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Yeelirrie uranium deposit in Western Australia

Stewart Needham
Science, Technology, Environment and Resources Section

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Introduction

The Yeelirrie uranium deposit was discovered in 1972 by Western Mining Corporation Ltd (WMC) in remote and semi–arid central Western Australia (WA). WMC submitted a proposal which was the subject of an Environmental Impact Statement (EIS) and assessment process. Whilst this assessment received approval, its development was denied by the Australian Labor Party's (ALP) 'Three Mines Policy', and the anti–uranium mining stance of the WA Labor government from 1983 to 1993 and 2001 to 2008.[1] An easing of the ALP's uranium policy and the election in September 2008 of a WA Liberal–National State government has provided the opportunity for the present owners of the deposit, BHP Billiton, to lodge an application for development to proceed.

BHP Billiton made an application to the Federal Minister for the Environment for a determination under the *Environment Protection Biodiversity and Conservation Act* (EPBC Act) on 22 May 2009. The proposal was determined to be of 'national environmental significance' on 19 June 2009, and therefore requires the full Environmental Impact Statement process to be carried out before it can proceed.

The uranium mineralisation lies close to the surface in an ancient drainage channel. If the project is approved, the ore would be mined by shallow excavation and trucked to a nearby purpose–built plant for treatment. The deposit contains about 52 000 tonnes of uranium oxide (U_3O_8) and would sustain an annual production of 5000 tonnes U_3O_8 ('yellow cake') for at least 10 years. This is about the same as recent production levels from the Ranger mine in the Northern Territory.

Little has changed in the last 25 years in respect of the level of geological understanding, the nature of the Yeelirrie mining proposal, or the environmental or social issues relevant to mine development. Issues that were identified in the previous EIS process[2] during the public consultation process will need to be addressed in a new EIS submitted to government, including such matters as safety, tailings disposal, rehabilitation and other environmental concerns.

If approved, Yeelirrie would bring the number of operational uranium mines in Australia to six – Ranger (NT), Olympic Dam (SA) and Beverley (SA) are active mines, and mining is expected to begin at Honeymoon (SA) in 2010 and Four Mile (SA) in 2011-2012. Uranium

1. In 1984 the federal Labor government introduced the 'three mines policy' where uranium production was limited to the three sites already being mined: Ranger, Nabarlek and Olympic Dam. This policy was abandoned during the Coalition Government from 1996 to 2007 and the present Labor Government has softened its approach. See Australian Academy of Science, 'Prospect or suspect – uranium mining in Australia', *Nova Science in the News*, viewed 27 May 2009, http://www.science.org.au/nova/002/002key.htm

2. WMC Ltd, *Yeelirrie Uranium Project WA, Supplement to Draft Environmental Impact Statement and Environmental Review and Management Program*, January 1979, 220 pp.

projects in development, which have been referred for assessment, or where referrals for assessment are shortly anticipated are listed below.

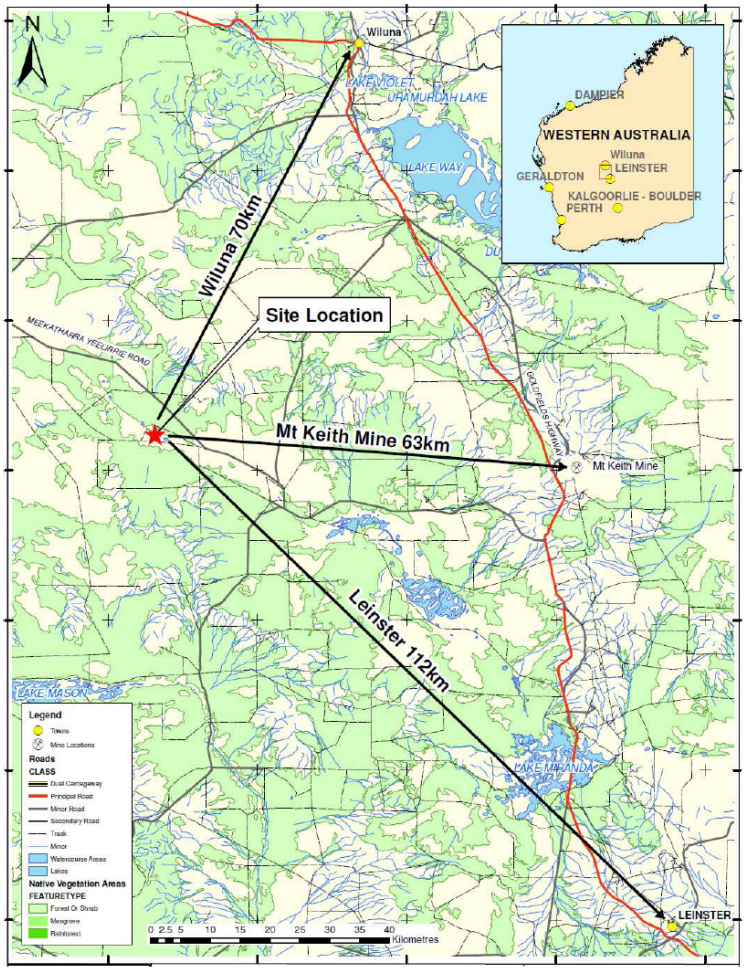
Proposed uranium projects which may become operational by 2014

