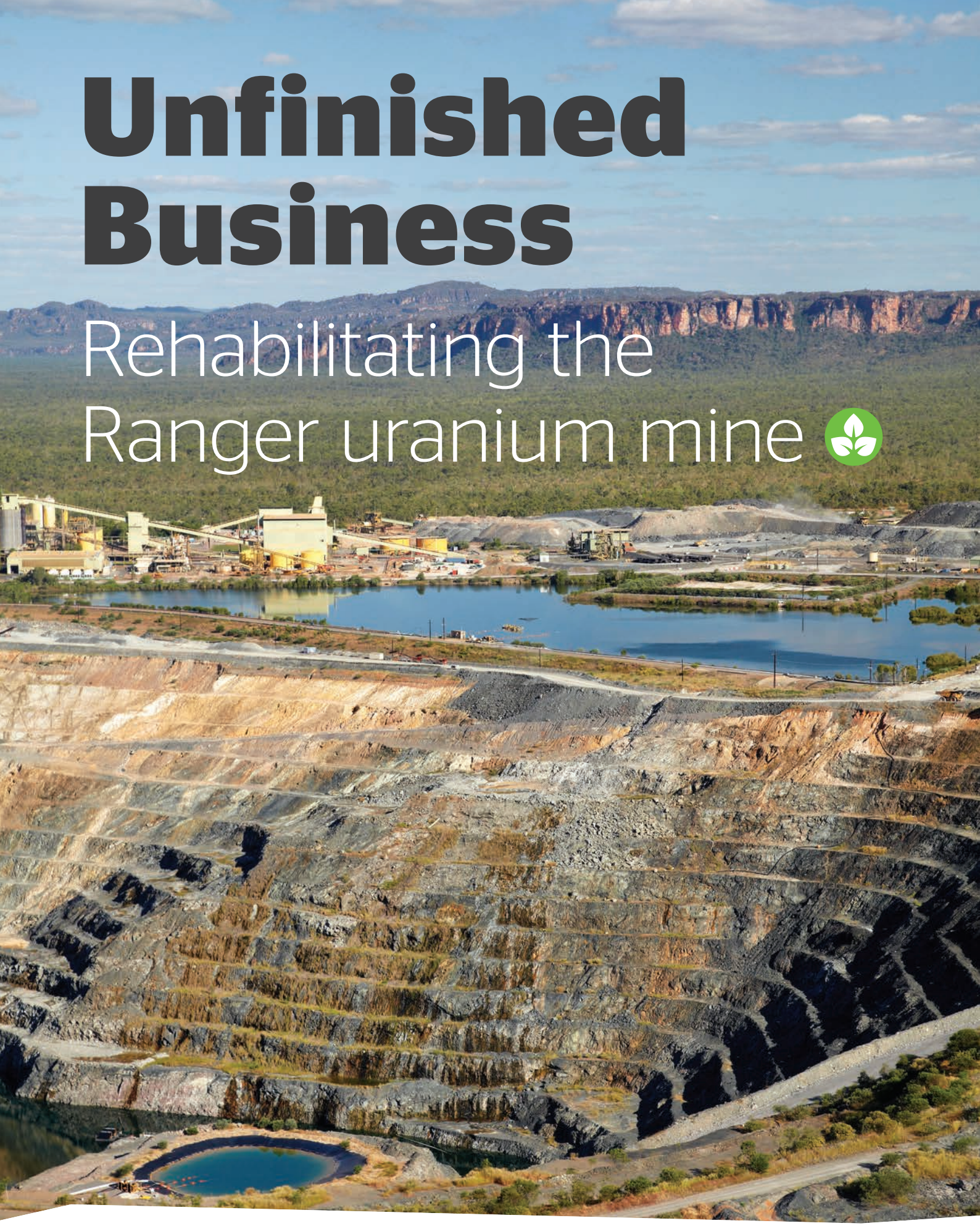
Unfinished Business

Rehabilitating the Ranger uranium mine



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Front cover. Ranger uranium mine. *Photo*. David Wall
Below. Ranger uranium mine with Djidbidjidbi (Mt Brockman) in background. *Photo*. Dominic O'Brien

This report was written by Rebecca Lawrence, a Research Affiliate with the Sydney Environment Institute and Dave Sweeney from the Australian Conservation Foundation.

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We acknowledge the Mirarr people as the Traditional Owners of the land where the Ranger mine is sited and their long-standing efforts to protect Country and culture.

Executive **summary**

Four decades of imposed uranium mining and milling by Energy Resources of Australia (ERA) and Rio Tinto is about to end at the Ranger uranium mine in Kakadu, leaving a heavily impacted site that requires extensive rehabilitation. Long contested by the area's Traditional Aboriginal Owners, the Mirarr people, the mine site is completely surrounded by the dual World Heritage-listed Kakadu National Park.

Rehabilitation of the Ranger uranium mine will be complex and costly. It must meet both community expectation and the mining company's legal obligation to restore the site to a standard where it can be incorporated into the Kakadu World Heritage area.

Australia has a long history of sub-standard mine closure and rehabilitation in the uranium and wider mining sector, and there is a clear need for a better approach and outcome at Ranger. The challenge is how to rehabilitate the heavily impacted mine and larger Ranger Project Area in a way that reduces adverse impacts and provides confidence that the living and peopled landscape of Kakadu is best protected, now and into the future.

In this report, we show how Australia's largest national park is at long-term risk unless the clean-up of Ranger uranium mine in Kakadu is done comprehensively and effectively. We examine rehabilitation plans for the controversial mine site and identify significant data deficiencies, a lack of clarity around regulatory and governance frameworks and uncertainty over the adequacy of current and future financing — especially in relation to future site monitoring and mitigation works.

The Ranger uranium mine is aiming for a rehabilitation standard never previously attempted or achieved. This has drawn national and international attention and puts increased pressure on the Australian and Northern Territory governments, ERA and Rio Tinto to get this right. The outcome at Ranger is of critical importance to Rio Tinto's international reputation as a responsible corporate citizen and the company's wider social license to operate.

Importantly, hope for the success of the rehabilitation project is shared by a wide range of stakeholders. There is now a real chance to move from an operational history of contest to a rehabilitation future of collaboration and co-operation at Ranger.

This report is an independent assessment of the rehabilitation and mine closure process to date. It explores some of the concerns and constraints surrounding the rehabilitation and makes recommendations that seek to address these in order to improve the chances of the successful closure and rehabilitation of the Ranger Project Area.

Recent archaeological work at Madjedbebe on Mirarr lands shows that **people have been continuously living in the area for at least 65,000 years**

Left. Simon Mudjandi, Rosie Mudjandi, May Nango and Jaykuk Djandjomerr at Madjedbebe site.
Photo. Glenn Campbell, The Age

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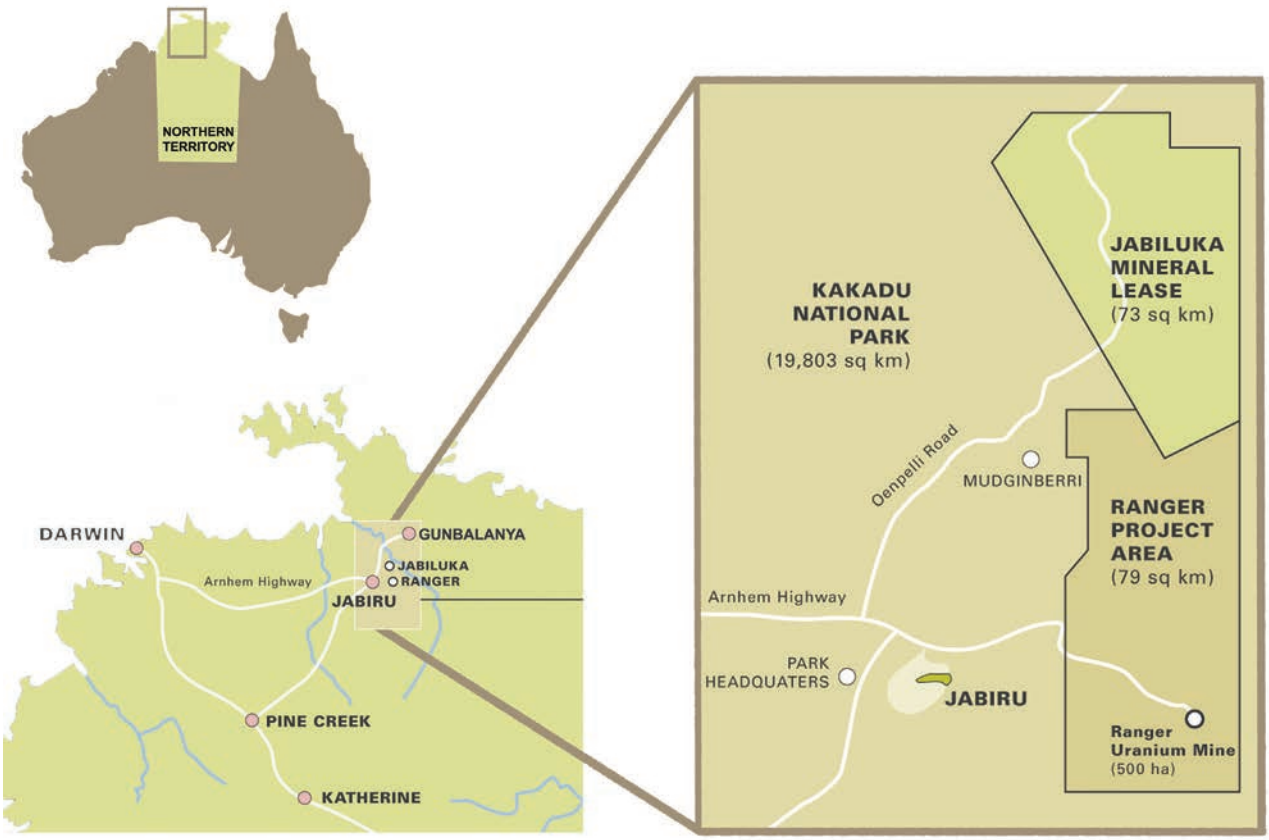
Ranger is surrounded by Kakadu and must **be rehabilitated to a World-Heritage standard**



Introduction

Ranger is Australia's longest running uranium mine and one of our most scrutinised and contested resource operations. It has attracted this attention through a combination of factors relating to product, process and place.

