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Ranger Mining Management Plan

PLN005

Approvals

	Name	Position	Signed	Date
Originator	[redacted]	Advisor	[redacted]	18/09/19
Checked	[redacted]	Superintendent	[redacted]	18/09/19
Approved	[redacted]	HSEC Manager	[redacted]	18/09/19

Revisions

	Date	Description	By	Check	Approved
0.11.0	26/09/11	Internal distribution	[redacted]	[redacted]	[redacted]
0.12.0	03/07/12	Distributed to external stakeholders	[redacted]	[redacted]	[redacted]
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0.19.1	01/04/19	Minor review	[redacted]	[redacted]	[redacted]
0.19.2	18/09/19	Review to address MMP additional information request	[redacted]	[redacted]	[redacted]

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Appendices

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Tables

AMENDMENTS

The following table (Table 1—1) outlines key amendments to the Ranger Mining Management Plan (MMP) 2019 under Section 41(3) of the *Mining Management Act*, These amendments were made in the course of the annual update to Ranger MMP.

Table 1—1: Amendments to the Ranger MMP submitted April 2019

Section/Table/Figure	Amendment(s)
1.Introduction	Environmental Requirement, Ranger Authorisation checklist
Figure 1-1: Organisation chart	Added Rehabilitation Manager and new Rehabilitation Department
2. Site Conditions	Physical Environment Climate Climate Figure 2-1 Dominant spoil types in area surrounding the Ranger Mine Hydrogeology Figure 2-6 Vegetation Habitat Map of the RPA
2.1 Physical Environment	Flora and Fauna Figure 2-6 Vegetation Habitat Map of the RPA Native Flora Species Weeds Native Fauna Species Table 2-7 Conservation listed species known to occur on the RPA Table 2-8 Feral Fauna Species known to occur in Kakadu National Park
2.2. Socio Economic Environment	Current Land Use
2.2.2 Project Stakeholders	Community engagement and collaboration
2.2.3 Work force Description and Demography	ERA work force Indigenous Employment and Initiatives Community Partnerships and Sponsorship
3.1 Statutory Requirements	Updated reference to the latest version of the Ranger Mine Authorisation Reference to latest version (Reference No. 0108-18)
4.1.2 Exploration Performance against Previous MMP – Ranger 3 Deeps Exploration Decline	Reference that ERA sought Mine Technical Committee (MTC) approval to decommission decline and associated infrastructure. Approval still in process.
4.2 Mining	Mining Reserves and Geology Mining Performance against Previous MMP

Section/Table/Figure	Amendment(s)
4.2.1 Mining Activities	Table 4-2 Ranger Ore Reserves
4.2.3 Mining Activities for the oncoming Period	Table 4-3 Mining activities Forecast Clarification to Pit 1 Landform added
4.3.1 Processing Activities – Tailings Storage and Disposal	In 2018 the Brine Concentrator (BC) brine waste stream was directed to the processing leaching circuit to recover uranium however in the long-term the brine waste stream will be injected to the Pit 3 underdrain for final storage Tailings Storage and Disposal North Notch Stage 1 & North Notch Stage 2
4.3.2 Processing Performance against Previous MMP – Treatment and Ore Processing Operations	Documentation of changed preventative maintenance strategy given December 2020 end of processing. Treatment and Ore Processing Operations Process Water Treatment
4.3.2 Processing Performance against Previous MMP – Tailings Storage and Disposal	Planned improvements to the tailings transfer system including sub aqueous deposition and second dredge
4.3.2 Processing Performance against Previous MMP – Process Water Treatment & 4.3.3 Processing Activities for the Oncoming Period – Process Water Treatment	Changes to process water treatment including increase in BC treatment capacity, High Density Sludge (HDS) treatment, Brine Squeezer and enhanced Pit 3 process water evaporation.
4.3.2 Processing Performance against Previous MMP – Pond and Release Water Treatment	Evaporator (turbomister) update. Table 4-8 Pond Water Performance Details
4.3.3 Processing Activities for the Oncoming Period – Tailings Storage and Disposal	Amphibious excavator operation in the Tailings Storage Facility (TSF). Treatment and ore processing operations Table 4-9 Processing forecast Tailing Storage and Disposal Table 4-10 Tailings disposal forecast Process Water Treatment Pond Water Treatment
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5.7 Environmental Performance	Emergency Response Team
6.1.3 Audits and Inspections	Table 6 -1: Environmental Management System Audits (Process Safety)
6.2 Air Quality	Alternative Methods for Estimation of SO2 Figure 1 Uranium Emissions Sulphur Dioxide

Section/Table/Figure	Amendment(s)
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6.4 Green House Gas and Energy	(Table 6-3) and major greenhouse gas emission sources figure (Figure 6-4 date range amended)
6.5 Weed Management	Environmental Performance Figure 6-5 Weed Loads, Ranger Project Area (RPA) 2017/2018 Figure 6.6 Weed Control Effectiveness, Ranger Project Area (RPA) 2017/2018 Figure 6-7 Weed Density on the Ranger Project Area (RPA) 2017/2018 Key Environmental Activities for the oncoming period
6.6 Fire Management	Objectives and targets Environmental performance • Table 6-5 Planned Controlled Burns • Figure 6-8 Fire Scar History Key Environmental Activities for the on-coming period
6.7 Feral Animal Control	Environmental Performance • Table 6-6 Animal Sightings & deaths register 2018 • Table 6-7 Feral Pigs culled during the reporting period
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6.9 Waste Management (Domestic & Industrial)	Waste tracking, Table 6-9 Waste Disposal Records Figure 6-10 Breakdown of Waste Types and Disposal Methods Radiation Contaminated Hydrocarbons Key Environmental Activities for the on-coming period

Section/Table/Figure	Amendment(s)
6-10 Cultural Heritage Management	Environmental Management Archaeological Sites affected by mining activities Heritage sites affected by mining activities
7 Water Management	Surface water data review and interpretation Ground water data review and interpretation Table 7-2 Summary of Water Inputs Table 7-3 Summary of Water Balance
8 Closure Planning and Rehabilitation	Reference to the Ranger Mine Closure Pan (MCP)
9 Environmental Commitments for the on-coming period	Table 9-1 Environmental Commitments Table 9-2 Performance against commitments contained in the previous MMP
10. Environmental Research	
11 References	Eco-logical Australia Ranger Mine Closure Plan (Chapter 2 Environmental Setting 2018) Territory Parks and Wildlife Conservation Act 1978 (NT) (TPWC Act)
Appendix A	Environmental Policy
Appendix B	HSE Risk Matrix
Appendix C	Environmental Incidents
Appendix D	Environmental Management Plans
Appendix E	Authorisation Requirements Annex D, E & F.

1 INTRODUCTION

Energy Resources of Australia's (ERA) Ranger Mining Management Plan (MMP) 2019 has been prepared in accordance with the requirements of both the Department of Primary Industry and Resources 'Template for the Preparation of a Mining Management Plan' *NT Mining Management Act*., Environmental Requirement, (ER18): Environmental Management Report and the 'Ranger Annual Environment Report' to comply with the requirements of Annex C of the Ranger Authorisation 0108-18. A checklist of requirements and where they have been addressed throughout the report is provided in Appendix E. A checklist of reporting Requirements as per Annex D and Annexures E & F of Authorisation 0108-18 has been provided in Appendix F

Activities carried out on the Ranger Project Area (RPA) continue to be consistent with the approved MMP.

This 2019 MMP applies for a 1-year period extending to 5 April 2020. This MMP documents the operational activities, environmental management framework, performance and commitments as at the date of submission.

1.1 Operator Details

Energy Resources of Australia Limited (ERA) is Australia's longest continually operating uranium producer. Rio Tinto owns 68.4 per cent of ERA shares with the balance of the shares publicly held and traded on the Australian Securities Exchange (ASX). Information about ERA and a business overview can be found at www.energyres.com.au.

ERA sells its product to Rio Tinto Uranium for use in power utilities in Asia, Europe and North America. The sale and management of the uranium product is managed under strict international and Australian Government safeguards to ensure that Australian uranium is only used for peaceful purposes. It maintains long term relationships with customers and meets their energy needs by providing consistent and reliable supply of uranium oxide.

Table 1—1 summarises the operator details for Ranger mine.

Table 1—1: Ranger mine operator details

Name of Operator	Energy Resources of Australia Limited
Name of Mining Site	Ranger mine
Address	Locked Bag 1
	Jabiru NT 0886
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

[redacted]	[redacted]
Commodity	Uranium
Product	Uranium Oxide (U_3O_8)

1.1.1 Organisational Structure and Responsibility

The Ranger mine site management team at the time of submitting this MMP is presented in Figure 1-1.[redacted]. Responsibility for maintaining the MMP and EMPs lies with the GM Operations. The Ranger mine site is supported by ERA functions including commercial, finance, HR, projects and environmental research.

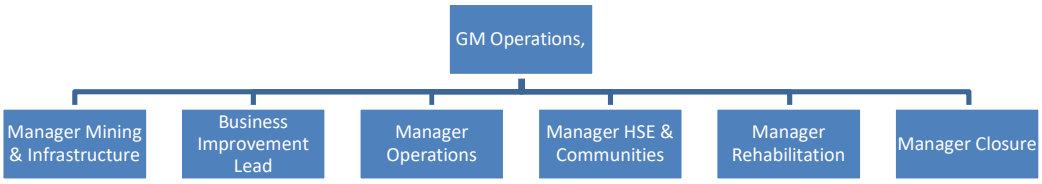


Figure 1-1: Organisation chart

1.2 Summary of Existing Operations

1.2.1 Title Details

Table 1—2 summarises the holder details associated with the Ranger mine.

Table 1—2: Ranger title holder details

Name of mining site	Ranger mine
Mineral Title	Ranger Project Area (RPA)
Mining interests	Uranium mining
Administration act	*Atomic Energy Act 1953 (Cth)*
Authorisation number	0108-18
Operator to whom Authorisation was granted	Energy Resources of Australia Ltd

1.2.2 Location

ERA's Ranger uranium mine is located in the Alligator Rivers Region of the Northern Territory (NT). The nearest major township of Jabiru is located eight kilometres west of the mine (Figure 1-2). The Ranger uranium mine lies within the 79 square kilometre Ranger Project Area (RPA). The RPA is accessible by road (via Kakadu Highway or Arnhem Highway) and by air with airport facilities located on the Ranger Project Area. Access to the mine and processing operations is restricted to authorised personnel and vehicles by gatehouse security on the RPA.

Land tenure in the region, relevant to the RPA includes portions 2273, 2376, 1656, 1657, 1662, 1685, and 1686 (Figure 1-3). Land tenure around the RPA is a combination of Aboriginal and Commonwealth Government freehold land managed through a number of leasing, governance and service arrangements. Aboriginal freehold title exists across most of the land in the RPA, with the titles held by the Kakadu Aboriginal Land Trust. The majority of NT Portion 2376 is declared as Kakadu National Park and leased back to the Director of National Parks (lease expiration 31 December 2077); the remaining part is within the boundaries of the RPA. The RPA also includes NT portions 1656, 1657, 1685, 1686, and part of NT portion 1662.

The RPA is located on Aboriginal land and surrounded by, but separate from the World Heritage listed Kakadu National Park (KNP). Natural topographical features include Mount Brockman and the Magela catchment (Figure 1-4). Built features of Ranger mine are shown in

Figure 1-5. A site plan showing contours and major surface hydrology features of the RPA is shown in Figure 1-6.

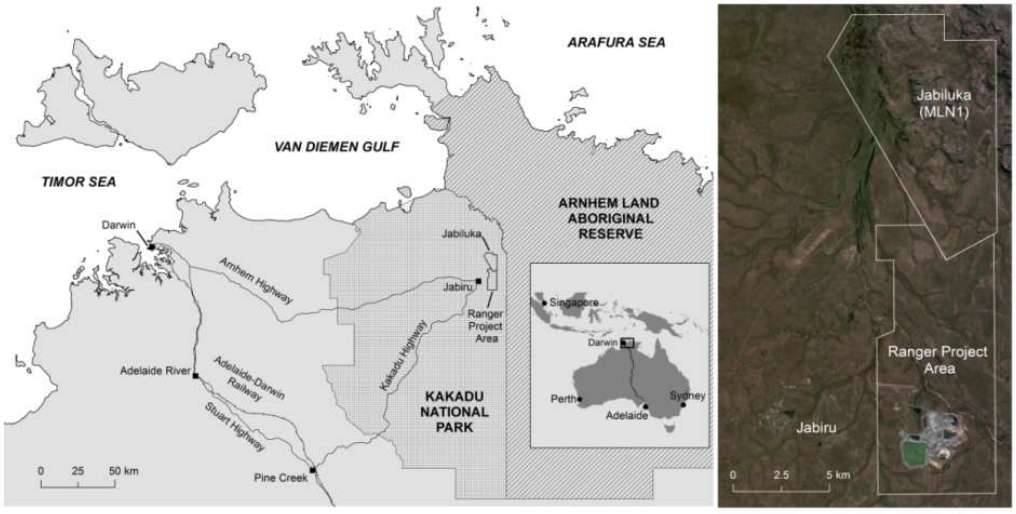


Figure 1-2: Ranger mine location

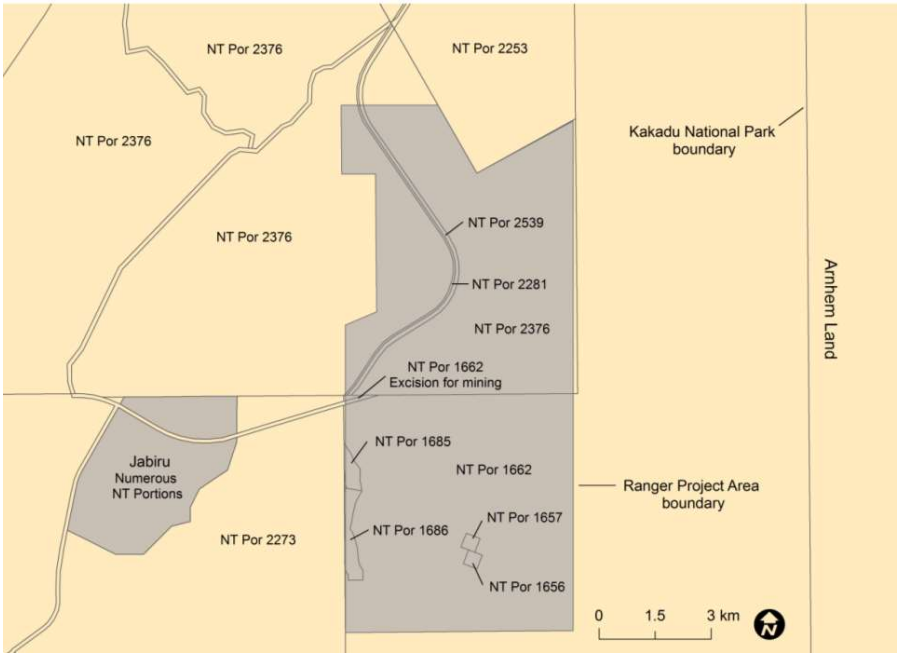
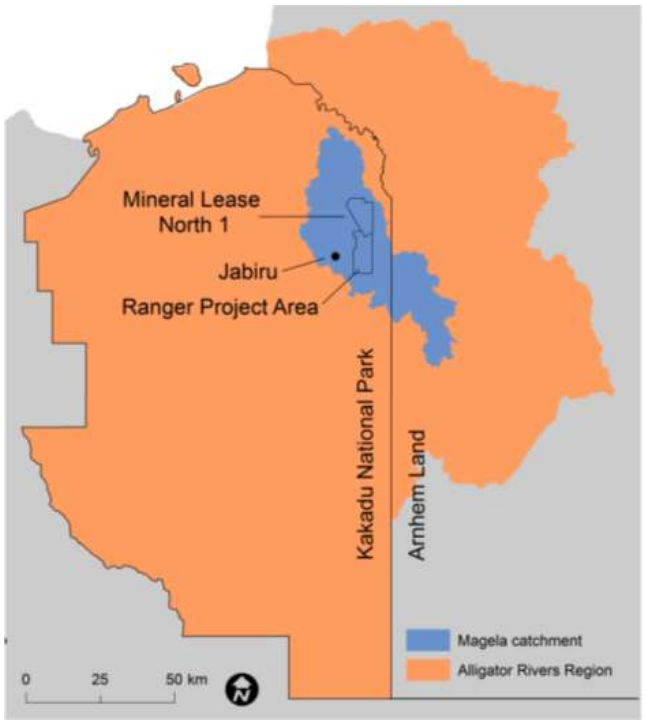


Figure 1-3: Tenures on the Ranger Project Area



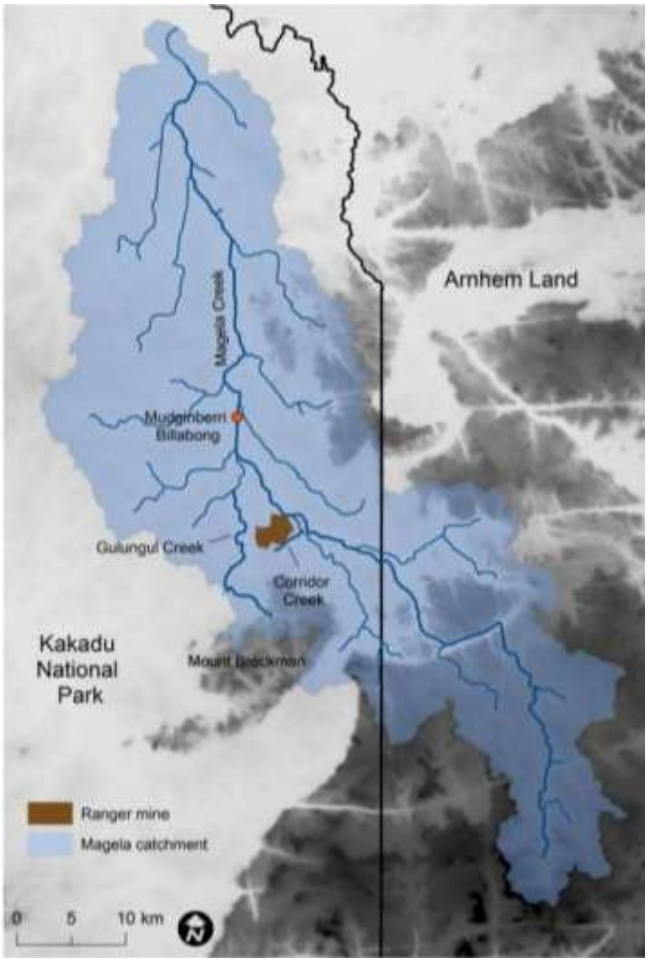


Figure 1-4: Proximity of Ranger mine to natural topographic features

1 Car Park
2 Security
3 Bulk Fuel
4 Shellsol
5 Simon Carves Yard
6 Water Management Yard
7 Ammonia Handling
8 Emergency Dump Tank
9 Calciner & Product Packing
10 Solvent Extraction
11 Sand Filters
12 Administration
13 Product Warehouse
14 Engineering & Supply
15 Ranger 3 Deeps portal
16 Decline Laydown Area
17 Exploration Decline Office
18 Sub Station
19 Demineralisation Plant
20 Power Station
21 Plant Services
22 Grinding
23 Leaching & Clarification
24 Tailings Neutralisation & Process Water Head Tank
25 Corridor Road
26 Water Treatment Plant 1
27 Neutralisation
28 Acid Leach
29 Laterite Treatment Plant
30 Coarse Ore Stockpile
31 Fine Crushing
32 Secondary Crushing
33 Acid Plant (Decommissioned)
34 Acid Storage
35 Brine Concentrator
36 Water Treatment Plant 2
37 Radiometric Sorting
38 Primary Crushing
39 Pond Water
40 Mine Wash Down
41 Retention Pond 2
42 Retention Pond 3
43 Mines Office
44 Orica Explosive Storage
45 Trial Evaporation Channels
46 Pit 1
47 Georgetown Creek Mine Bore 'L'
48 Corridor Creek Land Application Area
49 Retention Pond 5
50 Corridor Creek Wetland Filter
51 Tailings Dam
52 Retention Pond 6
53 Trial Landform
54 Magazine
55 Retention Point 1 Land Application Area
56 Retention Pond 1
57 Retention Pond 1Wetland Filter
58 Retention Point 1 Land Application Area Extension
59 Accommodation Camp
60 Workshop (Gagadju)
61 Jabiru East Land Application Area
62 Office of the Supervising Scientist
63 Telstra
64 Airport
65 Exploration Storage Yard
66 Jabiru East Potable Water Supply
67 Exploration Core Yard
68 Djalkmarra Land Application Area
69 Djalkmarra Land Application Area Extension
70 Pit 3
71 Levee
72 Magela Land Application Area
73 Borrow Pit
74 Pond
75 Exploration decline vent shaft

Figure 1-5: Ranger uranium mine operational features

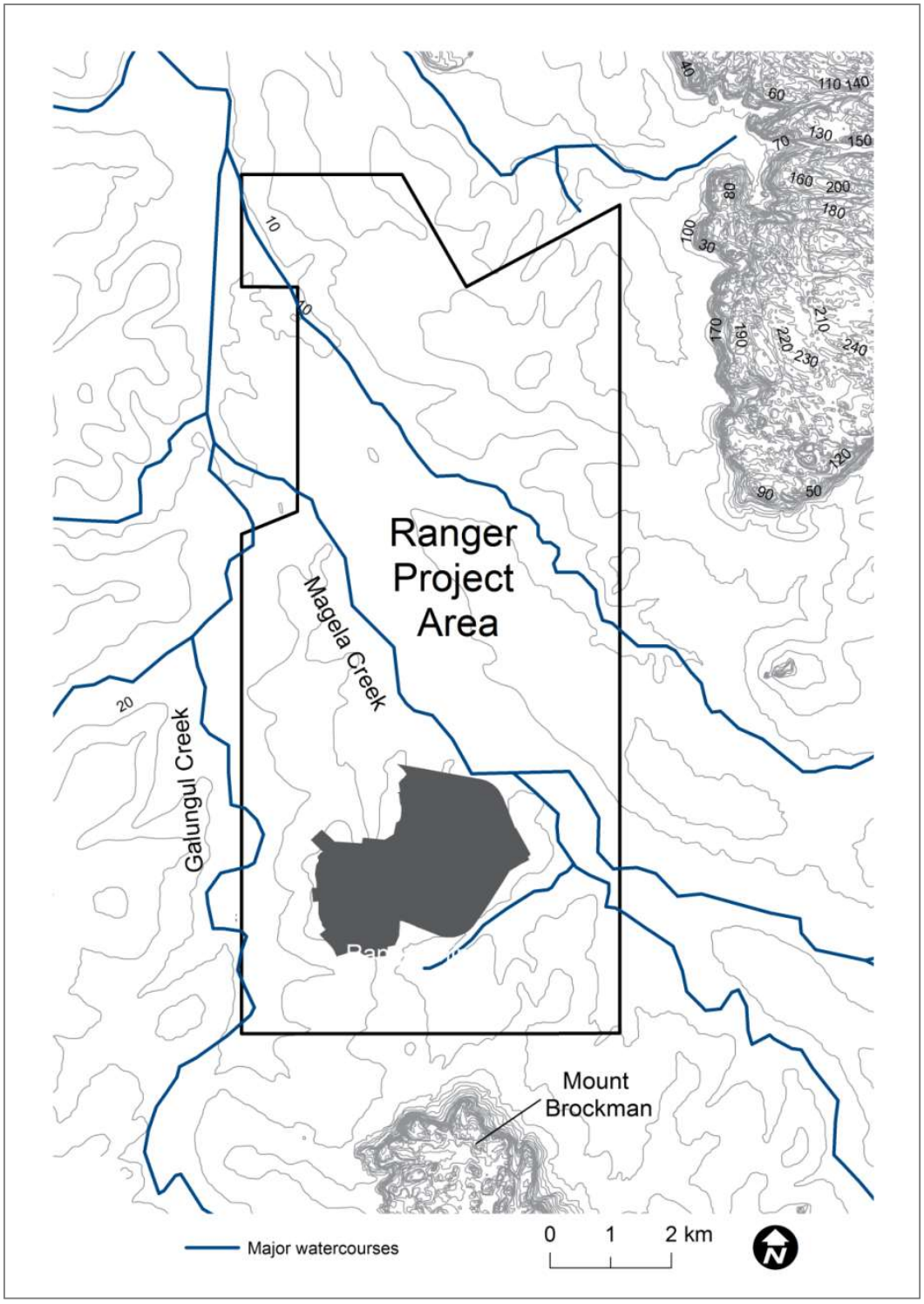


Figure 1-6: Ranger Project Area contours and surface hydrology

1.2.3 Project Summary and Improvements

The Ranger mine operates under legislation issued as part of the Commonwealth Government's *Atomic Energy Act 1953* and not under a conventional mining lease. Table 1—3 provides a historical timeline for the Ranger mine.

Table 1—3: Ranger mine timeline

Date	Description of Event
1969	Ranger orebodies discovered by joint ventures Electrolytic Zinc Company of Australasia Ltd (EZ) and Peko-Wallsend Operations Limited (Peko).
1974	The Australian Government, through the Australian Atomic Energy Commission, agrees to finance 72.5 per cent of the project and sell the uranium, with 50 percent of the net proceeds distributed to the joint ventures.
1974	February: Submission of Environmental Impact Statement (and supporting material) under the Australian Government's *Environmental Protection (Impact of Proposal) Act 1974*.
1975	May: Submission of Supplements 1 and 2 to Environmental Impact Statement (EIS).
1975	The Ranger Uranium Environmental Inquiry (Commonwealth of Australia 1976) is established.
1977	Final Fox report (Commonwealth of Australia 1977) recommends that uranium mining proceed.
1978	An agreement (section.44 Agreement) covering mining is signed with the Northern Land Council, representing the interests of the Aboriginal owners of the area. The Supervising Scientist position is established under the *Environment Protection (Alligator Rivers Region) Act 1978*.
1979	S.41 Authority under the Australian *Atomic Energy Act 1953* is issued. Construction at Ranger commences.
1980	Energy Resources of Australia Limited is established as a public company. It was the largest public float in Australian history at the time. Using open cut methods, mining of Ranger Pit 1 orebody commences in May 1980.
1981	The first drum of uranium oxide is produced on 13 August 1981.
1994	Mining of Ranger Pit 1 orebody is completed in December, after recovering 19.78 million tonnes of ore.
1996	Final approval to mine Ranger Pit 3 orebody is received from the Northern Territory Government in May.
1997	Open cut mining of orebody 3 commences in July 1997, with mining expected to continue until at least 2009.
2000	Rio Tinto acquires North Limited, the previous major shareholder in ERA.

Date	Description of Event
2006	October: ERA announces an increase in Ranger mine's reserves as a result of a reduction in cut-off grade of stockpiled and yet to be mined ores for processing, adding approximately six years to the predicted life of processing at Ranger to 2020.
2007	September: ERA announces an extension to the Ranger operating Pit 3, from extending mining at Ranger until 2012. ERA also announces expenditure for a pre-feasibility study to examine options to extend the mine further and to increase production from the processing plant.
2008	November: ERA announces a significant mineral exploration target defined at Ranger 3 Deeps of 15 to 20 million tonnes with a potential for 30,000 to 40,000 tonnes of contained uranium oxide.
2009	April: The laterite treatment plant was commissioned to extract uranium from weathered ores (referred to as laterite ores) that are unable to be processed through the existing processing plant.
2011	August: The ERA Board approves the construction of an exploration decline to conduct close spaced underground exploration drilling of Ranger 3 Deeps and to explore areas adjacent to the Ranger 3 Deeps resource.
2011	October: The ERA Board announced an accelerated renounceable entitlement offer (Entitlement Offer) of a new ERA ordinary shares to all eligible shareholders at an offer price of $1.53 per new share. The Entitlement Offer was successfully completed on 15 November 2011 with ERA raising its target amount of $500 million. The funds will be used to progress the implementation of ERA's strategic initiatives including the construction of a brine concentrator, construction of an exploration decline for the Ranger 3 Deeps resource and an expanded surface exploration on the Ranger Project Area.
2012	ERA approved the design, construction and commissioning of a Brine Concentrator facility at Ranger.
2012	Works began on the construction of Phase 1 of the Ranger 3 Deeps exploration decline. ERA has engaged MacMahon Holdings Limited to construct the 2.2 kilometre decline.
2012	June: The ERA Board approved expenditure of $57 million to conduct a prefeasibility study on the potential Ranger 3 Deeps mine. The study will be conducted from 2012 until 2014 inclusive.
2012	Onsite water management was boosted to expand capacity beyond potential flood levels, with the completion of Retention Pond 6 and Tailings Storage Facility (TSF) wall lift.
2012	Construction of a new levee to guard Pit 3 from Magela Creek in the event of a large flood event.
2012	Cessation of open cut mining in Pit 3. Commencement of Pit 3 backfill activities.
2013	Finalised the Ranger Mining Agreement with Mirarr Traditional Owners and implementation of a Relationship Committee.

Date	Description of Event
2013	The operation submitted a referral for the Ranger 3 Deeps mine under the *Environment Protection and Biodiversity Conservation Act 1999.*
2013	Final commissioning of a contingency pumping system linking the Tailings Storage Facility to Pit 3.
2013	Placement of waste rock over Pit 1 tailings to assist in ongoing dewatering of Pit 1. Approximately 70 per cent of the pre-load of waste rock was completed in 2013.
2013	Construction of the Brine Concentrator was completed. Commissioning tests and verification phase commenced.
2013	Backfill of 22.8 million tonnes of waste material into Pit 3 in preparation for the planned transfer of tailing from the Tailings Storage Facility and processing plant and storage of brines from the Brine Concentrator.
2013	Phase 1 of the Ranger 3 Deep exploration decline continued with 1,900 metres of tunnel development and 13.9 kilometres of underground exploration drilling completed.
2013	During 2013 surface exploration drilling was conducted on the Ranger Project Area.
2013	7 December: Suspension of processing operations following failure of Leach Tank 1. No employees were injured and the surrounding environment remained protected during the event and in the clean-up period that followed.
2014	5 June: ERA received written approval for a progressive restart of processing operations from the Northern Territory Department of Mines and Energy and the Commonwealth Minister for Industry. Progressive restart of processing operations commenced.
2014	Pit 3 underfill drainage layer and extraction pumping system installed.
2014	Construction of the tailings dam dredge completed.
2015	Pit 3 brine injection piping and infrastructure installed and commissioned.
2015	Tailings dam dredge and tailings transfer and water recovery/pumping infrastructure commissioned.
2016	All production tailings directed to Pit 3.
2016	December: Ranger draft Mine Closure Plan was submitted to regulators for feedback.
2017	April: Regulatory approval permitting ERA to begin the final stages of backfill in Pit 1 was obtained and this work has commenced.
2018	Laterite plant ceased operation due to exhaustion of laterite ore. Laterite plant placed under care and is awaiting demolition as part of the site closure project.
2019	Ministerial approval to commence decommissioning of the Ranger 3 Deeps exploration decline was given in 2019.