Project / state	Operator	Type	Status
Honeymoon SA	JV Uranium One and Mitsui	In-situ acid leach	Approved, under development, anticipated commencement 2010
Four Mile SA	JV Heathgate & Alliance Resources	In-situ acid leach	Approved, dispute with traditional owners over whether the agreement to proceed extends to the consortium partners. May start 2011–12
Yeelirrie WA	**BHP Billiton**	**In-situ alkaline leach**	**An appeal against the level of assessment (Environmental Review Management Program) was denied in October 2009 but with the period for public review extended from 10 to 14 weeks. ERMP in preparation**
Mount Gee SA	Marathon Resources	In-situ acid leach	The proposal has been referred and determined for assessment at the EIS level. Issues with poor environmental management at the site during drilling operations appear to have delayed stakeholder consultations and EIS preparation
Nolan's Bore NT	Arafura Resources	Open pit; mainly rare earths and phosphate with U as a by-product	EIS in preparation. Consideration of storage or disposal options for a thorium concentrate precipitate product/waste stream present unique challenges in this assessment process
Crocker Well SA	STCM	Small open pits	EIS in preparation
Oban SA	Curnamona Resources	In-situ acid leach	EIS in preparation
Wiluna WA	Toro Energy	In-situ alkaline leach	Referred 30 October 2009 for determination of assessment level
Beverley North	Heathgate Resources	In-situ acid leach	Referred 19 November 2009 for determination of assessment level
Lake Maitland WA	Mega Resources	In-situ alkaline leach	Referral for determination of assessment level anticipated late November 2009

This brief looks at the location, environment, geology and mineral resource of the Yeelirrie deposit and summarises its political history since discovery in 1972. The brief then examines some of the environmental, social and economic issues surrounding this project.

Location

The Yeelirrie deposit is between Wiluna and Leinster, WA, about 500 km north of Kalgoorlie and close to the Goldfields gas pipeline. Access by road from Perth is about 1040 km, taking about 13 hours. Land use in the region is rangeland pastoralism, with homesteads around 30 km apart. The nearest settlements are Sandstone (population 50), and Wiluna (population 300).



Location of the Yeelirrie uranium deposit (Source BHP Billiton)

Environment

Yeelirrie lies in the Murchison Biogeographic Region, an area of low mulga woodland on sandy soils derived from the very deeply weathered granites and greenstone belt rocks of the

Yilgarn geological province.[3] The ground is generally flat to slightly undulating with a relief of no more than 50–100 metres. Granitic breakaways separate higher gravely terrain from the sandy lower country with wide sandy creek lines, and dunes are more evident in the east. Annual rainfall averages 250 mm; maximum temperatures exceed 40°C for eight months of the year and minima can reach –2°C over three months in the winter. The dominant vegetation is hummock grasslands on sandplains, saltbush scrub on calcareous soils, samphire scrub on saline areas, and mulga woodland on slightly higher ground.

The Yeelirrie deposit lies in a creek line which is subject to occasional water flow. Surface and subsurface flow terminates in a salt pan system about 30 km downstream, i.e. to the southeast.

Geology

The uranium mineralisation lies in a fossil creek bed or 'palaeochannel' in which alluvial valley–fill sediments were deposited over millions of years.[4] Calcium and magnesium carbonate minerals have concentrated in the upper parts of these channel sediments to form a hard material called 'calcrete'. The calcrete also contains uranium, vanadium, potassium and iron which were leached from the surrounding granitic rocks of the Yilgarn Block over millions of years, transported by ephemeral stream flows, and then precipitated along with the carbonates as the calcrete slowly formed.