As a product, uranium is the raw material for nuclear power and weapons and is directly linked to the creation of large volumes of radioactive waste. As a process, Ranger mine was imposed on the traditional lands of the Mirarr people despite their clear opposition. As a place, Ranger is surrounded by Australia's largest national park, Kakadu, and is required to be rehabilitated to a standard where it can be incorporated into this World Heritage-listed area.

Kakadu is a truly unique region. It is one of less than 40 places around the world on UNESCO's World Heritage register for both natural and cultural values. From the escarpment country and rainforests to the wetlands and tidal mudflats, Kakadu encompasses a precious natural heritage and protects ecosystems of outstanding value, diversity and beauty.[1] The area known as the Ranger Project Area is surrounded by the 20,000 hectare Kakadu National Park, and shares these remarkable attributes.

Kakadu also contains some of the world's oldest and most important archaeological and art sites and is home to a living cultural tradition and practice. Recent archaeological work at Madjedbebe on Mirarr lands shows people have been continuously living here for at least 65,000 years.[2] The cultural legacy of these years is imprinted on the region and witnessed by many visitors, and Kakadu remains home to the Mirarr and other Aboriginal people. For them the issue is simple and irrefutable: "*Mirarr cultural values are integral to the cultural values of Kakadu National Park.*"[3]

Mining has ceased at Ranger and the milling of stockpiled ore is required to end by January 2021. From 2021 to 2026 is a mandated rehabilitation period. During rehabilitation, Energy Resources Australia (ERA) is required to: ***"...rehabilitate the Ranger Project Area to establish an environment similar to the adjacent areas of Kakadu National Park such that, in the opinion of the Minister with the advice of the Supervising Scientist, the rehabilitated area could be incorporated into the Kakadu National Park."***[4]

And also ensure that: ***"(i) the tailings are physically isolated from the environment for at least 10,000 years; (ii) any contaminants arising from the tailings will not result in any detrimental environmental impacts for at least 10,000 years;"***[5]

The regulation of Ranger and its rehabilitation is highly complex with many different actors across diverse jurisdictions. It is primarily regulated through Australian government power but with day-to-day operational oversight by the Northern Territory government.[6] It also has a stated aim to address Aboriginal interests through the Northern Land Council as advised by the Mirarr organisation, Gundjeihmi Aboriginal Corporation.

As mine closure approaches, this complex regulatory environment makes transparency difficult. Civil society organisations long sought the public release of the Ranger Mine Closure Plan (MCP) developed by ERA. After many delays, the MCP was publicly released in June 2018. At the same time, the Supervising Scientist Bureau (SSB), the national monitoring and research agency charged with tracking any impacts of uranium mining on Kakadu, released its MCP Assessment Report.

This report, *Unfinished Business: Rehabilitating the Ranger uranium mine* examines the MCP and provides an independent assessment of the rehabilitation and mine closure process, revealing several concerns and constraints. It highlights the need for increased scrutiny, broad stakeholder engagement and transparency to facilitate the best possible outcome for the successful closure and rehabilitation of Ranger.

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[1] In terms of natural values, Kakadu is home to 21 of Australia's 29 mangrove species, 900 plant species, 300 bird species, 50 native mammals, 100 species of amphibians and reptiles, one-quarter of Australia's freshwater fish and an estimated 10,000 insect types. It is one of the most biodiverse environments in Australia and many of these species are endemic to the region. Kakadu contains the world's richest breeding grounds for migratory tropical water birds.

[2] Clarkson, C *et al*. (2017). "Human occupation of northern Australia by 65,000 years ago." Nature 547: 306.

[3] Submission from the Mirarr people to the World Heritage Committee, ICCROM and ICOMOS, 1999, p.7.

[4] Clause 2.1, Ranger Environmental Requirements, Section 41 Authority.

[5] Clause 11.3, Ranger Environmental Requirements, Section 41 Authority.

[6] Australian government refers to the national government based in Canberra. Northern Territory government refers to the regional government based in Darwin.

History of **Ranger uranium mine**

1969 An aerial survey **identified the Ranger uranium deposits.** Soon after, the Electrolytic Zinc Company of Australasia (EZ) and Peko-Wallsend Operations Limited (Peko) began development work in the area.

1974 EZ and Peko consortium **expanded to include the Australian Atomic Energy Commission** and advance the commercial development of Ranger.

1974 The Australian Whitlam government signed the 'Lodge Agreement' with Peko and EZ for the Ranger mine to provide uranium ore to Japan. With this agreement in place, the mine was a *fait accompli*.[7] **Decades of imposed and opposed industrial activity ensued.** The Ranger uranium mine was authorised by the Australian government using the Atomic Energy Act (1953) — Cold War-era legislation that allowed the mining of uranium for military purposes. As a consequence, the primary legal power at Ranger resides today with the federal Resources Minister.

1975 *The Ranger Uranium Environmental Inquiry* (Fox Report) explored the tensions between environmental, Aboriginal, commercial and national interests around uranium mining in Kakadu. **It clearly acknowledged the opposition of Aboriginal people** but recommended "their opposition should not be allowed to prevail".[8]

1976 The Aboriginal Land Rights Act **explicitly excluded Ranger from its veto provisions.**

1978 Ranger was finally approved against the backdrop of a Northern Territory push for greater political autonomy from the national government. Through a combination of ministerial deals and informal institutional agreements, **the Australian government ceded regulatory power** over Ranger's day-to-day operations to the Northern Territory government.

1978 The Australian government established the Office of the Supervising Scientist (OSS), now called the Supervising Scientist Branch (SSB), to research and track the impacts of uranium mining in the Kakadu region. Although SSB is often perceived as the chief regulator, **their primary role is environmental research and to provide advice** to the federal Environment Minister who shares this with the federal Resources Minister.

1979 **The Ranger uranium mine began operations on Mirarr land,** following a no-consent Commonwealth 'Authority to Mine'. This was a profound social injustice for the Mirarr people, who had consistently opposed uranium mining on their traditional lands.

1979 — **The Australian government sold its stake in the mine,** leading to the formation of current mine operator Energy Resources of Australia (ERA).

1981 — The first ore was milled in August and the operation was formally opened in October. **Around 20 million tonnes of ore was extracted from the original open cut mine** (Pit 1) from 1981 until the deposit was exhausted in December 1994.

1988 — North Broken Hill Holdings (North) became the **principal shareholder** acquiring a 68% stake in ERA.

1995 — The Gundjeihmi Aboriginal Corporation was formed to **represent the interests of the Mirarr Traditional Owners** to the wider regional Aboriginal representative body — the Northern Land Council — and to the Northern Territory and Australian governments.

1997 — ERA started a **second open cut pit** at Ranger (Pit 3).

1998 — North and ERA tried to develop the adjacent Jabiluka deposit but were **stopped by sustained opposition from the Mirarr Traditional Owners,** with strong civil society and wider community support.

2000 — Rio Tinto purchased North and ERA — becoming **the largest shareholder in the Ranger uranium mine.**

2009 — ERA announced a Ranger 3 Deeps (R3D) underground resource on the Ranger site. However, despite development approvals and some initial work, **the project was abandoned in June 2015 due to depressed commodity prices and stakeholder concern.**[9] The R3D decline and associated infrastructure remains on care and maintenance.

2012 — The Ranger mine continued to process stockpiled ore but **no longer extracted new supply.** Over 40 years, Ranger has produced more than 120,000 tonnes of uranium oxide — one of only three uranium operations globally to have reached this scale.

2018 — ERA released the Mine Closure Plan which **details the rehabilitation approach.**

2021 — ERA required to **end all mining and processing at the Ranger site.**

2026 — End of the **current mandated rehabilitation period at Ranger.**

[7] Fagan, M. (2002). Broken promises: Land rights, mining and the Mirrar people. Indigenous Law Bulletin, 5(18), p. 12.

[8] Ranger Uranium Environmental Inquiry, 1977, p. 9.

[9] **http://www.energyres.com.au/company/history/**

Toxicity and tailings – the process of making uranium oxide

Following extraction by open cut mining, the ore is crushed and leached with a sulphuric acid solution. Kerosene and ammonia-based processing is then used to remove the uranium, which is converted to uranium oxide via exposure to a calciner or furnace. It is this uranium oxide, or yellowcake, that is sold abroad.

The radioactive slurry and toxic by-products that result from this leaching and milling process are known as tailings and contain around 70% of the radioactivity of the original ore. After processing these are much more mobile than when underground and are temporarily deposited into the tailings dam or tailings storage facility (TSF). As part of rehabilitation, the tailings will be placed into the mined-out pits and covered with waste rock.

