24th Extraordinary Session in November/December 2000 in Cairns. The Preamble, Objective and Method of Working covered by the Terms of Reference for the ISP for the second stage of the review process are given in Annex 2.

The ISP duly presented its progress report [Ref.6] to the World Heritage Bureau in June 2000. In the report and presentation the ISP noted a number of other issues that had been brought to its attention and were relevant to the JMA. These included:

- the interim water management arrangements at Jabiluka;
- leakage of tailings water at the Ranger mine and
- reported leaks of contaminated water from old mines in the region.

The ISP and IUCN explored the circumstances relating to these during its visit to the Kakadu National Park, the Jabiluka site and Ranger mine between 3 and 7 July 2000.

1.3 Report Structure

This report considers the response of the Supervising Scientist and others to the ISP's 17 recommendations presented in June 1999 and to the three additional issues identified above. It draws both on the Supervising Scientist's written response, on the information provided by the Supervising Scientist and on many detailed discussions with the Supervising Scientist and others during and subsequent to the site visit. The site visit Programme and Procedures aredescribed in the next section.

It was convenient to divide the ISP's first report [Ref. 4] into four activity areas:

- Hydrological modelling and the assessment of the retention pond design capacity;
- Risk assessment for the ERA proposal;
- Long term storage of mine tailings;
- General environmental protection issues.

This division has been followed here. However two sections have been added. These address:

- the three issues identified in *1.2* above
- management and review arrangements.

The last section presents the ISP final conclusions and recommendations.

2. Site Visit & Discussions

The outline programme for the site visit and discussions was proposed by the ISP and the detailed arrangements made by the Supervising Scientist. The programme followed is given in Annex 3. The ISP members were accompanied by a representative of IUCN, Dr Pierre Horwitz. The IUCN prepared a separate report describing Dr Horwitz's findings. This is attached to the ISP Report as Annex 4. The ISP is in agreement with almost all of the findings of the IUCN Report but some of the IUCN recommendations are slightly different and these will be identified in the following text. The ISP found the detailed arrangements and support provided to be very good. The Supervising Scientist was prepared to make changes to the programme or provide information required by the Panel at short notice.

2.1 Visits

A flight in a small aircraft from Jabiru over the Ranger mine, the Jabiluka site, the Magella Creek and flood plain, along the escarpment and over Swift Creek gave an excellent perspective of the various landforms and the settings of Ranger and Jabiluka in relation to these. The ISP was left with an impression of a beautiful, wild and varied landscape crossed by several major roads with bridging points at the river crossings. Smoke originating from controlled burning by the Park staff and the traditional owners was widespread. From the air the Ranger mine presents a considerable visual presence in the landscape but the Jabiluka site was much less evident, although its visual impact will increase if a Mill and additional retention ponds are introduced.

Following briefings by the staff of the ERA, visits were made to both Ranger mine and the Jabiluka site. The ISP/IUCN party was accompanied by the Supervising Scientist on both visits.

2.1.1 Ranger

At Ranger the party was shown the present mining operation at pit 3, the mill, the tailings dam and the disposal of tailings in pit 1. The location of the leak of tailings water from a pipe in the tailings corridor was examined. The party was also shown the wetland filters, retention ponds and irrigated areas. Two revegetated waste rock piles sites were visited.

2.1.2 Jabiluka

The Jabiluka site is in stand-by mode. A long decline has been driven through the sandstone and the schist to the ore body. Some ore was extracted during the construction process and this is stored on the surface in a covered stockpile. The party inspected the surface facilities including the ore stockpile, the waste rock and the retention pond. It walked down to Swift Creek and was shown stream flow and sediment monitoring sites.

The Kombolgie sandstone and the Cahill Formation schist were observed in the walk down the decline. Both rock formations are strong and only occasional support, using rock bolts and mesh or shotcrete [sprayed cement], is required. The decline and headings are shotcreted where they pass through the ore body to reduce radiation and radon emissions. Both the

sandstone and the schist show strong joint patterns but these are very tight with few water seepages. Seeps, where they occur, are small and appear to be associated with water from the surface layer entering through one of the many exploration boreholes which cover the whole of the area. The overall impression is that the sandstone and schist have very low overall bulk permeability and porosity.

Commentaries by the ERA during both the Ranger and Jabiluka visits were informative and the many and wide-ranging questions posed by the party were answered in an open and direct way.

2.1.3 Laboratories

Although not included in the original programme, brief visits were made to both the *eriss* and adjacent ERA laboratories at Jabiru.

eriss

The *eriss* laboratory has some 25 scientists, principally biologists, focussing on research on the impact of mining and the tropical wetland ecosystem. They report to the Supervising Scientist and provide support in assessing potential risks arising from existing or proposed uranium mining and on other environmental issues, which may impact on the Park's natural values. The laboratory has an impressive library facility. The party gained the impression that the *eriss* laboratory is directed towards applied research rather than being an operational monitoring unit. If the Supervising Scientist is to adopt a more proactive monitoring role in future then changes at *eriss* may be required. Its work is well regarded within the Australian scientific community.

ERA

The ERA laboratory has some 30 staff undertaking monitoring and assessment work for both the Ranger and the Jabiluka sites. It is a small, well- equipped, nationally accredited laboratory undertaking relatively routine analyses and interpretation and appeared to be well run. The work is directed principally towards areas of environmental safety and health, chemistry, water resources and associated management and biological monitoring. Some of the analytical work for Jabiluka is contracted by ERA to EWL Sciences in Darwin.

2.2 Discussions

Discussion meetings were held at *eriss*, following the programme given in Annex 3. These meetings focussed on the principal issues that had been raised in the ISP's initial [Ref.4] and progress [Ref.5] reports. Presentation by the Supervising Scientist, ERA, and consultants etc were followed by discussion to identify additional information requirements or unresolved concerns of the ISP or IUCN. The meetings were chaired by the ISP leader, Professor Wilkinson. Following each discussion session he indicated which of the ISP's former concerns he considered had been satisfied, while reserving final judgement until there had been time both to report the findings to those members of the ISP who had been unable to visit Kakadu and for careful consideration of all the issues by the full Panel. All meetings were conducted in an open and helpful manner. Additional information and analyses were provided when requested. The areas of science covered were wide ranging and the Panel was impressed by the depth of knowledge of the Supervising Scientist across most sectors.

In addition to the more formal large group discussions with the Supervising Scientist and others, ISP/IUCN met with Professors Wasson and White and the Supervising Scientist. There was also a private meeting between the ISP and a representative of the Gundjehmi Aboriginal Corporation, Jacqui Katona. This meeting involved only the ISP and Jacqui Katona at her request. The outcomes of these meetings will be referred to later in this report.

ISP/IUCN, with the Supervising Scientist, also visited the Kakadu Park Headquarters at Bowali Visitors Centre to meet Peter Wellings, Assistant Secretary, Parks Australia North and Terry Bailey, Acting Park Manager. The managers described the development of uranium mining and the Park and the attempts to reconcile the mining activities with Park values and with the interests of the traditional owners. They explained the procedures and protocols for the successful management by a staff of 75 of a Park attracting 250 000 visitors a year. Kakadu is the most researched of all the Australian Parks. Research can only be undertaken if a permit is granted by the Park management and local benefit is sought from any research activity. The Park managers were proud that Kakadu was a World Heritage Site and that they would be reporting to UNESCO in 2002 as part of a six yearly cycle. They identified some of the principal issues possibly threatening the Park's World Heritage values now or in the future as access, water buffalo, pigs, mimosa, fire, climate change, decline in small mammals, cane toads, frogs etc. The Park management noted that the Office of the Supervising Scientist undertakes scientific studies on their behalf, particularly in addressing problems that may impact on Park values. They referred to a pollution problem that had arisen at the Jim Jim Falls, work in establishing baseline information related to developing ecosystem stress indicators and the resolution of a number of problems arising from disused mineral mines in the Park. The Panel formed the view that there was a high level of trust and a good working relationship between the Park management and the Office of the Supervising Scientist.

During the week there were also a number of private meetings between IUCN, ISP and the Supervising Scientist . These generally focussed on management and review issues associated with the science, and which were inappropriate for open session discussion, rather than on the science *per se.*

3. Hydrological Modelling and Prediction, Impact of Severe Weather Events and Retention Pond Capacity

3.1 Rainfall Records [ISP First Report Recommendation 1]

In its original report [Ref.4] the ISP noted that the design of effective water management systems for Jabiluka were crucially dependent on the available rainfall and evaporation records and an expert interpretation and analysis of these. It is fortunate that such a reliable long- term record exists at Oenpelli and that there is good correlation with the shorter Jabiru data. The ISP noted that rainfall gauges employed at open sites frequently under record data [Ref.7 & 8] and recommended that the rainfall record should be increased by 5% and a modified, synthetically-generated rainfall record be prepared. The Supervising Scientist, in his response, notes that it is not the Australian Bureau of Meteorology's policy to make such adjustments to rainfall records and that there are a number of conservative factors built in to the stochastic analysis and the water management design. The Supervising Scientist will accept the recommendation but during the discussions asked the ISP to reconsider. Having done so the ISP recognises that, while it is not the practice of most meteorological services to

take account of the errors of rainfall measurement for operational use in hydrology, in view of the importance of these measurements to the success of the operation of the management system, this increase would be an appropriate addition to the other conservative factors built into the design. This is in the light of the results of various studies conducted into the effectiveness of methods of measuring precipitation**. The Supervising Scientist thus accepts the recommendation of the ISP.**

3.2 Meteorological Measurements at Jabiluka [ISP First Report Recommendation 2]

With respect to the meteorological measurements at Jabiluka, the ISP [Ref.4] recommended that instrumentation should be installed and measurements commenced without delay so that comparisons could be made with records from Oenpelli and Jabiru. The ISP was pleased to note in the Supervising Scientist's response [Ref. 5] that Class A pan evaporation had been measured at the site since 1998 and that three extra weather stations close to the proposed mine site and three rainfall stations in the catchment have now been installed. **The ISP recommendation has been met.**

3.3 Climate Change [ISP First Report Recommendation 3]

The ISP noted [Ref.4] the uncertainty in predicting climate change arising from the increase in greenhouse gases in the atmosphere. An excellent examination of this issue has been undertaken for the Supervising Scientist by Jones *et al* [Ref.9]. This formed a sound basis on which to make a first assessment of the implications of an anthropogenically generated change in climate on the proposed water management arrangements at Jabiluka. However the predictive capability of the climate change models is likely to be progressively improved with time. The ISP considered that the Supervising Scientist's report had not recognised the importance of keeping this issue under review and modifying the water management arrangements as necessary. The Supervising Scientist's response [Ref.5] suggests that the ISP may have misunderstood the Supervising Scientist 's position. The Supervising Scientist gives a commitment [Ref.5] that climate change will be kept under review during the life of the Jabiluka project. During the ISP/IUCN visit the Supervising Scientist re-iterated this commitment, the review to be undertaken not less than once every five years. **The ISP found this to be a satisfactory response**.

3.4 Runoff Coefficients [ISP First Report Recommendation 4]

In establishing the 1 in 10 000 year design capacity of the retention ponds, the ISP accepted that the methods described by the Supervising Scientist [Ref.3], using synthetically generated hydrological data to run 50 000 simulations, was following good hydrological practice and the techniques should lead to a robust design [subject to recommendation of a 5% increase in the rainfall data]. However one element in the hydrological modelling is the choice of run-off coefficients. The ISP recommended that the model should be run using observations from the Ranger site so as to validate these coefficients. The Supervising Scientist, in his response [Ref.5], notes that the run-off coefficients used in the Jabiluka model were derived from experience drawn from the Ranger mine. **The ISP requirement has been met.**

3.5 Water Management Arrangements[ISP First Report Recommendation 5]

The ISP [Ref.4] was unable to obtain a clear picture of the water management system proposed for Jabiluka from the Supervising Scientist's report [Ref.3]. The Panel sought an understanding in terms of the interconnection between the various elements and the flow

paths of water and potential contaminants around the site. The Supervising Scientist's response [Ref. 5] did not meet the ISP needs and further clarification was sought during the visit.