The Yeelirrie calcretes lie along the drainage channel of a broad flat valley above highly weathered rocks mostly derived from granite.

The valley–fill sediments are about 30 metres thick. On top of the calcrete is 1–2 metres of sandy, friable grey–brown soil or 'overburden', which is locally indurated (hardened) by silica and passes down into carbonated loam.

The *calcrete layer* consists of an upper pale brown, friable, 'earthy calcrete' which forms a fairly continuous layer grading upwards into the overlying soils; and a lower white, hard, nodular 'porcellanous calcrete' which is made up of 70 percent carbonate.

Below the calcrete is a reddish *clay–quartz unit alluvium*, which extends down to decomposed basement granite rocks. The alluvium contains disseminated detrital quartz grains and quartz–rich bands in clay loam, with thin seams of celestite (strontium sulphate), or thin arkose layers overlying the basement.

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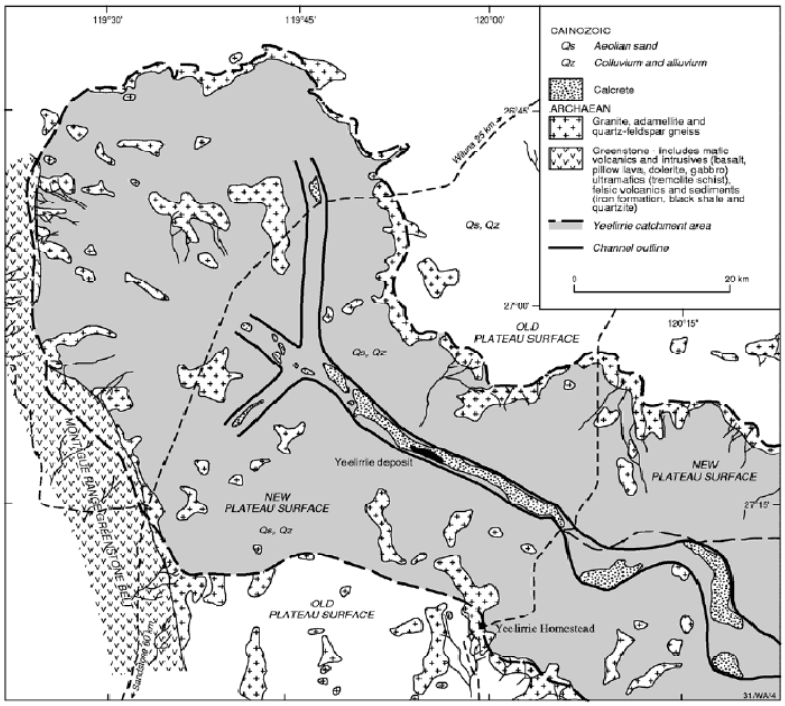
3. Department of the Environment, Water, Heritage and the Arts, *Murchison bioregion*, viewed 7 July 2009, http://www.environment.gov.au/land/publications/acris/pubs/bioregion-murchison.pdf

4. AD McKay and Y Miezitis, *Australia's uranium resources, geology and development of deposits*, AGSO – Geoscience Australia, Mineral Resource Report 1, 2001, 184 pp.

The uranium deposit is a horizontal sheet approximately 9 km long and up to 1.5 km wide. The ore zone averages three metres thick and lies between four and eight metres below surface and 90 percent below the water table. Around 90 percent of the mineralisation is in a zone four metres thick at the transition between the calcrete and the underlying clay–quartz alluvium.



Map of Yeelirrie deposit showing NW–trending palaeochannel. The ore body is shown black and the calcrete is stippled. The grey area is topographically lower and separated from the surrounding country by a low cliff or 'breakaway'.

Source: Geoscience Australia, Mineral Resource Report 1.

Mineral resource

The uranium mineralisation is carnotite, a potassium–uranium–vanadium oxide with the chemical formula $K(UO_2)2(VO_4)2.3H_2O$, comprising 59.86 percent uranium dioxide (UO_2). It forms a thin bright to greenish yellow film coating cavities and fractures, or is disseminated through the calcrete and clay–quartz alluvium. The estimated resources of the deposit are shown in the table below.