2 SITE CONDITIONS

2.1 Physical Environment

2.1.1 Climate

The climate of the Alligator Rivers Region (ARR) within which the Ranger mine is located, is dominated by a seasonal wet-dry monsoon cycle, with its large inter-annual and intra-seasonal variability largely associated with the effects of the El Niño Southern Oscillation, the Madden-Julian Oscillation and tropical cyclone activity (Trenberth *et al.* 2007). The wet season generally extends from late October to early April with predominantly westerly winds, while the dry season is dominated by easterly to south-easterly winds and extends from May to September. Historical climatic conditions for the Ranger mine area are presented in Table 2—1. Meteorological and climatic conditions are also presented in the Ranger mine's annual Water Management Plan and Wet Season Report.

The tropical cyclone season in northern Australia typically extends over the period of November through April, averaging two cyclones a year, with peak activity from December to March (BOM 2009). Increased cyclone activity in the Australian region has been associated with La Niña years, while below-normal activity has occurred during El Niño years (Plummer, *et al.* 1999; Kuleshov & de Hoedt 2003). When cyclones and tropical lows are present, the Ranger mine can experience elevated winds and rainfall.

The region has a hot climate, with mean maximum temperatures ranging from just under 32 degrees Celsius in June and July to just under 38 degrees Celsius in October (BoM 2016). Average monthly pan evaporation ranges from 295 millimetres in October to 160 millimetres in February (Chiew & Wang, 1999). Annual pan evaporation exceeds rainfall by approximately 1,000 millimetres Table 2 - 1.

Table 2—1: Historical Weather Data, Jabiru Airport

Parameter	Value	Month
Mean maximum temperature	37.6 °C	October
Mean minimum temperature	18.6 °C	July
Maximum average daily evaporation	9.5 mm	October
Minimum average daily evaporation	5.6 mm	March
Annual average daily evaporation	7.2 mm	-
Annual rainfall	1,563 mm	-
Annual evaporation	2,594 mm	-

BOM 2016, average of between 16 and 40 years depending on variable

2.1.2 Land Systems

Topsoil and Subsoil

The type (class) and distribution of soils across the land surfaces of the RPA are influenced by geology, topographic position and seasonal changes to the amount of moisture in the ground (Chartres, et al. 1991; Hollingsworth, et al. 2005; Story, et al. 1969). The four main geomorphic units have particular associated soil types, which in turn influence vegetation assemblages.

Colour variation in the soils is primarily a product of differential drainage and the resulting mineralogy of the component iron oxyhydroxides. Stony layers within the soil profile may represent the boundary between residual and non-residual (e.g. transported) materials.

Soils are non-saline and non-sodic and can be gravelly, with clasts of quartz, ferricrete and ferruginised rock. Kaolinitic minerals are common and illite, together with minor chlorite, can be inherited from underlying Cahill Formation schists. The cation exchange capacity is generally moderate to low in the near-surface horizons and there are low levels of organic materials and nutrients. Table 2—2 provides a brief description of the soil characteristics associated with the Ranger mine (Figure 2-1)

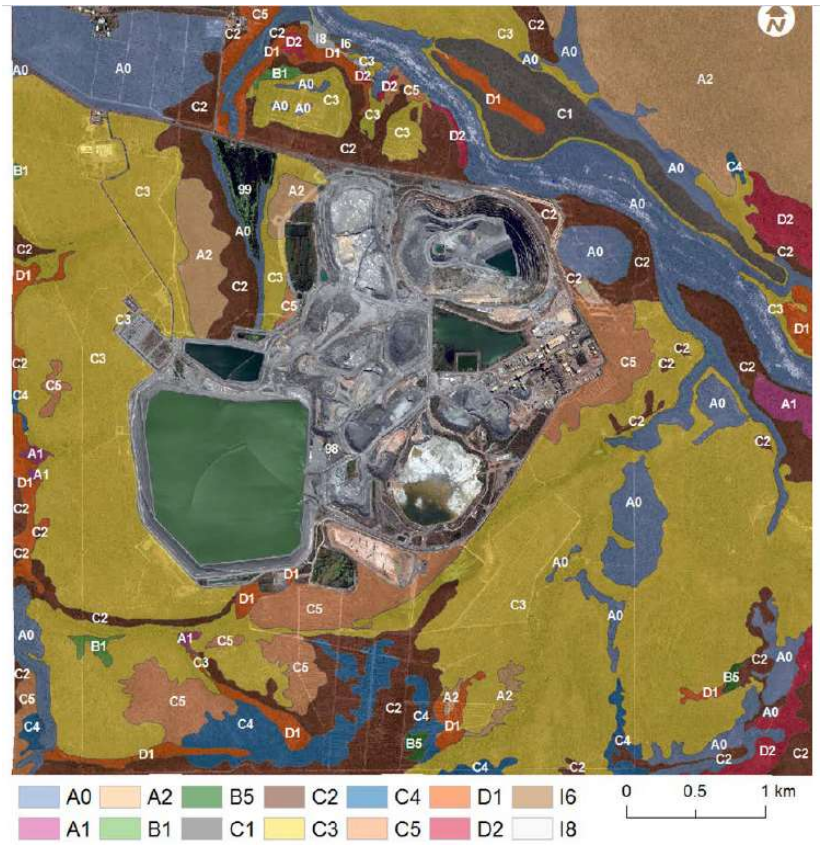


Figure 2-1: Dominant soil types in areas surrounding the Ranger mine

Table 2—2: Description of soil characteristics around the Ranger mine

Map Unit (Hollingsworth 1999)	Map Unit Description
A0	Organic horizon, sand/loamy surface.
A1	Deep pale brown, yellow and yellowish brown sands, sand/loamy sand surface and generally non-mottled single grained and sandy throughout. Variations include: light yellowish brown and dark brown; and, yellow brown, yellow and faint red brown mottles.
A2	Deep yellowish brown to very pale brown; highly permeable, generally non-coherent sand, bottoming onto ferruginous and quartz gravel and stone. Profiles may vary: depths may extend from 100 centimetres; in-situ gravels may occur within the lower horizons and the firm clay clod nodules may become hard; 10 to15 millimetres, prominent, red mottles.
B1	Deep brownish yellow to yellowish brown massive gravel free earthy sands with minor mottles common at depth. Profile variations include different degrees of mottles at depth, and on rare occasions overlie a buried zone.
B5	Shallow, gravelly, brown to yellowish brown, massive, earthy sands. Variations may have light brownish yellow and minor light grey horizons at depth, textures may not be heavier than loamy sands.
C1	Moderately deep to deep yellowish brown to light yellowish brown, sandy earths with no gravel present. No profiles bottom onto laterite pavement and gravel pans. Profiles may be deeper, lighter in chroma, and increasing in texture to sandy light clay.
C2	Moderately deep to deep sandy loams over a gravel pan.
C3	Moderately deep to deep, dark yellowish brown to yellowish brown, sandy earths with gravel throughout, bottoming onto ferruginous gravel.
C4	Shallow yellowish brown to brownish yellow sandy earths bottoming onto dense ferruginous gravel and stone. Mottles may occur. Variations include distinct, grey and prominent, red mottles in B-horizon.
C5	Shallow brown to yellowish brown gravelly sandy earths over a ferruginous and quartz gravel pan. Variations include colours to yellowish brown; depth varying to 30 centimetres; and, gravel contents ranging between 5 per cent and 50 per cent within the profile.
D1	Deep light brownish grey to grey loamy earths, massive.
D2	Deep to moderately deep yellowish brown to pale brown gravel-free loamy earths over a gravel/stone hardpan. Variations include textures to coarse sandy clay at depth; colours from pale brown to grey; and, mottles where sites are ponded.
I6	Deep profiles of grey to brown sands and earthy sands over a generally mottled light grey to pale brown clay and sandy clays.
I8	Profiles are very dark grey to greyish brown loamy earths and sandy earths over a brown to pale brown earthy sand, with mottles common. Considerable variation was found with all pedological characteristics.

Field investigations of hydraulic conductivity (Table 2—3) have identified that individual soil horizons range from very permeable, on account of the presence of naturally occurring piping, to impervious. The A and B horizons support a shallow, unconfined surficial aquifer that rests on a low conductivity C horizon, and underlain by an impervious bedrock D horizon. The unconfined aquifer is observed to recharge both the A and B horizons during the wet season, to the point where water expresses as base flow in lower areas of the topography and drainage lines. During the dry season, the upper A and B soil horizons can be entirely dry down to the confining C horizon. Hydraulic conductivities in the A and B horizons can range from 0.01 to 10 m/day-1 (Chartres, et al. 1991), whilst the range of hydraulic conductivities of underlying confining C and D horizons (discussed in a subsequent section) are indicative of low transmissive hydrogeological units (Intera 2016).

Table 2—3: Soil hydraulic conductivity

Horizon	Hydraulic Conductivity, K
Alluvial Sands and 'A' horizon	10 to 1 m/day
Bleached zone 'B' horizons	1 to 0.1 m/day
Saprolite 'B' horizon	2 to 0.01 m/day
Fractured rock 'C' horizon	0.1 to 0.001 m/day
Unfractured rock 'D' horizon	0.05 to 0.001 m/day

Depending on vegetation cover and the presence or absence of a surface rock lag, erosion is highly seasonal and is dominated by sheet erosion in the wet season. At the beginning of the wet season, understorey cover can be sparse due to preceding dry season conditions and vegetation loss due to fires. The variability of vegetation cover contributes to the impact of rain splash erosion. Where grasses and leaf litter remain, these assist in protecting the soil from early wet season rain splash erosion. However, as rainfall intensifies with the development of monsoonal troughs, other erosion processes become dominant including floods, sheet flow runoff, high winds and cyclones. Overland sheet flow, gully and erosion by streams increase and are particularly severe in areas where vegetation is disturbed. More details on these erosion processes are listed in Table 2—4.

Table 2—4: Typical erosion susceptibility of soils

Soil Type	Erosion Potential
Deep siliceous sands lacking structure	Vulnerable to rain-splash and overland flow erosion but are less vulnerable if covered by vegetation
Red earths well drained with good structure	Characteristic of areas with minimal erosion
Yellow earths less well drained than the red earths	More erodible, particularly if dispersive

Duplex soils with texture contrast and massive impermeable B horizons which form aquicludes when saturated, weakly structured topsoils	Most erodible, very vulnerable to slope wash and gully type erosion, due to dispersive nature
Alluvial soils	Generally, recipients of other soils but prone to erosion along breaks of slope
Shallow skeletal soils	Protected by surface layer of gravel but, if this is disturbed, erosion can be rapid

Topography

Ranger mine lies on plains to the north of the Mount Brockman Massif, which is an outlier of the Arnhem Land Plateau. These plains are generally flat with numerous swamps and are rarely more than 45 metres above sea level. South and east of Ranger mine, the Arnhem Land Plateau escarpment rises to between 200 metres and 300 metres above sea level. A major feature of the landscape is Mount Brockman, which rises 170 metres above the plain, approximately 3.5 kilometres south of Ranger mine.

Ranger mine is influenced to varying degrees by the following four land surface categories.

- The Mount Brockman Massif is a massive quartz sandstone outlier. Its steep escarpment and skeletal soils constitute part of the watershed of the Magela and Gulungul Creek systems. Due to its resistance to erosion and low soil moisture retaining capacity, a large volume of localised rainfall is readily accumulated in the surface drainage networks and causes rapid flood responses in creeks and drainage lines. Water infiltrates joints and fissures and contributes to groundwater recharge and the formation of springs and swamps, some of which continue to discharge well into the dry part of the year many months after the last rainfall.
- The Koolpinyah Surface, corresponding to the plains on which Ranger mine is located, is characterised by level, rolling or dissected lowlands. The surface consists of deeply weathered bedrock partly overlain by Late Tertiary to Recent sediments derived from the erosion of Cretaceous, Middle Proterozoic and Lower Proterozoic formations. These are mantled by ferruginous soils and ferricrete crusts.
- Alluvial plains have been formed by the flow of numerous rivers across the Koolpinyah Surface. Magela and Gulungul creeks flow in a northerly direction from the Mount Brockman Massif and dissect the RPA. Alluvial materials have been deposited by these creek systems to form the flat Magela floodplains to the northwest. Coarse, sandy Late Tertiary and Quaternary alluvial deposits cover part of the plains. These occupy channels of diverted streams and anabranches.
- Coastal Plains extend north of the Koolpinyah surface. These are flat, poorly drained and penetrate far inland along the broader river valleys.

Geology

The Ranger uranium deposits are located in the East Alligator region of the Paleoproterozoic Pine Creek Inlier. Mineralisation is contained in chlorite-altered metasediments of the Lower Cahill Formation (age approximately 1,870 million years) which overlie an older basement complex of Archaean granitoid gneisses and schists known as the Nanambu Complex (age approximately 2,470 million years). Unconformably overlying rocks of both the Lower Cahill Formation and the Nanambu Complex are sandstones and conglomerates of the Kombolgie Sandstone (age approximately 1,650 million years) which forms part of the Katherine River Group of the McArthur Basin.

Uranium mineralisation occurs within a northerly trending and gently easterly-dipping belt of Lower Cahill metasediments directly east of the Nanambu Complex (Figure 2-2). The Lower Cahill Formation has been informally subdivided into three units. All uranium ore occurs in chlorite schists referred to as Upper Mine Sequence schists. These overlie a sedimentary sequence dominated by carbonates and dolomites (Lower Mine Sequence) and are themselves overlain by mica schists with local horizons of amphibolite (Hanging Wall Schists), as shown in Figure 2-2.

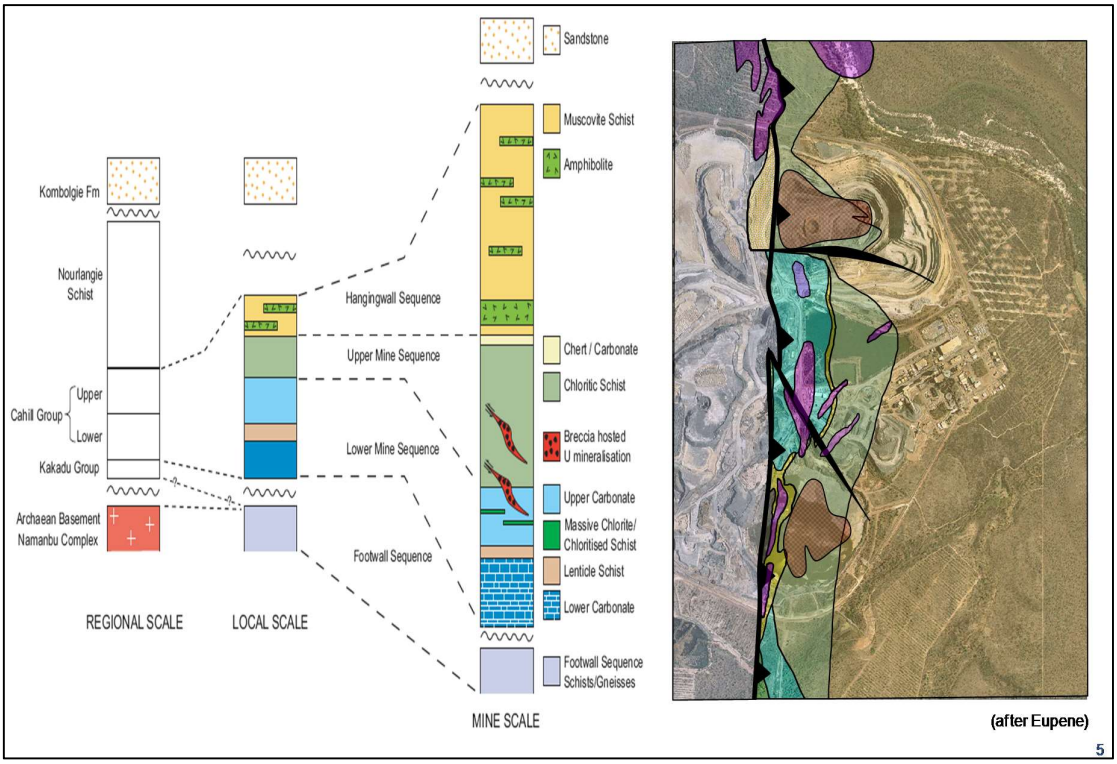


Figure 2-2: Stratigraphic sequence from regional to mine scale and corresponding geological map of the immediate area of the Ranger Orebodies

Geomorphology

The Magela floodplain, which lies 15 kilometres downstream of Ranger mine, represents a catchment of 815 square kilometres and joins with the floodplain of the East Alligator River.

The Magela floodplain is very flat with elevation changes of less than 0.7 metres over more than 40 kilometres. Although the inflow to the floodplain is well defined, waters continue to disperse across poorly or undefined channels until eventually discharging into the meandering channel of the East Alligator River. Average flow rates during a wet season, depending on channel definition, have been estimated at 0.02–0.05 metres per second (Roos & Williams 1992). Wet season vegetative growth within the floodplain proper accelerates quickly with the onset of the wet season and has a significant effect upon flow rates. Roos and Williams (1992) demonstrated that the aquatic vegetation retained flood waters in the lead up to and, in the period immediately after, the highest wet season flow.

The pattern of sediments accumulated in the Magela floodplain has been examined using radionuclide analysis. Wasson (1992) found that 90 per cent of the sediments transported by Magela Creek were deposited within the first 18 kilometres of the floodplain. The rest of the floodplain sediments are sourced from smaller catchments that enter the floodplain further down the Magela Creek catchment. It was also found that Magela Creek has had no significant influence on sediment deposition below Jabiluka Billabong for the last 3,000 to 4,000 years.

Hydrogeology

Hydrolithologic units (HLUs) are described and conceptualised across the Ranger mine, and represent a combination of geologic units and their groundwater flow and transport characteristics. HLUs consist of a single geologic unit, part of a geologic unit or cross geologic units, and therefore can be traditionally classified as aquifers or aquitards depending on their permeability. Previous investigations have noted that in some places across the Ranger mine, discreet geological units could encompass two or more of the defined groundwater units, hence the adoption of the HLU classification (Intera 2016).

Groundwater at the Ranger mine is generally encountered within 10 metres of the land-surface during the dry season and, following periods of extended rainfall, is closer to the land-surface during the wet season. Seasonal fluctuations in the superficial HLUs are typically around three to five metres, and rainwater which could infiltrate to the underlying fractured rock HLUs is mostly lost by evapotranspiration (Ahmad and Green 1986).

Early research carried out on the RPA defined the regional groundwater system according to lithology as either carbonate or non-carbonate (Verma and Salama 1986). Carbonate HLUs occur within the carbonate and cherty rocks of the Lower Mine Sequence of the Cahill Formation and were described by Verma and Salama (1986) as semi-confined to confined. Non-carbonate HLUs included a shallow fluvial unit, weathered bedrock unit, fractured rock unit and a 'deep' unit. It was noted that in some place aquifers could encompass two or more of the defined groundwater units

The general absence of carbonate rocks at the site, with the exception of an upwardly thrust fault block in the south-wall of Pit 3, lead to subsequent conceptualisation of the system as being made

up of two distinct HLUs: 1) a phreatic HLU of laterite and clayey sands; and, 2) weathered rock over a semi-confined HLU of relatively fresh fractured rocks (Ahmad and Green 1986).

The key aspects of the hydrogeological systems within the RPA include the extent and degree of weathering, the presence of faults/open fractures/brecciated zones and the presence of alluvial sediments. It should be noted that not all faults or inferred faults in the RPA are pathways for preferential groundwater flows, some faults are barriers and impede groundwater flow. For example, the Ranger Fault to the south of the Tailings Storage Facility, often referred to as the mafic dyke, is a clay-rich barrier to groundwater flow.

A map showing pre-mining groundwater catchments and directions of groundwater flows is presented in Figure 2-3.

Groundwater level fluctuations follow a distinctive wet season/dry season oscillation, reflecting significant recharge to the shallow residual soils. Declines in groundwater levels within shallow soils are due to vertical movement and loss of groundwater to the atmosphere and fluctuations of groundwater levels at depth are the result of a pressure response to changes in groundwater conditions in the overlying, shallow soils.

The shallow (weathered rock) groundwater's of Magela Creek are influenced predominantly by infiltration and evapotranspiration (Vardavas 1993), with water levels closely reflecting seasonal rainfall patterns and groundwater flow gradients strongly influenced by topography and local stratigraphy. Infiltration and movement of groundwater is, in turn, a factor of the degree and extent of weathering in the shallow HLU in the RPA.

To better characterise its shallow groundwater dynamics, Magela Creek can be subdivided into a sand tract and palaeochannel system, upstream of Mudginberri Billabong and the Magela Plain, downstream of Mudginberri Billabong (Wasson 1992). In the sand tract and palaeochannel system, initial recharge of the shallow groundwater systems occurs from the first flush of stream flow. It is reported that only 2 to 10 per cent of rainfall recharges the weathered and fractured rock HLUs (Vardavas 1988; 1993). Later in the wet season, when the water-table has risen, due to direct percolation of rainfall, interflow from shallow groundwater to stream flow occurs, resulting in an identifiable base flow (Wasson 1992). However, during recessional flows, only three per cent (18 square kilometres) of the catchment is estimated to contribute to Magela Creek baseflows (Chapman 1990; Chapman and Isidori 1990).

Rainfall recharge of the superficial groundwater system is discharged by way of evapotranspiration or to the surface water system as base flow during the wet season. During the wet season alluvial aquifers are in contact with creek or billabong systems (Chapman 1990; Vardavas 1993). The results of studies by Chapman (1990) and Varvadas (1993) have also indicated that only a small proportion of rainfall recharge water infiltrates the underlying fractured rock HLUs via structural controls or, by way of vertical leakage. A large fraction of the recharge waters moves through the soil profile as base flow (superficially) during and immediately following, the wet season. The remaining water left in the groundwater units is then lost to evaporation or evapotranspiration during the dry season.

Water quality data in the deeper, weathered or fractured rock HLUs suggests that groundwater level fluctuations are essentially pressure responses to changes in groundwater levels within overlying units, primarily because of the orders of magnitude lower coefficients of storage (effective porosity) found within these units compared to that found within the residual soils and alluvial aquifers. Groundwater level variations and flow patterns in upstream areas are more complex than those observed in downstream areas, suggesting greater local anisotropy and the presence of discrete, permeable zones in elevated areas.

Environmental tracer studies by Turner and Leaney (2009) identified important shallow groundwater-surface water interconnectivities in areas immediately east of the Ranger mine. There is some evidence that at peak flow levels, surface water-groundwater gradients can reverse, permitting some recharge from wetlands and billabongs back to groundwater, primarily to adjacent shallow alluvial HLUs. Similarly, it was found that upward hydraulic gradients have the potential for upward groundwater discharge to shallower hydrogeological units. Groundwater discharge to billabongs is probably constrained by the presence of low permeability silts/clays located at the base of these systems. As a result, surface water–groundwater interactions are primarily between groundwater in shallow alluvial HLUs located adjacent to billabongs or beneath and adjacent to creeks. Groundwater flows from weathered or fractured rock HLUs to surface water systems are, in relative terms, negligible. This conceptual model of recharge/discharge processes is illustrated in Figure 2-4.

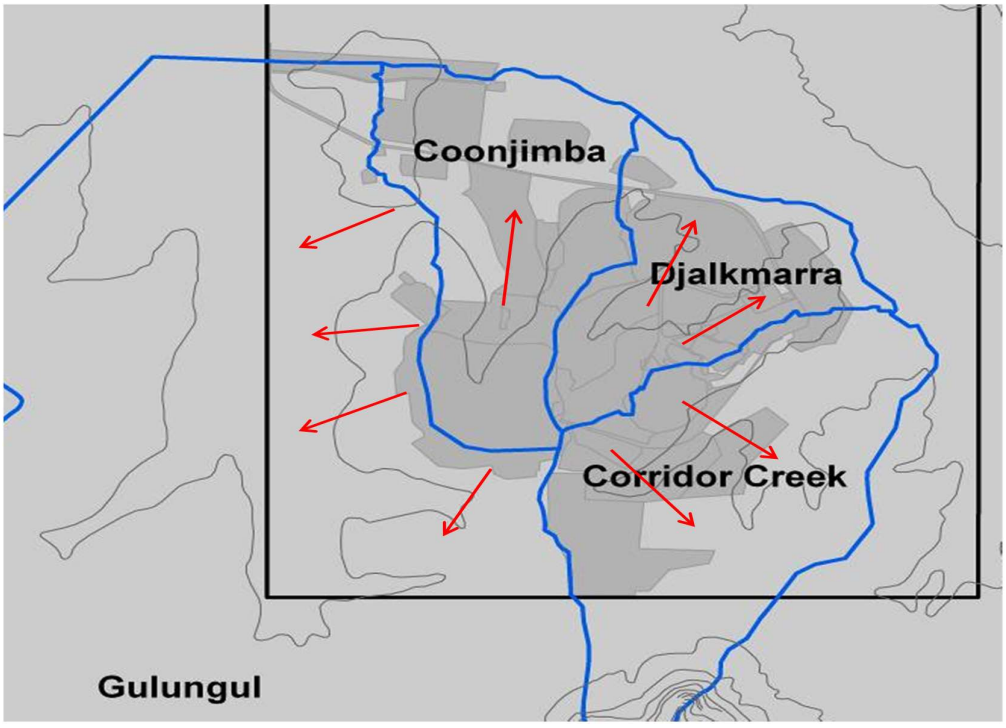


Figure 2-3: Groundwater catchments and approximate directions of pre-mining groundwater flows

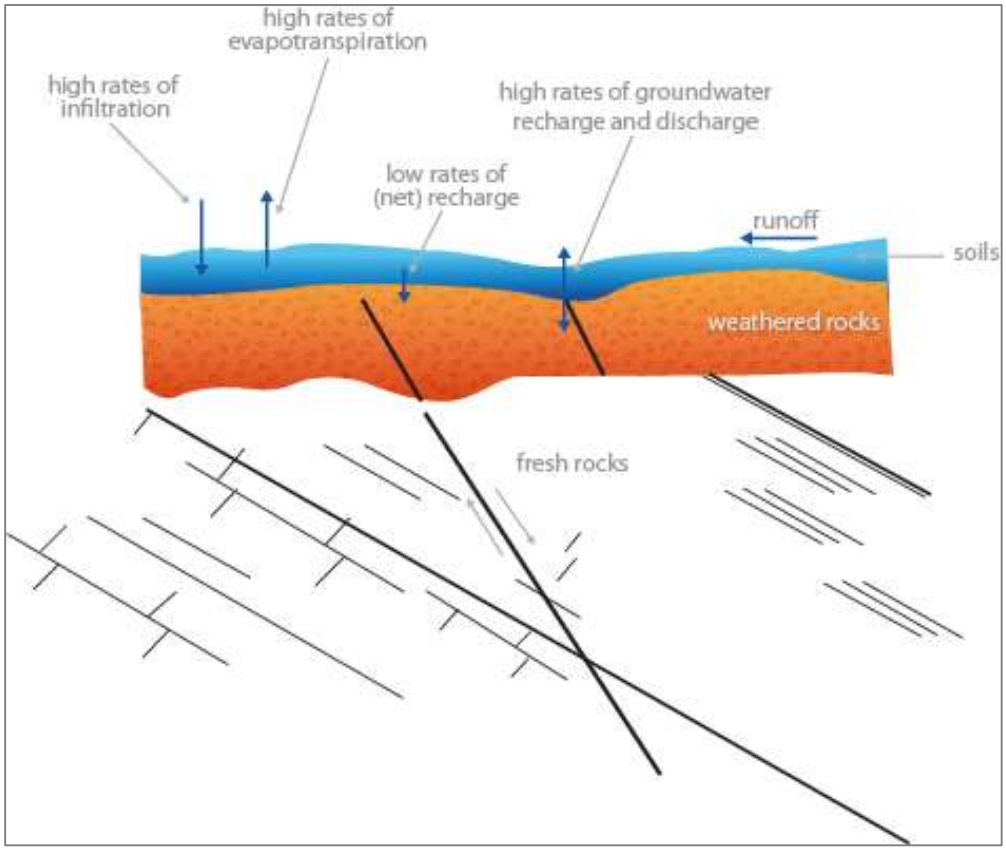


Figure 2-4: Conceptual schematic of groundwater recharge-discharge processes

2.1.3 Flora and Fauna

The RPA is surrounded by Kakadu National Park, which is an internationally recognised area of natural and cultural importance and is inscribed on the United Nations Education, Scientific and Cultural Organisation (UNESCO) World Heritage Register.

Vegetation

Schodde et al. (1987) described four vegetation types in the RPA dominated by Eucalypt open forest and/or woodland (Figure 2-5). The Four habitat types that occur on the RPA are listed in Table 2—5. None of the vegetation habitats are considered totally undisturbed and include small, un-mapped components of various habitats (Schodde, *et al.* 1987). The delineations in Figure 2-5 represent the predominant vegetation type on the site. Habitat 1 in Figure 2-5 is a combination of three habitats (Myrtle-Pandanus Savannah; Paperbark Forest; Coastal Deciduous Rainforest) but primarily represents habitats along Magela Creek and Gulungul Creek in the RPA. The vegetation is linear, following the edges of the creek channels but it often grades quickly into woodland.