On this occasion the party were presented with a schematic of the flow of water and uranium for the water management system that had been approved and previously described in the Supervising Scientist's report [Ref.3]. This was based on an average annual water and uranium budget and a retention pond capacity of 940 000 m3 with an area of 9 ha. The schematic shown differed from the original proposal in that the groundwater and flow from the ore stockpile are directed to the mill and consequently any uranium is trapped in the tailings waste. While the ISP accepts this approach is desirable, in operational terms it would be impossible to direct all the ore stockpile runoff to the mill without having some storage in the system. If the stockpile waste water was passed through the retention ponds, as pointed out in the ISP report [Ref.4], this would lead to a progressive build up of the concentration of uranium in the retention pond unless the pond water could be diluted by an amount of low concentration water from the hard standing, mine or mill area or from the borefield to equal that evaporated from the pond surface. However the annual water budgets do not indicate that sufficient dilution would take place. **The assumption made in the Supervising Scientist's report [Ref.3], and repeated in the Supervising Scientist 's response [Ref.5,] for a constant concentration of uranium, magnesium and sulphate in the pond may be valid but not until proved by a simulation exercise to explore annual variability and the ISP would recommend that this analysis be undertaken now for the approved JMA scheme and for any amended proposals once submitted.**

It was fully apparent to the ISP/IUCN during the visit that the Supervising Scientist and the ERA have been considering improvements that could be introduced into the design of the proposed works at Jabiluka to cope with the runoff from the ore stockpile. One approach that has been developed and introduced during the construction and stand-by stages is to cover the ore stockpile with sheeting. This would prevent any runoff from exposed ore and removes this source of uranium etc from entering the retention pond. It would appear prudent, however, to direct the runoff from the ore stockpile covers in to the retention pond. If such a covering to the ore stockpiles could be introduced during the proposed operation of the mine it would greatly reduce, although probably not totally eliminate, influx to the pond of uranium, magnesium, sulphate etc. **The ISP fully supports the approach of covering the ore stockpile.**

The Supervising Scientist's report [Ref.3], and the ISP comments on this [Ref.4], address the arrangements under the JMA for retention ponds with a capacity of some 940 000 m3 and an area of about 9 ha collecting water from the total containment zone and giving a 1 in 10 000 yr probability of being exceeded during the 30 yr life of the mine. The Australian government gave a number of commitments to the World Heritage Committee in 1999, one being that 'full scale commercial mining at Jabiluka would only be reached about 2009 following the scaling down of production at the Ranger mine.' In addition the traditional owners have placed a five year moratorium on any discussion of the Ranger Mill Alternative [RMA]. The ISP/IUCN party learnt that these events have moved Jabiluka into stand- by mode and have given time for further consideration by the ERA and the Supervising Scientist of the water management arrangements should the JMA proceed.

During the visit it was made very clear by the Supervising Scientist that, as of July 2000, the only approval the ERA had received was for the JMA as described in the Supervising Scientist's report [Ref.3]. However **the ISP consider that if sound suggestions were made to modify the water management system which appeared to give an environmental benefit in relation to the approved proposal then it would be remiss of the Supervising Scientist not to consider these. Before any approval was given such proposals would have to satisfy a detailed environmental impact assessment and be subject to independent review [see Section 9.7].**

The ERA briefly described one such proposal. This involved retaining the interim water management at its present capacity of about 168 000 m3 in a 3 ha pond and during the wet season, when inflow from the total containment zone would exceed capacity, pass the surplus flow through a reverse osmosis plant. The effluent containing uranium etc would be directed to the mill and the treated water would be irrigated outside of the containment zone and lost through evaporation. As described above, the ore stockpile would be covered. Providing the capacity of the reverse osmosis plant was sufficient to cope with the extreme 1 in 10 000 yr event, and there were adequate fail safe arrangements e.g. against power failure, such a system appears to have merit. The Supervising Scientist should be and is prepared to consider such a proposal. However **the ISP would look for some assurance that the Office of the Supervising Scientist has the skills 'in house' to make the appropriate in depth assessment, that other stakeholder groups, in particular the traditional owners, are included in the discussion/debate as early as possible and that there is an independent review process [see Section 9.7].** The ISP will consider this issue further in a more general context in a following section of this report.

4. Risk Assessment for the ERA Proposal

The ISP assessment [Ref.4] addressed those sections of the Supervising Scientist 's report [Ref. 3] which considered the probability of the water containment facilities failing and, if failure should occur, the resulting discharge of the retained water into Swift Creek and beyond.

4.1 Public Exposure Radiation Model [ISP First Report Recommendation 6]

The ISP accepted that, because of the extensive containment facilities that have been proposed for the Jabiluka site, the probability of exposing people to radiation would be very small. The Panel noted that the Supervising Scientist had developed a radiation exposure model for the Ranger mine and sought justification of its applicability to Jabiluka.

In response [Ref. 5] the Supervising Scientist stated that the results obtained using the Ranger model indicated that the maximum radiation exposure expected over the 30 year life of the mine would be about one tenth of the annual dose limit for members of the public. In these circumstances it was initially considered unnecessary to extend the model to the specific case of the Jabiluka project.

Since the original submission of the Supervising Scientist's report a specific Jabiluka model has been developed [Ref.10]. In response to the ISP Recommendation 6 this assessment

includes analysis of the risk associated with chemical toxicity of uranium with regard to soil ingestion, and dust inhalation.

As in the previous assessment a 1:50 000 year release scenario over a 20 day period was modelled with the activity being based on stock pile runoff contributing 1% to the total water flowing from the total containment zone. The critical group for radiological dose assessment purposes was taken as the Aboriginal people who would obtain bush food from the affected area identified as the backwater flood plain (BWFP) area of Swift Creek.

In using a concentration factor approach for a short term release situation a conservative estimate of dose arises. This conservatism is further enhanced when 92% of the predicted effective dose derives from the ingestion of fresh water mussels. Previous studies have demonstrated that the time scales for uptake and excretion of radium by the flesh of mussels are several years and hence the concentration factor approach results in an overestimate of dose. Exposure to a 'worst case scenario' results in a dose six times less than the International Commission for Radiological Protection's recommended annual dose limit.

Turning to uranium toxicity the Australian drinking water guideline is 0.02 mg/l. The modelled concentration in the BWFP is equivalent to 0.0015 mg/l and the highest concentration in one day is predicted to be less than 0.017mg/l. It is stated that the water guideline is not exceeded on any one day and the average over the year is predicted to be one-tenth of the guideline value. This predicted average, over- the- year figure is slightly less than the World Health Organisation guideline value of 2µg/l, [Ref. 11].

A safe level for total intake of uranium was estimated as 0.4 mg/d. This estimate was based on a 70 kg adult, and using a safety factor of 10 in applying the results of animal studies to humans. Taking into account the ingestion pathways considered of food, water and soil led to a modelled estimate of 0.0025 mg/d total intake, i.e. 1/160 of the safe level. If the WHO tolerable daily intake (TDI) of 0.6 µg/kg of body weight is used then the total dose becomes about 1/17 of the TDI. The difference in the two results is due to the WHO adopting a safety factor of 100 in extrapolating the results of the animal studies to humans. **In the view of the ISP this precautionary approach should be adopted in calculating a safe level for total intake. Notwithstanding this, the results indicate an event with a very low probability of occurrence based on average concentrations and this is acceptable to the ISP for Jabiluka.**
The inhalation scenario developed was based on assumed site occupancy of the affected area, i.e. the BWFP, of 365 hours/year that produces a total predicted dose of 1.7×10^{-4} µg/d over a three-month exposure period. **This figure is six orders of magnitude lower than the safe level for total intake for chemical toxicity and is therefore acceptable to the ISP.**

4.2 Biological Recycling [ISP First Report Recommendation 7]

In the event of the retained water being accidentally discharged downstream the Supervising Scientist made an assessment of the radiological and chemical exposure to aquatic animals [Ref 3]. The ISP expressed reservations about the approach that had been adopted and sought assurance that the effects of biological recycling of the contaminants in the aquatic ecosystem would be investigated [Section 3,4; Ref.4]. The Supervising Scientist [Ref. 3] bases assessment mostly on Johnston & Needham's (1999) [Ref.12] work on the impact of

chemical exposure of aquatic organisms [fish and macroinvertebrates] resulting from Ranger Mine discharges. What Johnston & Needham (1999) describe is a two-level approach to monitoring, first a chemical assessment to assure that concentrations of contaminants do not depart greatly from normal, and then a biological assessment based on toxicity tests using selected species. They note that there has been no evidence of mining-related effects (from Ranger Mine discharges, using this assessment approach) for more than a decade. In his report [Ref. 3], the Supervising Scientist argued that the chemical assessment was by "a criterion that was considered conservative by biological scientists [and which] was adapted to determine what change from natural values could be assessed as not being biologically significant", then assessing what chemicals might not meet this criterion if waters were discharged. The biological assessment, he said, "should result in no detectable change in the species and community diversity of a set of aquatic animals in water bodies downstream from the mine site", via "a regime of stringent ecotoxicological tests" and in "an extensive program of biological monitoring".

The ISP [Ref. 4] expressed reservations about this approach in that it implies a risk of impact on the aquatic ecosystem, but no ecosystem analysis *per se* has been carried out. Instead the approach relies on "surrogates for the whole ecosystem". The ISP wondered about ecosystem processes such as biomagnification, recycling, and secondary effects. The "a few species can represent the ecosystem" approach assumes that there is no in-stream processing i.e. biotic or abiotic uptake in sediments of Swift Creek. If discharges of contaminated material would be brief (of short duration) then effects of biological recycling might be minimal, but the ISP wanted this demonstrated by a study. Otherwise the restriction to an assessment of direct chemical and radiological toxicity on a few species was felt to be unacceptable for inference to impact on the "aquatic ecosystem".

The Supervising Scientist's response [Ref. 5] to these ISP comments and queries was as follows. Direct exposure *is* the dominant risk. The phrase "surrogates for the whole ecosystem" was poor wording and should have been "surrogates for all the directly exposed aquatic animals". The species chosen for the ecotoxicological tests were the end result of investigation of 19 species of plants and animals, of which 8 were chosen and a subset of 3 selected for the routine assessment program. In Appendix 4 of the Supervising Scientist's response [Ref. 13], Harris of CSIRO makes a number of points in response to the ISP report, especially to the call for an ecosystem approach. He agrees that such an approach is warranted ("merely performing eco-toxicological assays and sampling the biota might miss potential impacts at larger scales"), and that "There are sufficient data to begin to put such an approach together". He draws the ISP's attention to "the extensive research and monitoring that has been carried out - - since the late 1970s - -", and he attempts to pull some of the information together into a summary. It is pertinent to this section (recommendation 7), but also to Section 6 of this report [recommendations 14 and 15] (an environmental impact assessment and a comprehensive risk assessment, respectively) which are considered below.

In May 2000 the ISP [Ref. 6] sought further information or clarification on the following points related to their recommendation 7: that supporting data are needed for the conclusion that direct chemical exposure is the dominant biological risk and: that more information is wanted about biotic recycling and what impact there might be related to this. In the discussions during the site visit these points were addressed and were freely and frankly

discussed. **The ISP now feels, with the site visit and the face-to-face discussions behind them, that it can be safely assumed that direct exposure to radiological and chemical contaminants is the dominant risk and that this risk has been demonstrated by the Supervising Scientist to be very small or negligible. In addition, the ongoing assessment/monitoring procedure envisioned by the Supervising Scientist will ensure that the direct exposure risks are kept under continuing review.** But it is also true that there may be longer term and larger scale impacts, related to ecosystem processes, which are not yet described or are poorly understood. Hence an ecosystem level approach to monitoring and analysis is warranted and can begin now, as indicated by Harris [Ref.13]. **Thus, within a wider context, the ISP stands by its recommendation 7 which is that the effects of biological recycling of contaminated material in the aquatic ecosystem should be investigated but this could proceed in parallel with the JMA. We return to this issue in addressing the Supervising Scientist's response to ISP recommendation15 in Section 6 below.**

4.3 Partitioning of the Retention Ponds [ISP First Report Recommendation 8]

The ISP noted [Ref.4] that, as part of the water management arrangements, the poor quality water from the ore stockpile would be stored separately from other water collected on the total containment zone and that, in addition, retention ponds would be partitioned. The ISP's comment reinforced a recommendation from the Supervising Scientist. It has been confirmed that this proposal will be implemented. However it was noted during the ISP/IUCN visit that the 3 ha interim water management pond was not partitioned. The ISP note that this represents only a small volume of the water that would be contained under the approved ERA proposal but, **if the existing 3 ha pond is likely to remain on standby mode for a number of years, the Supervising Scientist might wish to consider whether the ERA should be required to partition this facility.**

5. Long Term Storage of Tailings

The ISP [Ref.4] noted the proposal to return the tailings from processing at a Jabiluka mill into the mine void and into specially excavated silos 100m below the surface into the Kombolgie Sandstone. This would remove a major source of potential environmental pollution in the short term but the ISP sought assurance that the movement of contaminants as a result of groundwater transport in the long term [10 000 years] would also be limited. The ISP [Ref.4] welcomed the modelling approach that had been used by the Supervising Scientist [Ref.3] and, during the discussions and visit to the site, sought to establish that appropriate hydrological and geochemical parameters had been used in the modelling process.

5.1 Isotope Measurements [ISP First Report Recommendation 9]

The ISP considered that isotope measurements of the groundwater could help to establish the hydrogeological parameters for the strata and recommended that such measurements be made. The Supervising Scientist arranged for the collection and analysis of three samples of water from seeps in the decline. However carbon 14 dating of these samples showed that the water was modern. It is likely that surface water is being introduced via the exploratory drill holes that have intersected the superficial aquifer. Having visited the site the ISP agrees that this is the probable explanation. The ISP also agreed that a proposed programme of dating of waters collected from existing boreholes in the region would not be justified but supported the

Supervising Scientist's proposal that, if ERA drills a new bore in the vicinity of the ore body, dating of water collected from this bore should be carried out. Such measurements would have the potential to build confidence in the hydraulic conductivity used in the modelling.