Resource estimates for the Yeelirrie deposit (Western Mining Corporation, 1982)

	Grade range % U3O8	Ore (Mt)	Av. Grade % U3O8	U3O8 (t)
Prime ore	>0.15	13	0.24	32 000
Intermediate ore	0.05–0.15	22	0.09	20 500
Total proved ore reserves		35	0.15	52 500

In its 1972 proposal, WMC proposed to mine the deposit by open cut, either with scrapers and backhoes or bucket–wheel excavators. A one–tonne per hour metallurgical research plant was commissioned at Kalgoorlie in late 1980 and a detailed feasibility study for production at the rate of 2500 tonnes U_3O_8 per year was completed in August 1982. There is also potential for 1000 tonnes per year of vanadium oxide by–product.

History of the project

Discovery and ownership

Western Mining Corporation (WMC) discovered the deposit in 1972, and between 1972 and 1980 undertook several phases of exploration and three trial mining programs.

In August 1978 Urangesellschaft Australia Pty Ltd bought a 10 percent interest in the deposit for $3 million, but this was reacquired by WMC in October 1993. At the same time Esso was given 15 percent equity in return for a commitment to fund 80 percent of the Stage I feasibility study and pilot plant, then costed at $ 21 million. Esso withdrew in May 1982 for commercial reasons and the share reverted to WMC. In 2005 ownership passed to BHP Billiton Ltd owing to a company takeover.

Environmental Impact Assessment and project development

An EIS was produced in 1978 and a Supplement to the EIS, addressing issues raised in submissions, was released in January 1979. The EIS was approved by both state and Commonwealth governments later that year. Detailed metallurgical studies were undertaken from 1980 to 1982 at a purpose–built pilot plant north of Kalgoorlie (the Kalgoorlie Research Plant). Approximately 220 000 m^3 of material was mined from three slots, with some ore transported to the Kalgoorlie plant for processing. Some mine overburden was used to provide a running surface on haul routes and access tracks. The majority of mine overburden was placed in five stockpiles.

In the twelve years to 1983 WMC and its partners (then including Esso) spent a total of $35 million preparing to develop Yeelirrie as an open cut mine, including building and operating the pilot metallurgical plant. A $320 million project was envisaged and sales contracts were being planned. However, the 1983 federal election and implementation of the ALP ‘three mines policy’ meant that permission to negotiate sales contracts was withdrawn in March 1983. Plans for Yeelirrie were then abandoned, the project was placed on ‘monitored care and maintenance’ (that is, periodic inspection with follow–up work as required to maintain the integrity of the rehabilitation works that had been undertaken), and the company’s attention focussed on developing Olympic Dam.

Project closure

In March 1996 WMC completed an environmental audit of the Yeelirrie Project Area and the former sample preparation facilities at the Yeelirrie Homestead.[5] The audit highlighted deficiencies in several areas including site housekeeping, site security and reporting, adequacy of signage, and management of radioactive materials. An Environmental Improvement Plan was developed to action the audit findings and work on all potential non–conforming areas was completed in 1998. A monitoring and security programme was also established with results reported annually to the WA Department of Industry and Resources.

One of the 'slots' from which a trial ore run was taken

The same excavation infilled and prior to revegetation

A Provisional Closure Plan was prepared for the site in 2001 and the first phase, involving capping of historic drill holes, was completed in 2002.[6] An amendment to the Radiation Management Plan was submitted in December 2003 which described rehabilitation activities to be undertaken within the Project Area in 2004. The overall objective of the closure finalisation works was to leave the site in a safe and stable condition which would pose a low risk of any future impact to the environment or health and safety of any person who may visit the site. Completion criteria for the proposed closure finalisation works were developed to satisfy a pastoral land use requirement in accordance with the outcomes approved in the Draft Environmental Impact Statement.

Seed collection and revegetation works were completed in 2004, and remaining open drill holes were capped, and a post–closure environmental and spot radiation monitoring program was established with reporting to the WA government as an appendix to the Annual Environmental Report.

With the election in 2002 of a new state Labor government with an anti–uranium stance, the 1978 state mining agreement for Yeelirrie was revoked in March 2004.

5. WMC Ltd website, 'Case study – Yeelirrie', *WMC Sustainability Site 2004*, viewed 7 July 2009, http://hsecreport.bhpbilliton.com/wmc/2004/performance/crp/environ/casestudy.htm

6. WMC Ltd website, 'Case study – Yeelirrie'.

Application to reopen the project

Even though the 1978 state mining agreement for Yeelirrie was revoked in 2004 by the WA government, WMC retained the mining tenements and awaited future opportunities. Following the change of state government in 2008, BHP Billiton commenced a new program in November 2008 to better define the ore resource, further investigate metallurgical techniques required for efficient ore processing, and engage in a new round of community consultation. It also indicated at this time that it was intending to prepare a new EIS.