Left. Mirarr Senior Traditional Owner Yvonne Margarula with footage of her father Toby Ganagale from 1978 when he spoke about the dangers of uranium. *Photo*. Glenn Campbell, The Age

The global impacts of mining uranium

There have been long-held concerns over the nuclear safety and security impacts of the Australian uranium sector. Critics maintain that despite safeguard arrangements and assurances, there can be no failsafe guarantee that Australian uranium does not directly fuel or indirectly facilitate other nations' nuclear weapons programs.

This concern was highlighted in the contest over planned uranium sales to India when the former head of the Indian national security advisory board stated: "*Given India's uranium ore crunch and the need to build up our [...] nuclear deterrent arsenal as fast as possible, it is to India's advantage to categorise as many power reactors as possible as civilian ones to be re-fueled by imported uranium and conserve our native uranium fuel for weapons-grade plutonium production*".[10]

Critics of the Ranger operation have also highlighted the direct connection between Australian uranium sales and the increased production of long-lived high-level radioactive waste. Large volumes of lower-level radioactive tailings at uranium mines, as well as concentrated higher-level radioactive waste at nuclear power facilities, create complex intergenerational management challenges. This highlights that, while nuclear generated electricity may have a lower carbon footprint than fossil fuels, it is a very long way from a low risk or 'clean' energy source.

ERA exports uranium to a range of nations including the USA, Japan, South Korea, China, the UK, France, Germany, Sweden and Spain. The Asian market has traditionally been important and the collapse of the uranium commodity price following the Fukushima crisis in Japan severely impacted ERA.

In 2011, the Australian Safeguards and Non-Proliferation Office of the Department of Foreign Affairs and Trade confirmed that "*Australian obligated nuclear material (uranium) was at the Fukushima Daiichi site and in each of the reactors*".[11]

The Mirarr people have long expressed concerns over the possible adverse impacts that uranium extracted from their country might have on others. Such concern was raised by former Mirarr senior Traditional Owner Toby Gangale in the powerful documentary *Dirt Cheap*, where he directly links proliferation and safety concerns with proposed uranium sales to Japan.[12]

In April 2011, Toby's daughter, the current Mirarr senior Traditional Owner Yvonne Margarula wrote to UN Secretary-General Ban Ki-Moon to convey her sorrow, stating: "*It is likely that the radiation problems at Fukushima are, at least in part, fueled by uranium derived from our traditional lands. This makes us feel very sad.*"[13]

In August 2014, Mr Naoto Kan — Prime Minister of Japan at the time of the Fukushima crisis — visited Kakadu to meet with the Mirarr community and acknowledge this shared sadness and impact.

Along with these broader international concerns, there has been sustained criticism of Ranger's operational and site-specific impacts. The mine has been highly contested and there is extensive documentation of nearly 1,000 leaks, spills, incidents and operational breaches during its commercial life.[14] It is imperative to ensure that the management of the Ranger mine rehabilitation is more robust and effective than its historical operations.

Right. Former Japanese Prime Minister Naoto Kan flying over Ranger Uranium Mine, 2014. *Photo*. Dominic O'Brien

[10] Subrahmanyam, K. (2005). "India and the Nuclear Deal," Times of India, 12 December 2005. **https://timesofindia.indiatimes.com/edit-page/India-and-the-nuclear-deal/articleshow/1327306.cms**

[11] Floyd, R. Australian Safeguards and Nuclear Safety Organisation, October 2011. **https://parlinfo.aph.gov.au/parlInfo/search/display/display.w3p;query=Id:committees/commjnt/8ef1cf22-228a-4386-b69b-04223a111dfe/0002**

[12] *Dirt Cheap 30 years on*: The story of uranium mining in Kakadu, **https://vimeo.com/73373709**

[13] **http://www.mirarr.net/library/australian-indigenous-leader-concerned-by-uranium-mining-and-impacts-on-japan**

[14] As of 7 June 2018, there had been 955 reportable incidents at Ranger.

What happens if ERA goes bust, defaults or is placed in administration **before rehabilitation is completed?**

Rehabilitation of the Ranger uranium mine

The simple environmental measure of a successfully rehabilitated mine site is that it should be rehabilitated to a point where a mining company can hand it back to the government without any risks to the environment or local communities.

In terms of public risk, a successfully relinquished mine site also means the tax-payer doesn't have to foot an environmental clean-up bill now, or sometime in the future.

Sadly, there are very few examples of successfully rehabilitated mine sites in Australia,[15] including in the uranium sector. In many cases, the Australian tax-payer is either left to pay for a botched rehabilitation, or the site is simply not rehabilitated at all.[16]

The Australian environment and public is currently burdened with more than 50,000 abandoned mine sites and there is no corporate entity or dedicated agency accountable or responsible for their rehabilitation.[17] While many of these sites do not pose significant risks, others do, and sometimes on a large scale such as at Mt Lyell (Tasmania) and Mt Morgan (Queensland).

[15] Roche, C and Judd, S. (2016). Ground Truths: Taking Responsibility for Australia's Mining Legacies, Minerals Policy Institute. **http://www.mpi.org.au/wp-content/uploads/2016/06/Ground-Truths-2016-web.pdf**

[16] Around 75% of mine closures are unplanned, raising significant environmental and regulatory issues, see Laurence, D. (2006) 'Optimisation of the mine closure process', *Journal of Cleaner Production* 14(3–4):285–98.

[17] Ibid.

Above. Jabiru in Kakadu wetlands. *Photo*. Dominic O'Brien

The legacy of failed rehabilitation

Rio Tinto — Mary Kathleen and Rum Jungle

The former Mary Kathleen uranium mine near Cloncurry in western Queensland was operated by precursors to the current Rio Tinto in two stages between 1956–63 and 1974–82. Since its closure and rehabilitation, the site has experienced significant tailings seepage.[18] These seepage rates have been higher than predicted and contaminants include saline and radioactive water, uranium, iron, nickel and manganese. There has been adverse and continuing local impacts with contaminated creeks and pollutants distributed through dust and wind .[19]

Similarly, Rum Jungle near Batchelor in the Northern Territory continues to impact the surrounding environment long after closure.[20] This mine was operated by Conzinc Rio Tinto of Australia, also a forerunner to the current Rio Tinto. Earlier rehabilitation works were inadequate and there are serious and continuing contamination issues at Rum Jungle today. The Australian and Northern Territory governments have a current Partnership Agreement for a new rehabilitation plan in late 2019, which is expected to cost $300 million in public funds — in addition to more than $60 million already spent.[21]

Across the wider Australian mining sector, local communities are frequently left with the environmental legacies of unrehabilitated mine sites. These include biodiversity loss when ecological restoration works fail or are entirely absent; environmental impacts associated with heavy metals and chemicals leaching from mine sites into local waterways; and local wildlife and vegetation being contaminated and poisoned. Further examples of failed rehabilitation of modern mines include Redbank and Mount Todd in the Northern Territory and Benambra (now Stockman) in Victoria. It is imperative the rehabilitation at Ranger and the protection of the dual World Heritage-listed Kakadu National Park breaks this trend and delivers a world-class mine rehabilitation and mine closure process.

Need for enhanced **scrutiny and transparency**

The experiences at Mary Kathleen and Rum Jungle highlight the complexities and challenges of uranium rehabilitation and raise serious concerns about the gap between promise and reality. Both operations were the direct responsibility of the Rio Tinto group and neither has been effectively remediated. There is a clear need for enhanced scrutiny and transparency to ensure the rehabilitation of Ranger is done differently, and better.

[18] **http://www.wise-uranium.org/udaus.html#MARYKATHLEEN**

[19] Senate Environment and Communications References Committee "Rehabilitation of mining and resources projects and power station ash dams as it relates to Commonwealth responsibilities", March 2019, p. 46.

[20] Mudd, G M. (2010). The Environmental Sustainability of Mining in Australia: Key Mega-Trends and Looming Constraints. Resources Policy, Volume 35, Issue 2, pp. 98-115.

[21] Senate Environment and Communications References Committee, "Rehabilitation of mining and resources projects and power station ash dams as it relates to Commonwealth responsibilities", March 2019, p.25.

The drivers of rehabilitation failure

Rehabilitation failures can be attributed to two main drivers. The first concerns the material environmental complexities involved in rehabilitating what is essentially a toxic waste dump.[22] At Ranger mine, processing residues (tailings) containing radionuclides, heavy metals and chemicals will be placed in the mined-out pits. These are planned to be mostly backfilled with radioactive waste rock — rock with concentrations of uranium sufficiently radioactive to require management — and capped with a final surface cover of clean or non-mineralised rock.

The statutory Environmental Requirements (ERs) which regulate mining at Ranger, require the site be rehabilitated to a standard where it can be incorporated into Kakadu National Park. No uranium mine in Australia, or globally, has been required to meet this standard. The ERs also require that Energy Resources Australia (ERA) is responsible for ensuring these toxic mine tailings are physically isolated and that any solutes escaping from the tailings do not cause environmental impacts for at least 10,000 years. While these time-scales may seem abstract, it is important to remember Aboriginal people have inhabited the Kakadu region for at least 65,000 years and so 10,000 years is not a fanciful time period, in either an Aboriginal or landscape time-scale.