5.2 Monte Carlo Simulations and 10 000Year Analyses [ISP First Report Recommendations 10 and 12]

The contaminant transport model was run stochastically and uniform probability density functions assumed. The results of the modelling were presented to the ISP in the form of cumulative probability plots. **The ISP is satisfied that this conservative approach justifies the conclusion that contaminant migration from the silos will be of the order of 50 metres or less into the sandstone and about 400 metres or less west into the schists over a 10 000 year period with a 95% probability.**

5.3 Mathematical Modelling and Cement/Water/Rock Interactions [ISP First Report Recommendation 11]

A hybrid numerical - analytical modelling approach has been adopted with uncertainty in the contaminant transport model being dealt with by Monte Carlo simulation [Ref.14]. During presentation of the modelling to the ISP considerable discussion centred on the boundary condition used for the two dimensional numerical groundwater flow model that appeared to limit the potential for upward flow and discharge to the Swift Creek and Magella floodplain. The ISP arranged for the British Geological Survey to run a groundwater mathematical model representing the regional flow pattern. **This confirmed that the modelling approach described in the Supervising Scientist's Report was acceptable.**

The ISP is satisfied at this stage with the two-dimensional transport model that has been developed and used but if the site is developed it would be worthwhile, as new data becomes available, to construct a three-dimensional contaminant transport model. However, we were pleased to note that preliminary work on this has been started by the Ecole des Mines on behalf of ERA's consultants, EWL Sciences. The ISP welcomes this development and foresees that the model will be strategically important in defining future data requirements, the layout of the groundwater-monitoring network, and as a site performance assessment tool.

During the ISP visit ERA presented new data on waste-cement interaction research conducted on their behalf by the University of New South Wales. The results indicate that the leachable uranium from the tailings/cement would be very low indeed (<2µg/l) and hence the source term is very much reduced by two or three orders of magnitude in the models. Furthermore the resulting alkaline plume from the silos could be expected to seal up porosity and further reduce the magnitude of flux of contaminants away from the repository area. **The ISP finds this to be a satisfactory outcome from these experiments.**

6. **General Environmental Protection Measures**

In view of the very special nature of the Kakadu National Park the standards of environmental protection desired should be among the highest in the world. The Supervising Scientist states [Ref.3] that such is a requirement for the Jabiluka site. The ISP [Ref.4] raised a number of issues where it considered such high standards might not be being met in relation to the JMA's potential impacts on the Park values and sought clarification.

6.1 Sediments [ISP First Report Recommendation 13]

The ISP [Ref. 4] noted that large volumes of waste rock either from the mine or the silos would have to be accommodated on the surface. This waste rock will generate sediment and the ISP sought information on its potential to impact on the aquatic ecosystems and on the proposals to contain the sediment. The ISP also sought further information from the Supervising Scientist on the landscape evolution models, vegetation studies on waste rock and calculations of the sediment load from the proposed Jabiluka activity. The Supervising Scientist provided a number of reports and published papers, some of which focussed on measurement and analysis of sediment generation and transport at the Ranger site [Refs.15 & 16]. Much of this work had been undertaken by *eriss* and it was clear that the Supervising Scientist has access to staff having capability in both the theory and practice of formation and transport of sediment from waste rock dumps. However the ISP/IUCN had to wait until the site visit in July for more detailed reports of the sediment issues relating to Jabiluka[Ref.17].The waste rock dumps proposed would have an area of 41 ha. Provided that they are progressively vegetated, the estimated maximum quantity of sediment entering Swift Creek downstream of the gauging site during the last 2 years of the mine's 30 yr life would lead to an estimated increase of 11% above background. At the confluence of Swift Creek with Magella Creek the increase would be 0.4%. These calculations do not include for the provision of sediment traps which, if introduced, should reduce loads substantially.

Base line flow and sediment concentrations were measured at two monitoring stations on Swift Creek and East Tributary upstream of the Jabiluka site and at one downstream station on Swift Creek. The monitoring stations were installed by *eriss*. Sediment measurements appear to have begun in 1998 and have continued to the present [July 2000]. The measurements cover the period of construction works at Jabiluka. The up- and down-stream measurements may be interpreted to show a very small increase in the more sandy component of the sediment load during the construction phase. However there was also some burning on the catchment and this has been shown elsewhere to increase sediment loads. If the increased loads are as predicted they should not impact on the freshwater ecology of Swift Creek or further downstream.

It was clear to the ISP that the Supervising Scientist can call on experienced scientists within *eriss* to provide high quality advice on sediment transport. However it is surprising, in view of the potential importance of this issue, that (I) the arrangements to collect the base line data for both sediment load and biological impact were not put in place much sooner; (ii) the position which the waste rock piles will occupy has not been finally selected; (iii) the calculations and their interpretation had not been subject to wide scientific scrutiny. While the ISP was satisfied with the presentations it recognises the limitations arising from the short data sets available and the difficulties in making representative sediment measurements. **The ISP would encourage the Supervising Scientist to continue the stream sediment measurements, linking these to aquatic ecology, and to establish erosion plots on the Jabiluka site with some urgency.**

6.2 A Mine Life of 40, 50, 60 Years [ISP First Report Recommendation 14]

The ISP noted [Ref.4] that the Supervising Scientist referred to the prospect of continuing the mine beyond its proposed 30 yr life. The Panel therefore recommended that the

environmental impact assessment be extended on the assumption of a 40, 50 or 60 year life. The Supervising Scientist's response [Ref.5] rather dismissed the need for these longer term assessments. However an extended mine life would require an increase in the size of the retention ponds for the approved proposal. The downstream catchment would be at risk from this larger volume of contaminated water. Unless there is an inflow of diluting water to match the water lost through evaporation evapo-concentration will occur. A greater volume of waste rock would also be produced which would generate additional sediment loads.

During their visit the ISP/IUCN were informed of proposals to reduce the size of the retention ponds, to use reverse osmosis to treat surplus water with the waste stream being directed to the mill, to cover the ore stockpile and to isolate all mill circuits from the retention pond. It was suggested that this would negate some of the issues raised by the ISP previously in connection with an extended mine life. This may be the case, and while the ISP would welcome any proposals that would lead to a greater level of security in protecting the natural values of the Park, such proposals will need to be subject to a rigorous scrutiny in terms of environmental impacts. If the proposals are to move forward this scrutiny should also cover the possibility of extended mine life. **The ISP recommendation 14 therefore remains. This extension of the risk management programme should be commenced without delay for the approved scheme. It should also be applied to any amended proposals once submitted.**

6.3 Risk Assessment on the Landscape/Catchment Scale [ISP First Report Recommendation 15]

Because of the proximity of the mines to the Park and the possibility of the eventual addition of the mining lease areas to the Park after rehabilitation, the ISP [Ref. 3] considered that a comprehensive risk assessment, including ecological, biogeochemical and hydrogeological factors, at the landscape/catchment scale for both Ranger and Jabiluka within the context of the Kakadu World Heritage Area, was required. This concern is also relevant to recommendations 6 and 7 [see section 4.1 and 4.2] and to recommendation 14 [section 6.2 above].

Following detailed discussions during the ISP visit, in particular those involving the *eriss* scientists and Harris from CSIRO, **the ISP concluded that the risks to the World Heritage values of Kakadu, as a result of a carefully designed, operated and monitored JMA, are minimal. Nevertheless it was recognised that the site will be subject to change or variability due to climate, land use, introduced species etc which may be unrelated to the mining activity. It would therefore be prudent to put in place landscape and ecosystem analyses at this stage. These analyses could then form the basis of a future extended monitoring programme at both the local and regional scale so that any mining-related activity effects can be distinguished from those arising from other causes**. **Furthermore,** although the ISP has reached the view that stringent efforts have been made by the Supervising Scientist to identify the potential risks, it must be recognised that **presently unforeseen environmental impacts may occur in the future as a consequence of the mining activity at Jabiluka. The IUCN report [Annex 4] identifies a number of possible secondary, cumulative or interactive effects potentially related to the proposed development. The analyses and monitoring suggested by the ISP are therefore essential.**

A first step in such an analysis would be a synthesis of existing information on the aquatic and terrestrial ecosystems and this should be commenced without delay to establish a broad base line and to prioritize the elements of the research needed to increase understanding of ecosystem processes such as recycling, biomagnification, and transfer of contaminants in food chains. The existing information could be in the primary literature, public documents ("grey literature"), or in the possession (hard copy or electronic formats) of *eriss*, ERA, or past visiting researchers based elsewhere. The flora and fauna, habitat requirements of species and trophic relationships among them would need to be described first. To the extent that these were not in the existing information or possible to determine from it, they would be the first priority for new research. As this kind of understanding accumulates, ecological modelling could begin and eventually would provide understanding of any potential cumulative and interactive effects of developments on the lease site and around it. This is fully compatible with Recommendation 2 in the IUCN report [Annex 4].

As part of a full ecosystems risk assessment, **a survey of the flora and fauna of the local area in and surrounding the lease site and in the adjacent flood plain should be conducted, with consultation of traditional owners of the area and, where appropriate, the managers of the lease, paying particular attention to the potential for the occurrence of rare and endangered or endemic species and refugial or relictual habitats, together with a determination of the degree of threat to them.** In discussions during the site visit it was suggested that endemic fauna may exist in groundwater, in fissures of the rocks at depth. This habitat should be included in the survey of the fauna. This requirement is also expressed in Recommendation 1 of the IUCN report [Annex 4]. However, while the ISP agrees that the ideal would be for this work to be conducted before any further development on the Jabiluka site, it recognises that the Park area adjacent to both Jabiluka and Ranger sites and the sites themselves have all been subject to extensive ecological research and monitoring over several years. Consequently the ISP considers that, while this survey to identify rare or endangered species is essential, it should not be a detriment to mining activity at this stage. The survey work should be put in place immediately and having the Jabiluka site in stand-by mode, possibly for the next four years, is helpful.

The assessments, in terms of landscape and ecosystem analyses, should consider a mine life of 40, 50 or 60 years. This would include the analysis of movement of water, air, dust and animals, and the role of the Jabiluka and Ranger mines on landscape/catchment scales. In particular, will plant or animal populations, habitats, resources (e.g. required minerals and nutrients), travel corridors, or water balance be impacted by the Jabiluka mine? **Planning for a long-term monitoring programme in support of these analyses covering the lease site and adjacent Park areas should also begin now so that several years of data can be collected, hopefully before any new mining activity is begun.** The objective should be to describe the inevitable patterns of change, which will have many causes e.g. climate change, land use etc, with emphasis on the aquatic environment. This is also covered in Recommendation 3 in the IUCN report [Annex 4].

The ISP is confident that the expertise required for the synthesis of existing information, for the new research, for the ecological modelling and for designing and implementing the long-term monitoring program, exists within *eriss* and other scientific organisations in Australia.

However, because Kakadu is so important internationally, there is the need for the monitoring, analyses and their interpretation to be subject to a high level of external independent scrutiny. Means of achieving this is offered by the ISP in a following section of this report.

6.4 Rehabilitation Fund [ISP First Report Recommendation 16]

The ISP sought to establish [Ref. 4] that appropriate funding arrangements were in place to meet any long- term rehabilitation arrangements should Jabiluka be prematurely closed. The panel was expressing a concern as to whether the Federal Government had sufficient control over the operation to ensure the World Heritage Area was protected in the long and short term and whether such powers would be exercised. During the ISP/IUCN visit assurance was given that the Australian government has final and absolute authority over all aspects of the Jabiluka (and Ranger) project through its various statutory instruments and constitutional powers. These include the legal powers held by the Supervising Scientist, export controls which are used to govern mining operations and the legal agreements involving the Aboriginal community, which are also supported by legislation.

The Supervising Scientist's response [Ref.5] referred to the procedures that had been established for the Ranger site where a rehabilitation plan is reviewed annually and is the basis of a Rehabilitation Fund. During their visit the ISP/IUCN party was shown waste rock piles at Ranger that had been vegetated. The ISP were informed that the Ranger fund represents a cash security of $A 30 m, held by the Australian government. Copies of the Plan of Rehabilitation for Ranger – March 2000 [Ref.18] were provided. This appears to be a comprehensive document .The Supervising Scientist's response [Ref. 5] noted that the Commonwealth Approval for the Jabiluka project included a similar arrangement for the preparation of an annual rehabilitation plan to establish the level of financial security. ISP/IUCN were advised that, after the latest assessment in 1999, the ERA provided an unconditional bank guarantee of $ 1.4 m for the cost of rehabilitation at Jabiluka in the event that the operation was to close. If the project moves from stand-by to production the amount of the bank guarantee would be progressively increased in line with the rehabilitation costs. It is proposed that the rehabilitation of the waste rock piles and revegetation will be undertaken progressively. The government requires the mining company to carry out the rehabilitation so as to establish an environment similar to that in adjacent areas of the Park. **The ISP finds these arrangements very satisfactory in principle.** However they noted that the National Land Council [NLC], which represents the traditional owners, is involved in agreeing the goals and objectives for rehabilitation with the Australian Parks authority prior to government ratification. The NLC is also represented on the Mine Technical Committee. Nevertheless the ISP gained the impression that the traditional owners do not feel that they are fully engaged in the process. This is unfortunate. The IUCN Recommendation 4 [Annex 4] also reflects this concern. **Means of securing greater involvement should be explored.**

The ISP also noted that the Australian government is to introduce the Environmental Protection & Biodiversity Conservation Act 1999. The report [Australia's Commitment to Protecting Kakadu] [Ref. 19] states that this will provide more comprehensive and pro-active protection for the World Heritage values than existing legislation.