Similarly, Firth (2012) described the main vegetation/habitat types on the RPA as comprising of woodland and open forest, mostly co-dominated by *Eucalyptus miniata* and/or *E. tetrodonta*, The RPA is surrounded for the most part by vast unbroken and undeveloped tracts of the same eucalypt woodlands and open forest savannas that cover at least 180,000 square kilometres in the NT alone (Hart & Jones, 1984). The topography of the RPA is relatively simple and as with vegetation, mirrors that of the region as a whole.

A tool has been developed by ERA to assess the environmental risk of disturbance (e.g. clearing and or exploration or construction) to terrestrial flora and fauna species of conservation significance on the RPA (Brady et al. 2007). As part of this work, the vegetation habitat map of Schodde et al. (1987) was simplified and broadened into two habitats (Figure 2-6).

- Lowland riparian and rainforest, which represents denser vegetation of the lowlands, typically associated with streams, creeks and billabongs. This habitat is equivalent to habitat 1 (Table 2—5: Summary description of vegetation types present on the RPA). The area of this habitat within the RPA represents 1.1% of the equivalent habitat found in Kakadu.
- Woodland, which includes all vegetation growing in lowland areas dominated by trees (except for lowland riparian and rainforest). This habitat is equivalent to habitats 2, 3 and 4 (Table 2—5: Summary description of vegetation types present on the RPA). According to Brady et al. (2007) classification system, most vegetation within the RPA (94%) is woodland, which represents 2.4% of the equivalent habitat in Kakadu.

Surveys of the aquatic habitats of the RPA and surrounds have been conducted including the initial assessments conducted for the Fox Report (Commonwealth of Australia 1976 & 1977). More recent surveys detailed below have assessed the billabongs and surrounding riparian zones within the RPA and surrounds.

No listed or endangered macroinvertebrate or fish species, nor any aquatic fauna species considered rare or restricted in distribution, have been recorded in the RPA

Aquatic vegetation, aquatic micro crustaceans, aquatic macroinvertebrates, fishes, frogs, aquatic and riparian reptiles, riparian birds, water birds, native riparian terrestrial mammals, and micro bats were sampled over two sampling periods in 1994/1995 (Corbett 1996) and 2000/2001 (Corbett *et al*. 2004) in three Ranger billabongs and two reference billabongs. The aim of these surveys was to obtain a comparative data set to assess whether or not recent operational activities at Ranger mine (Ranger billabongs) had adversely impacted on biota in billabongs immediately adjacent to the mine (reference billabongs).

The findings as presented in Corbett *et al.* (2004) concluded that for most biota, there were relative differences between billabongs within and between surveys. However, there were no significant differences in the number of functional groups, species richness or relative abundance between Ranger and reference billabongs and between the two surveys for most biota. This suggests there have been no significant changes in these biota communities over the past six years.

One billabong, the Djalkmara Billabong, provided the exception for many biota, where lower values in the diversity of aquatic vegetation, micro Crustacea, macroinvertebrates, fishes and waterbirds were determined to be related to the Ranger operations[1]. Impacts on this billabong associated with the Ranger operations included the underground inflow of epsomite from spray irrigation in the former land application area, blocking the natural back filling from Magela Creek during construction of the new entry road in 1999, pumping the billabong dry in 2000 during the construction of observation bore 3 and the utilisation of the billabong for the treatment of pond water prior to irrigation.

Monitoring of aquatic fauna downstream of Ranger mine has been undertaken for over 30 years to assess the health of aquatic communities and potential impacts from mining. The results show a consistent low level of uranium in mussels from Mudginberri Billabong, indicating an absence of any mining related influence (Bollhofer et al., 2013) Bioaccumulation studies have found radionuclide and metal uptake to be largely related to natural features of the catchment (e.g. geology and natural sediment concentrations).

Studies of macroinvertebrate communities upstream and downstream of the Ranger mine have concluded changes to the water quality downstream of the Ranger mine as a consequence of mining during the period 1994 to 2015 have not adversely affected macroinvertebrate communities (Supervising Scientists, 2016)

Studies of fish abundance in channel and shallow lowland billabongs in the RPA and in Kakadu concluded that changes to water quality downstream of the Ranger mine as a consequence of mining during the period of 1994 to 2015 have not adversely affected fish communities in both types of billabongs (Supervising Scientists, 2016).

[1] Most of Djalkmara billabong has been completely disturbed. The majority of the billabong's original footprint is now taken by Pit 3 and adjacent operational areas as well as the access road. The only remaining section of Djalkmara billabong is located between RP2 and Pit 3. That section has been heavily disturbed and is currently used as a pond water sump.

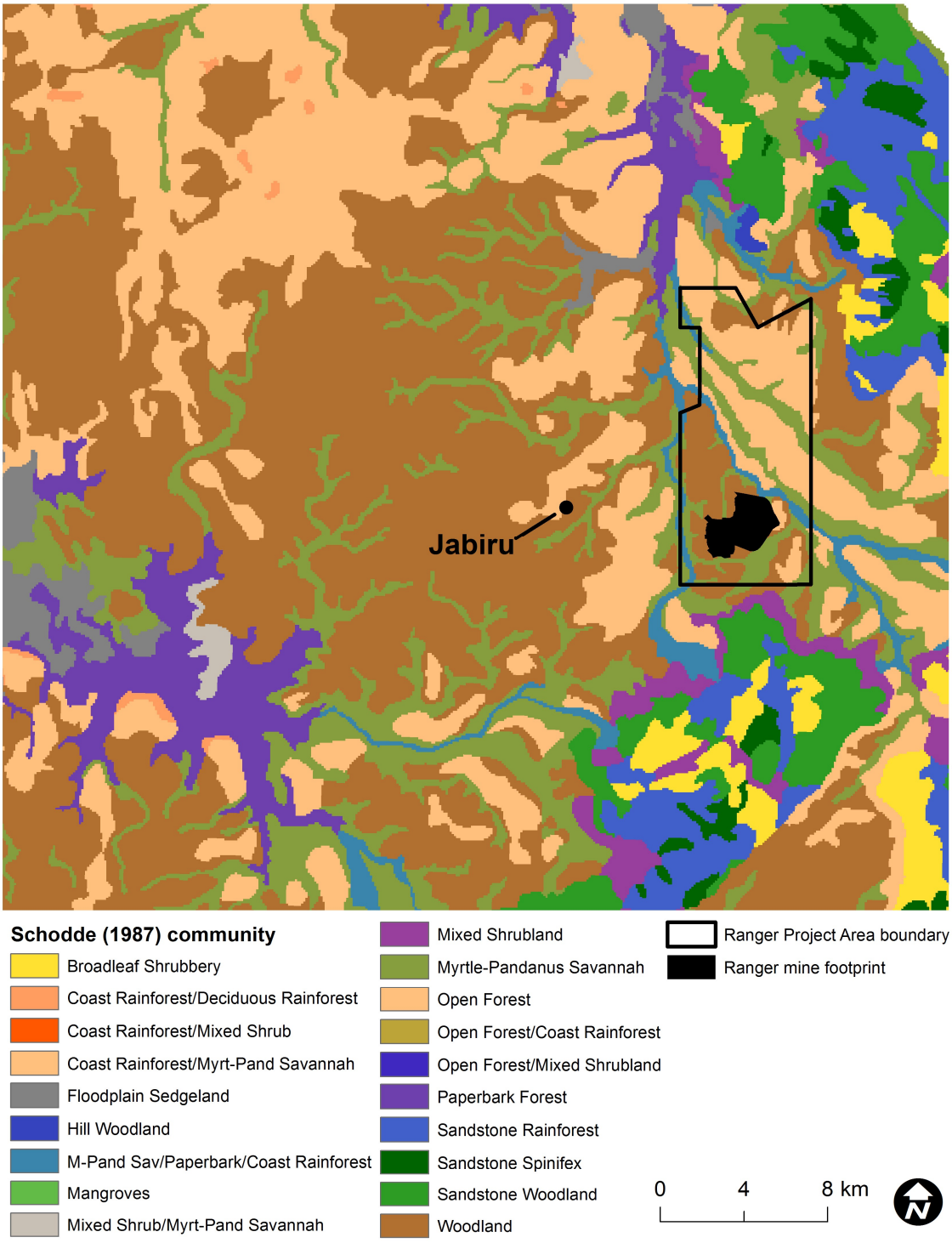


Figure 2-5: Vegetation habitats of the RPA and the region

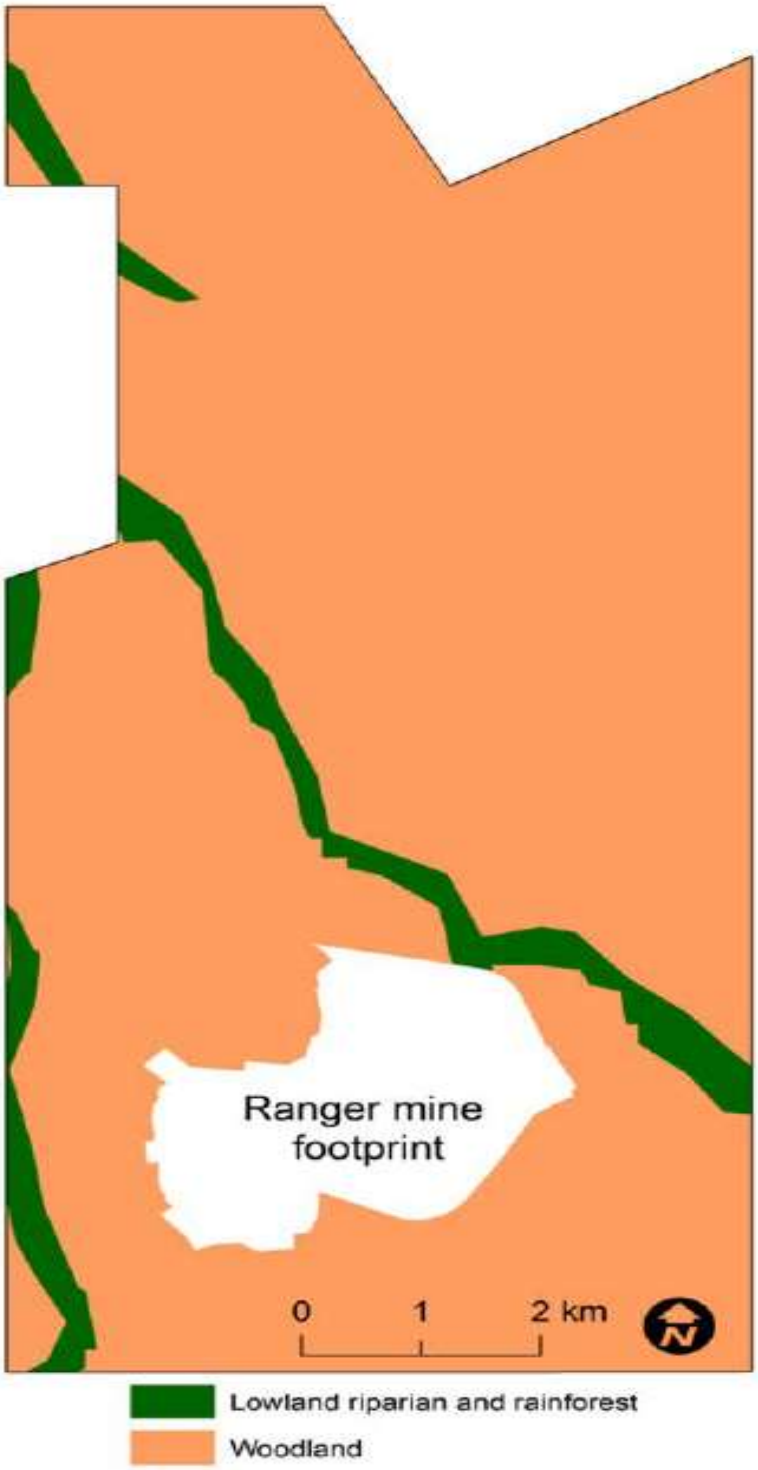


Figure 2-6: Vegetation habitat map of the RPA (based on Brady et al.2007)

Table 2—5: Summary description of vegetation types present on the RPA

Habitat	Summary Description*
1	Myrtle-Pandanus Savannah/ Paperbark Forest/ Coastal Deciduous Rainforest For a description of Myrtle-Pandanus Savannah refer to habitat 2. Paperbark forests line freshwater creek systems and the edges of billabongs and are dominated by *Melaleuca* spp. The canopy can be 15 to 20 meters in height and can vary greatly from open to almost closed. The shrub layer varies from sparse to dense and comprises *Acacia* spp., *Ficus* spp. on marginal areas and the ubiquitous freshwater mangrove *Barringtonia acutangula*. *Pandanus aquaticus* and *B. acutangula* line streams and channels. In zones edging woodland (which is often the case on the RPA), the trees are wider spaced and often form an ecotone with myrtle-pandanus savannah. In this ecotone area other eucalypts, bloodwoods and other savanna trees co-dominate with the paperbarks. Coastal deciduous rainforest habitat is not present on the RPA according to the description of Schodde et al. (1987); therefore a summary description is not provided.
2	Myrtle-Pandanus Savannah Consists of grassland with small open pockets of woodland, mixed shrubland and rainforest trees, interspersed with strips of *Pandanus spiralis* along the edges of floodplains and with paperbarks Melaleuca spp., along creeks and streams. Tall trees from such as *Corymbia* spp. and *Eucalyptus* spp. are sparingly present. A very patchy shrub layer of *Melaleuca viridiflora*, *M. nervosa* and *P. spiralis* occur. Common grasses include annuals from genera such as *Digitaria*, *Ectrosia*, *Panicum*, *Schizachyrium* and *Sorghum* and perennial grasses including those from genera such as *Eriachne* and *Themeda*. Sedges (Cyperaceae) are also a common component of the ground cover.
3	Open Forest Tall (12 to 20 metres) open forest dominated by *Eucalyptus miniata* and *E. tetrodonta* with other species of eucalypts present in the canopy. The only frequent non eucalypt that occurs in the canopy is Ironwood, *Erythrophleum chlorostachys*. The shrub layer consists of *Acacia* spp., *Calytrix exstipulata*, *Croton arnhemicus*, *Gardenia* sp., *Livistona humilis*, *Petalostigma quadriloculare*, *Planchonia careya*, *Terminalia* spp. and *Xanthostemon paradoxus*. Ground cover is usually sparse, inconspicuous, and comprises mostly annual grasses of *Sorghum* spp. and other herbaceous plants.
4	Woodland This habitat typically lacks a distinct canopy and is more stunted (usually less than 12 metres) than open forest and is dominated by bloodwoods (*Corymbia* spp.) but also contains eucalypts such as *E. miniata*, *E. tetrodonta* and *E. tectifica*. The structure is quite variable and can be tall on slopes to the point where it grades into open forest. The shrub layer is the same as in open forest but much sparser. The palm, *L. humilis* is common and pockets of *P. spiralis* may also be present. The ground cover is much denser than in open forest, containing mainly annual grasses, e.g. *Sorghum* spp. In stunted woodlands perennial grasses *Heteropogon triticeus* and *Sehima* sp. dominate.

* Schodde, et al. 1987

Native Flora Species

There has been a substantial survey and monitoring of the terrestrial flora across the RPA over the past 10 to 15 years. No species of conservation significance listed under the *Territory Parks and Wildlife Conservation Act 1978* (NT) (TPWC Act) or the EPBC Act has been recorded during those surveys. In a 2013 survey of lowland riparian and woodland areas of the RPA, over 90 flora species were recorded (Eco Logical Australia 2014). These species are also common in the surrounding Kakadu National Park (KNP) and did not include any threatened or rare species. Approximately 1,600 terrestrial and aquatic flora species have been recorded in Kakadu, including 15 species considered rare or threatened (Director of National Parks, 2016)

Weeds

The RPA has been surveyed annually for weeds by ERA since 2003, and approximately 80 species have been recorded. Gamba Grass (*Andropogon gayanus*) is the only weed of national significance that has been recorded in the RPA; however, its occurrence was restricted to isolated plants on roadsides or in the vicinity of the Jabiru Airport, which have subsequently been removed. Thirteen priority weeds have been identified for the RPA including five species declared under the *Northern Territory Weeds Act* 2001 (Table 2—6). These weeds are actively controlled using a combination of chemical controls (Glyphosate, Clomac, Goal Tender and Sulfomac) manual removal of whole plants or seed heads, and fire. Specific treatments are applied in response to seasonal conditions, with chemical control being preferred until conditions limited effectiveness. Fire and weed or seed head removal are generally undertaken toward the end of the wet season.

A weed load assessment was undertaken in May 2015 (Eco Logical Australia, 2015). The assessment assigned a weed load of high, medium, or low to each defined weed management area, or sub-area, based on a number of factors including management effort during the previous year, current weed load, weed species present, known weed responses to management, History of the weed management area, potential vectors of weed spread, and proximity to the site boundary. The assessment found that the higher weed loads were located in the more highly disturbed areas around the major work areas and in the areas where irrigation and slashing are used for site-based water management (Eco Logical Australia, 2015) The assessment determined that the current system of weed control in response to conditions on site is having a positive impact on weed load in many weed management areas (Eco Logical Australia, 2015)

Outcomes of the weed control programme are further discussed in Section 6.5.

Table 2—6: Priority weed species

Common name	Scientific name	*Weeds Management Act* category
Annual Pennisetum	*Cenchrus pedicellatus*	
Calopo	*Calopogonium mucunoides*	
Cupid's Flower	*Ipomoea quamoclit*	
Flannel Weed	*Sida cordifolia*	
Grader Grass	*Themeda quadrivalvis*	Class B, Class C
Hyptis	*Hyptis suaveolens*	Class B, Class C
Mission Grass	*Cenchrus polystachios*	Class B, Class C
Rattlepod	*Crotalaria goreensis*	
Sesame	*Sesamum indicum*	
Sicklepod	*Senna obtusifolia*	Class B, Class C
Siratro	*Macroptilium atropurpureum*	
Spinyhead Sida	*Sida acuta*	Class B, Class C
Wynn's Cassia	*Chamaecrista rotundifolia*	

** Weeds of National Significance are categorised under the Environment Protection and Biodiversity Conservation Act 1999*

Native Fauna Species

Kakadu contains over one third of Australia's bird species (271), one quarter of Australia's land mammals (77), 132 reptile species, 27 frog species, and overn246 fish species recorded in tidal and freshwater areas (Director of National Parks, 2016). Since the 1990s, a significant decline has been recorded in the abundance of 10 species of small mammals in Kakadu, including the northern drown bandicoot (*Isoodon macrourus*), Fawn antechinus (*Antechinus bellus*), common brushtail possum (*Trichosurus vulpecula*). The TPWC Act-listed pale field rat (*Rattus tunneyi*), and the EPBC Act listed northern quall (*Dasyurus hallucatus*, Woinarski et al., 2010). The decline has been attributed to a high fire frequency, feral cats, and cane toads (Woinarski et al., 2010).

Firth, (2012) undertook a desktop review of (flora) and fauna data held by ERA. This included 26 reports presenting the results of fauna surveys; three reports documenting aquatic flora and fauna survey work; seven documents that reviewed previous terrestrial and aquatic flora and fauna work; and relevant data bases of ERA Birdwatch events that occurred on the RPA from 2001 – 2011, inclusive.

A number of conservation significant species (including a relatively large number of mostly bird species which are listed under various migratory agreements) have been recorded on the RPA

during previous surveys (Table 2—7). The most notable of these, are the conservation listed northern quall *Dasyurus hallucatus* (Endangered[1]; Critically Endangered[2]) and the partridge pidgeon, *Geophaps smithii* (Vulnerable[1]; Vulnerable[2]) listed under the [1] *Environmental Protection and Biodiversity Conservation Act* 1999 (EPBC Act) [2] *Territory Parks and Wildlife Conservation Act* (TPWC Act) (Firth, 2012).

The northern quall population has undergone dramatic declines in the Top End as a result of ingesting the toxic cane toad and in many areas of the mainland such as Kakadu National Park has become almost extinct. Several recent surveys on the RPA have failed to detect it, suggesting that it is most probable extinct on the RPA. The only EPBC Act listed fauna species still known to occur on the RPA with any certainty are the partridge pigeon, fawn antechinus and black footed tree rat, the latter two only recently being conservation listed.

During the last fauna survey undertaken on the RPA in September 2013, at least[5] 127 species were recorded, comprising 8 native amphibian species, 79 bird species, at least 17 native mammal species, 20 reptile species and 3 introduced species. Seven EPBC Act or TPWC Act listed species were recorded within the 220-hectare survey area, situated towards the east of Pit 3 in the Magela Creek and former Magela land application areas, and in the vicinity of Retention Pond 1(Eco Logical Australia, 2014)

Table 2—7: Conservation listed species known to occur on the RPA (adapted from Firth, 2012

Common name	Species Name	EPBC Act (Cth) status	TPWC Act (NT) status	Preferred Habitat
Mammals				
Black-footed tree-rat	*Mesembriomys gouldii*	Vulnerable	Vulnerable	Tropical woodlands and open forests in coastal areas
Brush-tailed rabbit-rat	*Conilurus penicillatus*	Vulnerable	Endangered	Tropical woodlands; declined to near extinction since the 1980s.
Fawn antechinus	*Antechinus bellus*	Not listed	Endangered	Savanna woodland; tall open forest
Northern brown bandicoot	*Isoodon macrourus*	Not listed	Near threatened	Tall grassland, shrubland, savanna and open forest
Northern quoll	*Dasyurus hallucatus*	Endangered	Critically endangered	Eucalypt open forests; rocky areas
Pale field-rat	*Rattus tunneyi*	Not listed	Vulnerable	Found in in the higher rainfall areas of the Top End of the Northern Territory
Birds				
Black-tailed godwit[1-4]	*Limosa*	Marine; migratory	Not listed	Coastal regions

Common name	Species Name	EPBC Act (Cth) status	TPWC Act (NT) status	Preferred Habitat
Black-winged stilt	*Himantopus*	Marine	Not listed	Freshwater and saltwater marshes, mudflats, and the shallow edges of lakes and rivers
Broad-billed sandpiper[1-4]	*Limicola falcinellus*	Migratory	Not listed	Sheltered coastal, intertidal mudflats
Caspian tern[3]	*Hydropogne caspia*	Marine; migratory	Not listed	Coastal sheltered estuaries; inlets and bays
Cattle egret	*Ardea ibis*	Marine	Not listed	Wet grasslands; wetlands; mudflats
Common Greenshank[1-4]	*Tringa nebularia*	Marine; migratory	Not listed	Coastal and inland wetlands
Common sandpiper[1-4]	*Actitis hypoleucos*	Marine; migratory	Not listed	Coastal and inland wetlands; billabongs
Curlew sandpiper[1-4]	*Calidris ferruginea*	Critically endangered; marine; migratory	Vulnerable	Coastal areas; non-tidal swamps, lakes and lagoons; inland ephemeral and permanent lakes, dams
Eastern great egret	*Ardea alba modesta*	Marine	Not listed	Range of wetlands, from lakes, rivers and swamps to estuaries, saltmarsh and intertidal mudflats
Glossy ibis[1]	*Plegadis falcinellus*	Marine; migratory	Not listed	Swamps; flood waters
Great egret	*Ardea alba*	Marine	Not listed	Wetlands; mudflats; mangroves
Greater sand plover[1-4]	*Calidris leschenaultii*	Vulnerable; marine; migratory	Vulnerable	Sheltered beaches; intertidal mudflats or sandbanks; sandy estuarine lagoons
Green pigmy goose	*Nettapus pulchellus*	Marine	Not listed	Coast; tropical freshwater lagoons
Grey plover[1-4]	*Pluvailis squatarola*	Marine; migratory	Not listed	Coast; inland wetlands
Grey-tailed tattler[1-4]	*Tringa brevipes*	Marine; migratory	Not listed	Coastal intertidal pools; mudflats and rock ledges

Common name	Species Name	EPBC Act (Cth) status	TPWC Act (NT) status	Preferred Habitat
Lesser sand plover[1-4]	*Charadrius mongolus*	Endangered marine; migratory	Vulnerable	Inter-tidal sandflats and mudflats; beaches; estuary mudflats
Little ringed plover[2-4]	*Charadrius dubius*	Marine; migratory	Not listed	Lowland habitats with shallow standing freshwater
Long-toed stint[1-4]	*Calidris subminuta*	Marine; migratory	Not listed	Shallow freshwater or brackish wetlands
Magpie goose	*Anseranas semipalmata*	Marine	Not listed	Coastal and inland wetlands; billabongs
Marsh sandpiper/ Little greenshank[1-4]	*Tringa stagnatilis*	Marine; migratory	Not listed	Coastal and inland wetlands; estuarine and mangrove mudflats
Pacific golden plover	*Pluvialis fulva*	Marine	Not listed	Wetlands, shores, paddocks, saltmarsh, coastal golf courses, estuaries and lagoons
Partridge pigeon	*Geophaps smithii*	Vulnerable	Vulnerable	Lowland woodland
Radjah shelduck	*Tadorna radjah*	Marine	Not listed	Mangrove flats; swamps; freshwater swamps; lagoons; billabongs
Rainbow bee-eater	*Merops ornatus*	Marine	Not listed	Open woodlands and forest; grasslands; widespread distribution and habitats
Red-capped plover	*Charadrius ruficapillus*	Marine	Not listed	Sandflats or mudflats at the margins of saline, brackish or freshwater wetlands
Red-necked stint[1-4]	*Calidris ruficollis*	Marine; migratory	Not listed	Sheltered inlets, bays, lagoons, estuaries, intertidal mudflats and protected sandy or coralline shores
Ruddy turnstone[1-4]	*Arenaria interpres*	Marine; migratory	Not listed	Coasts including mudflats
Sharp-tailed sandpiper[1-4]	*Calidris acuminata*	Marine; migratory	Not listed	Fresh or saltwater wetlands
Swinhoe's snipe[1-4]	*Gallinago megala*	Marine; migratory	Not listed	Coasts; floodplains; rivers

Common name	Species Name	EPBC Act (Cth) status	TPWC Act (NT) status	Preferred Habitat
Terek sandpiper[1-4]	*Xenus cinereus*	Marine; migratory	Not listed	Sheltered coastal mudflats; mangrove swamps
Wandering whistling duck	*Dendrocygna arcuata*	Marine	Not listed	Rivers, billabongs, pools and lakes
White-bellied sea-eagle	*Haliaeetus leucogaster*	Marine	Not listed	Coasts; floodplains; rivers
Whimbrel[1-4]	*Numenius phaeopus*	Marine; migratory	Not listed	Primarily coastal distribution
Wood sandpiper[1-4]	*Tringa glareola*	Marine; migratory	Not listed	Coasts; floodplains; rivers
Reptiles				
Estuarine crocodile[1]	*Crocodylus porosus*	Marine; migratory	Not listed	Marine; freshwater
Merten's water monitor	*Varanus mertensi*	Not listed	Vulnerable	Creeks and billabongs

1Bonn; 2China Australia Migratory Bird Agreement; 3Japan Australia Migratory Bird Agreement; 4Republic of Korea-Australia Migratory Bird Agreement; 5 There were several bat species whose calls could not be positively identified,

Introduced Fauna Species

Eleven feral fauna species have been recorded in the RPA and an additional eight species have been recorded in Kakadu National Park (Table 2—8). Three species recorded in both the RPA and Kakadu (pig, cat and cane toad) are listed under the EPBC Act as key threatening processes to environmental, natural heritage and cultural heritage values.

Table 2—8: Feral Fauna species known to occur in Kakadu National Park and the RPA

Type	Common name	Scientific name	RPA	KNP
Mammal	Dog	*Canis lupus familiars*	Y	Y
Mammal	Buffalo	*Bubalus bubalis*	Y	Y
Mammal	Cattle	*Bos Taurus*		Y
Mammal	Cat	*Felis catus*	Y	Y
Mammal	Donkey	*Equus assinus*		Y
Mammal	Horse	*Equus caballus*		Y

Type	Common name	Scientific name	RPA	KNP
Mammal	Black Rat	*Rattus*	Y	Y
Mammal	House mouse	*Mus domesticus*	Y	Y
Mammal	Pig	*Sus scrofa*	Y	Y
Insect	Ginger Ant	*Solenopsis geminata*		Y
Insect	Pharaoh's ant	*Monomorium pharaonic*		Y
Insect	Singapore ant	*Amaonomorium destructor*		Y
Insect	Ghost ant	*Tapinoma melanocephalum*		Y
Insect	Big-headed ant	*Pheidole megacephala*		Y
Insect	Cockroach	*Periplaneta sp.*	Y	Y
Insect	European honey bee	*Apis mellifera*	Y	Y
Amphibian	Cane toad	*Rhinella marina*	Y	Y
Reptile	Flower pot snake	*Ramphotyphlops braminus*	Y	Y
Reptile	House gecko	*Hemidactylus frenatus*	Y	Y

2.2 Socio-Economic Environment

ERA operates the Ranger mine on the traditional lands of the Mirarr people and within a complex social, environmental and regulatory setting created over the past 35 years. In line with the Rio Tinto Communities standard, ERA regularly reviews the socio-economic context in which it operates and assesses the impact of operational and closure projects on the local and regional community to inform business decision making.

The socio-economic baseline data and impact assessments have been undertaken through desktop research and analysis, appropriate stakeholder consultation and modelling. Recent examples include the socio-economic impact assessment for the potential expansion of underground mining in 2013 and the social impact assessment (SIA) for ERA's exit from Jabiru completed in 2017 (refer 2.2.4).

2.2.1 Current Land Use

The RPA is located on land belonging to the Kakadu Aboriginal Land Trust and ERA has agreed access in accordance with the *Aboriginal Land Rights (Northern Territory) Act 1976*. Conditions are attached to the agreement, including compliance with the Environmental Requirements (ERs).

The town of Jabiru is situated on land owned by the Director of National Parks, which is in turn, leased to the Jabiru Town Development Authority. A native title determination application under the

Native Title Act 1993 (Cth) over the town area was lodged in 1997. The application was heard by the Federal Court in April 2013 and a decision was handed down in 2016.

The decision acknowledges native title; however, the status of that title varies from lot to lot depending on the particular use of the land. An amendment to the Aboriginal Land Rights (Northern Territory) Act 1976 provided for the township land to be transferred to the Land Trust upon execution of a new town lease. On 9 November 2018, at a special hearing of the Federal Court of Australia, a native title determination was presented to five Mirarr women who were central to the native title claim. The determination gives effect to the 2016 judgement recognising that Mirarr hold native title rights over Jabiru Township.