Two of the most significant ERs are:

- ***2.1 Subject to subclauses 2.2 and 2.3, the company must rehabilitate the Ranger Project Area to establish an environment similar to the adjacent areas of Kakadu National Park such that, in the opinion of the Minister with the advice of the Supervising Scientist, the rehabilitated area could be incorporated into the Kakadu National Park.***[23]
- ***11.3 Final disposal of tailings must be undertaken, to the satisfaction of the Minister with the advice of the Supervising Scientist on the basis of best available modelling, in such a way as to ensure that:***

  i) the tailings are physically isolated from the environment for at least 10,000 years;

  ii) any contaminants arising from the tailings will not result in any detrimental environmental impacts for at least 10,000 years.[24]

Unfortunately, history highlights that the mining industry tends to have an unfounded optimism in its ability to mine fragile ecosystems and then later restore these to their original state.[25] This is demonstrably not the case in relation to the actual practice of the Australian uranium industry. At Ranger, the hard truth is that the site cannot ever be rehabilitated to its original state and any claim otherwise is misleading. Against the background of this unpalatable reality, we need to take effective action to ensure the rehabilitation of the Ranger site is the best it can possibly be.

The second driver of rehabilitation failures is the systematic lack of transparency, accountability and financial security around rehabilitation and post-closure frameworks.[26] Public transparency and independent assessment of rehabilitation plans and works is crucial. The rehabilitation works at Ranger are occurring under the convoluted and archaic administrative and approvals framework that facilitated the mine's operations for decades. While there are public processes in place for environmental impact assessments for new mines, there are no equivalent requirements for public participation and transparency around the closure of current mines.

This is a significant regulatory failure, given that closing a mine in an environmentally responsible way poses at least as many challenges as operating one. In light of the longevity of potential environmental risks after closure, there is a compelling case that closure operations require dedicated and fit-for-purpose assessments that address the site-specific issues, and better reflect both evolving industry practice and community expectation.

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[22] On the systemic environmental challenges associated with mine rehabilitation, see Lamb, D, Erskine, P and Fletcher, A. (2015). 'Widening gap between expectations and practice in Australian mine site rehabilitation'. *Ecological Management & Restoration* 16(3): 186-95.

[23] Ranger Environmental Requirements, Section 41 Authority

[24] Ibid.

[25] For a general critique of the restoration paradigm, see Beckett, C and Keeling, A. (2018). Rethinking remediation: mine reclamation, environmental justice, and relations of care, Local Environment, 24, no. 3 (2019): 216-230.

[26] On the impacts of these regulatory failures for Aboriginal people, see O'Faircheallaigh, C, and Lawrence, R. (Forthcoming) "Mine Closure and the Aboriginal Estate" *Australian Aboriginal studies*

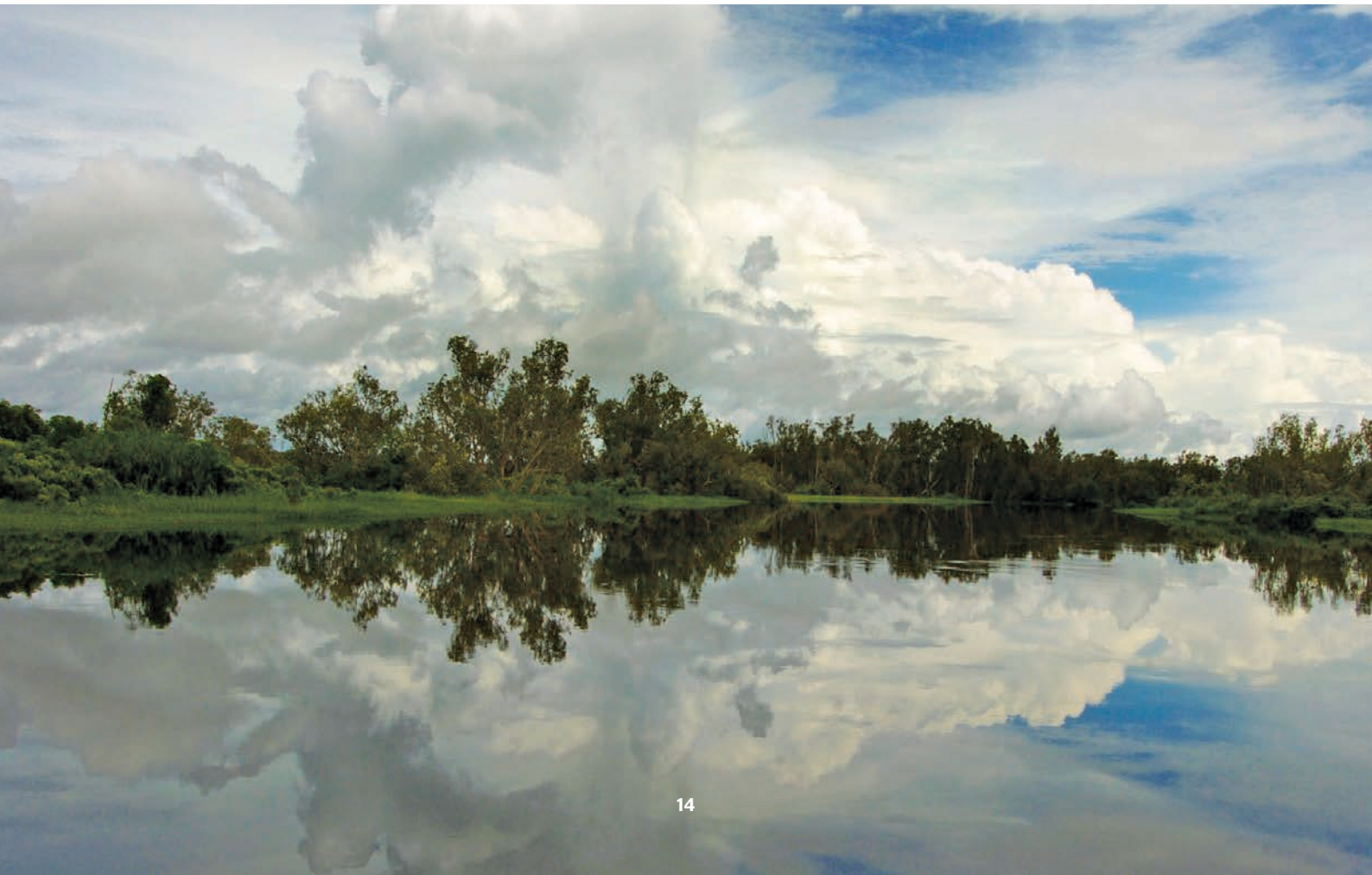
Right. Sandstone outcrops on Mirarr country.
Below. Magela floodplain. *Photos*. Dominic O'Brien

Should rehabilitation works fail, as they very often do, an insurance plan must be in place. Currently there is very little, if any, government regulation and oversight of the financing of rehabilitation, monitoring and future remediation works. This absence raises serious questions: **What happens if the mining company goes bust, defaults or is placed in administration before rehabilitation is completed? What happens if it is completed and handed back to the government, but subsequently rehabilitation is found to be inadequate and the environment is compromised or contaminated by pollutants leaching into local waterways? Who is responsible? Who is accountable? Who pays?**

These questions are particularly relevant to Ranger. They require explicit attention as the rehabilitation operation and its regulatory architecture is advanced. The absence of clear answers suggests these issues are either seen as not important or not relevant to government or industry. Neither position is acceptable or tenable.

This report outlines key challenges facing the rehabilitation of the Ranger uranium mine and divides these challenges into two broad categories: The substantive challenges around the material environment and the practical work during rehabilitation and after closure, and the process itself — how are decisions around the rehabilitation being made, who gets a say and who is responsible both now and well into the future?

We recognise there is important rehabilitation research and work being undertaken by both mine operator ERA and the Supervising Scientist Branch (SSB). However, we remain seriously concerned that the research and rehabilitation works are behind schedule, suffer from significant knowledge, data and capacity gaps, and that there are structural regulatory deficiencies at both a Northern Territory and national level that require urgent attention. These concerns are detailed in greater depth in this report.



The outcome at Ranger is of critical importance to Rio Tinto's reputation as a **responsible corporate citizen**

Key challenges: **Environmental**

The environmental challenges facing the rehabilitation of the Ranger uranium mine and the Ranger Project Area are profound. Mine site rehabilitation is notoriously difficult,[27] but rehabilitating a heavily impacted decades-old uranium mine in the Wet-Dry tropics to a similar standard as the Kakadu National Park World Heritage area raises the stakes higher again. In fact, there is no comparator: no-one has ever tried this before.

Most uranium mine sites end up as abandoned toxic waste dumps, rehabilitation failures or — as with the large-scale rehabilitation of the former DDR uranium mines in the Wismut region of Germany — part reclaimed, part restricted. At Wismut, federal funding of €7 billion has enabled significant environmental redress but further work and funding is still required. Continuing public health concerns mean large parts of the area will effectively remain restricted forever.[28]

The fact that Ranger uranium mine is aiming for a rehabilitation standard never previously attempted or achieved has drawn considerable national and international attention and put increased pressure on the Australian and Northern Territory governments, ERA and Rio Tinto to get this right. The outcome at Ranger is of critical importance to Rio Tinto's international reputation as a responsible corporate citizen, and its wider social license to operate.

Importantly, hope for the success of the rehabilitation project is shared by a wide range of stakeholders. There is now a real chance to move from an operational history of contest to a rehabilitation future of collaboration and co-operation at the Ranger site.

Here, we explore a number of key environmental challenges facing this work. This list is not definitive. Some challenges relate to the rehabilitation works while others are more closely related to post-closure environmental issues.

Leaking tailings and contaminated groundwater

Tailings dams are designed and constructed to minimise seepage, yet it is an accepted industry understanding that all tailings dams seep into the groundwater. This carries contaminants — salts, heavy metals and radionuclides — into the environment. With any mine closure it's important to be clear about the rate of this seepage, what solutes are contained in the seepage, where the groundwater flows and the likely environmental impacts.