6.5 Long Term Monitoring [ISP First Report Recommendation 17]

The ISP [Ref. 4] sought a commitment from the Australian authorities to monitor the hydrological and ecological systems once the rehabilitation process at Jabiluka was complete, possibly for 100 years. During the visit briefings the ISP learnt that the Supervising Scientist was discussing the design of a long- term, post rehabilitation monitoring programme for Ranger with the key stakeholders and in particular the Aboriginal community.
It was proposed to follow a similar approach at Jabiluka . Following mine closure at Jabiluka the rehabilitation programme could take another 5 to 10 years. The mining company would carry an obligation for any monitoring or reparation measures for a number of years beyond that but would then cease to have any commitment. It was noted that Australian governments have shown a readiness to pick up such obligations if necessary once a company's responsibilities have ceased. However a firm commitment from a government to some unknown circumstance in the future is unlikely to be given. The ISP accepts the approach that is proposed and the difficulty a government would face in making such a commitment so far into the future. However **in view of the unique value of the Kakadu World Heritage site the ISP considers that the Australian government should make a strong statement of intent to continue a monitoring programme at the Jabiluka site and in the adjacent Park area well beyond the time when the mining companies obligations have ceased.**

7. Other Issues

7.1 Tailings Water Leak at Ranger

Prior to its visit to Kakadu a leakage of tailings water which had occurred at the Ranger Mine was brought to the attention of the ISP. The Panel considered that information on the leak and the way in which the mining company and the government authorities had responded to this event could be of relevance to protecting the Park's environment surrounding the Jabiluka site. The ISP therefore specifically requested the Supervising Scientist to provide reports and a briefing on the leak during its visit.

The leak is described in a comprehensive report prepared by the Supervising Scientist [Ref. 20] The report has appendices covering responses by the mining company and the Northern Territory Department of Mines & Energy.

On the 28th April 2000 the ERA sent the Supervising Scientist a faxed notification of a non-infringement leak in the tailings corridor drain from the pipeline connecting the tailings dam and the mill at the Ranger mine. The notification was sent following in-house investigations to identify the source of abnormally high manganese values in a culvert that passes beneath the tailings corridor. The source of the elevated manganese was traced to the tailings dam area and a leaking flange on the tailings water return pipe. The estimated leakage rate was 0.3 l/s. The duration of the leak can be fairly well established from monitoring in the culvert and from this it was estimated that a total of 2000 m^3 leaked during the incident.

To estimate the amount of contaminated water that leaked through the culvert some very dubious dilution calculations were attempted by ERA that relied on using ammonium and manganese as conservative tracers. This approach was flawed since both species are redox

sensitive, ammonium oxidising in the environment to nitrate, and manganese oxidising to form insoluble species. Since nitrate is not one of the determinands routinely analysed by ERA it not possible to assess the importance of this process.

The Supervising Scientist, in assessing the impact of the leak on the Kakadu National Park, assumed a worst case scenario in that all of the 2000 m^3 released had reached the Magela Creek statutory monitoring point without any attenuation in the wetland filters of the tertiary containment system. Modelling demonstrated that any increases in the concentration of contaminants fell within one standard deviation of the mean of the historical data. **On the evidence of the modelling and non-statutory biological monitoring at the compliance point on Magella Creek it was concluded that there had been no adverse effect on water quality as a consequence of the leak. Hence the World Heritage values of the Kakadu National Park had not been affected**. **The ISP accepts this interpretation.**

In his report to the Minister of Environment and Heritage the Supervising Scientist [Ref.20] made 17 recommendations arising from the investigation. They covered a wide range of issues including ERA's management of the incident and environmental protection protocols, monitoring strategies, site inspection and on-site audit by the Supervising Scientist, incident reporting, and the working relationship between the Commonwealth and the Northern Territory government regarding the regulation of uranium mining.

The responses of the mining company and the Northern Territory government Department of Mines & Energy, as reported in the appendices to the Supervising Scientist's report [Ref. 20], require comment. The mining company fully acknowledged their shortcomings in relation to the incident and offered improvements in future operational practice. The Northern Territory government department, who has responsibility for the day to day monitoring of the Ranger site, considered that the leak had caused no environmental harm and that it did not infringe the mining company's licence, no action was required and that no change in the monitoring arrangements was necessary – a very different response from that of the Supervising Scientist.

Subsequent to the report the Minister of Environment and Heritage issued a press release on 27 June 2000. The Minister stated that the Australian Government was concerned that the report identified a breach of the Environmental Requirements by ERA and endorsed the Supervising Scientist's recommendations, stating that action would be taken to extend the statutory environmental monitoring programme to provide additional early warning capability.

In a press release dated 27 June 2000, the Minister of Industry, Science and Resources, responsible for the mining and processing of uranium ore, stated that the Government accepted the 17 recommendations in the Supervising Scientist's report and will be adopting a roots and branches appraisal of the system to make sure it is meeting today's requirements. The Minister also referred the report to the Northern Territory Minister for Resource Development and stated that he would be working with him to achieve solid outcomes.

In a statement tabling the Supervising Scientist's report on the leak the Minister indicated that the Commonwealth would be initiating actions that would strengthen the role of the Supervising Scientist through changes in the Working Arrangements between the

Commonwealth and the Northern Territory. The ISP saw this increased and strengthened role of the Supervising Scientist as a very positive outcome but sought also to establish its relevance to the Jabiluka site.

The implementation of the recommendations in the Supervising Scientist's report [Ref. 20] and their application to either Ranger or Jabiluka requires no further legal process in that the Environment Protection [Alligator Rivers Region] Act 1978 enables the Supervising Scientist to carry out routine environmental monitoring. This had not been done in the past because an agreement between the Northern Territory and the Commonwealth governments required that the operator [the mining company] should undertake the routine monitoring specified by the Northern Territory who would ascertain compliance by check monitoring. The role of the Supervising Scientist's Office was to agree the monitoring arrangements with the Northern Territory and conduct research to improve monitoring protocols. The leak at Ranger has demonstrated the unsatisfactory nature of this arrangement. The ISP has been informed that the implementation of the recommendations in the Supervising Scientist's report and the strengthening of the Supervising Scientist's role in monitoring is under active discussion at present. The Northern Territory Department apparently wishes to retain its position as regulator and **it will be crucial that any future arrangement between the Department, the Supervising Scientist and the mining company is transparent to all and ensures monitoring standards to world 'best practice' for Jabiluka and Range**r.

The role of the Northern Territory Department in the monitoring procedure was not previously fully appreciated by the ISP and only emerged during the course of its visit. Retrospectively it is a pity that no discussions had been arranged with representatives from the Northern Territory government.

During their visit the ISP were privileged to meet Jacqui Katona representing the Gundjehmi Aboriginal Corporation. She expressed the concerns of the traditional owners regarding the leak at Ranger and on activities on the Jabiluka site in general. Once the traditional owners had learned of the leak they had stopped taking water from the creek and harvesting food in the area. They felt that they had had no independent scientific advice to draw upon and were in effect excluded from the discussions. There had been meetings with the Supervising Scientist but the level of trust was not high. Nevertheless she supported suggestions that the role of the Supervising Scientist should be strengthened and extended, possibly to include a cultural dimension. **The ISP considers that it is crucially important for the future of Jabiluka that the traditional owners have a role in future monitoring arrangements. They have much relevant local knowledge to contribute.**

The ISP fully supports all the recommendations in the Supervising Scientist's report on the leak at the Ranger mine where they are relevant to the Jabiluka site. The ISP would wish the Australian government to put the new monitoring arrangements with respect to the Jabiluka site in place without delay, to make these known in advance of the next meeting of the World Heritage Committee in Cairns and to report formally on these to the meeting.

7.2 Stand-by and Environmental Management Phase

In May 2000 UNESCO World Heritage Committee provided the ISP with copies of letters between the Gundjhemi Aboriginal Corporation and the Australian authorities concerning the Interim Water Management Pond at the Jabiluka site. The issue raised by the Corporation was that the pond had been designed and constructed with an operating capacity of 168 000 m3 to contain water from the Total Containment Zone with a probability of failure of 1 in 10 000 but with a pond life of only one year. A delay in the decision to proceed with mining at Jabiluka and moving it into a stand-by mode, possibly for several years, means that the water management arrangements are now under capacity. To meet this concern a number of options were being considered by the mining company and the Australian authorities. These included an increase in pond size, treatment of any excess water by reverse osmosis and irrigation using the treated water, removal of water by truck for treatment/disposal elsewhere etc. In view of the possible impacts of such measures on the natural values of the Park, the ISP specifically requested the Supervising Scientist to provide information during the visit on progress with the stand-by water management arrangements at Jabiluka. Briefing sessions on the stand-by arrangements were provided by the Supervising Scientist during the ISP visit but at that time the proposals were not fully developed. Further information was provided by the Supervising Scientist to the ISP in late August 2000. In discussion with the ISP the representative of the Gundjhemi Aboriginal Corporation, Jacqui Katona, expressed the concerns of the traditional owners that the stand-by phase at Jabiluka could persist indefinitely. Consequently the ISP sought advice on whether there was any legal provision which required the mining company to either develop the mine or commence rehabilitation within a specific time frame.

Our understanding of the position at the Jabiluka site under the stand-by phase is as follows: The Jabiluka Mineral Lease was granted under Northern Territory legislation in 1982 for a period of 42 years and there is currently no legal requirement which would prevent the mining company from continuing to manage the site on a stand-by and environmental management basis until it is required to begin rehabilitation works which would need to commence about 5 years before the end of the lease period. Thus, in principle, it would appear that the mine could be in stand-by mode for up to 20 years. However the Supervising Scientist has indicated that, should further developments at Jabiluka be delayed for a protracted period or, if the mining company propose to mothball the site, the Supervising Scientist would consider what arrangements would be necessary to ensure that the site continues to pose no significant threat to the World Heritage property. Options that the Supervising Scientist would consider include re-vegetation of the waste rock stockpiles, emplacement of the mineralised material stockpile in the decline, sealing of the decline and decommissioning the water management facilities. During any mothballing period best practice environmental monitoring would be undertaken and this would involve the Supervising Scientist.

The ISP found this to be a satisfactory response but were uncertain as to what constituted a 'protracted period of time'. The Panel would recommend that an assessment of a rehabilitation programme of the type suggested by the Supervising Scientist should be formally addressed and reported on every five years.

Turning to the Interim Water Management Pond arrangements at Jabiluka , the option favoured by the mining company during the ISP visit was to treat any water which could not be

accommodated within the retention pond by reverse osmosis and then to irrigate within the fenced area of the site outside the Total Containment Zone with the treated water. At that time the Supervising Scientist had not seen the detailed proposals from the mining company and, while expressing the view that it was an option worth serious consideration, he reserved his position.

In late August 2000 the ISP were provided with additional information on the water management arrangements during the stand-by phase. A trial of a reverse osmosis plant using water from the Interim Water Management pond had been undertaken. The trial proved successful, producing a very low ion content in the treated water; the average and maximum concentration of uranium being less than 0.9 and 1.4 μg/l, respectively.

If the system were to be introduced any leakage from the plant would be returned to the retention pond. The plant outputs would be continuously monitored and if trigger levels of ion concentration were exceeded an alarm would be set off and the plant shut down. Replacement of any component could be made within 2 weeks and in the event of a prolonged failure of operation surplus water would be diverted and stored in the decline.

The treated water would be irrigated on to 3.6 ha within the fenced area of the site. During the dry season the system would operate so that there was no surface runoff of the irrigated water into surface water- courses. If irrigation was required during the wet season it would mix with rainfall and small quantities might enter water- courses but flow rates would be very low compared with the natural flow in surface water- courses and impacts should be negligible. However there would be an extensive monitoring of plant performance and of groundwater and surface water- courses to check for changes to the natural regime

On the basis of these proposals from the mining company, the trials undertaken, the contingency measures and the rigorous environmental monitoring scheme, the Supervising Scientist concluded that the operation of a reverse osmosis treatment linked to an irrigation system posed a negligible threat to the natural values of the Kakadu National Park and has therefore approved its implementation. **The ISP accepts the approach adopted on the understanding that the monitoring is rigorous and the longer- term performance is subject to some independent scrutiny [see section 8.2].**

7.3 Leakage from Old Mine Workings

Prior to its July visit the ISP's attention was drawn to a press report of a leakage of contaminated water from an old mining activity in the Park. In view of the possible relevance of this to the Jabiluka site the ISP obtained a briefing on the Supervising Scientist's activities in assisting in research issues associated with old mine sites and other environmental problems in the Park. The Panel was pleased to note that the Office of the Supervising Scientist has implemented an environmental surveillance programme in the South Alligator River valley within the southern region of the National Park. It was clear from the Panel's meeting with the Park Managers that they fully supported this programme and worked closely with the Office in its implementation [see section 2.2].