Besides the Mirarr people, other Aboriginal clans are Traditional Owners of land in the surrounding areas of KNP and Arnhem Land. Outstations and Aboriginal town camps lie within a 50 kilometre radius of Jabiru and include: Buffalo Farm, Cannon Hill, Madjinbardi (Mudginberri), Manaburduma – Jabiru town camp, Kurrajong Flats, Kapalga, Djurrbiyuk, Red Lily and Nourlangie Ranger Station, Patonga Airstrip, Patonga Homestead and Spring Peak.

The Magela catchment, within which the RPA is situated, contains several land use types including national park, mining leases and native title lands. Various historical uses of land within the Magela catchment include indigenous occupation followed by exploration and buffalo hunting from the 1880s. Missions were established in the region in the 1900s and pastoral grazing and agriculture occurred from 1906 at Oenpelli. Mining exploration occurred throughout the region from the 1920s including the development of series of small uranium mining ventures from the 1950s. More recently the region has been a popular tourist destination, particularly since the declaration of KNP (DEWHA 2009; Levitus 1995). Outside of current and historical mining impacts in the catchment, the Mudginberri Station (located north of Jabiru) was used for agriculture, research and was subject to broad scale clearing and cropping (Bayliss, *et al.* 1997).

2.2.2 Project stakeholders

Community engagement and collaboration

ERA engages with a wide range of stakeholders and community groups within the local Jabiru community, the West Arnhem region and other parts of the Northern Territory. This engagement is designed to provide members of the public, community groups and other stakeholders with an opportunity to learn and understand about ERA's operations.

Community engagement forums (see Table 2—9) provide support to help protect and promote cultural heritage, community health, small business development, including Indigenous business and education and sporting opportunities for young people.

Throughout 2018 ERA held discussions with the GAC and the Mirarr Traditional Owners on a diverse range of matters including rehabilitation planning, cultural heritage and environment protection, employment and training, water management, housing and town planning, community activities and the Kakadu West Arnhem Social Trust. In particular, some highlights included handover of the Mine

Closure Plan to Traditional Owners, initial discussions on formalising joint management of Madjedbebe and on country engagement with the ERA and Rio Tinto Boards

No significant or repeat community complaints were received in 2018.

Regulatory stakeholder engagement

Regulatory stakeholders (see Table 2—10) meet regularly to discuss performance and compliance in a range of critical areas, including health and safety, process safety, safe management of contaminated radioactive substances, waste disposal, transport safety, export controls, protection and rehabilitation of the environment, native title, development, taxes and royalties, labour standards and mine reclamation.

Table 2—9: Community engagement forums

Engagement forum	Frequency	Comment
ERA business updates	Bi-annually	Presentation and question and answer session from ERA's General Manager Operations regarding ERA operations and areas of key interest to all local community stakeholders, Traditional Owner organisations, Federal, Northern Territory and local government stakeholders. These are scheduled twice yearly, however may be undertaken more frequently as required.
Relationship Committee meetings	Quarterly	The Relationship Committee was established under the Ranger Mining Agreement between ERA and the NLC in 2013. The committee was established to ensure effective information sharing and review processes between ERA and the Traditional Owners and their representatives.
Jabiru Town Development Authority meetings	Quarterly	Jabiru serves West Arnhem region as a centre for mining, tourism and community services. Membership includes an NT Government representative (Chair), two ERA representatives, GAC representative and elected member of the West Arnhem Regional Council.
Ministerial briefings	Regularly as required	Briefings are provided to both Federal and Northern Territory Ministers and senior advisors on ERA operations including aspects of closure.
Kakadu Board of Management Meetings	Meetings held quarterly ERA update provided bi-annually	Kakadu National Park is a jointly managed park between Parks Australia and the Traditional Owners of Kakadu. A board of management has been established as part of the governance structure for the park and consists of Commonwealth Government representatives, Park Management and Traditional Owners from each region in the park. ERA provides an operations update, including mine closure status and consults with the broader indigenous population through this forum.

ERA information centre	Ongoing	The centre displays current information on ERA operations including closure and rehabilitation, with ERA personnel on hand to provide face-to-face interaction.
State of the Nation	Quarterly	Presentation and question and answer session provided to all ERA personnel and contractors on ERA operations by either the Chief Executive or General Manager Operations including aspects of closure, Jabiru and stakeholder engagement.
ERA information day	May - August	Monthly information days are held once a month from May to August of each year for Jabiru residents and the general public which includes an information stand and mine tour of Ranger operations.
Mine tours	Ongoing	Ranger provides organised guided group mine tours throughout the year, as requested from various industry representatives, interest groups and students.

Table 2—10: Regulatory engagement forums

Engagement forum	Frequency	Comment
Minesite Technical Committee (MTC) meetings	Monthly	The MTC is the formal forum for key advisory and stakeholder groups, including representatives of the NT Governments Department of Primary Industry and Resources (Chair), Supervising Scientist Branch, ERA, GAC and the NLC, to discuss and resolve technical environmental management matters relating to the operation of the Ranger mine. The MTC discusses matters relevant to the regulatory functions of the NT Government and the supervisory and assessment functions of the Supervising Scientist, as well as operational requirements of ERA and the views of the Mirarr and affected Aboriginal people. In addition the Commonwealth Department of Industry, Innovation and Science is an observer to the MTC.
Alligator Rivers Region Technical Committee (ARRTC) meetings	Bi-annually	The ARRTC was established under the Commonwealth *Environment Protection (Alligator Rivers Region) Act 1978* and reviews the appropriateness and quality of scientific research conducted by NT and Commonwealth Government agencies, ERA and others relating to protection of the environment from the potential impacts of uranium mining in the Alligator Rivers Region. In November 2017, in order to strengthen the independence of the Committee, the minister for the Environment and Energy, made changes to the Committee's membership. Members include independent scientific members (including Chairperson) and the NLC. Representatives for ERA continue to attend to provide advice, information and expertise to the Committee.
Alligator Rivers Region Advisory Committee (ARRAC) meetings	Bi-annually	The ARRAC was established under the Commonwealth *Environment Protection (Alligator Rivers Region) Act 1978* and facilitates communication between government, industry and community stakeholders on environmental issues associated with uranium mining in the Alligator Rivers Region. The Committee includes representatives from several NT Government departments, Charles Darwin University, Office of the Administrator of the NT, several Australian government departments, non-government organisations, ERA and other mining companies that operate in the region.
Routine Periodic Inspections (RPI)	Monthly	RPIs occur monthly and provide a forum for MTC members to attend site and undertake physical inspections of specific areas of focus. This is chaired by the Supervising Scientist.

2.2.3 Workforce Description and Demography

ERA Workforce

At 31 December 2018, ERA's total workforce numbers was 355 full time equivalent people, including 13 contractors (2017: 397 people). The operation is expected to continue to change as Ranger transitions from ore processing to rehabilitation. However, the extent to which this changes the size of the overall workforce is at this time unknown.

At the end of 2018, 149 (42%) of ERA's employees were residing in Jabiru, with the remainder of the workforce being Fly-in, Fly-out from Darwin or based in ERA's Darwin office.

Indigenous employment and initiatives

As a major employer in Jabiru and West Arnhem region, ERA has a strong focus on Indigenous employment. Indigenous employees are engaged in variety of roles within ERA, ranging from operations functions through to leadership positions at superintendent and senior-supervisor levels. At 31 December 2018, there were a total of 44 Indigenous employees (ten females and 34 males), with three Indigenous employees in leadership roles – two team leaders and one superintendent (2017: 43 Indigenous employees, three in leadership roles).

In 2018, ERA employed four new trainees (four male) and five full-time apprentices continued ongoing employment (three females and two males; four of whom are Indigenous) across various areas and roles including maintenance, mining, community relations and water management.

ERA's Pre-Employment Programme is designed to assist school leavers and other local people seeking to enter the workforce or find new employment. In 2018 ten participants began the five week course with seven completing the course and two going on to gain employment with ERA and other local businesses.

2.2.4 Community affairs

Town of Jabiru

ERA is a substantial contributor to the economy, population, infrastructure and services in Jabiru. Under the current mining agreement, ERA will cease mining and processing activities by 8 January 2021 and the head lease for the town of Jabiru expires in July 2021. ERA employees, contractors and their families represent 52% of the residential population (based on 2016 census data).

In 2017, ERA undertook a Social Impact Assessment (SIA) to assess the impact associated with ERA meeting its legal obligation of exiting Jabiru and the surrounding region. The information captured during the SIA is being used to inform the development of ERA's Jabiru Exit Strategy. The withdrawal of Ranger workforce will most likely change the culture and identity of Jabiru. Broadly, the impacts would be associated with changes to diversity and the physical, economic and demographic nature of the town.

Discussions are underway between Gundjeihmi Aboriginal Corporation (GAC), Northern Land Council, Commonwealth and Northern Territory government about the potential future of Jabiru. ERA is involved in these discussions and will support stakeholders in planning for the future of Jabiru.

The long term future for Jabiru is closely linked with the formal recognition of Mirarr Traditional Ownership of the land on which Jabiru Township is located and the options for the future lease governance.

Aboriginal organisations

The GAC is the representative body of the Mirarr Aboriginal people and the royalty receiving organisation for Ranger mine. As directed by the Northern Land Council It is the organisation with the greatest investment in, and ability to directly affect, the future of Aboriginal governance and representation in Jabiru. The GAC is also involved in town governance and many other aspects of life in Jabiru and surrounds and has made investments in and/or owns the GAC office complex in Jabiru, Kakadu Youth Centre in Jabiru, Djidbidjidbi Residential College in Jabiru, houses and associated buildings at Madjinbardi (Mudginberri) and Djirrbiyuk (Whistle Duck), including ongoing maintenance, and three retail businesses, being the Two Rivers Newsagency, Marrawuddi Gallery and Anmak An-me cafe at Bowali Visitors Centre.

Other Aboriginal associations in the Kakadu region are as follows:

- Gagudju Association Inc. – membership involves a number of various clans in KNP grouped together to provide services and assistance to its members. The association has business interests such as BP Service station in Jabiru, shareholdings in Kakadu Crocodile Hotel and the Cooinda Lodge Kakadu, which includes the Yellow Water Tours;
- Djabulukgu Aboriginal Association (DAI) – membership is made up of traditional clan groups between Jabiru and Gunbalanya. It is a community development organisation with a strong emphasis on skilling up local Indigenous people to take up employment within its enterprises, cultural and social services. DAI has an emerging Conservation Land Management focus, the aim of which is to create sustainable employment; and
- Warnbi Aboriginal Corporation (WAC) – the main objective of the Corporation is the administration of the Community Development Employment Programme (CDEP), which provides employment opportunities for local Indigenous people living in Jabiru and the Kakadu region. It also maintains infrastructure and roads for the outstations within Kakadu National Park.

Community partnership and sponsorship

ERA's Community Partnership Fund provides support for local community-based events, schools and students, sport, the arts and festivals. This support is delivered in a variety of ways including direct funding, community partnerships, in-kind support and donations of equipment and resources. [redacted] ERA also continued its long running support for the Mahbilil Festival, Kakadu Triathlon which raises funds for CareFlight,

ERA Golf Open, Jabiru and Gunbalunya end of year School Awards and the Jabiru Community Children's Christmas Party.

ERA, in partnership with GAC, delivers cross cultural awareness training. The training provides employees and contractors with an introduction to the unique cultural, environmental and historical values of the Kakadu region and the Mirarr Traditional Owners.

In 2018, ERA undertook a feasibility study for closure, which included planning aspects for Communities and Social Performance (CSP). The outcome of the feasibility study will be finalised in 2019 and will form the basis of CSP planning for Ranger mine closure.

3 STATUTORY AND NON-STATUTORY REQUIREMENTS

ERA has a system to identify, manage, assess and report against legal compliance requirements. This system includes EMS procedures, checklists, inspections and audits. Legal compliance is monitored on a continual basis from analysis of monitoring and other data, maintenance of compliance checklists and a system of regular audits and inspections. As part of this system, areas of non-compliance are promptly identified and actioned.

Inspections may also be conducted on an ad hoc basis by government authorities to assess, among other matters, performance against legal and other requirements.

Consistent with EMS procedures, any changes to legal requirements such as new approvals or changes to legislation are monitored. These changes may be identified from research, industry contact and correspondence from NGOs, government notifications, subscriptions, media reports and legal advice. ERA's EMS framework and procedural and training documentation is also reviewed on an ongoing basis and is updated as required to reflect changes in legal requirements. During the reporting period, required changes were made to the EMS documentation to ensure consistency with the changing legislative and approval requirements.

3.1 Statutory Requirements

Operations at Ranger are governed by both Australian and Northern Territory (NT) legislation and regulations. The key instrument that governs operations at the Ranger mine on a day-to-day basis is the Ranger Authorisation issued under the *NT Mining Management Act* 2001 (Authority 0108-18). The Ranger Authorisation incorporates the Environmental Requirements (ERs), which are attached to the section 41 (s.41) Authority issued by the Australian Government under the Atomic Energy Act 1953 *(Cth)*. ERA maintains a Compliance Obligation Register to identify and manage compliance with the many Acts and Regulations under both Commonwealth and Northern Territory legislation that are relevant to the regulation of Ranger mine.

As uranium mining and milling facility, international guidelines relating to radiation protection apply to operations at Ranger. The system of radiation management at ERA's operations is based on the justification, optimization and limitation principles established by the International Commission on Radiological Protection (ICRP), standardized by the International Atomic Energy Agency (IAEA) and adopted in a joint Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) and National Occupational Health and Safety Commission (NOHSC) document.

3.2 Non-Statutory Obligations

ERA is required to comply with the environmental management and sustainability requirements of its major shareholder, Rio Tinto. Rio Tinto has implemented Environmental Standards which aim to manage environmental risk at a consistent level across all Rio Tinto operations.

Several agreements are in place to support the function of ERA's regulators and the relationships between ERA and key stakeholders. Relevant agreements include:

- An agreement between the Commonwealth of Australia and the Northern Territory in relation to the principles to be applied in the regulation of uranium mining in the Northern Territory.
- A Memorandum of Understanding (commonly referred to as the 'Working Arrangements') which establishes procedures for consultation between the Australian Government's Office of the Supervising Scientist and the Northern Territory Department of Primary Industry and Resources (DPIR) in the performance of their legislative functions. The 'Working Arrangements' also set out the functions of the Minesite Technical Committee (MTC)
- GAC, Northern Land Council (NLC), ERA and the Commonwealth Government finalised the suite of agreements governing operations at the Ranger Project Area, including a new Mining Agreement in January 2013.

Ranger's Safety Management System and Environmental Management System has been certified to AS4801 and ISO14001 standards respectively since December 2003. The system is audited by an accredited external party on an annual basis to ensure compliance to these standards (for further details refer to Section 5 and Section 6.1).

3.3 Sacred, Archaeological and Heritage Sites

Sacred, archaeological and heritage sites have been identified and explained in an addendum to this MMP. The information contained within is considered to be sensitive and out of respect to the Traditional Owners this information will be treated confidentially.

It is noted that Section 6.10 provides details regarding the mandatory operational controls for the ongoing protection of cultural heritage sites.

4 OPERATIONAL ACTIVITIES

4.1 Exploration

4.1.1 Exploration Activities

All major projects on the RPA including any exploration projects are reviewed by the Ranger Minesite Technical Committee (MTC). For ERA, potential environmental impacts of drilling associated with exploration activities and their controls are described in an Exploration Management Plan. The MTC forum is then able to review and discuss if the management plan is adequate, after which ERA will receive preliminary stakeholder approval.

Prior to any drilling activities being undertaken, environmental assessments are conducted for each proposed drilling area via the Land Disturbance Permit process. This includes reviewing each proposed drilling area against the locations of known cultural heritage sites, conservation areas, remnant or mature vegetation and other sensitive environmental features, to minimise impacts as much as possible.

Each drilling location and its status is recorded and tracked through to rehabilitated through the acQuire management system. Rehabilitation works are undertaken in accordance with ERA standard operating procedure EXP007 Rehabilitation of Drill Sites

4.1.2 Exploration Performance against Previous MMP

Ranger 3 Deeps Exploration Decline

The Ranger 3 Deeps Exploration Decline and associated drilling programme was completed in September 2014 with a total of 47,000 metres of core recovered for the entire programme. Core is currently being stored at the exploration core storage area

Decline development activities associated with Ranger 3 Deeps were completed on 18 November 2014. Following this, a 36 metre drive into the ore body was completed on the 30 November 2014. Four thousand tonnes of mineralised material was excavated during the development period. In December 2014, following the excavation of the bulk sample, the exploration decline was placed into care and maintenance.

In the third quarter of 2017, following receipt of approval under the Environment Protection and Biodiversity Conservation Act 1999 (Cth), ERA processed the Ranger 3 Deeps bulk sample.

In July 2018, ERA sought MTC approval to decommission the decline and associated infrastructure. A final MTC application was submitted on 21 September 2018 (Smith & Pugh, 2018). ERA subsequently provided additional information in response to MTC requests on 29 November 2018 and is pending ministerial approval.

4.1.3 Exploration Activities for the Oncoming Period

There is no evaluation or exploration activity planned for the oncoming period

4.2 Mining

4.2.1 Mining Activities

Uranium is the target commodity at Ranger mine. No other commodities are targeted, mined or processed. ERA is currently processing stockpiled ore following the completion of open cut mining in 2012.

Stockpile Management and Grade Control

During active mining operations, extracted material was transported by truck to pass beneath a radiometric discriminator, which uses scintillometer heads to measure the gamma particle emissions of each load and categorise the material. Material was allocated to tipping locations, including the 'Run of Mine' (ROM) pad, based on grade classification (see Table 4—1). All information about current and proposed land disturbance (for security calculation purposes) is included in Chapter 8 and is detailed in the Annual Plan of Rehabilitation (APR).

Table 4—1: Ore grades and material type

Grade Class	Grade Range (% Uranium Oxide)	Material Type	Class
1	0.00-0.02	Un-mineralised rock	Waste
Low 2s	0.02-0.06	Very low grade	Waste
High 2s	0.06-0.08	Low grade ore	Ore
3	0.08-0.12	Ore	Ore
4	0.12-0.20	Ore	Ore
5	0.20-0.35	Ore	Ore
6	0.35-0.50	Ore	Ore
7	>0.50	Ore	Ore

Grades High 2's to 7 are classified as ore grade material, while grade Low 2 material has traditionally been considered sub-economic, ultimately to be returned as backfill to the mined-out pits and subsequently covered by Grade 1 un-mineralised rock to generate a final landform. Grade 1 material is also used to cap re-shaped remnant rock stockpiles as a growth medium to assist ecosystem re-establishment.

Waste Rock Dump

Waste rock is material of grade classes 1s and Low 2s, stockpiled in the areas shows in the diagram below (Figure 4-1). Material being mined from the waste dumps is discriminated as it is mined, with waste going into the pits. Higher grade material is classed as ore and is stockpiled on the Run of Mine (ROM) for processing.

Seepage and surface water runoff from the mineralized rock stockpiles and seepage from low-grade rock stockpiles is managed as part of the pond water system. The Ranger Water Management Plan provides detail on management, treatment and disposal of pond water on site.

Waste rock characterisation is addressed in ERA's Mineral Waste Management Plan (Appendix D.5). The primary purpose of this plan is to ensure that reactive mineral wastes are effectively managed at the Ranger mine. This plan identifies management strategies and practices implemented at Ranger with respect to mineral wastes and Acid Rock Drainage (ARD). The plan is intended to meet the requirements of the Rio Tinto Health Safety Environmental and Communities Performance Standards Chemically Reactive Mineral Waste (standard E13). Where appropriate, the plan refers to other existing Ranger, ERA and Rio Tinto documents, plans and procedures pertinent to ARD and mineral waste management.

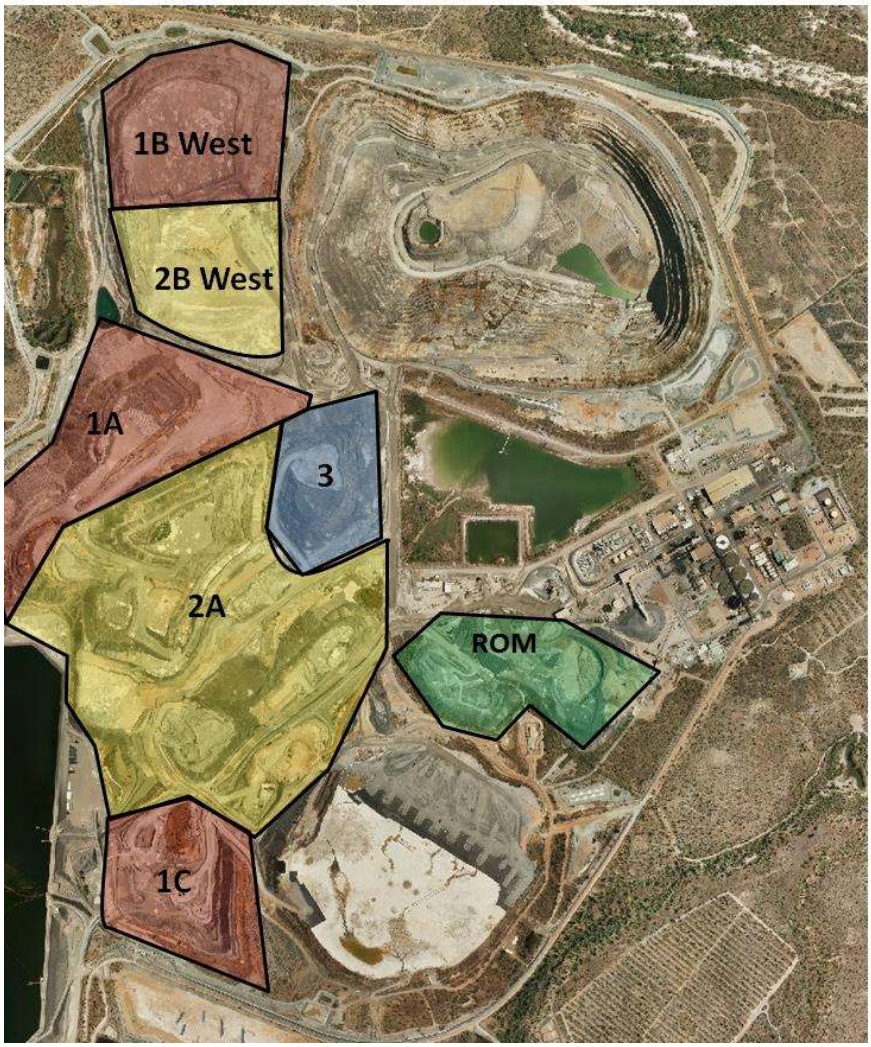


Figure 4-1: Mine Stockpile Locations

Mining Reserves and Geology

ERA's estimate of Ore Reserves for the Ranger stockpiles at 31 December 2018 was 3,735 tonnes of contained uranium oxide. This was announced to the ASX on 31 January 2019. (Table 4—2: Ranger Ore Reserves)

Table 4—2: Ranger Ore Reserves

Ranger Reconciliation	Contained U_3O_8 - tonnes
Ore Reserves as at 1 January 2018	5,783
Ore reserves depleted by processing	(2,280)
Other adjustments	
Favourable model variance	1,148
Low grade tonnes not mined or processed by 8 January 2021	(915)
Ore Reserves as at 31 December 2018	**3,735**

4.2.2 Mining Performance against Previous MMP

Stockpile re-handling was the form of mining that occurred throughout the reporting period. Direct feed of ore mined from stockpiles was fed to the crusher to minimise re-handling where possible. Some mining of ROM stockpiles did occur during the period, where blending to meet plant head grade, mineralogy or physical targets was required. All material mined from stockpiles was grade controlled using either the fixed or mobile discriminator units to determine its destination. During the 2018 reporting period, a total of 2.4 million tonnes of ore was processed through the plant

ERA continued to make progress in the rehabilitation of Pit 1. Regulatory approval permitting ERA to begin the final stages of backfill in Pit 1 was obtained in April 2017.

- This work commenced in May 2017 with 3.6 million tonnes in 2017 and 1.8 million tonnes placed in Pit 1 during the 2018 reporting period.
- Ongoing placement of the very low grade (low 2s) bulk rock fill in Pit 1 was completed in 2018.

4.2.3 Mining Activities for the Oncoming Period

The key mining activities to be carried out for the coming reporting period include:

- Ongoing mining of stockpiled ore material.
- Subject to stakeholder approval, ERA will begin placement of the un-mineralised waste rock layer to create the final landform of pit 1 in 2019.

Table 4—3 provides a forecast of the material movement in 2019.

Table 4—3: Mining Activities Forecast

	2019 Forecast
Stockpiled Ore to ROM (Mt)	3.2
Waste rock to Pit 1 (Mt)	4.4

4.3 Processing

4.3.1 Processing Activities

Treatment and Ore Processing Operations

Under normal operating conditions the process flow (Figure 4-2) and plant capacity (Table 4—4) is as below:

- Up to 2.5 million tonnes per annum of uranium ore is crushed and screened in a three-stage circuit and ground in one of three mills (two ball mills and one rod mill). With the addition of water the fine particles are slurried and thickened before being pumped through a cascade of leaching vessels containing an acidic solution at a pH of approximately two. Over a period of about 14 to 18 hours, more than 90 per cent of the uranium in the ore is dissolved. Pyrolusite, a natural mineral consisting essentially of manganese dioxide, is added to assist the leaching of the uranium from ore.
- Uranium in solution is separated from the solids through washing in a seven-stage CCD circuit. After separation there are two streams: the leach liquor pregnant with uranium and a waste tailings stream of depleted ore.
- The pH of the tailings slurry is raised by the addition of lime. This occurs in a mechanically agitated tank and once complete the slurry is pumped to the mined out Pit 3 for storage to allow solids to settle from the slurry. Process water in the Tailings Storage Facility, called supernatant liquor, is recycled to the processing plant.
- The pregnant leach liquor produced at the reverse end of the CCD circuit is passed through a clarifier and sand filters to remove residual fine particles. The solution is then purified and concentrated using a solvent extraction process. This process involves mixing in a series of counter current chambers the pregnant leach liquor with a high flash-point organic hydrocarbon (vivasol) containing an amine chemical. The amine selectively complexes the uranium, transferring it from an aqueous to an organic phase. The ‘loaded’ organic solution is fed into another circuit of four mixers/settlers in which the extraction process is reversed by increasing the pH from 1.8 to 3.5 by the addition of ammonia. The uranium is therefore stripped from the organic phase and transferred to the aqueous phase. Further pH control is achieved by adding ammonia and the resultant concentrated uranium-rich solution is pumped to tanks where ammonium diuranate (ADU), also known colloquially as ‘yellow cake’ is precipitated.

- The ADU precipitate is thickened, washed with water, centrifuged and dried at 800°C in a diesel-fired, multi-hearth furnace to produce the final uranium oxide (U3O8) product. It is then packed into 200 litre steel drums ready for transport.

The laterite treatment plant was constructed to extract uranium from weathered ores (referred to as laterite ores) that are unable to be processed through the existing processing plant. The plant was designed to produce approximately 320 tonnes of U_3O_8 per annum, performance details are shown in Table 4—6. The Laterite plant was decommissioned in 2018.

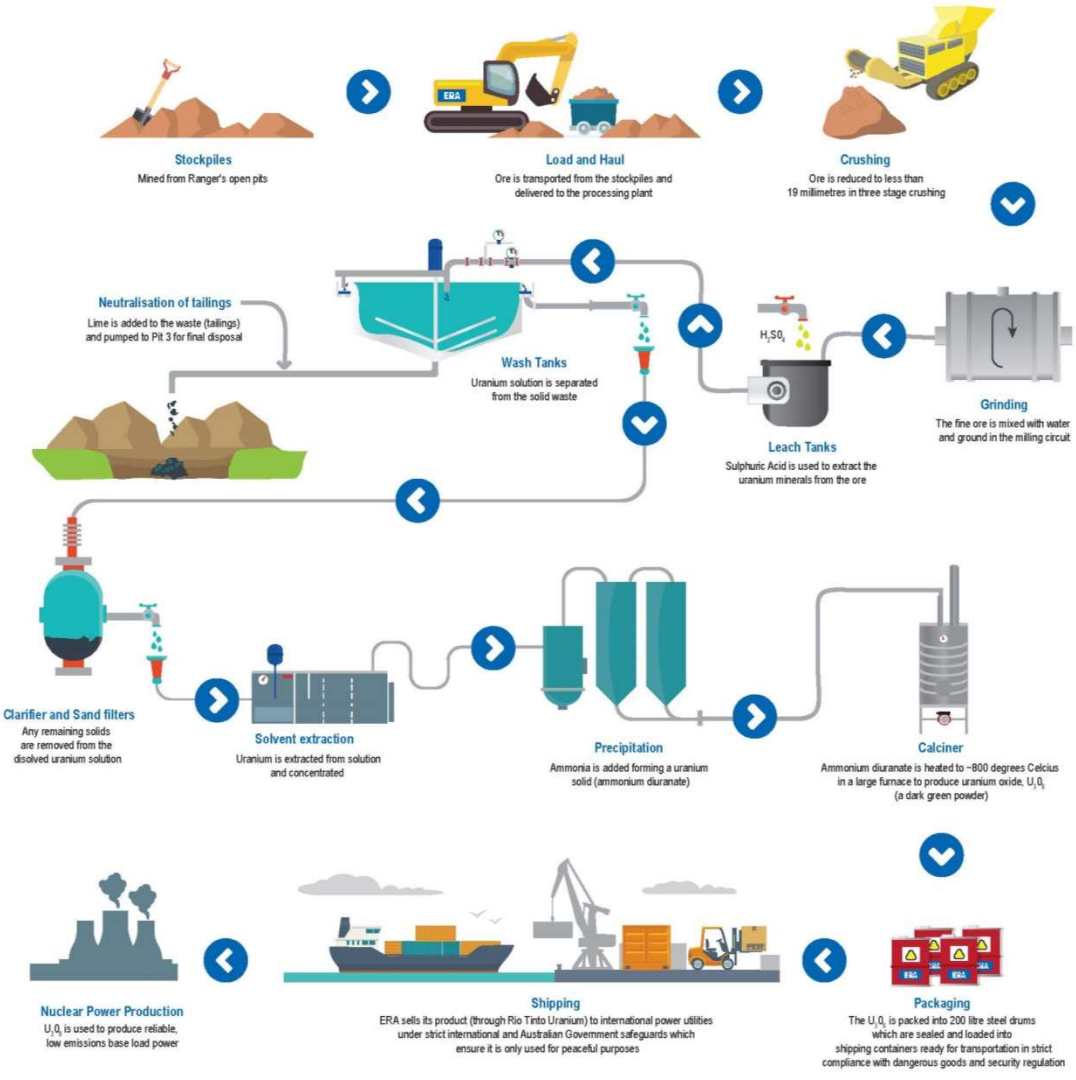


Figure 4-2: Ranger mine process flow diagram

Table 4—4: Ranger mine processing plant performance specifications

Specification	Capacity
Ore treated per year (Mt)	1.4 - 2.7
Uranium oxide grade	0.06 - 0.30%*
Uranium oxide produced per year (t)	1600 - 3000
Grade of uranium oxide product	>98%
Overall plant uranium oxide recovery	>85%

* Higher grade includes the Ranger 3 Deeps deposit

Tailings Storage and Disposal

The process water inventory is derived from waters that have passed through the uranium extraction circuit and all waters that have come into contact with that circuit. The process water catchment area covers the TSF, the processing plant area, the bund of the Brine Concentrator (BC) and Pit 3. Pit 1 has historically been used as a process water storage element, however with the commencement of bulk backfill in 2017; Pit 1 is now predominantly a pond water catchment. This is with the exception of the decant structures designed to drain water infiltrated into the pre-load layer as well as water seeping from buried tailings that is transferred to the process water inventory.