On 21 May 2009 the company lodged an application with the Federal Minister for the Environment for approval to mine the Yeelirrie uranium deposit. In June 2009 the Minister's delegate published her decision that the project would indeed require comprehensive assessment and approval under the *EPBC Act* before proceeding, citing likely significant impacts on listed threatened species and communities, listed migratory species, as well as nuclear actions.[7]

In accordance with a bilateral agreement between the Commonwealth and the States relating to environmental assessment proposals put to the Federal minister under the *EPBC Act*, the appropriate assessment regime was determined to be an *Environmental Review and Management Program (ERMP)* administered by the Western Australian Government. This process will provide a similar level of assessment to a Commonwealth-administered EIS.

This decision was appealed, with nine appellants requesting a public inquiry - the highest level of assessment available.[8] In September 2009 the WA Office of Appeals denied the appeal but recommended to the Minister that the public comment period be extended from 10 to 14 weeks.

BHP Billiton is now in the process of preparing detailed proposal for assessment under the ERMP process.

7. Department of the Environment, Water, Heritage and the Arts, *Notification of referral decision and designated proponent – controlled action*, Australian Government, 19 June 2009, viewed 7 July 2009, http://www.environment.gov.au/cgi-bin/epbc/epbc_ap.pl?name=show_document;document_id=34647;proposal_id=4906

8. Office of the Appeals Convenor, WA, Appeals against level of assessment 255–263 of 2009, September 2009, viewed 20 November 2009, https://secure.dec.wa.gov.au/appeals/documents/255-263-09_Appeals%20Convenor%20Report%20-%20Final%2002-10-09.pdf

Some key issues

Issues raised in the previous EIS process

During the 1978–79 EIS process several matters were raised in the submissions received from government agencies and the public.[9] Subsequent approval indicates that these issues were dealt with to the satisfaction of the state and Federal governments according to the standards and expectations of the day. However, the level of concern about uranium mining is still high in some sections of the Australian community. There is also a greater level of understanding of the modern operation of a uranium mine, on management of tailings, and on mine rehabilitation and mine closure, based on experiences since the 1970s relating to mining at Nabarlek, Ranger, and Olympic Dam; rehabilitation and closure at Nabarlek; and post–mine closure stewardship at Rum Jungle. So it is probable that many of these same issues will need to be re–examined by BHP Billiton in a new environmental impact assessment process, and that they will be closely scrutinised by stakeholders.

The following is a summary list of the substantive issues raised in the consultative process during the last EIS process[10]:

- radiological standards—comments mainly questioned the adequacy of the relevant Code of Practice[11] developed under the *Environment Protection (Nuclear Codes) Act 1978* and the International Commission on Radiation Protection. The company undertook to abide by the code;

- tailings disposal—concerns related to the possible contamination of groundwater, radon gas and radioactive dust emissions, and most submissions addressing the subject preferred the option of returning the tailings to the mine pit. However, WMC indicated that this option would 'quarantine' the lower–grade resources which lay underneath the target ore body from possible future extraction;

- mine rehabilitation—comments on the long term stability of the end–of–mine rehabilitation works and the level of risk to humans and the environment, mainly from radiological emissions;

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9. WMC Ltd, *Yeelirrie Uranium Project WA, Supplement to Draft Environmental Impact Statement and Environmental Review and Management Program*, January 1979, 220 pp; Department of Conservation and Environment WA, *Yeelirrie Uranium Proposal by Western Mining Corporation, Report and Recommendations by the Environmental Protection Authority*. Bulletin 53, 1979, 51 pp, viewed 7 July 2009, http://www.epa.wa.gov.au/docs/2693_Bulletin%2053.pdf

10. Objections focussing on the ethics and economics of uranium mining, and concerns about the effects radiological doses considered by authorities to be at negligible levels, are excluded.

11. Australian Radiation Protection and Nuclear Safety Agency, *Code of Practice and Safety Guide for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing (2005)*, viewed 7 July 2009, http://www.arpansa.gov.au/Publications/codes/rps9.cfm

- tailings dam design—stability and long term containment of contaminants related to concerns about permeability of the dam structure;

- management of contaminants at the treatment plant—this related to the chemical toxicity of vanadium pentoxide dust as well as soluble uranium and vanadium salts, and management of yellow and redcake dust in the drier and packing areas;

- location of the mining township—including possible airborne dust and gamma radiation reaching it from the mine, and management of sewage;

- availability of the draft EIS—and complaints that a fee was charged for copies; and

- environmental impacts during and after mining—mainly relating to the effects of dewatering.