This has always been controversial for Ranger. Widely varying seepage estimates have been presented over decades of operation. A major challenge has always been to ensure rigorous monitoring of groundwater to detect seepage and implement appropriate mitigation measures.

In 2009, controversy erupted at Ranger over the estimates of tailings dam seepage and the minimum level of statutory monitoring required when it was acknowledged that a realistic estimate of the seepage could be 100,000 litres per day flowing westward towards Kakadu National Park. While scientific opinions vary, the need for rigorous environmental monitoring, independent scientific review and public transparency were all highlighted during this controversy, and these concerns remain unresolved today.[29]

There is uncertainty about what will happen to the plume of contaminated groundwater currently sitting under the tailings dam after this is emptied of tailings. This plume has accumulated and grown as a result of seepage. As part of the rehabilitation works, tailings currently being stored in the tailings dam will be transferred by pipeline from

[27] Lamb, D, Erskine, P and Fletcher, A. (2015). 'Widening gap between expectations and practice in Australian mine site rehabilitation'. Ecological Management & Restoration 16(3): 186-95.

[28] **http://wise-uranium.org/udde.html**

[29] **https://www.smh.com.au/national/polluted-water-leaking-into-kakadu-from-uranium-mine-20090312-8whw.html?js-chunk-not-found-refresh=true**

Right. A jabiru lands on a waste rock pile at Ranger uranium mine. *Photo*. Dominic O'Brien

the dam to the former open-cut pits. But how to remediate the plume beneath the dam, and how the contaminated plume will respond once the weight of the tailings is removed from the dam above, remains unknown.

Rigorous and transparent risk assessments of tailings management during the rehabilitation operations are essential. The rehabilitation of the tailings dam and management of the contaminated plumes is set to be the focus of what is known as a 'stand-alone' application. This means it is not dealt with at length in the Mine Closure Plan (MCP) but will be a part of a separate assessment and approval process. There is currently no commitment by ERA, SSB or the Northern Territory and national regulators to make this process transparent or inclusive, something that is of serious concern and which we discuss in greater detail in this report.

Toxic contaminant mixtures

Even after rehabilitation has been completed, heavy metals and chemicals will continue to move into the surrounding environment. The main pathways for this pollution are contaminant leaching from the surface waste rock used to cover the tailings and from the tailings and brine buried in the mined-out pits. In 2013, ERA introduced a Brine Concentrator to help reduce contaminated mine water volumes in the tailings dam and manage heavy rainfall events.[30] This treats contaminated water to a point where it can be discharged to the environment, while the residual brine waste is disposed in the tailings dam.

However, contaminant leaching still takes place when water moves through the brine, waste rock and tailings and mobilises heavy metals and chemical residues. These contaminants include ammonia, magnesium, manganese, radium, sulphate and uranium. Both surface and groundwater will carry contaminants off-site and are known contaminant pathways. In rehabilitation terms, uranium, magnesium and sulphate are the solutes of most concern.

Australian freshwater and marine ecosystems are protected by the national Environment Department's Australian Freshwater and Marine Water Quality Guidelines. The basic premise is that the higher the concentration of a toxic contaminant, the more of a given species it will affect or even kill. The equation becomes 'at concentration X this % of a certain species will be impacted or die'. The Freshwater Guidelines review the scientific literature for tests on possible contaminants to as many species as possible. They thereafter develop average levels as guideline values to protect species at different levels, such as 80%, 95% or 99% of species.

This approach assumes all species react in a similar manner to the same contaminant, but it cannot capture all issues which affect the way a contaminant impacts aquatic ecosystems. Some contaminants cause non-lethal effects — like cancer and reproduction — some species are much more sensitive, and sometimes mixtures of contaminants can be more toxic when combined. In theory, guideline values for 99% protection should maintain the water quality for a pristine ecosystem. However, despite growing knowledge in the field of ecotoxicology many challenges and uncertainties remain.[31]

SSB has adopted the goal that 99% of the surrounding aquatic biodiversity should be protected. This means no more than 1% of the surrounding aquatic species should be damaged by mine site contamination. SSB has undertaken a number of studies on 'guideline values', which set theoretical thresholds for levels of individual contaminants that aquatic species can tolerate if this is to be achieved. This exercise essentially asks: What are the acceptable contaminant thresholds and levels for sensitive species? This research has primarily been undertaken in a laboratory environment where sensitive species — such as molluscs, algae and fish — are exposed to increasing levels of contaminants to determine the highest tolerable level, while still protecting 99% of the species.

[30] **http://www.energyres.com.au/sustainability/water-management/**

[31] Brietholtz, M, Rudén, C, Hansson, S O & Bengtsson, B-E. (2006). Ten Challenges for Improved Ecotoxicological Testing in Environmental Risk Assessment. Ecotoxicology and Environmental Safety, 63: pp 324-335.

This raises a range of questions, including:

- What levels of contaminant mixtures (i.e. thresholds) are acceptable in order to protect 99% of the surrounding species? In other words, what is theoretically acceptable?
- What contaminant mixtures will *actually* be produced by the rehabilitated mine site and migrate downstream from the site?
- How can we best ensure that *actual* contaminant mixtures do not exceed *theoretical* thresholds set to protect the environment?

The scientific research undertaken by SSB is valuable because it has identified the guideline values for individual contaminants such as manganese, magnesium, sulphate, ammonia and uranium. This provides relative scientific confidence in the benchmark for pollutant levels of individual contaminants tolerated by the surrounding environment. However, a major problem is that ERA's benchmarks for individual contaminant levels are more lax than those set by SSB.

Moreover, while benchmarks for individual contaminant levels on individual species are useful, they tell us little or nothing about what will actually happen in real-time when these contaminants mix through multiple pathways of water flows in the surrounding environment.

While SSB has undertaken important research into some contaminant mixtures, such as calcium and magnesium, neither SSB or ERA have publicly provided a clear assessment or complete modelling around the totality of toxic contaminant mixtures on-site. This again raises unanswered questions: What happens when surface water flows over waste-rock taking contaminant mixtures with it and then mixes with other flows of water through tailings and brine? What toxic cocktail can we expect downstream and what kinds of impacts will that have on the surrounding ecology? These issues need to be publicly and clearly explained so all stakeholders are aware of the future risks to Kakadu National Park. Transparency will help inform the most effective mitigation strategies.

A further complicating factor is that contaminant loads leaching downstream from the waste rock will not peak until around 300 years after closure. Leaching from tailings will take even longer, up to thousands of years. The longevity of these delayed impacts mean we need to rely on robust modelling to predict contaminant levels and mixtures. The problem is this modelling has not yet been undertaken, or if it has, it has not been publicly released in a clear and accessible format.

In short, no-one appears to know what the cocktail of contaminants flowing off the rehabilitated Ranger site into the surrounding Kakadu National Park will look like or how it will behave. This uncertainty is further compounded by the impacts of climate change, a critical factor we discuss further in this report.

There are other questions that must be asked, too. What happens in the case that modelling is finalised and predicts that contaminants will be higher than the ideal 'guideline values' for contaminant thresholds? What would ERA actually be prepared and able to do to stop chemicals and metals leaching into the surrounding environment over the next 10,000 years? What remediation methods would be available?

In the laboratory, if an experiment with vulnerable fish species demonstrates that contaminant mixtures are too high, and fish are dying, the solution is to re-run the experiment, 'dilute' the contaminant mixture and reduce the toxicity until it can be demonstrated that the fish can survive.

Kakadu is a living landscape, not a laboratory. We cannot expect that controlled experiments and modelling will translate into effective rehabilitation practices in a dynamic monsoonal environment. A key concern at the Ranger site is that water flows vary widely between the Wet and Dry seasons. There is a real risk that contaminant levels will increase during the Dry due to the lack of water and evapoconcentration.

We don't have an opportunity to 're-run' an experiment in Kakadu if contaminant levels are too high. And if we don't yet know the contaminant mixtures that will flow off the rehabilitated Ranger site and into Kakadu — because it hasn't yet been modelled — how can we know whether the objective of protecting 99% of the aquatic biodiversity is actually achievable, or simply a lofty goal to placate concerned stakeholders?

Risk of failed ecological restoration

One of the key Environmental Requirements (ERs) in ERA's operating license is to rehabilitate the Ranger uranium mine site to a standard where it can be incorporated into the surrounding Kakadu National Park. This is a complex ecosystem of savanna woodlands on natural soil in stark contrast to the revegetation of the mine site that will essentially take place on waste rock. At Ranger, there is scant soil available after 40 years of operations and so the starting point for the rehabilitation works is very different to the surrounding environment and far less amenable to successful revegetation.

Despite this, the current research by SSB appears to downplay this crucial environmental difference. It instead seems to aim for an unrealistic and idealised notion of restoring the environment to a prior 'pristine' state — an ambition that is quite simply impossible to achieve. Both ERA and SSB appear reluctant to explicitly and publicly acknowledge this uncomfortable truth. **The Ranger site has been heavily and adversely impacted, and while this damage can and must be mitigated, it cannot be erased.** This reality is not a rationale for lowering performance expectations but rather a call for clear and credible communication on what is achievable to inform realistic expectations for all stakeholders.

An example of this can be seen in the detailed baseline studies of the surrounding ecological environment by SSB. These directly relate to the ER that the site must be rehabilitated "to establish an environment similar to the adjacent areas of Kakadu National Park". The problem here is that the waste rock cover of the rehabilitated Ranger mine is unlike any landform and ecosystem in the immediate vicinity, which makes any study of similar sites highly problematic.