In 2012, ERA developed the Integrated Tailings, Water and Closure (ITWC) study to ensure closure of the Ranger operations will occur in accordance with statutory obligations, stakeholder expectations and business requirements.

A key element of the ITWC study is the Tailings and Brine Management (TBM) project, which coordinates the rehabilitation of Pit 1, Pit 3 and the Tailings Storage Facility and includes provision for managing tailings waste from ongoing milling activities until the end of production in January 2021.

This significant project provides an integrated operational pathway for:

- Converting the Pit 1 catchment area from process water to pond water (completed);
- Redirecting tailings from the processing mill away from the Tailings Storage Facility and directly into Pit 3 (completed);
- Returning water from Pit 3 to the Tailings Storage Facility (completed);
- Directing the brine waste stream from the Brine Concentrator to Pit 3 (it is noted that in 2018 the Brine Concentrator brine waste stream has been directed to the processing leaching circuit to recover uranium however in the long-term the brine waste stream will be injected to the Pit 3 underdrain for final storage); and
- Rehabilitation of the exhausted Pits 1 and 3 (in progress).

- Stakeholder approval to commence the excavation of the North Notch Stage 1 was received on 21st September 2018. Stage 1 involved MOL reductions to RL47.09m in the dry season and RL45.68m in the wet season. The clay core was excavated down to nominally RL48.5m and capped with 500mm of granular wearing course resulting in a nominal finished level of RL49.0m. Earthworks were completed in December 2018
- Stakeholder approval to commence the excavation of the North Notch Stage 2 was received on 3rd May 2019. Stage 2 involved MOL reductions to RL43.8m in the dry season and RL42.3m in the wet season. The clay core was cut down to nominally RL45.1m and capped with 500mm of granular wearing course resulting in a nominal finished level of RL45.6m. Earthworks were completed in June 2019
- Stage 2 incorporates a three-staged ramp and pad excavated into the upstream face of the notch. This facilitates supplies transfer to the dredge workboats as the water level drops, without affecting the approved MOLs. This arrangement should be sufficient until the water level falls below RL38m, at which point it is anticipated further MOL reductions and another notch may be required

Storage

The tailings dam (also referred to as the Tailings Storage Facility or TSF) was originally constructed in 1979 with first tailings being deposited soon after. The tailings dam has a dyke ('turkey nest') structure, being designed to hold both tailings and process water. Since commissioning it has been subjected to six crest raises with the final being completed in 2012 to the current clay core elevation of RL+60.5m.

Performance of the dam is monitored and inspected annually by independent engineers in accordance with the Ranger Authorisation and is operated within the requirements of the Australian National Committee on Large Dams and International Commission of Large Dams guidelines for tailings storage facility design and operation (ANCOLD 1999). The monitoring data and the outcomes of the engineering inspections are reported to the regulators to confirm that the structure continues to perform according to its design and operational criteria.

Approximately 23 million cubic metres of tailings stored in the tailings dam and must be transferred to Pit 3 to meet ERA's closure objectives. A number of options for the transfer of tailings was reviewed by ERA with the use of a dredge selected as best practicable technology as part of the ITWC prefeasibility study.

Disposal

Construction of the tailings dam dredge was completed in 2014 and it was commissioned, along with tailings transfer and water recovery/pumping infrastructure high density polyethylene (HDPE) pipelines in December 2015.

Tailings slurry is reclaimed by the dredge and transferred via the floating HDPE pipeline connected to an overland HDPE pipeline at the edge of the tailings dam for delivery to the deposition points in Pit 3 (Figure 4-3) (ERA 2014). The tailings layer in Pit 3 will consolidate with water being continuously expressed. Expressed water will flow both upwards (decant) to be recovered at the Pit 3 surface and

downwards to be recovered at the underdrain layer as shown in Figure 4-4. Decant water from tailings consolidation and rainfall run-off will be pumped via the process water tanks located at the edge of Pit 3 back to the tailings dam (ERA 2014) to allow for the continued floating and operation of the dredging infrastructure.

Based on the current dredge performance and with confidence in the implementation of planned improvements (refer Section 4.3.3), tailings transfer is estimated to be completed by Q1 2021.

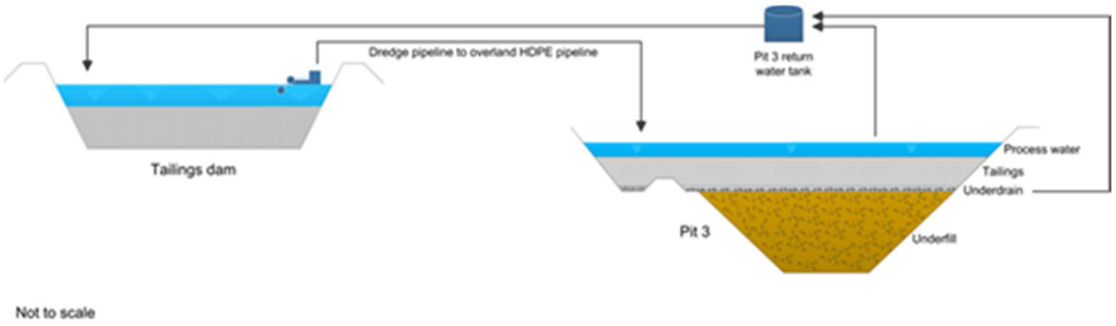


Figure 4-3: Flow diagram of tailings transfer

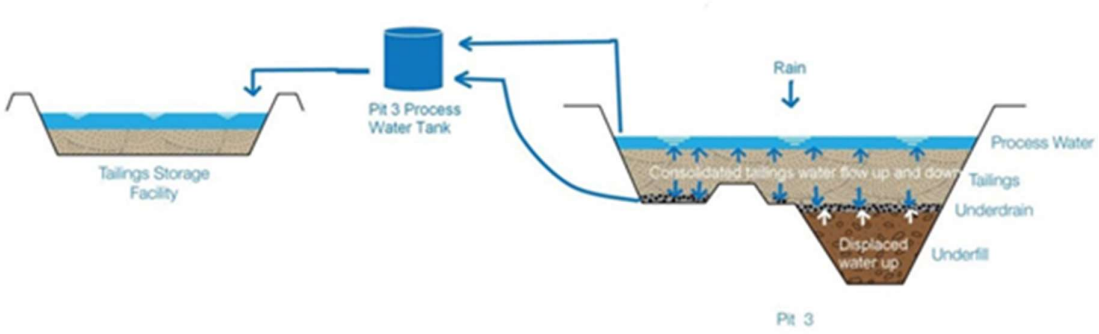


Figure 4-4: Expressed water from Pit 3

From 2015, all production tailings were directed to Pit 3, therefore the process water in the tailings dam will progressively reduce as it is treated by the brine concentrator, and the tailings mass in the tailings dam will be progressively transferred to Pit 3 by dredge operations (ERA 2014). These activities are integral to the successful execution of the closure strategy.

Brine injection (and underdrain)

Brine transfer pumping and injection infrastructure enables the concentrated brine waste stream from the Brine Concentrator to be injected and safely stored within the available void space within the underfill of Pit 3.

Five brine injection wells have been drilled directly into the Pit 3 underfill. Above the Pit 3 underfill is an engineered underdrain which comprises a layer of waste rock (nominally 2 metres) to a sump constructed at its low point and a bore installed from behind the rim of the pit to intercept the underdrain sump. The underdrain is designed to remove both water expressed downwards by the overlying tailings during the consolidation process, and entrained pond water displaced upwards from within the underfill by the brine injection process (ERA 2014).

As each injection bore reaches capacity or precipitates foul the surrounding voids within the underfill, the next injection well will be commissioned. In the event that all wells are exhausted, additional injection wells will be installed on the southern edge of Pit 3 to inject the remaining brine into the Pit 3 underfill. The brine injection system is expected to be operational 80 per cent of the time, with the brines diverted back to process water when required.

The brine injection system (concentrator, piping and infrastructure) was commissioned in 2015 and commenced full scale operation in 2016; however, operational issues with the Pit 3 underdrain bore have required that brines be diverted back to process water or the processing plant (refer Section 4.3.3). The brine injection system ties into the brine concentrator facility concentrated brine tank. A centrifuge pump transfers the hot concentrated brine via a pipeline to a storage (surge) tank. An inline heat exchanger partially reduces the brine temperature to prevent boiling in the pumps and pipelines. The brine is drawn from the surge tank and pumped to designated injection bore via a valved manifold through a brine delivery pipeline (refer Figure 4-5).

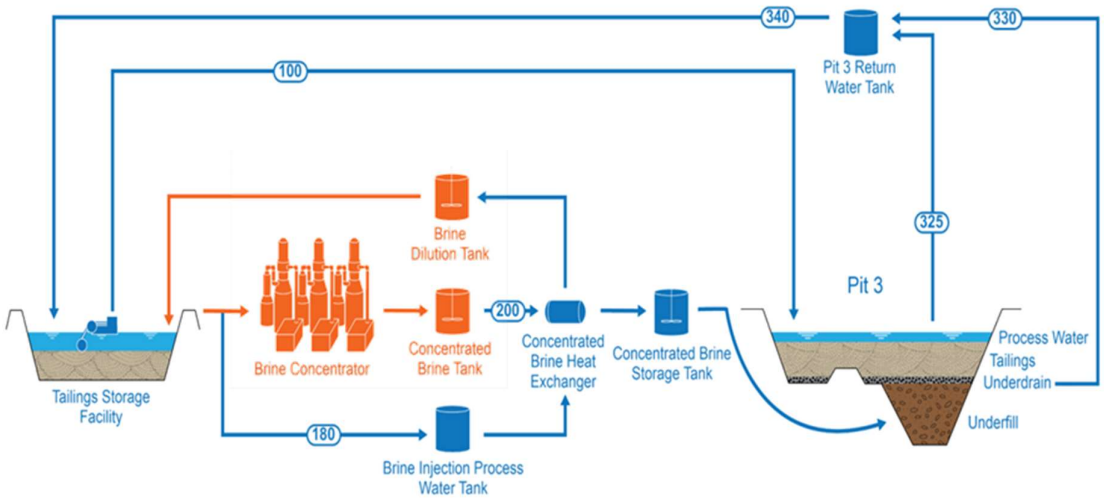


Figure 4-5: Flow diagram of brine injection and tailings transfer

Process Water Treatment

Process water is any water that has passed through or been in contact with the uranium extraction process. Process water is stored the Tailings Storage Facility (TSF) and Pit 3. Process water can be reused in the processing of ore, allowed to evaporate or treated using the Brine Concentrator.

The Brine Concentrator was commissioned in September 2013 and uses thermal energy to evaporate water, which produces clean distilled water (distillate) that is of a quality suitable to enter the release water class. The distillate can be released into the environment at times of flow in Magela Creek or disposed of via evapo-transpiration. The Brine Concentrator is designed to produce 1,830 megalitres of distillate per year to reduce the overall process water inventory at Ranger. The waste brine is injected into Pit 3, diverted to process water or sent to the processing plant for further processing.

Pond and Release Water Treatment

The pond water inventory is derived from rainfall that falls on the active mine-site catchments, generating water of a quality that requires active management. Pond water typically includes:

- Seepage and surface water runoff from the mineralised rock stockpiles;
- Seepage from the low-grade rock stockpiles;
- Runoff and rock water infiltrate from the southern and north western TSF embankment wall; and
- Runoff/discharges from the processing areas not directed to the process water circuit.

Based on the minimum operating levels in RP2 and RP6, by 1 December each year, the aim is to have a total pond water inventory of between 370 and 450ML. Pond water is able to be reused on the RPA for a range of purposes, including dust suppression and to supplement ore processing requirements. Ranger operates three water treatment plants based on pre-filtration followed by reverse osmosis to treat pond water. The permeate produced is of a quality suitable for release into the environment at times of flow in Magela Creek or disposal via evapo-transpiration.

RP1 and Magela Creek provide contingency water supply for plant operations should the pond water inventory be insufficient. The approved Ranger Water Management Plan provides the conditions under which abstraction may occur.

Release water is derived from incident rainfall that falls on catchments within the mine footprint considered to be of a quality that is able to leave the site as stormwater runoff. Release water is closely monitored as an integral part of statutory and operational monitoring to ensure that water quality objectives are met in Magela Creek. The main release water storage body is RP1.

A brief outline of the major pond and release water bodies can be found in Table 4—5. Detailed descriptions of the pond water inventory management elements can be found in Ranger Water Management Plan (RWMP).

Water catchments at Ranger are presented in Figure 4-6.

Table 4—5: Major water storages at Ranger

Pond	Water Class	Brief Description
RP1	Release	RP1 comprises an earthen embankment damming Coonjimba Creek to form an impoundment providing approximately 436 Megalitres of storage under normal conditions.
RP2	Pond	RP2 comprises an earthen embankment damming Djalkmarra Creek to form an impoundment providing approximately 1090 Megalitres of storage.
RP3	Pond	RP3 comprises an earthen impoundment within RP2 providing about 60 Megalitres of storage.
RP6	Pond	RP6 is a 1Gigalitre turkey-nested, double-lined pond and was commissioned in December 2012. The maximum water storage for RP6 is approximately 976 Megalitres.

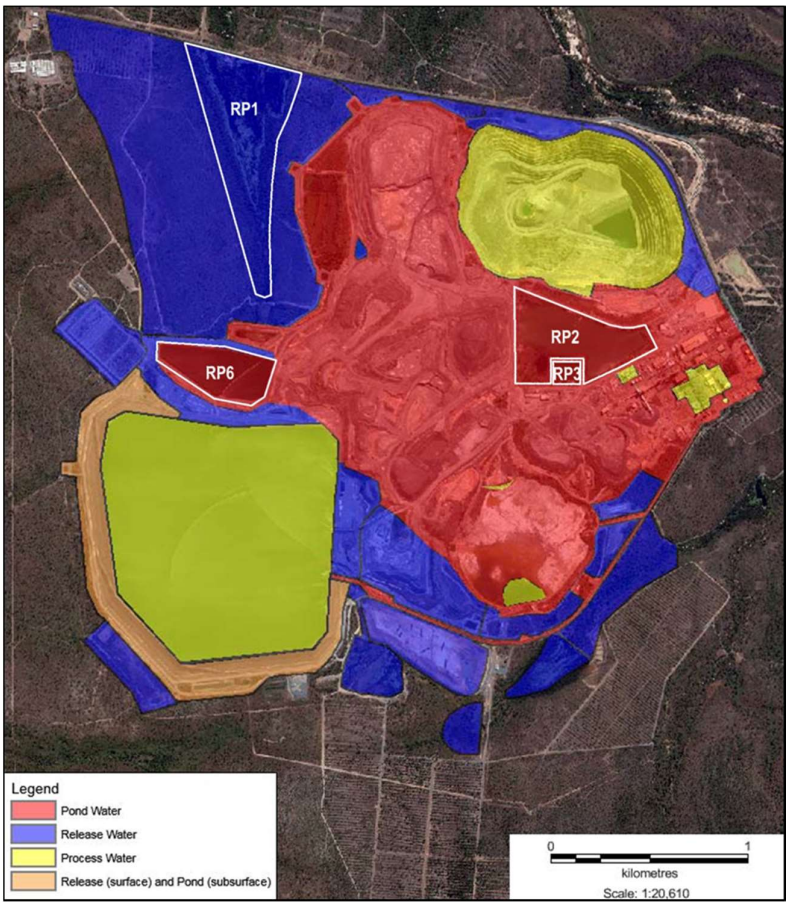


Figure 4-6: Water catchments at Ranger

4.3.2 Processing Performance against Previous MMP

Treatment and Ore Processing Operations

Plant throughput of 2.48 million tonnes of uranium ore and peak primary milling rates of 320 tonnes per hour were achieved through a consistent and sustained approach to optimised plant performance in 2018.

ERA produced 1,998.2 tonnes of uranium oxide in 2018 (2017: 2,294 tonnes), which was in line with market guidance of 1,600 to 2,000 tonnes.

Existing stockpiles of laterite ore have been depleted in the 2018 calendar year. Due to the depletion of Laterite ore the Laterite mill has now been decommissioned

In 2018 changes were made to reduce preventative maintenance on the processing plant with the December 2020 end of processing operations in mind. Maintenance activities on assets with known process safety hazards and those on key plant bottlenecks were not reduced. The change in maintenance strategy delivered cost savings as part of Transforming ERA Together through reduced external spend and increased plant utilisation.

A risk assessment program was developed to identify the risk associated with cancelling/reducing each maintenance change. Through the risk assessment sessions, it was decided to cancel/reduce only the maintenance plans that were identified during the process as a low risk.

This process included an extensive review of the storage tanks that were completed in 2018 with regards to the criticality level that has a direct impact on the inspection intervals and maintenance schedule of those tanks. The criticality review was completed in light with past inspection and failure history, specific design of the tanks (material, construction), volume, contents stored, business criticality vs. process safety criticality, consequences (including personal safety and environmental), usage (online, offline), risks introduced as a result of inspection/intrusive actions. The inspection intervals of some lower risk tanks have been increased, e.g. raffinate tank and CCDs (due to their construction specifics, e.g. raffinate is a 316L stainless steel tank, while CCDs are mounted on stilts which represent a particularly robust design with negligible risk of catastrophic failure), while the others were reduced due to their age and condition requiring more frequent inspections. The changes were documented through the MOC process.

Some of the higher risk large size pressure vessels, e.g. Ammonia Storage Vessels A and C, and Clarification Sand Filters A, B, C and D are inspected and maintained in accordance with the Risk Based Inspection strategy which allowed us to vary their inspection and maintenance intervals. This is documented in their respective RBI assessment reports.

There were changes in maintenance schedule and scope of some individual critical tanks which were assessed individually, using Level 2 RA and captured in their respective MOCs.

With regards to the pipelines and piping, we stepped up inspections of our tailings pipelines that run across the land by increasing inspection frequencies, more robust monitoring of any wear of those pipelines to minimise the risk of a leak into the environment. We identified the areas of those

pipelines that were of a higher risk of erosion wear, replaced or rotated those sections and continue monitoring them on a regular basis.

Table 4—6 provides an overview of the plant performance.

Table 4—6: Plant performance details

	2018
Primary mill throughput (t)	2,446,393
Laterite throughput (t)	49,470
Production (U_3O_8) (t)	1,999

Tailings Storage and Disposal

In 2018, the total amount of mill tailings deposited to Pit 3 was 2,485,668 tonnes.

The dredge transferred 3,634,860 Tonnes of tailings from the Tailings Storage Facility to Pit 3.

Brine transfer pumping and injection infrastructure remained in standby in 2018. During the reporting period the concentrated brine waste stream was recycled to the Tailings Storage Facility or sent to the processing plant for further processing.

Sub Aqueous deposition of Dredge transferred tailings commenced December 2018, a system trial will continue during the first half of 2019 to finalise a permanent design. Cone penetration testing in Pit 3 was undertaken in 2018 and will occur periodically throughout Dredge tailings transfer to validate transferred tailings consolidation.

In 2018, planned improvements to the tailings transfer system continued to be investigated and, where feasible, implemented. Planned improvements include:

- Reviewing options to modify or change the cutter head
- Improvements to dredging method
- Changes to the cutter mouth
- Options to pre-treat and/or break up material in advance of the dredge

In October, ERA approved infrastructure expenditure of $32 million to expand tailings transfer capacity (including the addition of a second dredge) in order to complete rehabilitation activities within the regulatory timeframe.

In 2018 further work on the underdrain bore was undertaken to enable the commencement of brine injection into the Pit 3 under fill in quarter four of the 2018 reporting period. This work is currently ongoing with a feasibility study commenced looking at reinstating/re-establishing the current under drain bore in the meantime the concentrated brine waste stream will be sent to either the TSF or the processing plant leach tanks for further processing

Table 4—7 provides an overview of the Pit 3 tailings disposal performance.

Table 4—7: Pit 3 tailings disposal details

	2018
TSF to Pit 3 (t)	3,634,860
Processing Plant to Pit 3 (t)	2,485,668
Brine Injection* (ML)	Off line during the reporting period

** Brine injection remained offline in 2018.*

Process Water Treatment

During the 2018 reporting period, the Brine Concentrator produced 1,900 mega litres of distillate, which is slightly above target of 1836 mega litres. In 2019, the Brine Concentrator is planned to produce 2,195 mega litres of distillate.

ERA is reviewing options to increase the treatment capacity of the Brine Concentrator to 134 per cent of nameplate capacity, as well as implementing alternate technologies and / or strategies for additional process water treatment capacity. The high density sludge (HDS, lime treatment) plant will be recommissioned in 2019. Studies will also assess opportunities for additional treatment capacity. This may be delivered through utilising the spare capacity of the Brine Squeezer (discussed below) for direct process water treatment or through linking available water infrastructure in flowsheets that enhance overall throughput. Examples of this approach may be partial treatment in the newly commissioned HDS plant followed by membrane treatment (pond water treatment plant and / or brine squeezer).

Studies and associated trials are anticipated to be completed through 2019 with implementation occurring in 2020 subject to appropriate MTC application.

ERA has commenced irrigation of process water around the walls of Pit 3 to increase the wetted surface area and optimise evaporation. The west wall evaporation system has been a successful trial and is the basis for further expansion. The findings from the trial led to improvements in the material selection for discharge lines and developed sound practices for installing lines safely when working over windrows. It also fed information into cost benefit analyses with regards to wall coverage.

Whilst the project for east wall evaporation is already being tracked, a Project Initiation Form (PIF) that outlines the scope, justification and assumptions made in the initial feasibility stage of the works will be submitted in coming days to formalise the works and financial justification.

Irrigation options for the Pit 3 eastern wall have been considered in past weeks and are currently in the process of being scoped for quotation. There may be some delays in the onset of system use dependent on process water availability through the return lines. If all water is being utilised, the system would be unable to operate. However, having discussed availability with the Mechanical

Engineer designing the future return water system, it looks as though there would be more than enough capacity to run the system after approximately 4-6 months of initial operation. We are currently generating a cost benefit analysis to determine whether setting up an independent pumping arrangement would return dividends; and if so whether there would be enough room on the Pit 3 ramp to facilitate additional infrastructure going forward.

It is intended that the system itself be installed in July / August 2019 in conjunction with the additional Mill discharge lines. This will be undertaken as a single work front, as a cost saving to the business.

By having this system in place by the end of August 2019 it ensures the system is available for use once there is sufficient excess pumping capacity in process water return lines later in the year. (Once dredging activities have returned sufficient water to the TSF to free up availability in the system)

The system once complete is forecast to be able to deliver 30L/s of irrigation over 880m of the eastern embankment. At an evaporation rate of 7mm per day this equates to between 14ML & 27ML of effective evaporation each year.

Pond and Release Water Treatment

The UF/RO (WTP1 & WTP3) and MF/RO (WTP2) pond water treatment plants operated intermittently and all operational Land Application Areas (LAA) were used for irrigation during the reporting period.

Table 4—8 provides an overview of the pond water treatment performance for 2018.

Table 4—8: Pond water performance details

	2018
Pond water inventory (ML)*	323.2
Pond water treatment (ML)	3891.9
Irrigation volumes (ML)	1406.2

** Pond water inventory is measured at 1st December coinciding with operational aims*

Between January 2016 and September 2016 a 'brine squeezer' project was trialled at Water Treatment Plant 1. The brine squeezer aims to increase release water volumes and decrease process water inputs. This trial was deemed successful and permanent fixtures are being planned. During the reporting period, a scope of works for the design and construction of a permanent brine squeezer was developed and a tender document released.

Construction of the Brine Squeezer commenced in late 2018 and is expected to be completed in May 2019, with commencement of routine operation following commissioning during the 2019/2020 wet season.

In September 2017 ERA installed two mechanical evaporators in the upper RP1 catchment. Mechanical evaporators have been installed to increase the amount of pond water that can be treated by allowing increased disposal of treated water. Only treated water (permeate and/or distillate) is used for mechanical evaporation.

In 2018, 12 additional evaporators were purchased and transported to ERA. These are yet to be approved and are currently non-operational. Subject to approval the evaporators may be brought into operation in the 2019 reporting period

4.3.3 Processing Activities for the Oncoming Period

Treatment and Ore Processing Operations

Forecasted processing and treatment of stockpiled ore activities are shown in Table 4—9. As anticipated the existing stockpiles of laterite ore were depleted in the 2018 reporting period. With the exception of the redundancy of the laterite plant and the changeover of the defined laterite leach tank back to the primary milling leach process train, there will be no significant process changes as a result of the depletion of the laterite ore.

Asset integrity programmes will continue with a strong focus on Process Safety hazards and controls as well as statutory and regulatory requirements. Maintenance strategies will reflect these priorities along with our normal preventative maintenance programmes that strengthen our HSE aspects of the operation of key assets. There are two partial plant shut downs scheduled for the 2019 reporting period, these are planned to commence in May and October and planned to run for 4 and 5 days respectively.

Capital projects have been identified for the 2019 period with a focus on sustaining of assets.

As part of the Power station cost savings initiatives our 3,000hr overhaul regime has been extended to 4,000hrs realising a 25% saving on maintenance. Further to that we will be completing repair of rotable items in house therefore saving further on external contractor spend.

The power station will execute its normal scheduled maintenance activities to maintain the reliability of the diesel alternators.

Table 4—9: Processing Forecast

	2019 Forecast
Primary mill throughput (t)	2,500,000
Production (U_3O_8) (t)	1,400 to 1,800

Tailings Storage and Disposal

The transfer of tailings to Pit 3 will continue until 2020 after which final rehabilitation of Pit 3 will continue. Tailings slurry reclaimed by the dredge is currently transferred to sub-aqueous deposition of the tailings slurry with option to revert back to three deposition points in Pit 3 for short periods

In 2019, planned improvements to the tailings transfer system will continue to be investigated and, where feasible, implemented. Planned improvements may include:

- Modification of the dredge cutter head
- Improvements to dredging method
- Changes to the cutter mouth
- A second dredge will be implemented during 2019

The dredge removes tailings in 3 - 4 metre cuts across the entire dam; however, it is currently restricted from removing the material closest to the wall. The preferred method for removal of this tailings hang up material will be mechanical excavation utilising and amphibious excavator.

Options analysis and risk assessment conducted on the use of an amphibious excavator which determined that mechanical excavation of tailings via amphibious excavator was the best option.

The scope is to only remove the Tailings from the internal batter. Excavation work to the internal batter to repair the 'rip rap' is an inherent risk to Site. The excavator has built in batter controls which will limit the excavator from digging through the wall.

In 2019 further study on the underdrain bore project will be undertaken to determine the feasibility of the commencement of brine injection into the Pit 3 under fill in 2019 reporting period. In the meantime, the concentrated brine waste stream will be sent to either the TSF or the processing plant leach tanks for further processing. Table 4—10 provides a forecast of the tailings to be transferred for final disposal in Pit 3 during 2019.

Table 4—10: Tailings Disposal Forecast

	2019 Forecast
TSF to Pit 3 (t)	6,692,246
Processing Plant to Pit 3 (t)	2,500,000
Brine Injection* (ML)	0

** Brine injection is subject to underdrain bore feasibility study to be completed.*

Process Water Treatment

In 2019, the Brine Concentrator is planned to produce 2,195 mega litres of distillate.

ERA is reviewing options to increase the treatment capacity of the Brine Concentrator to 134 percent of nameplate capacity, as well as installing additional process water treatment capacity. This additional treatment will either be in the form of additional brine concentrator trains or through the recommissioning of the high density sludge treatment plant.

In the oncoming MMP period ERA will continue to investigate and, where feasible, implement projects to reduce process water inventory. Potential projects, which are being investigated, include:

- Re-contouring of the western stockpile to reduce infiltration and pond water generation (note the waste stream from the treatment of pond water becomes process water, therefore a reduction in pond water results in less process water via the avoidance of the waste stream from its treatment).

Pond and Release Water Treatment

Pond water treatment volume is dependent on rainfall and unpredictable year on year. In line with previous years, in 2019 ERA aims to achieve a pond water inventory of between 370 and 450ML by 1 December. ERA will continue to investigate further controls that may allow water to be better managed based on quality, thereby minimising inputs to pond water inventory.

In 2019 ERA will commission and operate the new brine squeezer that will further treat the pond water brine to create release quality water and a more concentrated brine stream.

WTP brine feeds to the squeezer, whereas it previously was directed to the process water inventory (or recycled to RP2 when EC conditions allowed). The more concentrated brine from the squeezer will report to the process water inventory.

Operation and eventual discharge of clean water from the brine squeezer will be subject to separate regulatory approval. A MTC application was submitted in late 2018 with approval expected in Q1 2019.