Other issues likely to arise

There are several significant matters relating to the remote location and environment of Yeelirrie, mineral processing, and economic, timing and social issues, which will be of interest to the ERMP:

- recent uranium mine start–ups in remote areas: since the earlier EIS for Yeelirrie, two South Australian projects in similar environments and remote locations have progressed. The Beverley mine began operating in 2001 and a mine extension was approved in August 2008. A mining licence was issued for the Honeymoon deposit in September 2008 and site development works began in January 2009. Similar to Yeelirrie, both projects were subject to protracted development timelines, largely as a result of the 'Three Mines Policy', and issues dealing with the first application in Australia of 'in–situ acid leach' technology to extract the uranium from the ground. They have progressed more quickly to mine development owing to the pro–uranium mining policy of the South Australian government. The ERMP process for Yeelirrie will benefit from lessons learned from the environmental impact assessment procedures at these mines, and knowledge of the regulatory conditions which apply;

- mineral processing: like Beverley and Honeymoon, Yeelirrie involves the application of a certain mineral extraction technique for the first time. All other uranium mines in Australia use acid to leach uranium from ore—in large tanks at Ranger and Roxby Downs, and in the ground at Beverley and Honeymoon ('in–situ leach'). In the case of Yeelirrie, an *alkaline* solution will be used to extract uranium from the ore. The ore will be mined and transported to a processing plant where the leaching will take place in large tanks. Whilst this will be the first application of alkaline leach in this country, the technique is well established overseas, particularly in the USA. Generally speaking, the process carries environmental advantages over the use of acid as the waste liquor and tailings are regarded as less able to result in adverse impacts than the acid alternative. The disadvantage of the use of alkaline leach is that uranium recovery is less efficient at around 70 percent;

- timing: the WA Labor Opposition spokesman on minerals and petroleum has recently restated the party's opposition to uranium mining, and its intention to 'contain' any mining that had started once it regains power[12]; however, it would be unlikely that any operating mines would be halted. It appears likely that BHP Billiton will wish to proceed through the ERMP process as quickly as possible to limit the risk of a repeat of a change of State government precluding the development of the deposit;

- Aboriginal concerns: the previous EIS dealt with archaeological aspects, but noted that there was no significant residence or visitation by Aboriginal people, indicating no direct links to the land around the project area. Three public submissions queried this assumption, although none offered any material information to seriously challenge it. It is possible that the situation has changed over the last 30 years, such that Aboriginal claims—including rights to compensation or employment—will need to be re-evaluated;

- economic issues: many of the public submissions to the first EIS queried the cost of the project, its financial viability, and net financial benefits to Western Australia, in view of the need for long term stewardship post–mining. Given the role that nuclear energy may play in developing a lower carbon energy sector, the current economic and environmental imperatives for development will be more readily defined. Emphasis on uranium's potential to replace coal–fired electricity generation will be a point that will doubtless be made to counter some of the claims of anti–uranium lobby groups which may be advanced in the ERMP process;

- broader issues related to general opposition to the nuclear fuel cycle: assessments of uranium mining proposals always attract a large number of submissions from individuals and NGOs expressing concern over broad regulatory, political and commercial issues and the radiological and chemical risks to the public and the environment. In its evaluation of the appeals to the assessment level decision the WA Appeals Convenor found that broad 'downstream' nuclear issues (ie what happens to the uranium after it is exported) and related security and political matters such as nuclear non-proliferation are outside the definition of 'environment' applied by the WA EPA and thus outside the scope of the ERMP. Other issues related to for example worker safety, transport, and economic return have been tested in several earlier assessments of uranium proposals in the Northern Territory and South Australia, and it is highly unlikely that these issues will influence the ERMP process or outcome.

Conclusion

Based on the support of the current state government and the successful previous environmental impact assessment, it appears that the Yeelirrie uranium mine proposal is likely to receive approval, although the level of assessment will probably be more rigorous

12. 'WA Labor "won't back" uranium mining', *ABC News*, 17 November 2008, viewed 7 July 2009, http://www.abc.net.au/news/stories/2008/11/17/2422195.htm

than in 1978–79. Objections are likely to be based in the main on ethical anti–nuclear views, and possibly on increased engagement with Aboriginal issues. Given the WA Labor Party's continued opposition to uranium mining, a change in state government at the next election could complicate the process and will focus attention on the timely execution of the ERMP process.