This raises a further critical question: What is the real utility of the detailed scientific baseline studies of the surrounding environment if little of this will actually be replicable on the mine site?

This lack of clarity risks compromising outcomes if SSB's rehabilitation research and ERA's actual rehabilitation works are not more closely aligned.

ERA's plans for ecological restoration also contain several fundamental flaws. First, the proposed rehabilitation will likely result in a reduction of the 90 flora species initially observed on the site to less than 30 established and reproducing species.[32] This two-thirds reduction is disturbing and highly inadequate.

Second, ERA's proposed plans to analyse the impact of the introduction of fire into the ecosystem after five to seven years only includes a limited and inadequate one-off assessment of plant survival after seven years.

Third, ERA's plan is based on restoring fauna by indirect means only and does not actually include a specific fauna restoration plan. Instead there is an inherent presumption that fauna will recolonise the site after the establishment of flora creates appropriate habitat. This is a *fundamental* flaw as fauna re-establishment is likely to be reduced given the limitations on the expected flora that will be established. In simple terms, if there are fewer trees, bushes and grasses there will be fewer animals and insects repopulating the area and this pivotal issue is not adequately addressed by ERA.

Finally, the overall timeframes for the establishment, monitoring and further remedial rehabilitation are unclear in the MCP and appear to significantly overestimate what can be done in the limited time remaining before 2026.

Ecological processes do not work as quickly or predictably as people and planners often desire. It is unhelpful to state the end goal is to return the area to a similar state to what is was before within an unrealistic time frame. This sets up unachievable expectations, undermines stakeholder confidence and fails to reflect the complexity of the rehabilitation challenge. It is unlikely that visions of harvesting natural bushfoods from pristine country will be achieved within a generation or two on what are essentially rehabilitated waste dumps — both SSB and ERA should be honest about this. This is crucial, especially given that the Mirarr Traditional Owners will the primary users and carers of the site into the future.

It is fundamental to the **success of the rehabilitation effort** that a stable landform be achieved

Landform instability

The stability of the final landform at the rehabilitated Ranger site is pivotal to the long-term success of the rehabilitation works. This stability is partly dependent on successfully predicting how the buried tailings will behave. If these consolidate at greater or lesser rates than predicted, this will mean differences in the slope and shape of the above landform and increased risks to landform stability. There are significant concerns that ERA has not adequately modelled the tailings consolidation process and not paid sufficient regard to landform stability.[33]

The stability of the final landform is also partly dependent on the success of the revegetation works. If trees, bushes and grasses do not successfully populate the site then erosion will occur and the landform will become increasingly unstable.

[32] The MCP states that 'over 90 flora species' have been recorded over the two primary vegetation communities of the RPA, as well as 80 weed species. Phase 1 of the rehabilitation proposes planting 49 species, but because of the likelihood of 'confounding factors to success', the MCP proposes a success criterion of 35. This is one-third of the original number of species recorded on the site (p. 6–31). The document also indicates plant reproduction as a measure, but then suggests that 'considering the timeframe over which revegetation will be assessed, it is not considered reasonable to expect 100% species will flower and fruit. Therefore, a target of 80% of framework species is reasonable' (p. 6–32) — note that it is 'framework species' not 'all species planted' that is mentioned. If these success percentages are followed in linear fashion, there is a reduction from the 90 species observed initially on site, to likely less than 28 established and reproducing as being a measure of satisfactory outcome.

[33] SSB, Assessment report, p. 31.

Any instability can lead to increased sediment loads in surrounding waterways, polluted ecosystems and the formation of gullies. Gullies provide recharge pathways for groundwater through permeable rocks and soils where rainfall and runoff can seep down into the groundwater and exacerbate pressure on solute migration from the underlying tailings. This chain of events would have profoundly adverse impacts on the surrounding environment.

It is fundamental to the success of the rehabilitation effort that a stable landform be achieved. This is no simple feat. Even if site revegetation is successful, SSB has estimated that erosion rates will not stabilise for hundreds of years. It is essential there is clarity over who will be responsible for undertaking the maintenance due to erosion in the early to middle stages of the landform development.

It is also pivotal that there is independent testing of ERA's modelling that the tailings will not be exposed for 10,000 years. This is needed to provide some assurance that ERA's mandated requirement to isolate tailings for this length of time is possible and that the best techniques are adopted to advance this.

Disturbingly, ERA's current modelling appears to be based on an erroneous understanding of what worst-case scenario modelling should actually do. ERA states in the MCP that "any worst-case scenarios developed [in relation to tailings exposure] will need to be realistic and reasonable".[34] The entire rationale of worst-case scenarios is to model the unexpected and extreme, not what is realistic and reasonable.

ERA needs to urgently revisit the modelling, apply a credible real-world worst-case scenario methodology and make this available for independent testing to help build a transparent rehabilitation process that delivers real and lasting outcomes.

Climate change impacts and risks

The Kakadu region is set to experience rapid rates in sea-level rise due to climate change. By 2030, a mere decade away, the region will see mild saltwater inundation of floodplains. By 2070, this saltwater inundation will be widespread, affecting around 65% of freshwater floodplains.[35] This will create significant ecological and governance challenges for the region as rapid and complex transformations take place in the environment.[36]

This is the fast-changing environment in which the rehabilitation of the Ranger uranium mine will take place. The impacts of climate change will make their mark in profound and unpredictable ways. Recent research has highlighted the uncertainties and risks inherent in the cumulative impacts of both climate change and the rehabilitation of the Ranger uranium mine on the surrounding environment, including on groundwater and ecosystems.[37–38]

Although acknowledged in SSB's modelling, these analyses appear conspicuously absent in the mining company's MCP. While ERA states that global climate change scenarios have informed the studies underpinning the MCP, it is unclear how as the discussion on risk management does not explicitly address climate change risks at all.

[34] ERA (2018) Mine Closure Plan, Issued Date: May 2018. Revision #: 0.18.0, p. 6-3

[35] Bayliss, P *et al*. (2018). Assessing sea-level rise risks to coastal floodplains in the Kakadu Region, northern Australia, using a tidally driven hydrodynamic model. *Marine and Freshwater Research*, 69(7), pp.1064-1078.

[36] Dutra, LX, *et al*. (2018). Understanding climate-change adaptation on Kakadu National Park, using a combined diagnostic and modelling framework: a case study at Yellow Water wetland. *Marine and Freshwater Research*, 69(7), pp.1146-1158.

[37] Kabir, M, Mudd, GM, Ladson, AR and Daly, E. (2008). Groundwater-climate relationships, Ranger uranium mine, Australia: 3. Predicting climate change impacts. In *Uranium, Mining and Hydrogeology* (pp. 361-370). Springer, Berlin, Heidelberg.

[38] Humphrey, CL, Bishop, KA and Dostine, P.L. (2018). Vulnerability of fish and macroinvertebrates to key threats in streams of the Kakadu Region, northern Australia: assemblage dynamics, existing assessments and knowledge needs. *Marine and Freshwater Research*, 69(7), pp.1092-1109.

It is a remarkable and profound deficiency of the closure plan that a rehabilitation project with a clear regulatory requirement that tailings be isolated from the surrounding environment for 10,000 years does not provide any detailed risk analysis or assessment of climate change impacts in an unpredictable and fast-changing monsoonal environment.

Lack of knowledge around key social and environmental risks

An overarching concern regarding rehabilitation and post-closure at Ranger is the lack of knowledge and attention around key social and environmental risks and their management.

It is surprising and deeply concerning that, despite the often-repeated claim that the Ranger uranium mine is the most regulated and monitored mine site in the world, so little is known about some of the most fundamental environmental and rehabilitation challenges.

This is evidenced, for example, by the continuing uncertainty over how contaminated groundwater beneath the tailings dam will be remediated — will it move off-site and towards Kakadu National Park or will it rise and be appropriately managed? This is just one example of the important knowledge deficits in the current rehabilitation planning process.

SSB calls these gaps key knowledge needs and provides a list in their assessment report of the MCP. This long list of key knowledge needs contains many questions and uncertainties but very few answers. It demonstrates there is still a lot we don't know about what will happen to the site and the surrounding Kakadu World Heritage region, either during rehabilitation works or after closure. This is particularly concerning given rehabilitation works have already begun and are due to be completed in 2026.

While SSB's list of key knowledge needs appears extensive, it actually fails to identify a crucial series of knowledge gaps and uncertainties which fall outside the narrow scope of the 'biophysical environment'. In particular, SSB report fails to identify social impacts as a knowledge gap, despite the fact there are no ongoing or planned monitoring activities of the social impacts of closure of the Ranger mine on Aboriginal people.

The Kakadu region is set to experience **rapid rates in sea-level rise**

This is inconsistent with the original *Ranger Uranium Environmental Inquiry — the Fox Inquiry —* and the Commonwealth Environment Protection (Alligator Rivers Region) Act (1978), both of which clearly stipulate the importance of the social and cultural domains to the environment.[39]

There are two social impact studies that collated significant material on uranium mining in Kakadu that should inform the closure planning at Ranger. The first is the *Social Impacts of Uranium Mining Project* undertaken during the 1980s.[40] The second is the *Kakadu Regional Social Impact Study*, which was done during the contest over the Jabiluka mine proposal in the late 1990s. Neither of these studies feature in ERA's closure plan, and there is no discussion of how the issues raised in these

[39] While there has been substantial and ongoing investment in the monitoring of biophysical environmental conditions arising from the mining operations, particularly, but not solely, through SSB Office, there has been no parallel commitment to engagement with the social and cultural environmental consequences — despite the clear obligation placed on the Australian government, its agencies and private interests by the Commonwealth legislation (Environment Protection (Alligator Rivers Region) Act (1978)), which defines environment as specifically encompassing the social and cultural domains:

> environment includes:
>
> (a) ecosystems and their constituent parts, including people and communities;
>
> (b) natural and physical resources;
>
> (c) the qualities and characteristics of locations, places and areas; and
>
> (d) the social, economic and cultural aspects of a thing mentioned in paragraph (a), (b) or (c).