Several small uranium mines operated in the South Alligator River valley during the 1950s and '60s. At that time, unlike the present, comprehensive rehabilitation requirements were not in place. Remedial work was undertaken in 1991 to reduce the physical and radiological hazards associated with the sites and the Office of the Supervising Scientist has inspected these annually. *eriss* has also carried out a wide- ranging freshwater biological monitoring programme. Specific investigations have recently been made by the Supervising Scientist into the radiological status of exposed tailings at an old mine near Gunlom Road and an assessment has been made of options to rehabilitate an adit in Rockhole Mine Creek which has a small discharge of acidic water. Reports on these investigations were provided to the ISP.

The Supervising Scientist, as well as undertaking detailed investigations and studies of the type described above, also participates more generally in the planning process co-ordinated by the Park Managers to rehabilitate the historic mining sites so as to meet the expectations of stakeholders, including those of the traditional owners. **The ISP concluded that the relevance of this work to Jabiluka was that it demonstrated the Supervising Scientist's long involvement in monitoring and addressing problems from uranium mining in the area. As a result the Office of the Supervising Scientist is well placed to assess the possible risks to the environment arising from any new mining proposals and has the experience to put in place a comprehensive monitoring programme to detect any adverse changes and to act accordingly.**

8. Administration, Management and a Science Advisory Committee

8.1 The Office of the Supervising Scientist

During the course of its visit the ISP was particularly impressed by the Supervising Scientist's depth of knowledge over the wide range of issues discussed. The Panel also found the quality of the Office's staff and the scientists in *eriss* whom they met to be high. However the number of Office staff appears to be small in relation to their range of responsibilities and, in particular, as new proposals relating to activities at Ranger and especially at Jabiluka have to be so carefully assessed prior to acceptance or rejection. The Panel understood that there is to be an increase staff numbers and this must be welcomed.

The Jabiluka proposals require experience of a wide range of scientific and engineering disciplines. The Supervising Scientist has called upon some of the best specialists in Australia to provide advice in areas where the particular skills did not lie 'in house'. This was not considered to be necessary in the case of most of the ecological studies in that the Supervising Scientist could turn to *eriss*. Looking to the future, the water resource management design and, if the mine proceeds, the operational issues associated with water will be of considerable importance and will require input on a day to day basis. **It was noted that the mining company has a small team of water resource specialists operating within their laboratory but they appear to have no counterparts within the Office of the Supervising Scientist. The ISP considers that, if this is the case, it is a lacuna that needs to be filled.**

The ISP were also concerned that the Supervising Scientist did not have a designated manager for either the Ranger or Jabiluka projects. All enquires and issues were channelled through the Supervising Scientist. While, as indicated above, the ISP was impressed with his

depth of knowledge over a wide range of issues, it was considered that there was, and will be, the need for a Jabiluka Project Manager with day to day responsibility for the site. This will be particularly important when the role of the Office of the Supervising Scientist with respect to the on-site monitoring is broadened following the recommendations made by the Supervising Scientist in his report following the leak at the Ranger mine. If possible **the ISP would wish to receive details of any new OSS management arrangements for Jabiluka before the meeting of the World Heritage Committee at Cairns.**

8.2 The Need for an Independent Science Advisory Committee

The ISP was provided with a comprehensive listing of the environmental Recommendations and Requirements on the mining company arising from the 1997 Jabiluka Environmental Impact Statement. These clearly need to be revised as new designs and operational procedures are introduced. The Supervising Scientist, in his response [Ref. 5] to the ISP Report [Ref. 4], describes the revision and review procedures. Environmental Performance Reviews are held every six months on specific topics. In parallel with these the Mine Site Technical Committee, comprising the Supervising Scientist and representatives from the Northern Territory Department of Mines & Energy, the Northern Land Council and the mine operator also meets and assesses current issues.

These review arrangements are supported by the ISP and should continue but they lack transparency and a fully independent perspective. It is noteworthy that a number of senior Australian scientists, for example Professors Wasson and White [Ref. 2] and others, have raised issues that led to a reappraisal of some of the Jabiluka design procedures and monitoring approaches. Such independent but informal inputs are seen by the ISP and by IUCN [Appendix 4] as being very positive in terms of ensuring that world best practice is applied to protecting the natural values of the World Heritage Site. However the ISP and IUCN consider that such important interventions should not be left to chance. **It is recommended that an Independent Science Advisory Committee of possibly no more than seven members should be established.** The members should be independent scientists and engineers specialising in fields relevant to the Jabiluka activity and environmental protection. They should be mainly from Australia but the inclusion of one or two international scientists may be appropriate. The Supervising Scientist would be a member *de facto* and there should also be a scientist representing the traditional owners. The Chairman should be selected from the Australian members. Membership should be restricted to 3 or 4 years so that new members with fresh ideas are introduced. The Advisory Committee would review the previous year's activities and comment on proposals for the future. It would normally meet annually but could be called upon at short notice to advise on any major issues that arose. **The Committee's terms of reference, membership, secretarial support etc would need to be agreed between the Australian government and the World Heritage Committee. Its essential feature would be its independence and its ability to report freely.**

9. Conclusions and Recommendations

9.1 The visit to Kakadu, the additional information provided in papers, reports and other publications and the extensive discussions, have given the ISP a much more detailed insight than formerly into the scientific and other issues associated with the proposed Jabiluka uranium mine and its potential to impact on the natural values of the Kakadu World Heritage

site. The ISP is now in a position to make its final assessment of the risks of the mining activity in relation to the Jabiluka Mill Alternative [JMA], as presented in the Supervising Scientist's Report [Ref. 3].

9.2 The first ISP report [Ref. 4] offered 17 recommendations and the Supervising Scientist has responded to these [Ref. 5]. They were also discussed systematically during the ISP's visit. The present report has considered the current status of each of these recommendations and this status is summarised in *9.2 (a)* to *(h) below.*

*9.2 (a)*The ISP finds for the following 10 of its 17 recommendations that the recommendation has been met, or additional information has been provided which removes the ISP's former uncertainties:

Recommendation
1 [see 3.1 Rainfall Records]
2 [3.2 Meteorological Measurements]
3 [3.3 Climate Change]
4 [3.4 Runoff Coefficients]
6 [4.1 Public Exposure Radiation Model]
9 [5.1 Isotope Measurements]
10 [5.2 Monte Carlo Simulations & 10 000 yr analyses]
11 [5.3 Mathematical Modelling & Cement/Water/Rock Interactions]
12 [5.2 Monte Carlo Simulations & 10 000 yr analyses]
16 [6.4 Rehabilitation Fund]

9.2 (b) Concerning Recommendation 5 [see 3.5 Water Management Arrangements] the ISP were uncertain initially about the proposed water management arrangements and sought clarification. Additional information, including schematic flow diagrams, was presented during the visit. Two main points emerged from discussions on this information as follows:

Firstly, the delay in proceeding with the mining activity at Jabiluka has enabled both the mining company and the Supervising Scientist to consider new designs and management arrangements that could lead to a reduction of potential impacts on the natural values of the Park e.g. by covering the ore stockpiles. This approach, in seeking to improve the system from an environmental viewpoint, is welcomed by the ISP. However new arrangements for the water management system may be proposed which differ from the approved scheme. **The ISP would wish to have assurance that any new proposals for the water management system or any other major changes to the JMA are fully discussed with the stakeholder groups at an early stage and are subject to a rigorous environmental assessment and independent review prior to their approval by the Supervising Scientist.**

Secondly, the Supervising Scientist has stated, on the basis of simplifying assumptions, that there will be no build up of contaminants as a result of evaporation from the retention ponds. **The ISP recommends that a contaminant simulation study of the water management system of the approved JMA should be undertaken now and for any amended proposals once submitted. Design flow arrangements should be adjusted if necessary.**

9.2 (c) The ISP's Recommendation 7 [see 4.2 Biological Recycling], while recognising that accidental discharge of the retained water would be a very rare event, considered that the approach by the Supervising Scientist of using surrogate species to assess the impact on aquatic animals should be extended to include consideration of biological recycling. Following detailed discussions the ISP now accepts that direct exposure to radiological and chemical contaminants would be the dominant risk and that this risk is very small. However **the ISP would still wish to see the effects of biological recycling of contaminated material in the aquatic ecosystem investigated but within a wider context as described under *9.2 (g)* below.**

9.2 (d) The ISP's Recommendation 8 [see 4.3 Partitioning of Retention Ponds] reinforced a similar proposal from the Supervising Scientist. However **the existing 3 ha pond is not partitioned and the Supervising Scientist may wish to consider such a partitioning as a maintenance or safety measure.**

9.2 (e) The ISP's Recommendation 13 [see 6.1 Sediments] sought assurance that the problems relating to sediment production, transport and control had been addressed. Field measurements and analysis show that the impact of future mining within the JMA Activity would be very small. The low concentrations predicted could be greatly reduced by the planned provision of sediment traps. However **the ISP noted that much of the data used in the analysis had been drawn from other sites and, while accepting this approach at the design stage, would encourage the Supervising Scientist to continue the stream sediment analysis on Swift Creek, link this to aquatic ecological studies and establish erosion plots on the Jabiluka site with some urgency.**

9.2 (f) **The ISP's Recommendation 14 [see 6.2 A Mine Life of 40, 50, 60 Years] still stands. This extension of the risk assessment should be commenced without delay for the approved JMA. It should also be applied to any amended proposals once submitted.**

9.2 (g) The ISP's Recommendation 15 [see 6.3 Risk Assessment on the Landscape/ Catchment Scale] sought a more comprehensive risk assessment . After discussion the Panel concludes that the risks to the World Heritage values as a result of a carefully designed, operated and monitored JMA are minimal. Nevertheless the region and the site are, and will possibly continue to be, subject to major changes unrelated to mining. There may also be unforeseen problems arising from the mining, although at present this seems unlikely. **The ISP considers it would be prudent and necessary to put landscape and ecosystem analyses in place. In parallel with such analyses a survey and monitoring programme should be established by the Supervising Scientist immediately. The survey of the flora and fauna of the lease site , the surrounding Park area and the flood plain should pay particular attention to the occurrence of any rare/endangered endemic species and any potential threats to them. The survey would require the full co-operation of the traditional owners and the managers of the lease. Hopefully several years of data can be collected and analysed before any further mining activity begins. This would enable the effects of mining-related activity to be distinguished from those due to other causes.**

9.2 (h) Recommendation 17 [see 6.5 Long-term Monitoring] sought a commitment to the establishment of a long-term monitoring programme . The ISP recognises the problems the Australian government would face in making a firm commitment to respond to unforeseen circumstances in the distant future. However, in view of the unique value of the Kakadu World Heritage site, **the ISP would wish a strong statement of intent to be offered by the authorities so that a monitoring programme could be continued well beyond the time at which the mining company's obligations cease.**

9.3 With respect to the tailings water leak at Ranger [see 7.1] the ISP noted the concerns of the traditional land owners. Both ISP and ICSU consider it to be crucially important that the traditional owners have a role in future monitoring arrangements at Jabiluka. They have much relevant local knowledge to contribute. The ISP fully supports all of the recommendations in the Supervising Scientist's report on the leak at the Ranger mine in as far as they are relevant to Jabiluka. **They would wish the Australian government to put the new monitoring arrangements for Jabiluka in place without delay, to make these known in advance of the World Heritage Committee's meeting in Cairns and to report formally on these to this meeting.**

9.4 With respect to the interim water management arrangements [see 7.2] the traditional owners expressed concern that the stand-by phase could persist indefinitely. The Supervising Scientist has indicated that, should further development at Jabiluka be delayed for a protracted period, arrangements would be necessary to ensure that the site continues to pose no threat to the World Heritage site and that such arrangements may involve rehabilitation measures. The ISP found this to be a satisfactory response but were uncertain as what was meant by 'a protracted period'. **The ISP recommend that an appropriate assessment be made every five years and formally reported on by the Supervising Scientist.**

To cater for an increased likelihood of overtopping of the 3 ha retention pond and following a recent successful trial the Supervising Scientist has approved the use of a reverse osmosis treatment plant and irrigation within the fenced site with the treated water. **The ISP accepts this approach on the understanding that monitoring is rigorous and longer-termperformance is subject to independent scrutiny.**

9.5 The ISP noted the wide-ranging monitoring programmes and advice on the rehabilitation of old uranium mines that the Office of the Supervising Scientist [OSS] had provided to the Park Managers [see 7.3 Leakage from Old Mine Workings]. The Office thus has very relevant experience which may be used to assess the risks from new mining proposals, to put monitoring programmes to detect change in place and to respond accordingly.

9.6 The ISP found the quality of the staff of the OSS and *eriss* to be very high [see 8.1 The Office of the Supervising Scientist]. **However the ISP would recommend that within the OSS there should be:**
(I) a designated project manager for Jabiluka;
(ii) an in-house specialism in water resource management.