In the oncoming MMP period ERA will also install and commission an additional 12 mechanical evaporators (for a total of 14). These additional mechanical evaporators will provide increased capacity to dispose of treated water, allowing greater volumes of pond water to be treated.

5 ENVIRONMENTAL MANAGEMENT FRAMEWORK

ERA has implemented a comprehensive integrated Health, Safety and Environmental Management System (HSEMS) that provides a framework to manage compliance with relevant legislation and statutory approvals and conforms to organisational objectives and community expectations.

The General Manager Operations is responsible to ensure that the HSEMS is implemented and maintained; however, health, safety and environmental accountabilities and responsibilities are allocated at every level of the organisation. These accountabilities and responsibilities are documented in role descriptions, work performance objectives and within the relevant plans and procedures.

5.1 Management System and Certification

ERA's HSEMS is based on a 'plan, do, check and review' cycle that encourages continual improvements in performance. It uses a suite of procedures for key activities that have the potential to generate environmental and social impacts. These procedures are continually reviewed, communicated to employees and audited for compliance.

Since 2003 ERA has maintained certification of the HSEMS to International and Australian Standards (ISO14001 and AS4801). The performance of ERA's HSEMS is regularly audited; details of the performance of ERA's HSEMS are discussed further in Section 6.1.

5.2 Environmental Policy

The ERA Environmental Policy has been developed in accordance with the HSEMS. The Policy's goal is to ensure the minimisation of environmental harm from ERA's activities. The Policy outlines the responsibilities of employees and contractors to ensure environmental harm is minimised and also summarises how ERA intends to achieve its Policy commitments. The Environmental Policy is reviewed periodically and is signed off by the Chief Executive. The ERA Environmental Policy is attached as Appendix A.

5.3 Hazard Identification and Risk Management

Environmental aspects and impacts are identified and evaluated in accordance with *ERS003 Hazard Identification and Risk Management*.

The standard describes the required level of assessment, the necessary competencies of the risk assessment team and the risk assessment context and process, including review frequency. The potential impacts from aspects are classified using a risk matrix (Appendix B) based on the consequence and likelihood of each potential impact. The risk rating is then used to establish minimum levels of control for the treatment of aspects and impacts including significant risks. Appropriate controls are then identified to either minimise or eliminate the potential impact. The adequacy of existing controls is assessed, which may result in the implementation of new controls or improvements to the existing controls.

All identified aspects and impacts are recorded on the ERA HSE Risk Register. Periodically or when processes change, ERA reviews the Ranger mine's aspects and impacts. Risk reviews may also be triggered by the management of change process, audit non-conformance findings and significant potential incidents. The minimum frequency for review of environmental aspects and impacts is:

- At least annually for critical and high HSE risks; and
- At least every three years for moderate and low HSE risks.

5.4 Objectives and Targets

ERA's Environmental objectives and targets are foremost stated through the ERA Environmental Policy. The annual Sustainable Development Report (included in the Annual Report) reports on performance against these objectives for the prior year (available at http://www.energyres.com.au/media/38_reports_and_publications.asp). ERA has made other environmental objectives and targets in documents such as Environmental Management Plans, statutory reports and applications to the Mine site Technical Committee.

It is noted where objectives and targets are documented in environmental management plans such objectives and targets are voluntarily set, based on internal business planning processes and obligations and form part of ERA's process for systematic risk reduction. Therefore, while such objectives and targets may be set with consideration to legal and other requirements, they are separate to and are not intended to increase, change or impede ERA's legal obligations and/or commitments.

A summary of environmental commitments contained in the MMP is given in Section 9.

5.5 Environmental Training and Education

It is a requirement at ERA that personnel are trained, competent, and understand the risks and controls associated with the activity that they perform. Effective training helps to maintain a high level of HSE performance, compliance with company and legal requirements and an ability to effectively respond to emergency situations. Competencies of personnel are verified and documented.

ERA's environmental inductions and training programme aligns with the requirements of Schedules 6.2 and 6.3 of the Ranger Authorisation and are effective in communicating the requirements of the MMP to all employees and contractors.

Records of all training and inductions are maintained and available for inspection.

Induction programme

The induction requirements for ERA employees and contractors are described in *ERA013 Induction Procedure*. A General Induction is given to all employees and contractors in accordance with this procedure. The *ERA Ranger Mine - Site Induction* addresses, as a minimum, an overview of the Environment Policy, information on the general environment requirements of all employees, site-wide procedures and permits and a basic outline of legislation relevant to the operations. These

requirements are to be expanded upon as necessary in the area specific inductions to be conducted by the designated site contact or area supervisor.

Training Programme

In accordance with *ERS006 Training and Competency Standard*, specific training requirements for each role are identified by a Training Needs Analysis. The role specific Training Needs Analysis is allocated as a set of qualifications in the Learning Management System. This allows training records to be effectively managed, tracked for completeness and ensures retraining is conducted as required.

5.6 Non-Conformance and Corrective Action

Incident Reporting

All incidents, including near-miss incidents, are reported, recorded, investigated and corrective actions are identified and implemented in accordance with *ERS014 Non-conformance, Incident and Action Management*. Incidents are recorded in the HSE business solution and necessary personnel notified upon the occurrence. Investigation findings for significant incidents are formally documented and communicated across site.

All incidents with an actual environmental impact are also reported under Section 29 of the Northern Territory's Mining Management Act. Section 29 incident reports are provided to the Supervising Scientist Branch, Northern Territory Department of Primary Industry and Resources, Northern Land Council, Commonwealth Department of Industry, Innovation and Science, and Gundjeihmi Aboriginal Corporation. Incident cause(s) and corrective and preventative actions arising from these incidents are tracked by these organisations during Routine Periodic Inspections (RPI's). RPI's are held on site at monthly frequency. Incident summaries are also presented at the biannual Alligator Rivers Region Advisory Committee (ARRAC) meeting attended by a broad cross-section of stakeholders.

Between 1 January 2018 and 31 December 2018 19 environmental incidents were reported, (2 Medium, 15 Minor and 1 Near-miss) to stakeholders under Section 29 and follow-up during monthly Routine Periodic Inspections. These environmental incidents are described in Appendix C.

Actions

Corrective and/or preventative actions resulting from activities such as incidents, risk assessments, monitoring, audits, management of change, interactions and inspections are assigned in the HSE business solution and e-mails sent to necessary personnel. An escalation process occurs should actions not be completed within the designated time frame. This process is described in *ERS014 Non-conformance, Incident and Action Management*.

5.7 Environmental Emergency Preparedness and Response

Business Resilience and Recovery Programme

Preparation for and mitigation of disaster events is an essential element of ERA's HSEMS to manage incidents identified as having serious potential effects on the business, its people and the environment in which it operates. The Business Resilience and Recovery Programme was developed in accordance with *ERS012 Business Resilience and Recovery*. It outlines the following requirements associated with emergency preparedness and response (including environmental emergencies):

- Roles and responsibilities before, during and after an emergency, including responsibilities associated with internal and external communications
- Training and awareness requirements for personnel involved in emergency response
- Exercises that are to be conducted in preparation for an emergency
- The level of response required for each potential environmental emergency including a checklist for response for each potential emergency identified

ERA routinely evaluates response capabilities via desktop and full scale simulated exercises throughout the year. Outcomes from full scale and desktop simulated exercises are reviewed internally and learnings are used and managed within the operational context of the business. Exercises are conducted based on operational availability and constraints and are scheduled by the Emergency Services Supervisor in consultation with the General Manager Operations.

Emergency Response Team

The ERA Emergency Response team (ERT) is the primary responder to deal with a life, environment or asset threatening event. The ERT consists of the dedicated roles of Emergency Services Supervisor, Emergency Services Officers (ESO) and volunteers from the workforce (ERT members). [redacted]

[redacted].

In 2016 ERA introduced the Authority to Practice, which allows qualified ESO's to utilise specialised skills, interventions and medications in the event of an emergency. These skills and medications can be used in emergency situations and daily treatments. During the reporting period of 2017 ERA had no poisons licence to continue the Authority to Practice, however during 2018 ERA were able to obtain this and will be working towards once again obtaining the authority to practice throughout 2019

All members of the emergency response team (both ESO and ERT) are required to obtain a minimum qualification of Certificate 3 in Mines Rescue. During the reporting period existing and some new ERT members have been undertaking the qualification with the majority of members completing this. In 2017, new members of the ERT will also complete the Certificate 3 Mines Rescue qualification, with existing members performing professional development task to work towards obtaining a Certificate 3 Public Safety.

5.8 Implementation, Monitoring and Review

Environmental Management Plans

ERA has developed and implemented a number of Environmental Management Plans (EMPs) to outline the potential environmental impacts associated with the Ranger mine and mitigation strategies (operational controls) to be implemented to minimise identified potential impacts. Effective implementation of ERA's HSEMS ensures that these plans are based on statutory requirements, corporate requirements and the evaluation of aspects and impacts and contain adequate operational controls commensurate with the level of risk.

Adherence to controlled documentation (such as EMPs, SOPs and work instructions) is mandatory. Controlled documents are embedded in the HSEMS designed to detail a specific procedure and process with associated accountabilities. ERA has a document control process to ensure documents are updated regularly this serves to confirm they are appropriate to the current potential risk that ERA operations may pose and that ERA remains compliant with NT and Commonwealth legislation. Document review frequency is risk based and determined by the criticality of the task to be performed. Out of sequence reviews may be undertaken in response to legislation changes, incidents, non-conformances and industry advances, among other sources.

Table 5—1, lists the Environmental Management Plans currently in use at Ranger. These plans are provided in Appendix D of this MMP (parts 1 to 6).

Table 5—1: Environmental Management Plans

Document	Plan Title
AMP001	Air quality protection management plan
GEP001	Greenhouse gas and energy efficiency plan
LUP001	Land use management plan, including: • Land disturbance • Weed management • Fire management • Top soil management • Cultural heritage • Fauna management
HMP001	Hazardous materials and contamination control plan
MWP001	Mineral waste management plan

Document	Plan Title
NMP001	Non-mineral waste management plan
RAP001	Radiation management plan*
RWMP001	Ranger water management plan*

**The Radiation Management Plan and Ranger Water Management Plan have not been provided with the submission of this MMP as they are separately reviewed and approved by stakeholders.*

Environmental Monitoring

ERA maintains a comprehensive environmental monitoring programme, measuring any actual or potential environmental impacts from its operations and associated activities. These monitoring programmes include (but are not limited to) those listed in Table 5—2. Monitoring programmes are discussed in various sections of the MMP as indicated Table 5—2.

Table 5—2: Environmental monitoring programmes

Monitoring programme	Reference
Atmospheric emissions	Section 6.2
Flora and fauna	Section 6.7
Groundwater	Section 7
Meteorology	Section 2.1.1
Non-mineral waste	Section 6.9
Potable water	Section 6.11
Radiation	Section 6.3
Revegetation	Section 8
Surface water	Section 7
Tailings volumes and densities	Section 0
Waste rock and ore grade	Section 4.2
Weed management	Section 6.5

Performance Assessment, Auditing and Review

The review and effectiveness of management and mitigation strategies is incorporated into the monitoring and performance measurement programmes within each Environmental Management Plan.

Evaluation of the performance of controls for ERAs significant environmental impacts is measured in a number of ways. The processes may include a formal or less formal process, such as through monitoring, audits (internal and external), interactions, inspections, document review, recording incidents and both preventative and corrective actions.

Auditing as part of an assessment of environmental performance is conducted where required in accordance with *ERS016 Performance Assessment and Auditing* and ISO14001 requirements. Audit findings are documented and remedial actions planned and implemented. Completion of actions is tracked in the HSE business solution.

Management reviews are conducted to ensure the performance of the HSEMS continues to be suitable and is effective in satisfying the operations HSE policies, objectives and targets. The management review outputs involve decisions and actions made in relation to commitment to continual improvement of the HSEMS.

6 ENVIRONMENTAL MANAGEMENT AND PERFORMANCE

ERA is committed to delivering the highest standards of environmental performance to meet or exceed legal and other requirements. This commitment extends to using leading practice initiatives to minimise the impact of our operations on the environment and community.

The implementation and effectiveness of the control strategies for risks identified in the MMP, previous OPRs/AERs and management plans are outlined in the following format:

Objectives and Targets:

- Outline of the relevant objectives and targets that demonstrate a commitment to the protection of the environment.

Environmental Management:

- The adequacy of the proposed control strategies to manage risks associated with operations during the reporting period;
- Variations from proposed control strategies implemented during the reporting period and the reasons for them; and
- The works carried out during the reporting period and proposed to be carried out over the next reporting period.

Environmental Performance:

- Monitoring results during the reporting period, including a comparison of these results against the, policy, objectives and targets, relevant statutory requirements and monitoring results of previous years;
- Performance outcomes;
- Long-term trends in monitoring data; and
- Discrepancies between the predicted and actual impacts of the operation and analysis of the potential cause of any significant discrepancies.

Key Environmental Activities for Oncoming Period:

- Initiatives proposed for the next reporting period to improve or further assure acceptable performance.

6.1 Environment Management System and Certification

6.1.1 Objectives and Targets

ERA has developed objectives and targets for the operations which are reviewed annually as part of the business planning process.

Specific objectives and targets are detailed in the following sections for each of the environmental aspects.

Section 9 also provides an overview of the commitments contained within this MMP and relevant to the oncoming period.

6.1.2 Environmental Management

ERA's environmental management framework is described in detail in Section 5. The certified HSEMS provides the framework in which all aspects with potential or actual consequences from ERA's operation are managed.

This section, Section 6.1, aims to provide an update on the performance of the environmental management system. Subsequent sections within Section 6 will provide an update on the management and mitigation strategies for meeting the objectives and targets and reducing the impact of specific environmental aspects, as well as the monitoring and measurement against key performance criteria.

6.1.3 Environmental Performance

During the reporting period, ERA completed all actions to address the significant findings from previous audits through to completion. In 2018, the performance of ERA's EMS was audited, as shown in Table 6—1.

Table 6—1: Environmental Management System Audits

Audit	Lead Auditor	Purpose/Scope	Date
ISO 14001:2015	[redacted]	Annual Routine Surveillance and Transition Audit	February 2018
Rio Tinto Business conformance audit	[redacted]	Compliance against internal Environmental Standards	May 2018
Annual Authorisation Audit	Supervising Scientist, DPIR, GAC, NLC	Assessed the systems and practices in place for managing rehabilitation activities.	September, 2018
Process Safety	[redacted]	Oversite Audits	Quarterly 2018
Process Safety Audit	[redacted]	Measure progress toward implementation of Rio Tinto D6 Process Safety Standard, fully implementable by January 2021	27-Feb-3 March 2019

The following presents the progress on actions arising from audit recommendations.

ISO 14001:2015 Annual Routine Surveillance and Transition Audit

The objective of the assessment was to conduct a surveillance and transition audit and confirm that elements of the scope of certification and the requirements of the management standards are effectively addressed by the organisations management system and that the system provides the frame work to achieve statutory, regulatory and contractual requirements and other organisational strategies and/ or objectives by:

- To confirm that the management system conforms with all requirements of the audit standard
- To confirm that the organisation has effectively implemented its planned arrangements
- To confirm that the management system is capable of achieving the organisations policies and objectives.

Audit Findings

During the course of the audit there were 9 minor nonconformities three of which were in relation to the ISO14001:2015 Standard, five of which were in relation to AS/NZS4801:2001 Standard and one combined 14001/4801.

There were 12 Observation and 1 Opportunity for Improvement recorded, 4 of these recorded observations related to iso14001:2015 with 6 relating to AS/NZS 4801:2001, and one combined 14001/4801, with the opportunity for improvement aimed at improving the ERA systems or activities relevant to the questions posed.

Action Management

All minor nonconformities have been recorded in the site management system (SAP) for their management, follow up and action. All minor nonconformities have been completed and will be reviewed along with all recorded observations at the next ISO Conformance audit is to be conducted in Q1of 2019.

Rio Tinto Business Conformance Audit

The compliance audit (BCA) includes all process throughout the Energy Resources of Australia (ERA) Ranger Site.

The scope of the audit was based on the current Control Effectiveness profile (CEP) and was determined with the site General Manager. The scope also included the Management System and focused on agreed core processes.

Audit Findings

During the course of the audit one Major Non-Conformance and 18 Minor Non-Conformances were identified that related to ERA not complying with Rio Tinto Health, Safety, Environment and Community (HSEC) Business Standards. It is noted that non-compliance with a Rio Tinto HSEC

standard is not indicative of non-compliance with a statutory requirement but rather a gap in management of an actual or potential risk against an internal business standard.

Action Management

All nonconformities have been recorded in the site management system (SAP) for their management, follow up, and action tracking. All findings and actions will be reviewed during the next Rio Tinto Business Conformance Audit.

Annual Stakeholder Environment Audit

The objective of the 2018 Annual Environmental Audit was to assess ERA's capacity to comply with the amended Ranger Authorisation, with a strong focus on the newly embedded expectations relating to the Ranger Mine Closure Plan, groundwater and rehabilitation reporting requirements.

The audit found that generally ERA had commenced developing strategies to address the newly embedded planning and reporting requirements within the Authorisation with no statutory breaches to the requirements of the Authorisation determined during the audit.

Audit Findings

Three Category 2 Non-Compliances were identified that related to ERA not complying with their own management systems which may create the potential for future non-compliance to the Authorisations environmental protection intent.

Five conditional findings were also identified, where the audit team felt improvement was needed or specific components of the audited activity had yet to be fully implemented.

Ten observations were provided by the audit team for consideration by ERA aimed at improving the ERA systems or activities relevant to the questions posed.

Action Management

All nonconformities have been recorded in the site management system (SAP) for their management, follow up and action. These findings are reviewed during monthly RPI audits along with all recorded observations. The next Annual Stakeholder Environmental Audit is to be conducted at the end of Q2 2019.

Process Safety Audit

The Rio Tinto D6 Process Safety Standard is implementable and auditable from January 2021. This audit was a part of a Rio Tinto Worldwide external audit against D6 Standard intended to gauge sites individual progress and off a view of the likelihood of that site being fully implemented by due date.

Audit Findings

The audit was not intended to issue findings but rather an implementation score against each of the 16 Elements of the Standard. ERAS was scored at 47 points of a possible 64 with an overall "on track" result

Action Management

Each score against each Element have been put into the ERA Maintaining Process Safety Excellence to Closure (2019-Closure) Plan. These actions for each part of the 16 Elements have been included into Action 10 in this Plan which is "Implement the Rio Tinto D6 Process Safety Standard in full by due date in January 2021. These actions for each clause are reported and tracked monthly by Senior Site Leadership.

6.1.4 Key Environmental Activities for Oncoming Period

During the next reporting period ERA will:

- Continue its commitment to continual improvement through the maintenance and implementation of the HSEMS;
- Develop objectives and targets supported by the implementation of HSE Improvement Plans at all levels of the business;
- Undertake a ISO certification audit of the HSEMS to confirm the requirements of ISO14001:2015 are effectively addressed

6.2 Air Quality

6.2.1 Objectives and Targets

ERA's objective with regard to air quality is to protect the health of workers and the community and comply with all relevant statutory requirements.

6.2.2 Environmental Management

Air quality is managed at Ranger in accordance with the:

- AMP001 Air Quality Control Management Plan;
- RAP001 Radiation Management Plan;
- EVP064 Stack Sampling; and
- Rio Tinto E12. Air quality protection standard.

Air quality controls are implemented at Ranger to minimise significant air emissions and potential impacts and to comply with legal and other requirements.

Dust reduction measures are included in the operational procedures for all areas at Ranger Mine, and in significant dust generating areas of the processing plant specific dust extraction equipment is installed. In addition, the crushing plant dust extraction, calciner dust extraction and product packing dust extraction all have interlock systems which do not allow the processing plant to be operated unless these dust extraction systems are functioning.

Further controls that are utilised to minimise impacts on air quality during operations include:

- Six monthly tests of interlocks in the processing plant;
- Negative pressure in the calciner;
- Ammonia gas detection system and alarms;
- Low sulphur diesel used in the PowerStation and mobile/stationery equipment;
- Wash down equipment in processing plant to minimise dust generation;
- Dust suppression by water trucks on mine haul roads and stockpiles;
- Water sprays on conveyors and transfer points; and
- Capping (with weathered rock) of dewatered tailings held Pit 1 in preparation for pit closure.

6.2.3 Environmental Performance

Point Source Emissions

Air quality monitoring on point source emissions from across the site; include uranium and sulphur dioxide.

Uranium

As per Annex A.4 and Schedule 4.2.5 of the Ranger Authorisation (0801), the calciner and product packing dust extraction systems have exhaust stacks that are required to be monitored on a quarterly basis for uranium emissions and compared to the daily authorised limit of 1.5 kilograms-per-day (kg/day). This monitoring is undertaken in accordance with USEPA Method 29 and USEPA Method 5 by Ektimo – Queensland Branch.

Since July 2015 (e.g. the start of Q3-2015), the Radiation & Hygiene Department and Production Metallurgists also review the monthly maximum daily run times to show that, even on the day of each month when the system is operational for the longest duration, the maximum emissions remain below the daily authorised limit of 1.5 kg/day (refer Figure 6-1).

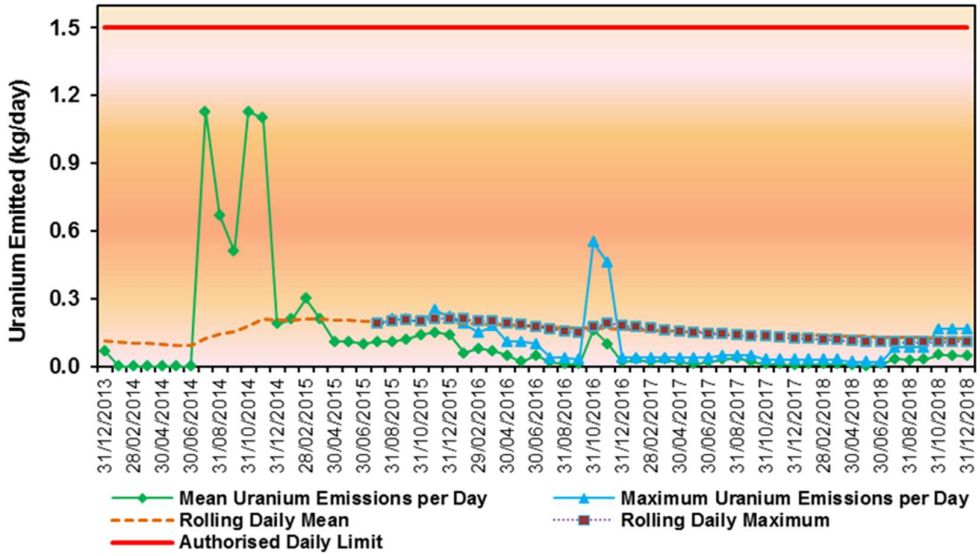


Figure 6-1: Uranium emissions trend

Sulphur Dioxide

The emission of sulphur dioxide at Ranger includes exhaust from the Power Station and Brine Concentrator diesel engines, the Calciner and the Low Pressure Boiler. The majority of emissions are estimated using engineering calculations based on the total fuel consumption and quality of the fuel (i.e. sulphur content) obtained from fuel suppliers. This approach calculates a maximum sulphur dioxide emission expected from diesel combustion and does not factor in other engineering controls (i.e. scrubber systems). The exception to this is the Calciner, where emissions are measured through the exhaust. Overall sulphur dioxide emissions are impacted by the considerable variability in stack testing results at the Calciner. The average concentrations of sulphur dioxide detected in stack testing on the Calciner in 2018 showed an average emission rate of 779.7kg/yr. (calculated from calciner feed hours per year of 4,873 at an emission rate of 0.16kg/hr). Overall sulphur dioxide emissions for Ranger mine decreased during the reporting period by 4% to an average of 1538kg/yr.

Alternative Methods for Estimation of SO2

Two different approaches to calculate SO2 emissions estimates from the calciner and the power station have been investigated.

1. SO2 emissions from burning fuel can be calculated using the fuel analysis approach based on fuel usage and sulphur content.

2. SO2 emissions from burning product can be calculated using the mass balance approach. If you can provide the quantity of product going into the calciner and the product sulphur content, then SO2 can be calculated in tonnes.

Assuming that all sulphur in the product is burnt, the SO2 emissions would be calculated as follow:

*Sulphur throughput (tonnes) = [Product feed (Tonnes)] *[Product Sulphur Content (%)]*
*SO2 (tonnes) = [Sulphur throughput (tonnes)] *[SO2 Molar mass (g/mol)] / [Sulphur Molar Mass (g/mol)]*

The mass balance approach is completely acceptable under the NPI program for the calciner. It was also advised that that S02 emitted from the calcining process is variable due to the sulphur content in the product, therefore should not be calculated via estimation techniques and should be measured via emission monitoring/sampling which is done on a quarterly basis.

Methods used to calculate SO2 emission estimates for NPI reporting are as follows:

Emission Estimation Technique (EET)	
Code	Description
1	Mass Balance
2	Engineering Calculations
3	Direct Measurement
4	Emission Factors
5	Approved alternative EET method

The EET used for the calculation of SO2 emission estimates from the Ranger operation for Power Station Stack or point source are Code's 2, 3, and 4, and for fugitive or nonpoint sources Code 2 is used code descriptors are shown in the above table.

Fugitive Emissions

Fugitive air emissions are generally dust emissions that may be generated by material handling (e.g. earthmoving, crushing, ore screening and conveyor transfers), wind erosion (on stockpiles, roads and other disturbed areas) or vehicle movements.

Monitoring of ambient dust is undertaken at Ranger mine, Jabiru East and Jabiru as part of the radiation monitoring programme and is reported regularly to the MTC as a component of the Radiation Protection and Atmospheric Monitoring Programme for ERA's Ranger operations. Ambient dust levels throughout the reporting period were low and at acceptable levels.

Other sources of fugitive air emissions include the by-products of combustion or other sources (i.e. loss from storage tanks). All emissions to air, including these other sources of fugitive emissions, for Ranger Mine are calculated and reported under the *National Environment Protection (National*

Pollutant Inventory) Measure (NPI NEPM). ERA Ranger Mine NPI NEPM data can be viewed via the website (www.npi.gov.au).

6.2.4 Key Environmental Activities for Oncoming Period

During the next reporting period, ERA will:

- Continue to implement its existing dust controls;
- Install and commission of new ammonia scrubber; and
- Continue to manage air quality in accordance with the authorisation and legislative requirements.

6.3 Radiation Management

6.3.1 Objectives and Targets

The objective of radiation management is to ensure that workers, members of the public and the environment are not exposed to unacceptable levels of ionising radiation which may arise from the uranium mining and processing operations.

6.3.2 Environmental Management

Radiation exposure risk identification, management and monitoring are managed at Ranger in accordance with the:

- RAP001 Ranger Mine, Radiation Management Plan ;
- RAP002 Ranger 3 Deeps, Radiation Management Plan;
- The Ranger Authorisation to Operate 0108;
- ARPANSA Radiation Protection Series No: The Code of Practice for Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing;
- The Northern Territory Radiation Protection Act and Regulations;
- Rio Tinto H06 Radiation Exposure Control; and
- ARPANSA Radiation Protection Series C-1: Radiation in Planned Exposure Situations.

The Ranger Authorisation requires ERA to manage a system to control the radiological exposure of people and the environment arising from its mining and milling activities; including an authorised monitoring programme. The system that ERA utilises to control the radiological exposure of workers and the environment is fully described in the relevant Radiation Management Plan. The results of the authorised monitoring programme are reported in annual Radiation Protection and Atmospheric Monitoring Programme report that is submitted to the MTC annually at the end of March. Environmental monitoring locations are situated at in the township of Jabiru and Jabiru East (airport) and in controlled and supervised areas on site.

6.3.3 Environmental Performance

ERA confirms that the Radiation Safety team remains adequately staffed to maintain compliance with annex A, Clause 14 of the Ranger Authorisation throughout the reporting period. The major activities or events that had an effect on radiation management at ERA operations during this reporting period included:

- The 2017, Ranger mine and Ranger 3 Deeps, Radiation Protection and Atmospheric Monitoring report received acceptance from the NT Department of Primary Industry and Resources and the Minesite Technical Committee (MTC) on the 18 July 2018.
- The 2018 radiation dose records were uploaded to the Australian National Radiation Dose Register (ANRDR) and notifications sent to the NT Department of Health within acceptable timeframes each quarter.
- On the 24 September 2018, the three yearly review of both the Ranger Mine and the R3 Deeps Radiation Management Plans (RMPs) were submitted to the stakeholders for review. In a letter dated the 11 January 2019 ERA received feedback on the RMP submissions.
- An online training package was completed in December 2018 for the truck drivers who transport Uranium Ore Concentrate (UOC). The training package covers the driver's responsibilities in the event of an emergency. It is now a requirement that all drivers who transport UOC complete this training annually.

Dose Results

Doses were calculated using methodology required by the Code of Practice on Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing[2] and approved in the Authorisation to operate. The total effective dose is the sum of the dose from three exposure pathways: External gamma radiation, inhalation of radon decay products (RDP), and inhalation of long lived alpha activity (LLAA).

The maximum and mean annual radiation doses received by designated and non-designated workers in the reporting period are summarized in Table 6—2. Results for the full years are also contained in the Annual Radiation Protection and Atmospheric Monitoring Reports presented to the MTC in March of each year.

Long term effective dose trends for designated and non-designated workers are presented in Figure 6-2 and Figure 6-3 respectively. The maximum and mean annual radiation doses received by designated and non-designated workers remains below the annual legal dose limit.

[2] Australian Radiation Protection and Nuclear Safety Agency (2005). Code of Practice and Safety Guide: Radiation Protection and Radioactive Waste Management in Mining and Mineral Processing' Radiation Protection Series Publication No. 9, August 2005.