[40] SIUMP — Australian Institute of Aboriginal Studies. Uranium Impact Project Steering Committee (1984). Aborigines and Uranium: Consolidated Report on the Social Impact of Uranium Mining on the Aborigines of the Northern Territory. Canberra, Australian Government Publishing Service. This was the consolidated report of the Committee, which reported every 6 months directly to Parliament from 1978 to 1984.

Right. Comb-crested Jacana, Kakadu National Park.
Photo. Jordi Prat Puig

original studies link back to, or might inform, the closure.[41] This is problematic as it means key social baseline data collected throughout the life of the mine is not integrated into the mine closure process.

It is a profound failure by ERA to have not included this extensive social impact data in the MCP, and equally by SSB to have not highlighted it as a key knowledge need in their own assessment of the closure plan. SSB has been criticised numerous times since its inception for failing to engage with these crucial issues.[42] The social impacts that the closure of Ranger mine will have on Aboriginal people pose considerable challenges.[43] To continue to ignore these issues would constitute a significant social injustice.

A further concern is the apparent reluctance of ERA to clearly articulate and acknowledge where uncertainty and knowledge gaps exist in the MCP. Instead, the MCP gives the impression that everything is understood and on track.

This is simply not the case. The rehabilitation is not fully on track and SSB in their own assessment of the mining company's MCP concludes the document "does not yet provide sufficient evidence to demonstrate that the current plan for rehabilitation of the Ranger mine site will achieve the required Environmental Requirements (ERs)".[44]

Given the purpose of the rehabilitation process is to meet the long-standing ERs, this alarming assessment by SSB demands an active response. A key national agency indicating early in the project that success is not assured should be a red flag for the regulators, ERA and Rio Tinto.

The social impacts that the closure of Ranger mine will have on Aboriginal people **pose considerable challenges**

[41] The one social impact assessment (SIA) that is referred to in the MCP concerns an SIA of the base case scenario and associated impacts, commissioned by ERA and undertaken by Jacobs consultancy in 2016–2017. The base case reflects ERAs obligations under the current lease agreements to rehabilitate the town and associated infrastructure (i.e. bulldoze it). It does not have a specific focus on Aboriginal cultural and social issues, but concerns the town as a whole. Moreover, the said SIA does not assess any other further scenario other than the base case, so Mirarr aspirations are not assessed. The SIA was not publicly released: for a summary of the SIA, see **http://www.energyres.com.au/uploads/general/170717_ERA_SIA_-_Factsheet_FINAL.pdf**

[42] Already in 1997, Howitt's research demonstrated that "scientific (environmental) research [in Kakadu] has largely proceeded independently of social impact and cultural impact research, despite the requirements of the Environment Protection (Alligator Rivers Region) Act 1978". See Howitt, R, 1997 Aboriginal Social Impact Issues in the Kakadu Region, Report Prepared for the Kakadu Region Social Impact Study and the Northern Land Council. Sydney: Macquarie University, p. 10.

[43] See footnote above on the definition of the environment in the Environment Protection (Alligator Rivers Region) Act (1978).

[44] Supervising Scientist 2018. Assessment Report: Ranger Mine Closure Plan Rev #: 0.18.0 May 2018. Internal Report 658, September 2018, Supervising Scientist, Darwin. P. viii.

There is continuing uncertainty over how the regulatory process governing the rehabilitation of Ranger will unfold

Key challenges: **Governance and regulation**

This part of the report identifies challenges with the process surrounding the rehabilitation and closure of Ranger mine. While these necessarily overlap with the substantive and material environmental challenges, process challenges are primarily focused on governance and regulation.

Low benchmark for rehabilitation through weak closure criteria

Closure criteria for the rehabilitation of Ranger have been developed by ERA and were presented in the company's 2018 Ranger Mine Closure Plan. The closure criteria set the benchmark against which regulatory authorities can evaluate the rehabilitation work. Closure criteria relate to many issues including ecological restoration, tailings management and the acceptable amount of salts, radionuclides and heavy metals that can be released into the surrounding environment. They will provide quantifiable guidance and enforceable power to the regulatory authorities.

Given their importance in the rehabilitation framework, there are serious problems with ERA's current closure criteria. They are weak and set the benchmark far too low. The proposed ERA closure criteria consistently fail to rely on evidence-based quantification and are not consistent with SSB's Rehabilitation Standards, which set out SSB's view on how the success of rehabilitation can best be measured.

There are major discrepancies between ERA's Closure Criteria and SSB's Rehabilitation Standards in relation to dissolved concentrations of uranium and manganese in surface water after rehabilitation works are completed. For uranium, SSB Rehabilitation Standard proposes 2.8 ug/L, yet ERA propose a much higher acceptable limit of U 17 ug/L. Similarly, for manganese, SSB Rehabilitation Standard proposes 75 ug/L, yet ERA proposes a much higher acceptable limit of Mn 500 ug/L.[45]

In short, ERA is setting a much *lower* rehabilitation benchmark by proposing the surrounding Kakadu environment can be exposed to significantly *higher* contaminant levels than what the expert national authority says is needed to protect these sensitive ecosystems.

Fundamentally, it is counter-intuitive, if not outright naïve, for governments to allow a mining company to set its own closure criteria. SSB's Rehabilitation Standards are based on 40 years of research and monitoring, but they are not mandatory. Rather they "form the basis of the Supervising Scientist's *advice* on the closure criteria and rehabilitation plans proposed by the mine operator, Energy Resources of Australia (ERA)".[46]

Despite SSB being widely regarded as the expert authority on Ranger uranium mine, it is given an advisory role only. **It is the mining company — with an interest in ensuring closure criteria align with financial and corporate concerns — that is effectively playing the role of government by proposing its own closure criteria.**

For many stakeholders the period of commercial operations at Ranger was characterised by high levels of procedural corporate capture and low levels of transparency. It is imperative that this historical legacy does not determine the approach adopted at Ranger into the future.

Lack of transparency and regulatory certainty

There has been a long history of effort from the Mirarr people, environmental non-government organisations, civil society groups and the broader public to access key information about the environmental impacts of the Ranger mine.

In 2005, the Gundjeihmi Aboriginal Corporation recommended to a Senate inquiry that "the principle of complete transparency and public reporting on all environmental matters should be adopted by ERA,

[45] For SSB's Rehabilitation Standards, see **https://www.environment.gov.au/science/supervising-scientist/publications/ss-rehabilitation-standards**. For ERA's proposed closure criteria, see page 6–19, in ERA (2018) Mine Closure Plan, Issued Date: May 2018. Revision #: 0.18.0

[46] **http://www.environment.gov.au/system/files/resources/eac1374f-538b-488b-bc70-7b23c83ad75c/files/rehabilitation-standards-ranger-uranium-mine.pdf**

the SSD and DBIRD [Northern Territory Department of Business, Industry and Resource Development]. All of the information held by SSD and DBIRD should be publicly accessible as a matter of public and stakeholder interest."[47]

While there has been some limited progress towards a more transparent and publicly accountable mine closure process, including the admission of Gundjeihmi Aboriginal Corporation to the Ranger and Jabiluka Minesite Technical Committees and the public release of ERA's Mine Closure Plan in June 2018, there is still much that needs improvement.

Approval of the less-complex rehabilitation activities are being undertaken through the MCP, and these are publicly accessible. However, approval of the more technically complex activities will occur independently of the MCP, through discrete 'stand-alone' applications. These activities are fundamental to the success of the rehabilitation works but there is no commitment by ERA, SSB or any regulatory authorities to provide public access to these stand-alone applications or public input into their assessment.

This means key decisions for the rehabilitation of the Ranger mine — final landform, remediation of the tailings dam, the disposal and consolidation of tailings into the mined-out pits and the rehabilitation of Ranger 3 Deeps (R3D) — will potentially be kept from public scrutiny. Such an approach is completely at odds with standard regulatory requirements for environmental assessment processes for proposed projects, which include defined opportunities for public participation and consultation. Instead, it is currently completely unclear if, and how, stakeholders and the public will have any access to the assessment process for the stand-alone applications.

There is continuing uncertainty over how the regulatory process governing the rehabilitation of Ranger will unfold. There are stakeholder concerns that ERA, SSB and the Northern Territory and Australian governments are partially making up the rehabilitation and mine closure approvals process as they go along. The regulatory landscape governing Ranger is often unclear and difficult to navigate.[48] There are concerns the chains of responsibility and accountability between the Australian government, the Northern Territory government and ERA are not clearly or adequately defined.

Despite this, both ERA's MCP and SSB's Assessment Report present the regulatory environment in an entirely uncritical fashion. These documents merely list relevant regulations rather than address their gaps and weaknesses or explore their actual interplay in real-world conditions.

SSB Assessment Report fails entirely to critically assess the regulatory and stakeholder management processes described in ERA's closure plan. By not actually assessing this crucial part of the plan, SSB has either assumed this is outside their mandate or that ERA's accounts of these processes are valid and acceptable. Both these assumptions are problematic and troubling. ERA's stakeholder management processes require just as much scrutiny and critique as its accounts of the biophysical rehabilitation processes.