9.7 The present review arrangements are supported by the ISP however they lack transparency and a fully independent perspective [see 8.2 The Need for an Independent Science Advisory

Committee]. **The ISP recommends that in addition to the present arrangements an Independent Science Advisory Committee be established to review progress annually and advise on new proposals.**

9.8 Overall the ISP considers that the Supervising Scientist has identified all the principal risks to the natural values of the Kakadu World Heritage site that can presently be perceived to result from the Jabiluka Mill Alternative proposal. These risks have been analysed in detail and have been quantified with a high level of scientific certainty. Such analyses have shown the risks to be very small or negligible and that the development of the JMA should not threaten the natural World Heritage values of the Kakadu National Park. However the region is subject to major seasonal or long-term changes which are unrelated to mining activity. Further, although presently appearing unlikely, there may be unexpected impacts due to mining. Consequently a comprehensive monitoring programme and supporting analyses of the environmental systems at the local and regional scale are necessary so that any impacts due to mining can be distinguished from those due to other causes. **Such a programme will involve several years of data collection and analysis but could run in parallel with the JMA.**

The establishment of an Independent Science Advisory Committee would introduce a wider perspective into the review framework providing an essential element in protecting the natural values of the Kakadu World Heritage site into the future.

ACKNOWLEDGEMENTS

The members of ISP wish to thank Dr Anne Larigauderie of ICSU and Dr Sarah Titchen, WHC UNESCO, for the help and information they have provided during the course of their work.

References

1. Anon, (1998) *Report on the Mission to Kakadu National Park, Australia 26 October to 1 November 1998*, presented to the Bureau of the World Heritage Committee 27-28 November 1998 WHC – 99/CONF. 205/INF.3A

2. Wasson, R., White, I., Mackey, B. & Fleming, M. (1998) *The Jabiluka Project, Environmental issues that threaten Kakadu National Park* – submission to UNESCO World Heritage Committee delegation to Australia.

3. Anon (1999) *Assessment of the Jabiluka Project* – report of the Supervising Scientist to the World Heritage Committee- Environment Australia WHC – 99/CONF. 205/INF. 3C

4. Likens, G.E., Plant, J.A., Rodda, J.C. & Wilkinson, W.B. (1999) *Review of an Independent Scientific Panel of the scientific issues associated with the proposed mining of uranium at Jabiluka in relation to the state of conservation of the Kakadu National Park* – review by a panel established by the ICSU WHC – 99/CONF. 205/INF.3E

5. Anon (1999) *Supervising Scientist's Response to the ICSU Review of the Supervising Scientist's Report to the World Heritage Committee, Environment Australia* WHC – 99/CONF. 205/INF. 3F

6. Likens, G.E., Plant, J.A., Rodda, J.C. & Wilkinson, W.B. (2000) *Independent Science Panel, 2nd Phase assessment of the scientific issues associated with the proposed mining of uranium at Jabiluka in relation to Kakadu National Park* – preliminary report to the World Heritage Committee June 2000

7. Sevruk, B. (1982) *Methods of correction for the systematic error in rainfall measurement for operational use.* Operational Hydrology Report No. 21, WMO Geneva

8. Sevruk, B. (1989) *Wind induced measurement error for high intensity rain.* Precipitation Measurement WMO/AHS/ETH Workshop on Precipitation Measurement, St Moritz, 3-7 December 1989

9. Jones, R.N., Hennessy, K.J. & Abbs, D.J. (1999) *Climate change analysis relevant to Jabiluka.* Report from CSIRO Atmospheric Research included as Attachment C in the Assessment of the Jabiluka Project – Report by the Supervising Scientist to the WHC Environment Australia.

10. Martin, P. (1999) *A radiation exposure assessment for the release of water to Swift Creek from the proposed Jabiluka retention pond.* Supervising Scientist's Internal Report 318 - Environment Australia

11. Anon (1998) *WHO Guidelines for Drinking Water Quality, 2nd edn. Addendum to Volume 1 Recommendations* WHO Geneva

12. Johnston, A. & Needham, S. (1999) *Protection of the environment near the Ranger uranium Mine* - included as Attachment A in the Assessment of the Jabiluka Project – Report by the Supervising Scientist to the WHC - Environment Australia.

13. Harris, G. (1999) *A landscape scale analysis of the potential impacts of the Jabiluka mine.* Report by CSIRO included as Appendix 4 in the Response to the ICSU Review of the Supervising Scientist's Report to the WHC - Environment Australia.

14. Kalk, F.R.P. & Dudgeon, C.R. (1999) *Analysis of the long-term groundwater dispersal of contaminants from the proposed Jabiluka mine tailings repository.* included as Attachment E in the Assessment of the Jabiluka Project – Report by the Supervising Scientist to the WHC - Environment Australia.

15. Evans, K.G., Saynor, M.J. & Willgoose, G.R. (1998) *Changes in Hydrology, sediment loss and microtopography of a vegetated mine waste dump impacted by fire.* Land Degrad. Develop. **10** 507-522

16. Evans, K.G. (2000) *Methods for assessing mine site rehabilitation design for erosion impact.* Aust. J. Soil Res. 2000, **38**, 231-247

17. Evans, K.G., Saynor, M.J., Moliere, D.R. Prendergast, J. B. & Erskine, W.D. (2000) *Assessment of the environmental impacts of Jabiluka mine waste rock dump erosion on Swift Creek.* Unpublished report

18. Stockton, D., Daniell, M., Knight, J. & Walton, C. (2000) *Ranger uranium mine: amended plan of rehabilitation.* Unpublished report by EWL Sciences Pby Ltd for ERA Ranger Mine

19. Anon (2000) *Australia's commitments: Protecting Kakdu.* Progress report to the Bureau of the World Heritage Committee, 15 April 2000 – Government of Australia

20. Anon (2000) *Investigation of tailings water leak at the Ranger uranium mine.* Supervising Scientist's Report 153 - Environment Australia.

Annex 1

Composition of the Independent Science Panel

Phase 1

First ISP Report - 22 April to 13 May 1999

Professor Gene Likens – Director, Inst. of Ecosystem Studies,Box AB, Millbrook, New York 12545 USA

Professor Jane Plant – Assistant Director, British Geological Survey, Keyworth, Nottingham NG12 5CG UK

Dr John Rodda - President, International Association for Hydrological Science, Maclean Building, Institute of Hydrology, Wallingford, Oxfordshire UK

Professor Brian Wilkinson [Panel Leader] - Senior Consultant, Solutions to Environmental Problems [StEP], (formerly Director, Centre for Ecology & Hydrology),17-18 Union St, Ramsbury, Wiltshire SN8 2PR UK

Phase 2

Preliminary ISP Report on the Response of the Supervising Scientist -15 March to 15 April 2000

Professor Gene Likens
Professor J A Plant
Dr John Rodda
Professor Brian Wilkinson [Panel leader]

Field Visit - 3 to 7 July 2000

Dr Ben Klink British Geological Survey [representing Prof. Plant]

Professor Roger Green, University of Western Ontario, London, Ontario N6A 5B7, Canada

Prof. Brian Wilkinson [Panel leader]
[Dr Pierre Horwitz – Director, Centre for Ecosystem Management, Edith Cowan University, 100 Joondalup Drive, Western Australia representing the World Conservation Union (IUCN)]

Final ISP Report - 7 July to 18 September 2000

Dr Ben Klink & Prof. Jane Plant
Prof. Roger Green
Dr John Rodda
Prof. Brian Wilkinson

Annex 2 Terms of Reference

Preamble

Following the decision of the twenty-second session of the World Heritage Committee in Kyoto, Japan in December 1998, the third extraordinary session of the Committee was held at UNESCO Headquarters in Paris on 12 July 1999.

A list of the documents and reports presented to, and examined by, the third extraordinary session of the World Heritage Committee is contained in Annex I.

The purpose of the extraordinary session was to "decide whether to immediately inscribe Kakadu National Park [Australia] on the List of World Heritage in Danger" as a result of the development of a uranium mine within the Jabiluka Mineral Lease located in an enclave of the World Heritage property. Whilst the Committee decided not to inscribe the property on the List of World Heritage in Danger it adopted a lengthy decision. The full decision of the extraordinary session of the Committee is annexed to these Terms of Reference (see Annex II).

In summary, the extraordinary session of the Committee requested follow-up cultural heritage conservation work by the Australian authorities and asked for additional scientific work. The Committee's decision states that:

> "To resolve the remaining scientific issues, such as those raised in the [Independent Scientific Panel] ISP report [WHC-CONF.205/INF.3E], the Committee asks ICSU to continue the work of the ISP (with the addition of any additional members) to assess, in co-operation with the Supervising Scientist and IUCN, the Supervising Scientist's response to the ISP report [WHC-CONF.205/INF.3F]. The report of the ISP's assessment should be submitted to the World Heritage Centre by 15 April 2000 for examination by the twenty-fourth session of the Bureau of the World Heritage Committee in 2000."

The Report of the Rapporteur of the third extraordinary session of the Committee is available in English and French on the World Heritage Centre's web site at http://www.unesco.org/whc/archive/repcom99x.htm.

Objective

The overall objective is for the ISP of ICSU to provide a written assessment of the June 1999 response by the Australian Supervising Scientist **(hereafter "ASS Report 2")** to the ISP report of May 1999 **(hereafter "ISP Report 1")**. The assessment is to be based on the assumption that the processes concerning mining, milling and waste storage are being undertaken at the Jabiluka site (this was the assumption made in ISP Report 1). The ISP's work will assist the World Heritage Committee in resolving the remaining scientific issues relating to the uranium mine, mill and underground storage of tailings at Jabiluka and any potential for impact on the World Heritage values of Kakadu National Park, Australia from the mine, mill and storage of tailings.

Method

In the context of the decision of the third extraordinary session of the World Heritage Committee (UNESCO Headquarters, Paris 12 July 1999) and being cognisant of the need to

proceed on the basis of the Precautionary Principle, the ISP of ICSU will:

1. note and analyse ASS Report 2 and assess whether that review contains new information, analyses and/or a change in the level of certainty of the science used to assess the impact of the uranium mine, mill and underground storage of tailings at Jabiluka on the World Heritage values of Kakadu;

2. following the analysis referred to in point 1. above, submit a succinct Progress Report (to include an executive summary) to the Director of the UNESCO World Heritage Centre by 15 April 2000 for presentation to the twenty-third session of the Bureau and the Committee (UNESCO Headquarters, 26 June to 1 July 2000). This report will be known as the **ISP Report 2**;

3. supplement the analysis referred to in point 1. above by an on-site inspection (to take place from 3 to 7 July 2000) and discussions between representatives of the ISP, the Supervising Scientist and IUCN. The ISP will operate in a fully independent and objective manner and consequently may seek other relevant technical and scientific information as they deem necessary;

4. submit a succinct and comprehensive Final Report (to include an executive summary) to the Director of the UNESCO World Heritage Centre by 15 September 2000 for examination by the twenty-fourth extraordinary session of the Bureau of the World Heritage Committee (Cairns, Australia 23 and 24 November 2000) and the twenty-fourth session of the World Heritage Committee (27 November to 2 December 2000). This report will be known as the **ISP Report 3**;

5. be represented by the leader of the ISP at the twenty-fourth sessions of the World Heritage Committee and its Bureau in 2000 to allow the ISP to have the opportunity to justify the positions taken by the ISP in their written analyses.

Note: In order that the ISP deliberations may be as thorough, effective and conclusive as possible, it will be necessary for the ISP of ICSU to be kept informed by the Australian government (by communicating through the UNESCO World Heritage Centre) of any new information relating to activities at Ranger and Jabiluka that may be relevant to the ISP analyses. The "more precise details of the output and scale of any parallel activities at the Ranger and Jabiluka uranium mines as well as on any legal provisions taken in that respect" to be provided by the Australian government by 15 April 2000 (see 3(c) of the Committee decision in Annex II), will be important information in this respect.

Annex 3

Timetable for visit by ISP to Kakadu

Monday 3/7/00

8:30 – 9:30	Flight from Darwin to Jabiru East (2*ISP, 1*IUCN, AZ) Prof. Wilkinson, Dr Klinck, Dr Horwitz
9:30-10:00	Briefing for ISP and consultants for flight over Kakadu (BP)
10:00–12:00	Fixed wing flight from Jabiru over the region, including the world heritage area, to obtain an aerial perspective. Flight over the world heritage area will be in 3 Cessna aircraft and segments will include: • Trip from Jabiru airport to Ranger, to Magela Creek and along Magela Ck to the Magela floodplain, • Flight to the East Alligator River within sight of the ocean, then back to the South Alligator floodplain, and on to Cooinda • Fly from Cooinda on to mines in the South Alligator Valley. • Fly back along the escarpment to Ranger, then along Swift creek/ haul road to Jabiluka, • Return to Jabiru East.
12:00–1:00	Lunch at ***eriss***
1:00–3:00	Meeting between ISP, Bob Wasson, Ian White and the Supervising Scientist
3:15–3:30	Afternoon tea
3:30–5:00	Introduction at ***eriss*** on the Ranger Mine (AJ). Main features of Ranger site, particularly environment protection features, will be pointed out prior to a site visit (A Jackson/Mal Wedd).
5:00	Jabiru East to Jabiru accommodation, ISP/IUCN will be issued with car.

Tuesday 4/7/00

8:30–10:00	Pickup from ***eriss*** by bus. Guided tour by ERA around Ranger and the spill site. SS staff will be present for consultation.
10:00–12:30	ERA Training Room Discussion on the history of environmental protection at Ranger – Brief presentation by SS and outline of SSR 139 – Questions from ISP re the history of environmental protection at Ranger – Brief presentation by ERA (Andrew Jackson/Mal Wedd) on recent leak of process water. – Brief presentation on SS report on the leak. (The report will be sent to

ISP members before the visit.)