Table 6—2: Maximum and mean annual radiation doses for workers in 2018

Time period	Designated workers dose (mSv)		Non-designated workers dose (mSv)	
	Mean dose	Maximum dose	Mean dose	Maximum dose
Q1 – 2018	0.38	1.32	0.11	0.24
Q2 – 2018	0.38	0.96	0.14	0.24
Q3 – 2018	0.49	2.36	0.22	0.35
Q4 – 2018	0.26	0.90	0.12	0.24

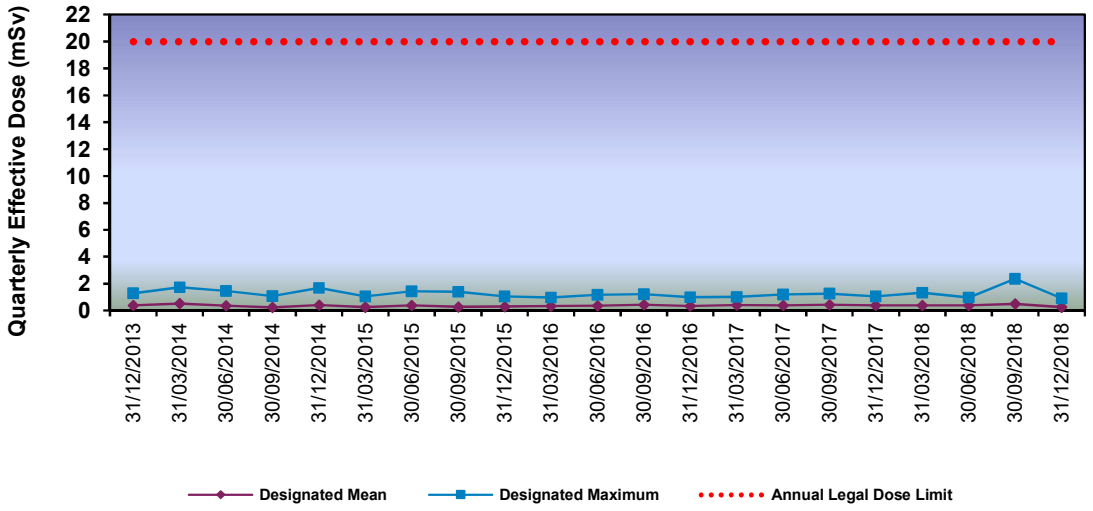


Figure 6-2: Designated Workers' Quarterly Effective Dose Trend

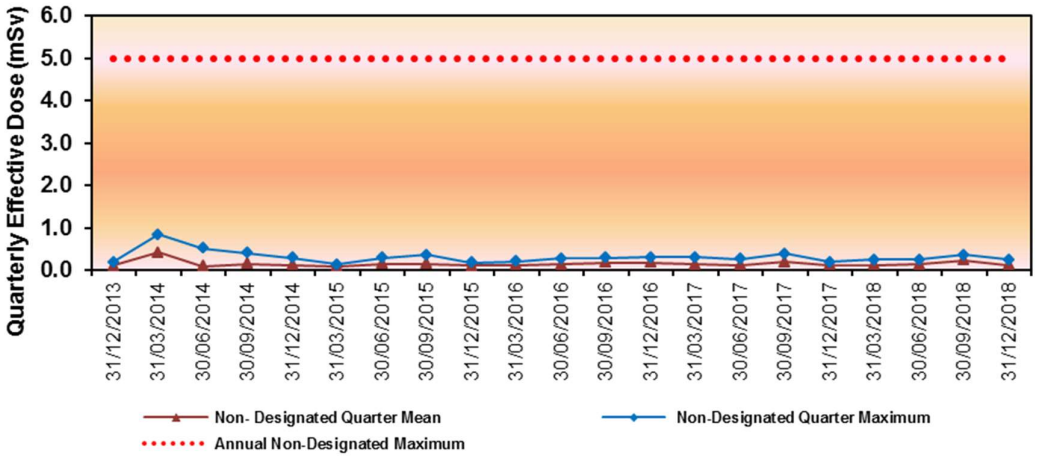


Figure 6-3: Non-designated workers' quarterly effective dose trend

6.3.4 Key Environmental Activities for Oncoming Period

ERA will continue to manage radiation in accordance with the authorisation and relevant legislative requirements.

A radiation dose assessment will be undertaken to confirm that the radiation closure criteria will be met in the post closure phase. The dose assessment includes two phases of modelling and will consider potential radiation exposure to members of the public as well as terrestrial and aquatic biota.

6.4 Greenhouse Gas and Energy

6.4.1 Objectives and Targets

The objective of greenhouse gas energy efficiency plan is to document a process which by ERA can maintain compliance with relevant energy use and greenhouse legal requirements.

6.4.2 Environmental Management

Greenhouse Gas and Energy is managed at Ranger in accordance with:

- GEP001 Greenhouse Gas Energy Efficiency Plan
- EVP102 Greenhouse and Energy Reporting Overview
- EVP070 Monthly Greenhouse Gas and Energy Reporting
- EVP101 Six Monthly Greenhouse Gas and Energy Reporting
- National Greenhouse and Energy Reporting Act 2007 (NGER)

The *National Greenhouse and Energy Reporting Act 2007* (NGER Act) provides a single national framework for reporting and disseminating information related to greenhouse gas emissions, greenhouse gas projects, energy consumption and energy production of corporations. Ranger's data capture and reporting strategy assists in ensuring that all Scope 1 and Scope 2 emission sources defined in the regulation are monitored using a consistent approach.

6.4.3 Environmental Performance

The NGER Act requires controlling corporations to register and then report, on a financial year basis, greenhouse gas emissions and energy production and consumption. The data reported under the NGER Act is made available to the public after 16 months.

Greenhouse gas emissions for the Ranger mine are summarised in Table 6—3.

Table 6—3: Greenhouse gas emissions and energy usage break-down

	2017-18
Greenhouse Gas Emissions (tCO_2-e)	132,575
Energy Use (GJ)	2,157,898

The Ranger operation relies on diesel as its primary source of energy. An overview of greenhouse gas emission sources for the Ranger mine (based on July 2017 to June 2018) is presented in Figure 6-4.

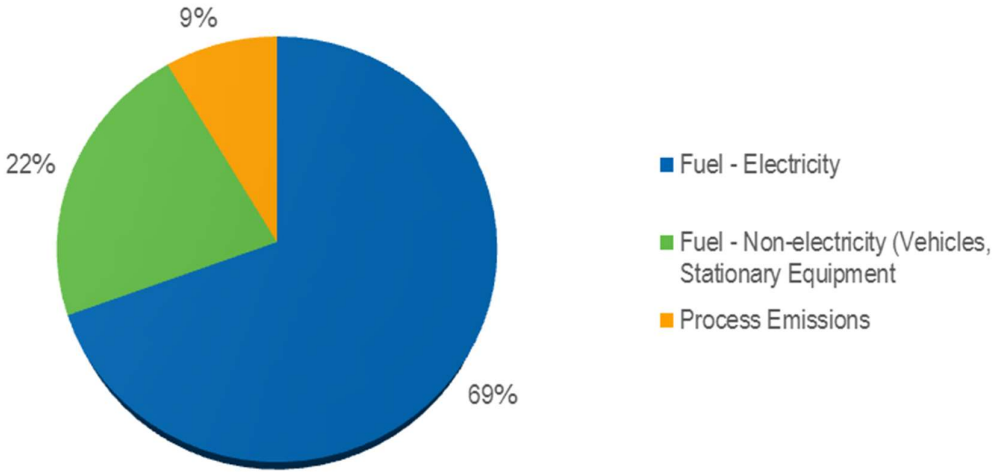


Figure 6-4: Major greenhouse gas emission sources

The *National Greenhouse and Energy Reporting (Safeguard Mechanism) Rule 2015 (Safeguard Rule)* took effect from July 2016. This requires ERA to maintain emissions below the reported baseline number which is determined by the Clean Energy Regulator (CER) based on NGER scheme data reported between 2009-10 and 2013-14.

During the reporting period ERA remained below the reported emission baseline number of 138,472 tCO_2-e. ERA continues to monitor greenhouse gas emissions and energy usage and any implications under the safeguard mechanism.

Whilst the NGER Act requires controlling corporations to register and then report on emissions, the NGER Safeguard Rule requires that emissions are reported by each registered facility. During the reporting period, in order to improve the management of obligations under the NGER Act and

Safeguard Rule the reporting obligations for the Ranger Mine were transferred from Rio Tinto Limited (as the Controlling Corporation) to Energy Resources of Australia Ltd. The Clean Energy Regulator approved the transfer of NGER Act obligations from Rio Tinto to ERA in March 2017.

6.4.4 Key Environmental Activities for Oncoming Period

ERA will continue to manage greenhouse gases and energy in accordance with the authorisation and relevant legislative requirements.

6.5 Weed Management

6.5.1 Objectives and Targets

The land use targets with respect to weed management at Ranger and Jabiluka are:

- Manage weeds in a manner that is consistent with management practices within the surrounding Kakadu National Park
- Achieve nil establishment of new weed species at Ranger and Jabiluka

6.5.2 Environmental Management

Weed management is managed at Ranger in accordance with:

- LUP001 Land Use Management Plan
- YWM001 1 Year Weed Control Programme
- Ranger and Jabiluka Weed Management Report
- EVP031 Weed Spraying using the Quick-spray and backpack units
- Rio Tinto E14. Land disturbance and rehab control standard

Weed control activities are conducted year round in response to environmental conditions (Table 6—4). Adaptive management decisions are made throughout the year within the framework of general priorities including:

- Informal prioritisation of species of the highest importance
- Early treatment of large areas of infestation to limit establishment of weeds and less herbicide
- Use of residual herbicides to reduce the frequency of spraying required
- Prioritisation of areas that border Kakadu National Park to prevent introduction of weeds into the park.

Table 6—4: Annual weed control calendar

Event	Action Following Event	Approximate Period
Late dry season	Minimal weed control – only as required (mainly for irrigation / revegetation areas) Manual removal of Rattlepod	Jul - Oct
Build-up - first significant rain	Boom spray all tracks Blanket spraying of high density weed infestations Spraying of areas hard to access during the wet	Oct - Dec
Wet season - steady rain	Intense spraying (bulk of weed control hours performed) Wet season burns - use of fire control for dense weed infestations	Dec - May
End of wet season – seed-heads have started to develop	Manual removal Dry season burns - use of fire control for dense weed infestations	April - June

All weed control activities are recorded in a Weed Control Log, including the location (Weed Management Area or WMA), date, duration, control method and amount and type of herbicide used. Weed management outcomes are reported for each weed management season in the annual *Ranger and Jabiluka Weed Management Report*.

6.5.3 Environmental Performance

Weed control activities during the reporting period are derived from the completed report of outcomes from the 2017/2018 season. It is noted that weed management in the 2018/2019 season commenced during the reporting period, however outcomes of this work will be reported at the end of the season in the 2020 MMP.

During the 2017/18 weed control season, a total of 2,593.3 person hours (2016/17: 2,234 hours) were spent controlling weeds on the RPA. This is an increase in hours spent over the 2016/17 weed control season. This was due to suitable weather conditions, reasonable accessibility and minimum rain delays, and effectual preventative maintenance. Control hours were above target. And continued success in work-process-optimisation is leading to more control effort and better control outcomes (for example equipment maintenance and provisioning of herbicides).

In the 2017/18 weed control season, herbicides Glyphosate, Sulfomac, Clomac and Goal Tender were used. Glyphosate is a non-specific contact herbicide that must be applied to green and growing vegetation to be effective. Sulfomac, Clomac and Goal Tender are residual herbicides that are applied to the ground to prevent specific weeds species from emerging. Clomac and Goal Tender have both pre-emergence and post-emergence activity. Hand-pulling and seed-head-cutting (manual control methods) were also used for some weed infestations.

During the reporting period, ERA personnel also conducted weed management activities that are not included in the hours of control effort, such as inspections of vehicles and equipment for weed seeds, providing weed education and identification training, assessing weed risk of land disturbance and conducting the annual weed survey.

Annual weed mapping focuses on both Weed Seed Load and Weed Control Effectiveness. A review of Weed Seed Load and Weed Control Effectiveness for the reporting period is discussed in the 2 paragraphs below. The report WCP001 2018-19 Weed Control Program provides a high level of detail of the weed control effort and weed monitoring results

Weed density mapping for 2017/18 is shown in Figure 6-5. As expected, weed density is relatively higher in areas of site that are highly disturbed or and in Land Application Areas that are subject to routine slashing and dry season irrigation. Notwithstanding this, weed density mapping for the reporting period has improved compared to the previous reporting period.

Weed Control activities and their effectiveness for the 2017/18 reporting period is shown in Figure 6-6. Overall the Weed Control Program has been effective in the prevention of weed species reproducing seed. The majority of the WMAs identified as having declined in Weed Control Effectiveness (WMA's 1A, 2B, 9A, 10B, 10C, 6E and Tailings Dam) over the 2016/17 season, do not represent decline across the whole WMA but rather relatively small isolated patches of weeds. The increase of weeds in these areas is anticipated to be recoverable in subsequent weed control efforts.

Figure 6-7 illustrates the percentage of the Ranger Project Area with weed densities of high, moderate, low and no known weeds. Compared with the previous reporting year there has been a decrease in the percentage of area with high and moderate weed densities and as a result there is an increased area with a low weed density. The percentage of the RPA with no known weeds has remained the same.

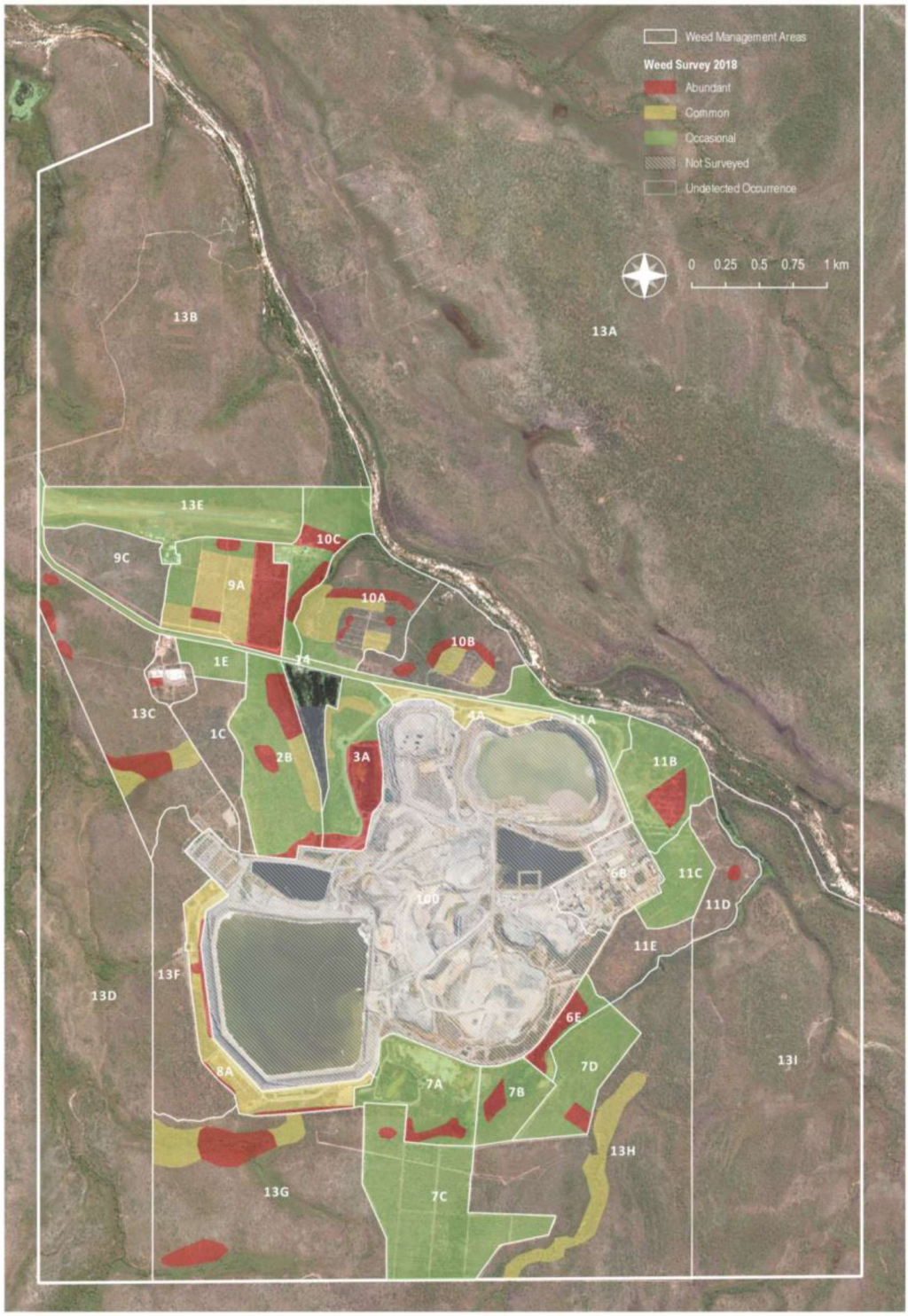


Figure 6-5: Weed loads, Ranger Project Area 2017/2018

Figure 6-6: Weed control effectiveness, Ranger Project Area 2017/2018

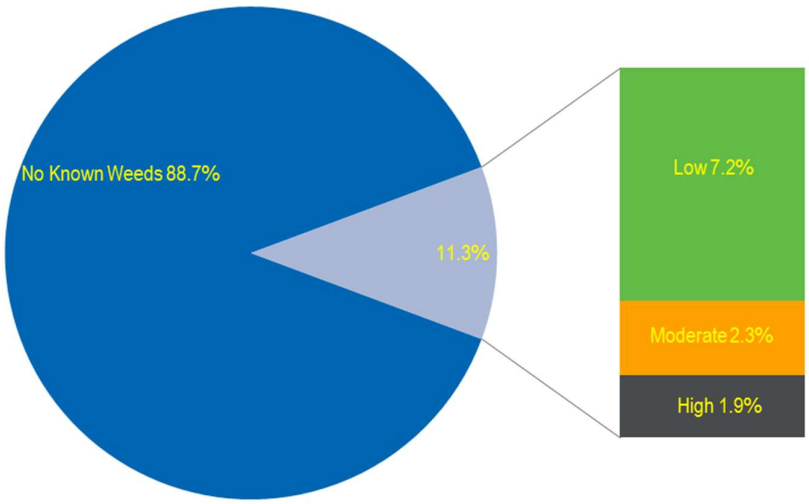


Figure 6-7 Weed density on the RPA 2017/2018

It is noted that in 2017 ERA had planned to undertake a trial to investigate optimal herbicide application rates (e.g. Sulfomac and Clomac), in the presence of saplings. While the trial did not eventuate at that time the recent revegetation (planting of seedlings) of the former TSF laydown yard has provided an opportunity to undertake this trial in the 2018/2019 wet season.

Consequent to the previous identification of Gamba grass at the Jabiru Airport in July 2016, monthly weed inspects were undertaken to check for the presence of Gamba grass. Gamba grass was not observed on any occasion indicating containment and control measures have been effective.

6.5.4 Key Environmental Activities for Oncoming Period

During the next reporting period ERA will:

- Assess the presence (and if present control) of Gamba grass at the Jabiru Airport at monthly intervals during the wet season as planned in the 2018/19 Annual Weed Control Program;
- Assess presence of Gamba grass on RPA and MLN01 both through annual weed mapping and day to day field work activities (and if present control)
- Undertake a trial to investigate optimal herbicide application rates (Sulfomac and Clomac) in the presence of saplings;
- Continue to engage with herbicide supplier to identify and trial target specific and residual herbicides to improve weed management performance; and

- ERA will continue to manage weeds in accordance with the authorisation and relevant legislative requirements.

6.6 Fire Management

6.6.1 Objectives and Targets

The objective of the fire management plan is to identify, document and undertake prescribed burn activities throughout the Ranger Project Area, Jabiluka and Djarr Djarr for asset protection, fuel reduction and weed control.

6.6.2 Environmental Management

Fire is managed at Ranger in accordance with:

- LUP001 Land Use Management Plan
- YFM001 1 Year Fire Management Plan
- SFP001 Fuel reduction and weed management burning for the RPA
- Rio Tinto E14. Land disturbance and rehab control standard

Following an annual fire planning meeting, a *One-Year Fire Management Plan* is prepared for each calendar year, outlining ERA's strategy for fire management on the RPA and the Jabiluka lease including location, timing, purpose, accountabilities and resources for all controlled burns planned for that year.

In general, prescribed burns are conducted early during the dry season when they are likely to be less hot and easier to control. However due to weather and availability of competent personnel some variation and flexibility is reasonable. All designated burns must be completed before the end of June each year with any additional burns requiring additional approvals and permits.

6.6.3 Environmental Performance

The one-year fire management meeting held on 12 December 2018 was attended by representative from Northern Territory Police, Fire and Emergency Services and the Department of the Environment, ERA staff at the meeting included the:

- Emergency Services Officer;
- Superintendent Health and Safety;
- Specialist Environment,
- Supervisor Environment Support, and
- Environment Advisor.

In the 2018 annual plan there were 29 burns proposed, 24 were conducted including 9 wet season burns (Table 6—5), this includes areas 11A and 11B which were not originally included in the

proposed burn plan, but were burnt in July, due to an encroaching fire from the North that threatened the airport and exploration areas.

Fire scar history for the reporting period (from the North Australian Fire Information website) is given in Figure 6-8.

Table 6—5: Planned controlled burns

Area	Burn I.D.	Date	Size (Ha)	Purpose	Comment
Area 22	1	05/06/2018	183	Site requirement	Successful
Area 24	2	22/05/2018	565	Site requirement	Successful
Area 23	3	04/02/2018	9	Site requirement	Successful
Area 25	4	05/06/2018	194	Weed management	Successful
Area 19LAA	5	28/02/2018	25	Asset protection	Successful
Area 19E	6	03/05/2018	24	Asset protection	Successful
Area 10B	7	27/02/2018	13	Weed management	Successful
Area 10LAA	8	23/02/2018	342	Weed management	Successful
Area 8A/D	9	22/05/2018	228	Asset protection	Successful
Area 13C	10	07/06/2018	16	Weed management	Successful
Area 13A	11	25/04/2018	12	Weed management	Successful
Area 19B	12	14/07/2018	22	Access / Weed Management	Successful
Area 9B	13	25/04/2018	3	Asset protection	Successful
Area 9C	14	25/04/2018	9	Asset protection	Successful
Airport / Airstrip	15	13/07/2018	69	Asset protection	Successful
Area 10A	16	22/04/2018	42	Asset protection	Successful
Area 5B	17	22/02/2018	67	Weed management	Successful
Djarr Djarr	18	24/05/2018	120	Asset protection	Successful
Jabiluka	19	23/05/2018	120	Asset protection	Successful
Trial Land Form	20		6.5	Weed management and revegetation protection	Not Conducted
Area 21	21		8	Access / Weed Management	Not Conducted
Area 1	22	06/06/2018	75	Weed Management	Successful
Area 5A	23	22/02/2018	189	Weed Management	Successful

Area	Burn I.D.	Date	Size (Ha)	Purpose	Comment
Area 17A	24		46	Weed Management	Not Conducted
Area 17B	25		7	Access / Weed Management	Not Conducted
Area 11A	26	13/02/2018	250	Response to an encroaching fire	Successful
Area 11B	27	21/02/2018	12	Response to an encroaching fire	Successful
Area 13B	28		44		Not Conducted
Jabiluka	29	24/05/2018	120	Asset protection Re-Burn	Successful

Figure 6-8: Fire scar history

During 2018 ERA undertook the Respond to Wildfire Cluster training. The theoretical course was held in April 2017 followed by practical training which was delivered by nationally accredited trainers while conducting planned burning activities. The delivery on the 2018 fire management plan was above expectation with fuel loads from the previous reporting period significantly reduced and will continue to be managed through the 2019 reporting period. The 2019 1 Year Fire Management Plan was approved on 16 January 2019. The Fire Management Plan provides for burns to be conducted before June 30. Burns completed after June 30 require additional approval from the General Manager Operations and permits to be issued by governing authorities. Two areas were burnt in July but this was due to an encroaching fire from the North that threatened the airport and exploration areas.

Improvements identified for 2019 include early approval of the Fire Management Plan and an extended period to complete planned burns (January to June) through the introduction of wet season burning. The 2019 1 Year Fire Management Plan aims to continue a programme of wet season burning and provide for an extended period to complete planned burns (January to June) and as such approval of the plan was targeted for January 2019 (this plan was approved on 16 January 2019).

6.6.4 Key Environmental Activities for Oncoming Period

During the next reporting period ERA will:

- Continue to manage fire in accordance with the authorisation and relevant legislative requirements;
- Coordinate the early approval of the Fire Management Plan (Q1 2019); and
- Coordinate a programme of wet season burns.

6.7 Feral Animal Management

6.7.1 Objectives and Targets

The main objective of feral animal control is to maintain cultural heritage and environmental values and minimise risks to health, safety, to employees and contractors on the RPA and MLN1.

6.7.2 Environmental Management

Feral animals are managed at Ranger in accordance with the:

- LUP001 Land Use Management Plan
- EVP057 Feral Animal Control Plan
- Rio Tinto E14. Land disturbance and rehab control standard

ERA's Land Use Management Plan (LUMP) provides guidelines by which ERA can coordinate and strategically manage both introduced and native fauna on the RPA in order to protect both human life and biodiversity values.

It is generally accepted that the eradication of an established introduced species population is not achievable with current technology. Hence, the focus of most management programmes is on reducing the density of a population of species to reduce their impact on biodiversity and human safety, as well as preventing new species from establishing. Therefore, control effort resources will primarily focus on the control of pigs and wild dogs on the RPA and MLN1.

6.7.3 Environmental Performance

ERA maintains a register of animal sightings and deaths, entries in the register for 2018 reporting period are presented in Table 6—6, none of the animals observed are listed threatened species.

Table 6—6: Animal sightings and deaths register 2018

Date	Location	Species	Notes
11/01/2018	Demineralisation Plant	Northern Brown Bandicoot	Deceased – Assumed to have been struck by vehicle
14/01/2018	Maintenance change rooms	Children's Python	Relocated - Captured safely and released into the wild
05/03/2018	Mine Access Road	Possum	Deceased – Assumed to have been struck by vehicle
19/06/2018	RP6 Road	Snake (unidentified)	Deceased – Assumed to have been struck by vehicle
28/06/2018	Off site	Wallaby	Deceased – Struck by vehicle
07/08/2018	Off site	Wallaby	Deceased – Struck by vehicle

Wild Dogs

During the reporting period no activities where performed during the reporting period. ERA has a wild dog control programme, permitted under the Northern Territory Parks and Wildlife Commission Permit to Take Protected Wildlife #64179.

Feral Cats

During the reporting period there were no reported sightings of feral cats, therefore no traps were placed during the 2018 reporting period.

Feral Pigs

A feral pig control programme was also undertaken on the RPA during the reporting period. The programme was scheduled to occur during the dry season. The programme was undertaken using ground shooting techniques. During the reporting period 16 pigs were culled on the RPA.

A record of the number of animals, location, breeding condition, age class, sex and health condition was recorded where possible (Table 6—7).

Table 6—7: Feral pigs culled during the reporting period

Location	Number	Age class	Sex	Breeding condition	Description*
Georgetown	12	Young adult	M	n/a	Healthy
Georgetown	4	Young adult	F	n/a	Healthy

6.7.4 Key Environmental Activities for Oncoming Period

During the next reporting period ERA will:

- Undertake a feral animal control programme targeting feral pigs but may target other species opportunistically, or in response to sightings; and
- Ensure all feral animal control works comply with the relevant policies and procedures and Northern Territory codes and legislation.

6.8 Hazardous Materials and Contamination Control

6.8.1 Objectives and Targets

The objective of hazardous material and contamination control at Ranger is to eliminate, as far as practicable, high risk chemicals and hazardous substances.

6.8.2 Environmental Management

Hazardous material and contamination control is managed at Ranger in accordance with:

- HMP001 Hazardous Material and Contamination Control Plan
- ERS057 ERA Standard Hazardous Substances
- Rio Tinto E15. Hazardous materials and non-mineral waste control standard

Hydrocarbons and other hazardous substances are kept in designated storage compounds designed and managed in accordance with relevant standards and procedures. An inventory of all chemical storage areas at Ranger and the chemicals stored in these areas are recorded in ChemAlert. Monitoring and inspection programmes are maintained for these facilities to ensure hazardous materials and wastes are being adequately stored and disposed and that any spills or leaks are promptly reported and managed.

Every person employed or contracted by ERA has a responsibility to take all reasonable steps to prevent harm to the environment occurring from a hazardous substance spill. Should the spill constitute a reportable event ERA will report the event to the relevant authorities.

Some vessels and tanks used for the storage and containment of hazardous substances are required to be certified as per the Australian Standard AS 1210. Details of certification and inspections of statutory asset is located on the site statutory register and managed by the Asset Management team. ERA has also identified a number of additional storage tanks, which do not require certification under the current Regulations or any Australian Standards, but are of sufficient criticality to warrant periodic inspection by competent person. This is also maintained in register managed by the Asset Management team.

6.8.3 Environmental Performance

During the reporting period, all spills were controlled and contained immediately using emergency spill kits or earthmoving equipment to form a temporary bund (environmental incident reports for spills are included in Appendix C). Depending on the material, recovered contaminated material can either be returned to the processing circuit for reprocessing or transported to an on-site temporary storage area prior to final disposal into Pit 3. Volumes taken to this area are being tracked. During the 2018 reporting period there were 14 reports of spills with a combined total volume of 9087L. (Table 6—8). The highest volume of these spills (8085L) involved fluids from the processing circuit; the remaining volumes of 1,002L were hydrocarbons.

Performance against previous MMP

In the previous MMP the following key environmental activities to improve controls to manage risks associated with the transfer of ammonia were reported. These activities remain in progress and an update is provided below:

Installing remote shut-off valves inline on the four ammonia vapour lines - Status update: Scheduled install in April 2019 following commissioning of new Ammonia scrubber system;

Install functionality such that these shut-off valves will be able to be activated from the Mill Control Room - Status update: Scheduled install in April 2019 following commissioning of new Ammonia scrubber system;

Remove the ammonia vaporizer unit - Status update: Scheduled install in April 2019 following commissioning of new Ammonia scrubber system; and

Improve the bulk sulphuric acid bunding including cleaning out of the concrete drain and installation of a new dedicated sump pump – Status update: New automated sump pump installed and commissioned. Drain and sump cleaning completed and awaiting sealing in early 2019 dry season.