Rather than simply accepting ERA's glancing representation of this complexity through diagrams of stakeholder maps and decision-making processes — as if this actually explained the regulatory reality on the ground — it would be more useful for ERA and the Australian and Northern Territory governments to acknowledge the uncertainty of the current process.[49] This could be aided by providing a transparent evaluation of where uncertainty lies and where regulation is lacking, and clearly articulating what challenges lie ahead.

As previously noted, the rehabilitation works at Ranger are occurring under the pre-existing administrative and approvals framework that has facilitated the mine's operations for decades. This approach is based on a series of assumptions,

[47] Gundjeihmi Aboriginal Corporation, Submission to House of Representatives Standing Committee on Industry and Resources Inquiry into Developing Australia's Non-Fossil Fuel Energy Industry, May 2005, p. 39.

[48] Lea, T, Howey, K and O'Brien, J. (2018). Waging Paperfare: Subverting the Damage of Extractive Capitalism in Kakadu. *Oceania, 88*(3), pp.305-319.

[49] Figure 1–3: "NT and Commonwealth parallel closure approvals processes" in ERA (2018) Mine Closure Plan, Issued Date: May 2018. Revision #: 0.18.0

relationships and understandings that are outdated and not suited to rehabilitation and closure. Closure operations require dedicated and fit-for-purpose assessments that address site-specific issues and reflect evolving industry practice and community expectation. A contemporary approach to a complicated mine closure should not be based on a non-transparent, last century approvals regime.

An open review of the regulation of the Ranger rehabilitation is needed, along with a fresh approach and framework to meet the new challenges of rehabilitation and closure.

Funding for rehabilitation, post-closure monitoring and remediation

There have long been significant concerns around ERA's ability to fund the rehabilitation and monitoring of the Ranger mine site. In 2014, when ERA was pushing to extend the life of the Ranger mine through the underground R3D project, the company argued R3D was necessary to fund the rehabilitation of the mine site. This left many stakeholders, including the Mirarr people, concerned about ERA's ability to fund a full rehabilitation and disturbed by threats to leave an unrehabilitated mine site if ERA did not get approval for R3D.[50]

Concerns from the Mirarr and wider stakeholders, coupled with a depressed commodity price meant R3D was not advanced and funding for the Ranger rehabilitation remained uncertain for some time.

In April 2016, Rio Tinto made a commitment to provide a credit facility of $100 million to ERA, boosting the rehabilitation budget to more than $500 million. This was still insufficient and in December 2018 the predicted clean-up bill increased from $512 million to $808 million — $296 million more than ERA's initial estimate.[51] In February 2019, this amount was further increased to $896 million.[52]

Against the backdrop of sustained financial losses by ERA over the last 10 years, many stakeholders have welcomed Rio Tinto's commitment to ensuring ERA has the capacity to deliver on its obligations. These increases in the cost estimate better reflect the complexity and extent of the rehabilitation works required at Ranger. It is a concern that early company projections had an unrealistic understanding of the complexity and cost of rehabilitation works and it is important the rehabilitation project adopts the best practices, not the cheapest ones.

A significant unresolved concern is that these revised estimates do not include costs for monitoring. Nor do they include estimates for remediation works after the active rehabilitation period. This issue has long been a concern to many, including the Mirarr Traditional Owners. In 2005, the Gundjeihmi Aboriginal Corporation recommended to a Senate Inquiry that ERA be "required to establish a fund in perpetuity that can be used to maintain and monitor the rehabilitated area and if necessary repair any of the rehabilitation works that fail".[53] Similarly in 2008, the Australian Conservation Foundation formally raised concerns over the lack of monitoring funds, and the risk that cost-shifting could see this become a national liability and a tax-payer burden.

This issue remains missing in ERA's closure plan and SSB's assessment report. The absence of this contingency and capacity needs to be explicitly addressed.

Independent monitoring

Monitoring work at Ranger mine during and post rehabilitation raises many challenges. The rehabilitation works themselves involve significant environmental risks, yet there is no proposed monitoring plan for the period of active rehabilitation works. There is scant detail on how the rehabilitation of the Ranger Project Area will be monitored or managed after closure.

[50] **http://www.Mirarr.net/library/held-to-ransom-rio-tinto-s-radioactive-legacy-at-kakadu**

[51] **https://www.abc.net.au/news/2018-12-11/ranger-uranium-mine-rehabilitation-cost-blowout-jabiru/10601696**

[52] **https://www.australianmining.com.au/news/era-increases-rehab-costs-for-ranger-uranium-project/**

[53] Gundjeihmi Aboriginal Corporation Submission to House of Representatives Standing Committee on Industry and Resources Inquiry into Developing Australia's Non-Fossil Fuel Energy Industry, May 2005, p. 12.

Below. Stone country, Mirarr country. *Photo*. Dominic O'Brien

Most concerning is the lack of any discussion on the governance and management plan for the perpetual care and maintenance of the radioactive tailings from the surrounding environment.

The ERs require that tailings be physically isolated from the surrounding environment for a period of not less than 10,000 years. The MCP states: "As it will not be physically possible to monitor and measure this over the defined period of 10,000 years, a model will be required to show that this can be achieved".[54] The MCP includes a statement about the technical modelling for how the tailings will be physically isolated, but nothing on who will be responsible for monitoring this, how the monitoring will be managed or how any remediation and mitigation of tailings contamination will be financed and governed over such a long-time span. A technical model for the tailings management cannot replace an actual management plan.

We also need to remember that, although the Ranger mine is often referred to as the most closely monitored and managed uranium mine in the world, it has a documented and extensive history of unplanned incidents and adverse impacts, numbering close to 1,000 reportable incidents from 1979 to 2018.

These incidents have occurred during an active period with high levels of oversight, raising the question of what will happen if there is no robust monitoring and remediation plans in place. **There is a real risk the rehabilitated site may cause as much or more impact to the surrounding environment as it did during operations because there will be less monitoring and response capacity after closure.**

There needs to be a resourced, credible and continuing commitment by Rio Tinto and ERA to fund monitoring and remediation works in addition to current rehabilitation works. This cannot be left up to the self-regulation or the largesse of these mining companies. The Northern Territory and Australian governments have a duty to ensure that requirements are realised through regulatory reforms, active project oversight and robust legislation.

Without this, the future of Kakadu cannot be assured, and this is simply too high a price to pay. The rehabilitation challenge is current, clear and considerable. Now it needs to be met.

[54] ERA (2018) Mine Closure Plan, Issued Date: May 2018. Revision #: 0.18.0, p. 6-3.

Summary of **recommendations**

Changes are needed in the approach to the Ranger rehabilitation works to improve the chances of a successful outcome. We recommend that:

1. **Energy Resources of Australia's next iteration of the Mine Closure Plan adopts a public consultation framework and adequately addresses:**
   - ecological remediation of the site including the closer alignment of SSB's research work with what is achievable on the rehabilitated site.
   - the impacts of climate change on rehabilitation prospects and approaches.
   - the social impacts of mine closure, particularly on the Mirarr people.
   - enhanced modelling around contaminant mixtures and contaminant pathways.
   - credible worst-case scenario modelling, particularly in relation to landform, erosion and tailings management.

2. **The Northern Territory and Australian governments review and revise the current regulatory system and rehabilitation framework to ensure it is consistent with best industry practice and community expectation, and adopt improved mechanisms for increasing transparency and public engagement and participation, including:**
   - a commitment to the public release and consultation on future iterations of the Mine Closure Plan.
   - a commitment to formal public consultation on the proposed 'stand-alone' applications.
   - a requirement that ERA make key project documents public, including the monitoring plan for the actual rehabilitation works and a detailed post-closure plan for the monitoring of the rehabilitated Ranger Project Area that addresses issues of water quality and topography.
   - a dedicated post-closure plan for the perpetual care, maintenance and isolation of the mine tailings, including assurance mechanisms.
   - an independent assessment of the adequacy of the post closure financial provision, financial management plans and governance structures.

GLOSSARY

Brines: Residues from treating industrial process water used at Ranger. These are highly saline and have corrosive, toxic and sediment forming properties.

Tailings: Waste residues left behind after mineral processing, often of a slurry like consistency. These contain radionuclides with around 70% of the radioactivity of the original orebody along with heavy metals and chemicals. Tailings are highly mobile in wind and water and pose an inter-generational hazard.

Tailings dam: Facility where tailings and mill residues are stored after processing.

Yellowcake: A name originally given to the yellow substance ammonium iduronate but now applied to a mixture of uranium oxides, principally U3O8, which may be yellow or olive green.

ABBREVIATIONS

DBIRD	NT Department of Business, Industry and Resource Developments
DDR	the former East Germany
ERA	Energy Resources of Australia
ERs	Environmental Requirements
EZ	Electrolytic Zinc Company of Australia
MCP	Mine Closure Plan
Peko	Peko-Wallsend Operations Limited
RPA	Ranger Project Area
R3D	Ranger Three Deeps project
SSB	Supervising Scientist Branch
SSD	Supervising Scientist Division
TSF	Tailings Storage Facility

Below. Billabong sunset, Kakadu. *Photo*. S. Tomas

There needs to be a resourced, credible and continuing commitment by **Rio Tinto and ERA to fund monitoring and remediation works** in addition to current rehabilitation works

Kakadu: **time for rehabilitation and repair**

Australian Conservation Foundation
Level 1, 60 Leicester Street
Carlton VIC 3053
ABN 22 007 498 482

Telephone 1800 223 669
Website acf.org.au
Email acf@acf.org.au
Twitter @AusConservation

AUSTRALIAN CONSERVATION FOUNDATION