- Discussion on Leak

12:30–1:30 Working lunch at Ranger with introduction to Jabiluka.

Description of Jabiluka site including water, tailings and waste rock management. Issues related to water consumption, water quality and the pond will be discussed, as will some of the options related to the JMA. (Andrew and Peter Lloyd, ERA)

1:30–5:30 Jabiluka site inspection

- Drive from Jabiru to Jabiluka
- Inspection of surface facilities and discussion of proposed layout including mill, pond, waste rock dumps etc
- Inspection of the decline by bus
- Walk from site to Swift Creek and along Creek to Oenpelli Road
- Pickup on Oenpelli Rd and travel to Ubirr for view of sunset

Wednesday 5/7 Prof. Green joined the ISP

8:00–12:00 Discussion on general issues related to Jabiluka

- Requirements arising from the EIS/PER process and from the SS report and ISP response (DISR)
-
- Discussion of issues raised by the ISP in its report No 2 (lead by SS), but excluding those relating to groundwater, waste rock erosion and ecological risk assessment (these to be covered on Weds & Thurs).
- Discussion of issues related to rehabilitation and restitution at Jabiluka (DISR)

12:00–1:00 Lunch at ***eriss***

1:00–5:00 Discussion of groundwater issues related to Jabiluka.

- Overview by SS consultant on groundwater issues and summary of the response of SS and consultants in the June 1999 report of the SS.
- Discussion on groundwater issues raised by ISP

Thursday 6/7

8:00–12: 00 Waste Rock Dump erosion

- Presentation by SS staff on erosion issues including description of ***eriss*** erosion research program (landscape evolution modelling), the basis for estimates of sediment loss from the Jabiluka site to Swift Creek, and the comparison with existing sediment loads in Swift Creek and the Magela floodplain
- Outline of erosion minimisation strategies for Jabiluka waste rock dumps and other works (ERA)
- Discussion of issues raised by ISP

12:00–12:15 Travel to PAN

2:00–2:15 Meeting with Parks Australia North (Park Headquarters) and **Lunch**

2:15–2:30	Travel to *eriss* Visit to the eriss laboratories
2:30 - 3:00	Ecosystem risk assessment issues
~~3:00~~–5:30	– Approach adopted by SS (CH) – Ecosystem wide analysis (SS Consultant). – Discussion of issues raised by ISP. – Private discussion ISP with Jacqui Katona of Gundjehmi Aboriginal Corporation
7:30 - 8:30	
Friday 7/7	
8:00–12:00	Free time for ISP to prepare a summary of its position
12:00–~~12:30~~	Lunch at *eriss* Visit to the ERA laboratories
12:30 - 1:00	
1:00–4:00	Final meeting to discuss outstanding technical issues with the ISP. – ISP to summarise its current position – ISP and SS to agree on future action
4:00–6:30	Drive to Darwin
7:30 - 8:30	Discussion on stygiofauna with Dr Bill Humphries, Western Australian Museum

Annex 4

Final Report on the UNESCO Mission to Kakadu 3-7th July 2000

Final Report to the IUCN

Prepared by

Dr Pierre Horwitz

Director, Consortium for Ecosystem Health, Edith Cowan University

100 Joondalup Drive, Joondalup, WA, 6027

Contents

Introduction

My tasks, as I understood them, were to:

1. Work in cooperation with the ISP and the Supervising Scientist to consider the scientific concerns raised by the World Heritage Committee, so that the ISP can make a recommendation to the twenty-fourth session of the World Heritage Committee in Cairns.

2. Prepare a report for the IUCN covering:

- the current status of issues associated with Kakadu National Park
- adequacy of the measures developed to address the concerns raised at the extra ordinary World Heritage Committee meeting on 12th July 1999; and
- advise on what actions IUCN should take on this issue at the 2000 World Heritage Committee meeting.

In both tasks I was asked to provide comment particularly related to the adequacy of the water retention ponds at the Jabiluka mine site, and problems related to the recently reported leak of radioactive waters at the Ranger mine site.

My constraints, as I understood them, were to:

1. Consider the development only in the context of the impacts it might have on the World Heritage Area which *surrounds the Jabiluka lease site*.
2. Consider only *the scientific aspects* of the development and the impacts it might have on the *natural values* of the WHA.

I have interpreted my tasks and constraints to mean that I was to undertake:

• an examination of the natural values of the World Heritage Area which might be at risk from the development;

• an examination of the legal and administrative processes which have been set in place to act as a safety net to ameliorate, or preferably eliminate, the ecological impacts of the development on the World Heritage Area; and

• an examination of the reported leak from tailings pipe at Ranger as an example of the adequacy of response mechanisms to events likely to degrade World Heritage values surrounding the Jabiluka uranium mine.

Notes and Observations Relevant to Task

Overall Climate of the Mission

The mood of the five days 3rd - 7th July was one of open and frank, although often intense, discussions. My questions to ERA staff, available consultants, and staff of the Supervising Scientist were answered in a reasonable and timely manner. I cannot think of an occasion when I felt that information was being withheld from me. I was impressed by the Supervising Scientist's understandings of, and ability to articulate clearly, the full suite of issues under examination. I noted the absence of a member of the Northern Territory's Department of Mines and Energy, the regulatory authority for the proposed mine. With the exception of a meeting with Professors Wasson and White, I did not meet with NGOs or other independent scientists while on the Mission. I therefore sought alternative or confirmatory viewpoints after the Mission, in the process of compiling this report.

Overall Impression of the Australian Government's Position

At the risk of over-simplifying complex issues, my overall impression of the joint message delivered to the Mission by the Australian Government and ERA was along these lines:

1. The development site surface «footprint» could be seen as being relatively small compared to the overall size of the Jabiluka lease.
2. The Jabiluka lease area could be seen as being small compared to the large size of the Kakadu WHA.
3. The impacts of proposed activities at Jabiluka could be portrayed in such a way that they seem relatively insignificant compared to a variety of other threats to WHA values in the Kakadu National Park region.
4. The Jabiluka mine and mill site will be designed so that its effects on the surroundings could be seen as being relatively minor compared to the existing activities at Ranger.
5. The impacts of existing uranium mining at Ranger on the surrounding ecology as judged by Supervising Scientist could be seen as being insignificant.
6. The leak of contaminated water from the tailings pipe at Ranger, although commonly regarded as having technically breached two environmental requirements, could be seen as having an insignificant ecological impact on natural values.

These arguments cannot be upheld until the following qualifications are satisfied:

1. The ecological impacts can only be gauged fully when a clear and detailed statement of the natural values of both the Jabiluka lease site and its surroundings has been provided. This is necessary so that a sense of the special and priority values of the place which need to be protected from the development can be identified. In particular, the rare, endemic and/or endangered flora and fauna of the region, and the relictual/refugial habitat need careful consideration.

2. While the direct effects of contaminants on selected elements of the downstream flora and fauna are the subject of detailed investigations and monitoring exercises (see below), there is a more complex analysis of potential impacts required for this development which is mitigated by its location embedded within a World Heritage Area. In particular, the development needs to be seen in the light of whether it might exacerbate, or be confused with, other threats to the values of the World Heritage Area.

3. Two methods for evaluating the significance of impact were provided to the Mission by the Supervising Scientist in response to questions from the ISP. One method dealt with a statistical treatment of data, and the other a cross-tabulation between duration of impact and severity of impact. Neither method evaluates *significance* of ecological impact in the context of the likely response by the traditional owners in particular, or the public of Australia in general: there is therefore a third dimension (beyond duration and severity of impact), namely *perception of significance*.

4. While on-site and adjacent downstream monitoring seems adequate, a number of issues are not clear and in some cases the subject of on-going negotiations, *viz*: responsibility for decision-making relative to an event or a trend in monitoring data; judging the significance of an event or trend; or long-term post-close out events or monitoring. The legal and administrative arrangements for all of these issues need clarification to ensure the highest level of long-term protection and responsiveness is available for all natural values of the area.

5. The Independent Scientific Panel of the ICSU is also considering the steps taken to alleviate concerns relevant to these matters and will report separately.

Natural Values of the Area Surrounding the Jabiluka Lease Site

One of the original ISP Recommendations was:

15. A comprehensive risk assessment, including ecological, biogeochemical and hydrological factors, at the landscape/catchment scale for both Ranger and Jabiluka should be undertaken in the context of the World Heritage Area.

This recommendation is supported by Wasson *et al.* (1999):

The ecological and conservation value of the Jabiluka area has not been assessed by making comparisons with the Park as a whole. A complete risk assessment would have performed such an analysis. The risk to the conservation and World Heritage values of Kakadu arising from the mine is therefore unknown. (See also Wasson *et al*. 1998.)

The Supervising Scientist's Response (1999), and on the advice of Harris (1999), was:

... the risk to the World Heritage values of Kakadu National Park is very small provided that the waste rock dump is managed in a manner that protects the environment of Swift Creek.

It is acknowledged that impacts will be seen downstream of the mine site should a water borne contamination event occur. Evidence has been produced to demonstrate apparently minor ecological impacts on the downstream species and habitats which occur in the lower Swift Creek floodplains and the Magela Creek floodplains, because, it has been

argued, most aquatic species are relatively recent arrivals (over the last 3000 years) which have broad distributions in these types of habitat.

However, the Mission was also presented with evidence to suggest that endemic, rare and/or endangered species of flora and fauna, and relictual and refugial habitats may occur in the vicinity of the development area, and/or in the region likely to be influenced directly or indirectly, downstream or upstream, by the development activity. Examples given included a species of skink, several species of macro-crustaceans, and special characteristics of the biota found in permanently moist gullies or other such habitats. These observations are supported by comments made by Humphrey (1999).

In addition, during discussions it emerged that the area may contain groundwater fauna in the fissures and fractures of the rock at depth, and that, if found, such faunae would be likely to be endemic. These habitats have not been the subject of surveys in and around the lease site.

Indeed, discussions with ERISS staff have indicated that a full and proper survey of the flora and fauna of the lease area and its surroundings has not been conducted. *Consistent with the precautionary principle, it is inappropriate to argue that the risk to the World Heritage values is very small because the nature of those values has not been documented, and the susceptibility of those values to all aspects of the development is yet to be the subject of an analysis. Due diligence, therefore, is to set the context of the development, and the lease site, within the breadth of natural values of the region which management seeks to protect.*

Recommendation 1

Conduct, with the full consent and consultation of traditional owners of the area and where appropriate the managers of the Jabiluka lease, a survey of the flora and fauna of the local area in and surrounding the lease site, paying particular attention to the potential for the occurrence of rare and endangered, or endemic species, and refugial or relictual habitats likely to contain such natural values. Where such elements are located, an analysis of the degree of threat posed to them as a result of all aspects of the development proposed for the region, should be instigated. In keeping with best practice, such surveys will give baseline data and ideally would be conducted before further development on-site.

Furthering the matter of an ecological risk assessment, substantial documentation, and discussions during the Mission, have covered the nature of primary impacts. These risks occur where a contaminant might directly affect, for instance, the continuing survival of a species. These risks can be distinguished from secondary impacts, and cumulative or interactive impacts, where the effects of the development might be felt through more indirect means.

Examples of secondary, cumulative or interactive effects potentially related to the proposed development could include:

- the effects of weed dispersal transmitted via the mine site to establish and proliferate outside the lease, or
- the introduction of diseases with weed species or feral animals which might affect local native species outside the lease site, or

- the effects of a new water body in the Swift Creek catchment which might attract winged biota and act as a sink for their populations; or
- the effects of airborne dust from the mine site which might change the behaviour of key pollinator species outside the lease site, or
- the effects of spray irrigation which may allow for the establishment and/or proliferation of invertebrate or plant species hitherto unseen in the area (which may themselves provide a food source for particular native species which thereby become locally more abundant than previously known, with flow on effects through the food web); or
- the build up of biomass in sprayed irrigation areas causing trophic shifts and cascades outside the lease area, or
- the combined effects of a build up in sediment in a tributary creek from the waste rock pile, with altered water chemistry as a result a changed fire regime on the lease site and adjacent to it;
- and so on.

These sorts of examples acknowledge the ecological truism that a regional development of any sort like the one proposed here will result in changed conditions on the lease site, and that these changed conditions will be mediated beyond the lease site by species and influences which do not recognise political boundaries. These indirect effects may seem minor but together might cause a significant impact on a critical element of the ecological system. They are often extremely difficult to predict. In keeping with the precautionary principle, ecological modeling and long-term broad-based monitoring should be instigated.

Recommendation 2

ERISS, ERA and other holders of data need to conduct a synthesis of existing and new information on both aquatic and terrestrial ecosystems to establish, for example, trophic relationships, and to provide for an understanding of key ecosystems functioning in the lease site or adjacent to it. Building on the synthesis, ecological modeling should be commenced with a view to the delivery of an ecological understanding of potential cumulative and/or interactive effects of all developments on the lease site or adjacent to it.

The term «ecological modeling» is used here to denote the process by which the components of the ecological system are recognised to interact and influence each other, to illuminate key ecological functions and processes. Ford's (1999) eight steps of modeling are an example of this process, where the 'problem' will be to detect the potential cumulative and/or interactive effects. The modeling would be a precursor to the monitoring programme as requested below in Recommendation 3.

Recommendation 3

Design and implement long-term broad based monitoring of the leases and adjacent park areas, with emphasis on the aquatic but not excluding other environments. The objective is to describe patterns of change, which are inevitable and will have many causes eg. climate, introduced species and land use. This long term monitoring will provide a context for distinguishing any role of mining activities in causing the changes. If possible this monitoring scheme should be implemented soon so that several years of data can be collated before any new mining activity is begun.

In asking for ecological modeling and long-term broad based monitoring there needs to be a recognition that this will be «state of the art» application and knowledge. The international community can be confident that the existing skills, enthusiasm and experience within ERISS and other scientific organisations in Northern Australia will provide the necessary foundation for the work. It is important to note that the nature of these requests is consistent with the framework of the recently agreed Australian and New Zealand Guidelines for Fresh and Marine Water Quality, and consistent with non-specific long-term monitoring programs proposed for other World Heritage Areas in Australia where threats to values are plausible yet difficult to discern.

The international community also needs to be confident that the results of each of these activities will be subject to the high standard of peer review and peer exposure usually exercised to appraise scientific work produced by ERISS. Work produced by ERA needs to be subject to the same sorts of scientific evaluation.

Cultural Activities and Natural Values

The peopled landscape of the region surrounding the Jabiluka mine site is undeniable, and special values of the environment may exist in the region as a direct or indirect result of the activities of the traditional owners of the land. It is therefore incumbent on both the Australian Government and the mining company to acknowledge these special relationships in their analysis of impact assessment. At least two examples can be cited:

- if refugial habitats exist in the region, they may only exist there because traditional burning practices have protected them from escape of wildfires;
- particular species of special dietary importance to traditional owners may be maintained by harvesting techniques and regimes.

Any regional development which changes, directly or indirectly, the nature of these traditional activities may well influence the distribution and abundance of flora and fauna in the region. In other words, the sheer presence of the mine in the lease area may have a significant impact on the natural values of the surroundings due to the cessation of, or changes to, traditional practices.

Recommendation 4

The Australian Government and the Mining Company should recognise the special relationships between the activities of traditional owners of the land, and the occurrence of special natural values of the World Heritage Area, and account for these relationships in their impact assessment procedures, and Ministerial Recommendations and Requirements.

The four recommendations made above will enable all involved parties to achieve and improve on the Ministerial Recommendations and Requirements arising from the 1997 Jabiluka EIS and the 1998 Jabiluka PER. For example, a Recommendation from the former:

44. The baseline data surveys to be conducted by ERA must identify any species in the project area that are considered to be rare or threatened. The project design must be amended, the extent necessary, to ensure the protection of, and minimal impact on, these species (in the case of threatened species, recovery should not be significantly impeded).

and Requirements from the latter:

10. ERA is to develop and implement measures to the satisfaction of Environment Australia and the Supervising Authority to ensure the protection of the flora and fauna species including in particular those listed in s.6.6.3 of the Assessment Report

11. ERA is to devise and implement, to the satisfaction of the Supervising Authority, a biological monitoring program that includes Swift Creek and other suitable analogues

15. ERA is to ensure that the Jabiluka proposal does not have any significant adverse impact on the world heritage values of Kakadu National Park, ERA is to take all reasonably possible steps to ensure that there is no impact on national estate values.

The Regulatory Framework

In the issues discussed above, and other issues associated with the proposed development, questions will inevitably focus on: the nature of qualitative words and phrases such as «significant» and «reasonably possible steps»; and whether the regulatory framework adopted by the Australian Government is sufficient to plan for appropriate protection to World Heritage values, and to detect and act on problems before these values are affected. In discussing these matters, the following observations can be made:

The fluid nature of the proposed development

Plans for the proposed development at Jabiluka are in a state of transition, and the Mission was presented with new information, different to that presented in the EIS or PER. For example:

- the size of the water retention pond for construction and standby phases has been retained at 3 ha,
- a reverse osmosis plant will operate to enable treated water to removed,
- treated water will be applied to the lease area by spray irrigation,
- the dimensions, number and locations of the silos for storing tailings paste are being designed presently,

- the characteristics of the tailings paste and the cement additions are undergoing evaluative laboratory tests,
- the size, location and characteristics of the waste rock piles, and their rehabilitation, are being formulated and evaluated presently.

Ministerial recommendations and requirements made on the mining company appear to be relevant to these new plans. Recommendations 1-4 made above, plus those recommendations made in the forthcoming ISP report, should help to ensure that World Heritage values are not adversely affected. Ultimately the international community will need to seek assurances that:

- these new developments will be subject to scientific peer review and detailed formal assessment, and
- any approval should only be given if the risks to the natural values of the Park can be shown to be negligible.

The role played by non-government and/or independent groups

Eventual responses by the Australian Government to issues raised by non-government environmental groups (for instance Hitchcock and Staples 1998), and independent academic and consulting scientists (for instance Wasson *et al.* 1998, 1999), in the dispute over the Jabiluka mine proposal, has highlighted the key positive roles these two different groups play in Australian environmental affairs. The international community may wish to monitor any signs of a weakening in the Government's willingness to attend to issues raised, or a weakening in Government support for individuals who play these roles, as indicative of attempts by it to avoid environmental best practice.

Commitments to best environmental practice

The Australian Government, through the Federal Minister for Resources, has placed some 77 requirements resulting from the 1997 Jabiluka EIS, some 17 Requirements from the 1998 Jabiluka PER, and a further 17 Requirements resulting from issues raised by the Independent Scientific Panel of ICSU. These requirements appear extensive and encompassing, and call on the mining company ERA to operate accordingly. Their efficacy with respect to World Heritage values can only be judged, however, by the degree to which the company is committed to best practice, and the degree to which the Australian Government is committed in its regulatory role.

There has been a concern expressed by non-government groups and independent scientists that the Federal Government of Australia has relinquished its authority over aspects of the uranium mining activities. This occurred by downgrading the independent and regulatory role of the Supervising Scientist, and the Federal Minister for the Environment, in favour of an agreement with the Northern Territory Government to delegate to it the authority for the day to day operations of the mine(s). This concern, in combination with recent developments (see below), is currently being addressed by the Australian Government at the highest level. In tabling (in the Australian Parliament) the Supervising Scientist's report on the leak of tailings water at the Ranger Uranium mine, the responsible Minister for Industry, Science and Resources included a statement as follows:

It is now and has been for the life of the mine that the NT [Northern Territory] is the day to day regulatory authority. This is made clear under the agreements between parties which describe the respective roles of the Commonwealth and the Northern Territory. The first agreement detailing the working arrangements was written in 1982. The agreement was revised in 1995 under the previous Government.

I have been renegotiating with the NT Minister the Agreement between the NT and the Commonwealth on uranium mining in the NT. It has been the view of this Government that the relationships needed to be strengthened. To that effect it is our intention that the agreement will make provision for the relevant NT legislation to carry a requirement that in specified areas in relation to uranium mining the Commonwealth Minister will have a formal and absolute role on specific matters.

(Australia Senate (2000))

As these issues are on-going, the results of this process will need to be monitored closely by the international community to ensure that these concerns are indeed dealt with. As the situation stands, a statement (albeit in the Australian Senate) to strengthen the Federal Government's control over uranium mining within a World Heritage Area is probably insufficient to quell concerns.

Tailings Pipe Leak

One of the objectives of the Mission was to explore the circumstances and responses to a leak from a tailings water return pipe at the Ranger uranium mine. Commitment to best environmental practice for the proposed Jabiluka development might be gauged by the responses to this event by ERA and the Governments.

The event is described in detail in the Supervising Scientist's Report no. 153. This report includes the Supervising Scientist's assessment of the leak and its effects, plus five appendices:
- the notification of the tailings water leak from ERA
- ERA's Ranger Mine incident investigation - report to the Supervising Scientist
- ERA's internal review of the 'Significant Incident'
- Letter from the ERA Chief Executive
- Northern Territory Department of Mines and Energy incident investigation.

In short the event was described by the Supervising Scientist as having negligible impact on people and the environment, and no adverse impact on Kakadu National Park. However, in the report, the Supervising Scientist highlighted reduced standards of maintenance, failures in mine site inspection programs, and deficiencies in the statutory monitoring program.

The Supervising Scientist's report includes 17 recommendations which set out to heighten the company's statutory obligations to monitoring, auditing and reporting for contaminants in the receiving environment. The recommendations also urge for improvements in the operations of the Minesite Technical Committee, and working relationships within and between the responsible agencies in the Northern Territory Government and the Commonwealth Government. All seventeen recommendations have been accepted by the relevant Commonwealth Minister and await action (see above).

The mining company's response appears to have been appropriately thorough and self-effacing, after the event. The Chief Executive's letter to the Supervising Scientist

acknowledges the unsatisfactory way in which the incident arose and was handled by his staff, outlining key factors and responses. These issues appear to be consistent with those recommendations made by the Supervising Scientist, including a question regarding the reliance on one downstream monitoring site for 'assessment of seriousness' rather than using points within the operating site to act as early warnings for investigation and action.

The response by the Northern Territory's Department of Mines and Energy is somewhat inconsistent with the Supervising Scientist and the mining company ERA responses. It refers to the «alleged» leak and to the «seepage», finds no evidence of environmental harm, and does not consider the leak, or the reporting of it, to be an infringement of ERA's license to operate. The response claims there is no reason for Aboriginal people to be concerned, makes no mention of required improvements in the mine operation as a result of the incident, and makes no recommendations. In short, the Northern Territory Government appears out of step with both the Federal Government's representative and the mining company, and therefore appears to have vindicated concerns over its role as the Supervising Authority.

Monitoring: Decision-Making Triggers, and Long-term Post Decommissioning

Other outstanding issues remain, and they are directly applicable to concerns over the potential for the existing regulatory framework to detect and respond to environmental change at Jabiluka: what are the decision-making triggers for monitoring, and how should they be incorporated into regulatory operations, during minesite activities, during rehabilitation, and post-decommissioning?

These questions are consistent with one of the original ISP Recommendations:

17. A commitment should be obtained to establish a long-term, possibly 100 year programme to monitor surface water, groundwater and the ecosystem at frequent intervals. This is to be subject to periodic review.

They also relate to a number of Ministerial Recommendations and Requirements for the 1997 Jabiluka EIS and the 1998 Jabiluka PER.

One of the issues to emerge from the Mission was the arrangements for long-term monitoring following decommissioning of the Jabiluka mine and mill, and following close-out upon rehabilitation of the lease site. The Mission was advised that the specifics of the long-term monitoring will be the subject of an agreement between all relevant stakeholders at an appropriate time. This on-going nature of negotiations, and non-specific nature of Ministerial Recommendations and Requirements for the project (see 1997 Jabiluka EIS Recommendations 64 and 65) will require that the international community keeps a watching brief.

Similarly, another issue related to monitoring is that of determining appropriate triggers for decision-making. While the overall purpose of monitoring is specified in Ministerial conditions for the proposed development, those conditions do not specify the parameters to be used, the trigger values of concern, nor the processes which should be followed (although admittedly it would probably be unreasonable for them to do so). Existing procedures at Ranger used by ERA appear to be the subject of on-going work and discussions with the Minesite Technical Committee (see ERA 2000, Appendix 2 in Supervising Scientist 2000), and these appear to be based on a procedure developed by

the Office of the Supervising Scientist whereby a ‘focus level’ might be +/- one standard deviation of the mean, or greater than the 80th percentile, and where a trigger for reporting (and action) might be +/- two standard deviations of the mean, or greater than the 95th percentile. The international community may need to request that these focus levels and triggers are subject to appropriate scientific peer review.

References

Australia Senate *Official Hansard* No. 9, 2000, 15682-15684 (27th June 2000).

Ford, A. (1999). Modeling the Environment. Island Press, Washington DC.

Harris, G. (1999). A landscape scale analysis of the potential impacts of the Jabiluka Mine. Appendix 4 in Supervising Scientist (1999) Response the ICSU Review of the Supervising Scientist's Report to the World Heritage Committee.

Hitchcock, P. and Staples, J. (1998). Kakadu: World Heritage in Danger. A submission to the World Heritage Committee of UNESCO by Australian Conservation NGOs.

Humphrey, C. (1999). Potential effects of the Jabiluka Mine upon the biodiversity of Kakadu National Park. Appendix 3 in Supervising Scientist (1999) Response the ICSU Review of the Supervising Scientist's Report to the World Heritage Committee.

Supervising Scientist (2000). Investigation of tailings water leak at the Ranger uranium mine. Supervising Scientist Report 153. Supervising Scientist, Darwin.

Wasson, R.J., White, I., Mackey, B. and Fleming, P.M. (1998). The Jabiluka Project. Environmental Issues that threaten Kakadu National Park. Submission to UNESCO World Heritage Committee Delegation to Australia.

Wasson, R.J, White, I., Mackey, B. and Fleming, (1999). Comments on: Assessment of the Jabiluka project. Report of the Supervising Scientist to the World Heritage Committee. Unpublished.