Table 6—8: Volume of spilled materials

Material	Quantity	No. of Incidents	Disposal location
Hydrocarbons	~1,002L	8	Depending on recovery methods spilled hydrocarbons may be disposed of via hydrocarbon storage area, controlled waste laydown area or disposal in Pit 3
Process liquids/materials	~8,085L	6	Reprocessing – spills of process materials are recovered and returned to the processing circuit

6.8.4 Key Environmental Activities for Oncoming Period

ERA will continue to manage hazardous material and contamination control in accordance with the authorisation and relevant legislative requirements. In addition, ERA will:

- Install and commission new Ammonia scrubber system.
- Evaluate the potential environmental risk associated with the Pit 3 Northern Ramp controlled waste sludge disposal via inclusion of the Pit 3 North Ramp Controlled Waste Disposal as a contaminant source in a future scenario of the Pit 3 Solute Transport GW model prepared by Intera. This package of work is now included as part of closure activities and as such further details to be provided in the 2019 Closure Management Plan.

This package of work is now part of closure activities and as such further details to be provided in the Ranger Mine Closure Plan.

It is noted that the INTERA Pit 3 Solute Transport Model methodology aims to estimate peak Mg loading to Magela Creek from Pit 3 tailings in a 10,000-year time period. Post closure groundwater flow and solute transport modelling was conducted for two deposition options for tailings distributions. In addition, a sensitivity analysis examined how peak loading varies with changes in key modelling parameters.

Modelling results predict peak Mg loadings for the two depositions options modelled are very small compared to the mean historical Mg loading in Magela Creek upstream of the Ranger Mine.

The post closure flow and transport model used for the assessment conducted by INTERA was developed based on the post groundwater flow model in INTERA (2019), with appropriate modifications to simulate solute transport and incorporate an excavation damaged zone around Pit 3. Including the use of Hydro lithologic units and the properties determined through calibration of the site wide ground water flow model (INTERA 2019)

In summary, predicted Mg loadings to Magela Creek from Pit 3 for the two deposition options modelled and the sensitivity analysis represent a small fraction of the mean natural Mg loading in Magela Creek upstream of the Ranger Mine and of the mean historical mine derived Mg loading.

6.9 Waste Management (Domestic and Industrial)

6.9.1 Objectives and Targets

The overall objective of waste management at ERA is to manage waste streams in accordance with the waste minimisation hierarchy within the bounds of legal and other requirements and operational constraints:

- Waste avoidance and reduction at source;
- Reuse and recycling;
- Waste treatment (reduce the degree of hazard or nuisance); and
- Disposal (considered after all other options have been eliminated).

The following target has been established for hazard reduction of non-mineral wastes destined for disposal:

- Manage waste streams such that no radiation contaminated (or potentially radiation contaminated waste) leaves Ranger mine.

6.9.2 Environmental Management

Domestic and industrial waste is managed at Ranger in accordance with:

- NMP001 Non-Mineral Waste Management Plan
- Rio Tinto E15. Hazardous materials and non-mineral waste control standard

It is important to note that due to the nature of ore mined at Ranger Mine, radioactive contamination may occur on equipment, machinery or materials that have come into contact with ore or originating from a controlled area. Such contaminated material is not permitted to leave site unless it can be cleaned and passes a *Radiation Clearance Certificate* inspection. It is with this limitation that offsite waste disposal options cannot be considered for many waste types, constraining the offsite reuse, recycle and disposal options.

The nature and characteristics of waste types will determine how they are segregated, stored and collected. Wastes may be treated or disposed of on-site or off-site. If off-site disposal or treatment is not available waste must be disposed of in approved on-site locations. Figure 6-9 outlines the on-site waste storage and disposal locations.

Figure 6-9: On-site storage and disposal locations at Ranger

6.9.3 Environmental Performance

During the reporting period, waste management activities were undertaken in accordance with the requirements of the *Non-Mineral Waste Management Plan* and in compliance with relevant legal requirements.

Waste Tracking

ERA maintains a system for the tracking and recording of waste recycling and disposal. Waste data is reported internally and externally through various reporting mechanisms. Table 6—9 shows a summary of the non-mineral waste disposal volumes for the RPA during the reporting period.

Table 6—9: Waste disposal records

Waste description		2018 Quantity (t)
Disposal (Onsite)	Hazardous Waste – Pit 3	100
	Non Hazardous Waste –Landfill	67
Storage (Onsite)	Hazardous Waste (Western Stockpile)	783
	Waste Hydrocarbons	5
Incineration (Turbo Burning)	Waste Hydrocarbons	0
Recycle/Reuse (Offsite)	Hazardous Waste	197

Figure 6-10 shows a breakdown of waste types and disposal methods, showing the largest contributors.

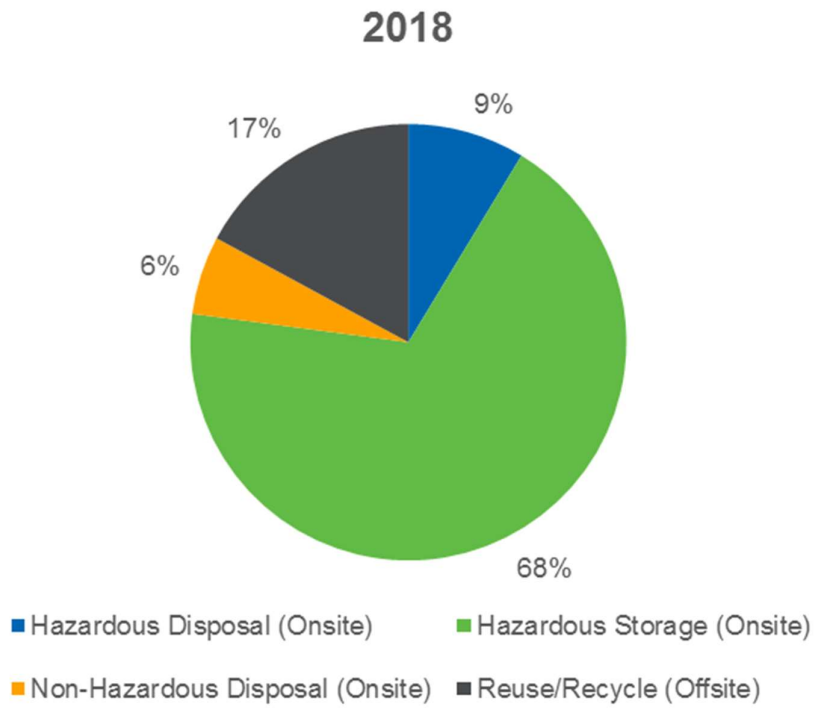


Figure 6-10: Breakdown of waste type and disposal methods

Key points of note for domestic and industrial waste management in 2018 include:

- Storage of hazardous waste has increased to represent the method of disposal for 68% of waste (2017: 59%). This is due to the introduction of the Western Stockpile as a hazardous waste storage area in October 2016 and is considered to be representative of future years (final disposal of this waste will be in Pit 3 during closure);
- Investigations to identify the preferred disposal option for the "black jack" hydrocarbon waste were completed in the 2018 reporting period and the outcome is outlined below (Radiation-Contaminated Hydrocarbon Waste). Incineration of waste hydrocarbons using the turbo burners was not undertaken in 2018 reporting period;
- Hazardous waste generation during the 2018 reporting period (888 tonnes, comprising of waste disposed to Pit 3 and storage at the Western Stockpile and the Hydrocarbon Storage Area). This was slightly lower than the 892 Tonnes that was reported in the 2017 reporting period. And is greatly influenced by asset maintenance in the processing plant; and
- Quantities of domestic (non-hazardous) waste disposal and hydrocarbon waste sent offsite for recycling were similar to the previous reporting period.

Disposal of Hazardous Substances

Details of all hazardous materials, (listed waste under the NT *Waste Management and Pollution Control (Administration) Regulations* (Schedule 2)) disposed of by ERA via offsite or on-site disposal are recorded in a waste register. The register contains details of the material's name, volume, and disposal method and disposal location.

ERA disposes radioactive contaminated items within the approved disposal area if they are unable to be decontaminated for offsite disposal. ERA did not dispose of any sealed source density gauge during the reporting period.

Radiation-Contaminated Hydrocarbon Waste

Investigations to identify the preferred disposal option for the radiation-contaminated hydrocarbon waste, in particular "black jack" hydrocarbon waste, were ongoing during the reporting period. Black jack is the term used to describe the waste by-product of Mobiltac, an unleaded, diluent-type, heavy bodied open gear lubricant which is used in the processing plant and is exposed to potential radiation contamination.

The preferred option for treatment and disposal of the radiation-contaminated hydrocarbon waste is via a near-surface geological waste repository (pending final licencing requirements). ERA will develop a scope of works for the characterisation of a representative sample of the hydrocarbon waste in Q2 2019 to ensure requirements of the low level waste facility can be met.

This package of work is now included as part of closure activities and as such further details to be provided in the Mine Closure Management Plan

6.9.4 Key Environmental Activities for Oncoming Period

ERA will continue to manage domestic and industrial waste in accordance with the authorisation and legislative requirements. Additionally, ERA will:

- Evaluate “black jack” hydrocarbon waste against the requirements of the low level waste facility;

6.10 Cultural Heritage Management

6.10.1 Objectives and Targets

The objectives of the Cultural Heritage Management System (CHMS) are to ensure that:

- Cultural heritage sites are not damaged or disturbed in any way by ERA operations.
- Aboriginal and non-Aboriginal Cultural heritage sites which exist on the RPA are located documented and managed in accordance with relative Territory and Commonwealth legislative requirements.

6.10.2 Environmental Management

The following documents form part of the Cultural Heritage Management System (CHMS) at Ranger:

- The Interim Cultural Heritage Protocol (signed between ERA and GAC)
- Rio Tinto Communities and Social Performance standard
- Rio Tinto Cultural Heritage management procedure
- CHM001 Cultural heritage management system manual
- CHM002 Cultural heritage sites RPA Management Plans
- ERA176 Action Damage or Disturbance to Cultural Heritage Site
- ERA177 Action finding unrecorded cultural heritage site
- ERA200 Action finding human remains
- ERW179 Planning and conduct cultural heritage surveys
- EVP019 Land Disturbance Procedure
- F10139 Permit to Work - Land Disturbance Permit

Implementation of the CHMS ensures strict operational controls (both physical, as well as, administrative elements) are in place to mitigate the potential risk of disturbance to cultural heritage sites. Most pertinently, the boundaries of all known archaeological sites are identified by red painted star pickets and cultural heritage signage. Figure 6-11 provides an example of signage at cultural heritage sites.

All cultural heritage sites are displayed on a Geographic Information System (GIS) system, providing the spatial details of all sites. This GIS data is used to inform a rigid land disturbance permitting

system to ensure compliance in the field with the CHMS. A fully authorised land disturbance permit (LDP) has controls embedded for both environment and cultural heritage protection.

The CHMS is subject to biennial Rio Tinto Business Conformance Audits, Risk Reviews, ERA Site Managed Assessments and ongoing improvements. Elements may change due to changes in the working environment of ERA operations, changes to NT or Commonwealth heritage legislation or cultural criteria as requested by Traditional Owners.

In 2018, a review and update of ERA's standards and procedures was completed to ensure cultural heritage is protected and to achieve compliance with Rio Tinto's updated cultural heritage management guidelines

Figure 6-11: Examples of signage at cultural heritage sites

6.10.3 Environmental Performance

During the reporting period, cultural heritage management on the RPA continued to be conducted under the Interim Cultural Heritage Management Protocol for the RPA. The protocol requires that archaeological surveys are undertaken prior to new land disturbance by an independent archaeological specialist (approved by GAC) with participation by Mirarr Traditional Owners. There were no archaeological surveys conducted during the period.

Archaeological sites affected by mining activities

A total of 99 archaeological sites and 69 background scatters (isolated, singular or small numbers of stone artefacts / flakes) have been identified and recorded on the RPA. 28 of the background scatters have previously been disturbed under an approved heritage permit and ERA also received permission to plant native vegetation within the boundary of two sites (Crassweller 2014). There are

four restricted work areas on the RPA associated with sites listed on the Aboriginal Areas Protection Authority (AAPA) register.

The potential risk of damage by operational activity at these sites varies with their distance from the operational area. All archaeological sites and background scatters have site management strategies and all ground disturbance work outside the operational area is subject to the land disturbance permit process, which includes a review of cultural heritage. During the reporting period, no sites or scatters have been affected and there have been no breaches of Northern Territory or Commonwealth heritage legislation resulting from mining on the RPA.

Heritage sites affected by mining activities

There are no recorded or known heritage sites with historic heritage value on the RPA.

6.10.4 Key Environmental Activities for Oncoming Period

ERA will continue to manage cultural heritage in accordance with the authorisation and legislative requirements.

A Cultural Heritage Management Plan specific to closure will continue to be developed in 2019 in collaboration with the Mirarr Traditional Owners and the Gundjeihmi Aboriginal Corporation.

6.11 Potable Water Management

6.11.1 Objectives and Targets

ERA's objective with regard to potable water supply is to protect the health of employees, contractors and visitors, the community and to comply with all relevant statutory requirements.

6.11.2 Environmental Management

Interconnection of different water types on site is a risk that may result in harm to the health of workers, the community or the environment. The integrity of the site potable water supply is required in order to prevent accidental occurrences of process and pond water entering potable water systems. Potable water is managed at Ranger in accordance with:

- Ranger Water Management Plan (RWMP) – updated annually and submitted to the MTC for review on 1 October every year;
- SFP062 Management of Water System Integrity;
- F0020 Permit to Work Water; and
- The Ranger Authorisation to Operate 0108-18;
- Rio Tinto E11. Water quality protection standard

SFP062 and the RWMP detail the precautions taken in order to prevent contamination of the potable water systems by other water systems. These include, but are not limited to:

- Installation of non-return valves (to prevent back-flow) at all potable water outlets;
- Service connection fittings used throughout the potable water system are incompatible with all other service connection fittings used on the site;
- A Permit to Work – Water must be completed and authorised by the relevant area Superintendent for any changes to water systems;
- Potable water controls are articulated at the site induction for all personnel and contractors.

ERA's Process Safety management system requires the above controls are verified by senior personnel on a monthly basis.

6.11.3 Environmental Performance

In addition to the above controls, ERA has a robust monitoring programme in order to verify the potable water quality. This programme involves monitoring of potable water at Ranger and Jabiru East sampling at both the source bores and end use tap, in accordance with the requirements outlined in the Ranger Authorisation. Further details regarding surface water and groundwater monitoring is provided in Section 7, results of potable water monitoring are analysed below.

The potable water quality recorded for the period 1 January to 31 December for 2018 has met the Health Guidelines for physical and chemical characteristics as defined by the Australian Drinking Water Guidelines[3].

The majority of Aesthetic Guidelines were also met for the reporting period with an exception of free residual chlorine, which was above 0.6 milligrams per litre on several occasions in both the Jabiru East and Ranger potable water supply. This occurs because ERA doses on the conservative side to ensure sterilised safe drinking water. However, the maximum free residual chlorine remained below the Health Guideline of 5 milligrams per litre.

Summary statistics for Ranger and Jabiru East potable water from 2018 are presented in Table 6—10 and Table 6—11 respectively.

Potable water bore extraction volumes for the period 1 January to 31 December for 2018 are provided in Table 6—12. There are no planned changes to the potable water usage, so estimated usage in 2019 is in line with usage in 2018.

Potable water level is measured at two bores for the Magela borefield (77_4 and 78_10) and at four bores at the Brockman borefield (82_7, 83_5, 83_6, 84_3). Potable water bore levels for the period 1 January to 31 December for 2018 are provided in Figure 6-12. This graph shows a strong seasonal variation trend.

[3] NHMRC and NRMMC (2011). Australian Drinking Water Guidelines Paper 6 Australian Government. 1: 1244.

Due to a higher than average rainfall total for the 2018 reporting period Bore 83_6 did not see a decline in water levels as much as the other bores due to its proximity to the creek line.

Where data gaps exist these have connected to improve visual representation of the potable water levels.

Table 6—10: Composition of potable water sampled at Ranger (2018)

Group	Parameter	Units	n	Mean	Median	Min	Max	Health Guideline	Aesthetic Guideline
General	In-situ pH		51	7.85	7.83	7.59	8.34	-	6.5 – 8.5
	In-situ EC	µS/cm	51	373.82	368	329	542	-	-
	Alkalinity	mg/L	12	196.92	193	171	244	-	-
	Turbidity**	NTU	51	1.75	0	0	10.10	-	5
Radiological	Gross α***	Bq/L	8	0.20	0.20	0.11	0.29	500	-
	Gross β***	Bq/L	5	0.15	0.16	0.12	0.18	500	-
	Uranium	µg/L	12	0.58	0.5	0.4	1.3	17	-
Chemical*	Aluminium	µg/L	12	3.21	2.5	2.5	11	-	200
	Antimony	µg/L	12	0.17	0.10	0.10	0.80	3	-
	Arsenic	µg/L	12	0.13	0.10	0.10	0.40	10	-
	Barium	µg/L	12	2.74	1.00	0.80	18.10	2000	-
	Beryllium	µg/L	12	0.05	0.05	0.05	0.05	60	-
	Boron	µg/L	12	10.58	8.0	5.0	32	4000	-
	Calcium	mg/L	12	17.58	16.50	13.0	30.0	-	-
	Cadmium	µg/L	12	0.03	0.03	0.025	0.07	2	-
	Chromium	µg/L	12	0.22	0.10	0.10	1.20	50	-
(Residual)	Chlorine (free)	mg/L	406	1.14	1.15	0.18	2.20	5	0.6
	Copper	µg/L	12	27.01	24.65	10.60	71.50	2000	1000
	Iodine	µg/L	12	5.00	5	5	5	-	-
	Iron	µg/L	12	10	10	10	10	-	300
	Lead	µg/L	12	0.51	0.45	0.2	1.20	10	-
	Magnesium	mg/L	12	37.08	36.50	33.0	46.0	-	-
	Manganese	µg/L	12	0.30	0.25	0.25	0.80	500	100
	Mercury	µg/L	12	0.003	0.003	0.003	0.008	1	-
	Molybdenum	µg/L	12	0.08	0.05	0.05	0.20	50	-
	Nickel	µg/L	12	1.08	0.25	0.25	9.0	20	-
	Nitrate	mg/L	12	0.15	0.15	0.13	0.17	50	-

Group	Parameter	Units	n	Mean	Median	Min	Max	Health Guideline	Aesthetic Guideline
	Potassium	mg/L	12	0.54	0.5	0.5	1.0	-	-
	Sodium	mg/L	12	4.33	4	3	8	-	180
	Selenium	µg/L	12	0.11	0.10	0.10	0.20	10	-
	Silver	µg/L	12	0.05	0.05	0.05	0.05	100	-
(Dissolved)	Sulphate	mg/L	12	7.64	7.93	3.72	9.46	500	250
	Zinc	µg/L	12	67.58	53.5	32	182	-	3000
Biological	E. coli	per 100mL	12	0.5	0.5	0.5	0.5	<1 in 100 ml	-
	Total coliforms	per 100mL	12	0.5	0.5	0.5	0.5	-	-

* All chemical parameters are total concentrations unless otherwise stated.
** In-situ turbidity used instead of laboratory turbidity.

*** Measured from bore

Table 6—11: Composition of potable water sampled at Jabiru East (2018)

Group	Parameter	Units	n	Mean	Median	Min	Max	Health Guideline	Aesthetic Guideline
General	In-situ Ph		51	7.83	7.83	7.53	8.10	-	6.5 – 8.5
	In-situ EC	µS/cm	50	360	360	324	383	-	-
	Alkalinity	mg/L	12	190.25	188	177	205	-	-
	Turbidity**	NTU	51	4.19	3.50	0	15.9	-	5
Radiological	Gross α	Bq/L	8	0.085	0.085	0.025	0.14	500	-
	Gross β	Bq/L	8	0.084	0.05	0.05	0.16	500	-
	Uranium	µg/L	11	2.15	2.05	1.62	2.64	17	-
Chemical*	Aluminium	µg/L	12	2.5	2.5	2.5	2.5	-	200
	Antimony	µg/L	12	0.11	0.1	0.1	0.2	3	-
	Arsenic	µg/L	12	0.53	0.5	0.4	0.6	10	-
	Barium	µg/L	12	6.50	6.45	5.20	7.50	2000	-
	Beryllium	µg/L	12	0.05	0.05	0.05	0.05	60	-
	Boron	µg/L	12	9.25	9.50	6	13	4000	-
	Calcium	mg/L	12	26.75	26.50	25	29	-	-
	Cadmium	µg/L	12	0.025	0.025	0.025	0.025	2	-
	Chromium	µg/L	12	0.42	0.4	0.3	1.10	50	-

Group	Parameter	Units	n	Mean	Median	Min	Max	Health Guideline	Aesthetic Guideline
(Residual)	Chlorine (free)	mg/L	408	0.55	0.45	0.12	2.20	5	0.6
	Copper	µg/L	12	5.31	5.05	3.10	7.90	2000	1000
	Iodine	µg/L	12	0.5	0.5	0.5	0.5	-	-
	Iron	µg/L	12	10	10	10	10	-	300
	Lead	µg/L	12	0.17	0.20	0.10	0.20	10	-
	Magnesium	mg/L	12	26.5	26	24	29	-	-
	Manganese	µg/L	12	0.25	0.25	0.25	0.25	500	100
	Mercury	µg/L	12	0.003	0.003	0.003	0.007	1	-
	Molybdenum	µg/L	12	0.05	0.05	0.05	0.1	50	-
	Nickel	µg/L	12	0.25	0.25	0.25	0.25	20	-
	Nitrate	mg/L	12	0.05	0.05	0.03	0.07	50	-
	Potassium	mg/L	12	4.75	5	4	5	-	-
	Sodium	mg/L	12	5	5	3	7	-	180
	Selenium	µg/L	12	0.1	0.1	0.1	0.1	10	-
	Silver	µg/L	12	0.05	0.05	0.05	0.05	100	-
(Dissolved)	Sulphate	mg/L	12	0.20	0.20	0.15	0.24	500	250
	Zinc	µg/L	12	10.25	9.5	9	17	-	3000
Biological	E. coli	per 100mL	12	0.50	0.5	0.5	0.5	<1 in 100 ml	-
	Total coliforms	per 100mL	12	1.42	1	1	6	-	-

* All chemical parameters are total concentrations unless otherwise stated.
** In-situ turbidity used instead of laboratory turbidity.

Table 6—12: Potable water extraction volumes 2018 and predicted volumes 2019

Borefield	2018 usage (m^3)	2019 predicated usage (m^3)
Magela	46,876	50,000
Brockman	127,120	150,000

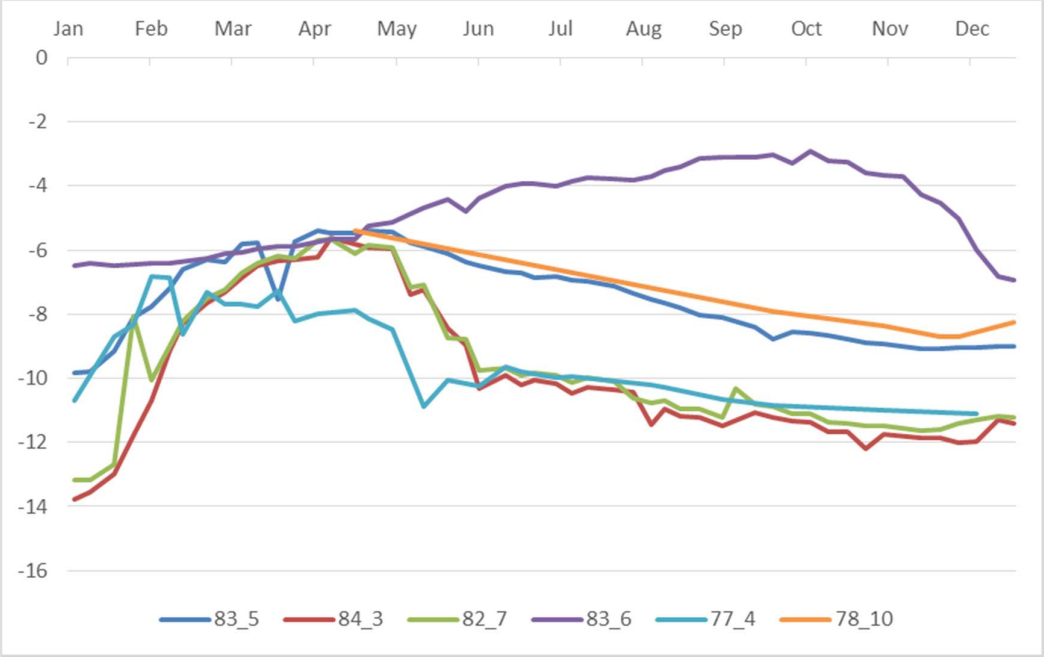


Figure 6-12: Potable water bore levels 2018

6.11.4 Key Environmental Activities for Oncoming Period

ERA will continue to manage potable water in accordance with the authorisation and legislative requirements.

7 WATER MANAGEMENT

7.1 Objectives and Targets

The primary objectives of ERA's water management system are to:

- Protect the wider environment, especially Magela Creek and Gulungul Creek from the impacts of ERA operations;
- Meet all current statutory requirements;
- Manage water according to quality rather than origin;
- Ensure data is collected to inform both operational and closure based decisions; and
- Strategically manage process and pond water inventories in accordance with the current closure model.

7.2 Environmental Management

Management of water is primarily undertaken in accordance with the following:

- Ranger Water Management Plan (RWMP) – updated annually and submitted to the MTC for review on 1 October every year;
- The Ranger Authorisation to Operate 0108;
- Rio Tinto Standard E11. Water Quality Protection.

The RWMP provides an overview of Ranger's water management systems including water transfer, disposal, monitoring, and water balance. The RWMP meets the requirements of the Ranger Authorisation and includes:

- A complete explanation of the operation and maintenance of the water management system;
- The contingency procedures for disruptions in the operation and maintenance of the water management system; and
- The surface and ground water monitoring programmes.

The water management system forms part of ERA's certified ISO 14001 Environmental Management System. The procedures and processes outlined in Section 5 are integrated into water management; as such hazard identification and risk management and actions and strategies in response to identified risks will not be detailed in this section. Notwithstanding, the RWMP does include details regarding activities to be undertaken to address information/knowledge gaps, and risk mitigation.

7.2.1 Monitoring Programme

ERA's water quality monitoring programme is included as an appendix to the RWMP and involves the measurement of water quality from surface water and groundwater samples to meet statutory and operational requirements.

Statutory sites are sampled and analysed in accordance with the requirements of the Ranger Authorisation. Any changes made to the statutory monitoring programme will only be with the approval of the Supervising Authority.

Operational monitoring is not a statutory requirement and as such ERA maintains flexibility in its operational monitoring programme to best serve the needs of the business and maximise environmental protection. Operational monitoring includes:

- Monitoring to support actions subject to applications, proposals and notifications;
- Monitoring to support routine operations; and
- Monitoring to support optimal water management and to identify system improvements.

As part of the water monitoring Quality Assurance / Quality Control programme ERA has Standard Operating Procedures (SOP) for:

- Instrument calibration
- Sample collection and dispatch including Chain of Custody and appropriate sample storage;
- Sample analysis including collection of duplicates and blanks; and
- Data storage and verification.

All ERA Water Management personnel are trained in SOPs deemed relevant for their work and are deemed competent by trainer assessors.

7.2.2 Current Conditions

Surface water

The Ranger Mine footprint is divided into catchment areas. Each catchment may comprise of several elements such as retention ponds, sumps, collection basins and groundwater interception ponds. The location of water management elements, including statutory and operational surface water monitoring sites, is displayed on Figure 7-1. Detailed information regarding the Catchments and the Elements can be found as an appendix of the RWMP.

ERA have an established water balance model to aid with the design and management of water resource systems. The Ranger water balance model is regularly reviewed subject to operational requirements. The most recent calibration was completed in March 2017.

A schematic representation of flow pathways, including relationships between on-site surface water catchments and water release points, is given in Figure 7-2.

Groundwater

As a generalisation across the site, groundwater is described based on three water bearing zones: Aquifer 1 (both a and b), Aquifer 2 and Aquifer 3. The general description of these zones is presented in Table 7—1.

Table 7—1: Description of aquifers (Weaver et al, 2010)

Aquifer Class		Geological Description and Typical Depth	Hydrological Description
Aquifer 1a		Sediments in alluvial channels (sands, gravels and transported sediments). Aquifer 1a is usually present at the surface, associated with creek channels.	Hosts the water table in the wet season. Likely to behave as a porous medium.
Aquifer 1b		Upper weathered and lateritic sediments generally located away from surface water channels. Aquifer 1b is usually present at the surface, although in places it may be buried beneath fil.	Ephemeral wetting in wet season. Hosts the water table in the wet season. Likely to behave as a porous medium.
Aquifer 2		Weathered bedrock aquifer with some clay present Aquifer 2 is generally found beneath Aquifer 1a or 1b (or both), but can also be present at the surface.	Hosts the water table in dry season. Likely to behave as a fractured porous medium. Not effective or widespread aquitard.
Aquifer 3		Fractured bedrock aquifer largely unweathered. Aquifer 3 is usually found beneath Aquifer 2, but can also be found directly beneath fill, Aquifer 1a, or Aquifer 1b if Aquifer 2 is missing.	Fully saturated at all times (unless affected locally by dewatering associated with mine activities). Varies between confined and semiconfined conditions. Groundwater flow and solute movement are likely to occur predominantly within fractures and fractured zones.

The groundwater monitoring network is divided into seven areas of interest around the Ranger Operation. For each area, groundwater elevation, hydraulic gradient and inferred groundwater flow direction, and constituents of potential concern (COPC) concentrations and trends are assessed. This provides greater focus on source terms, site activities, pathways and receptors relevant to the particular monitoring programmes and/or site areas.

The location of groundwater monitoring sites and the seven areas of interest is presented in Figure 7-3. Piezometers constructed to specifically monitor standing water level (SWL) at various points around the RPA are presented Figure 7-4.

Figure 7-1: Location of water management elements (statutory sites in yellow boxes)

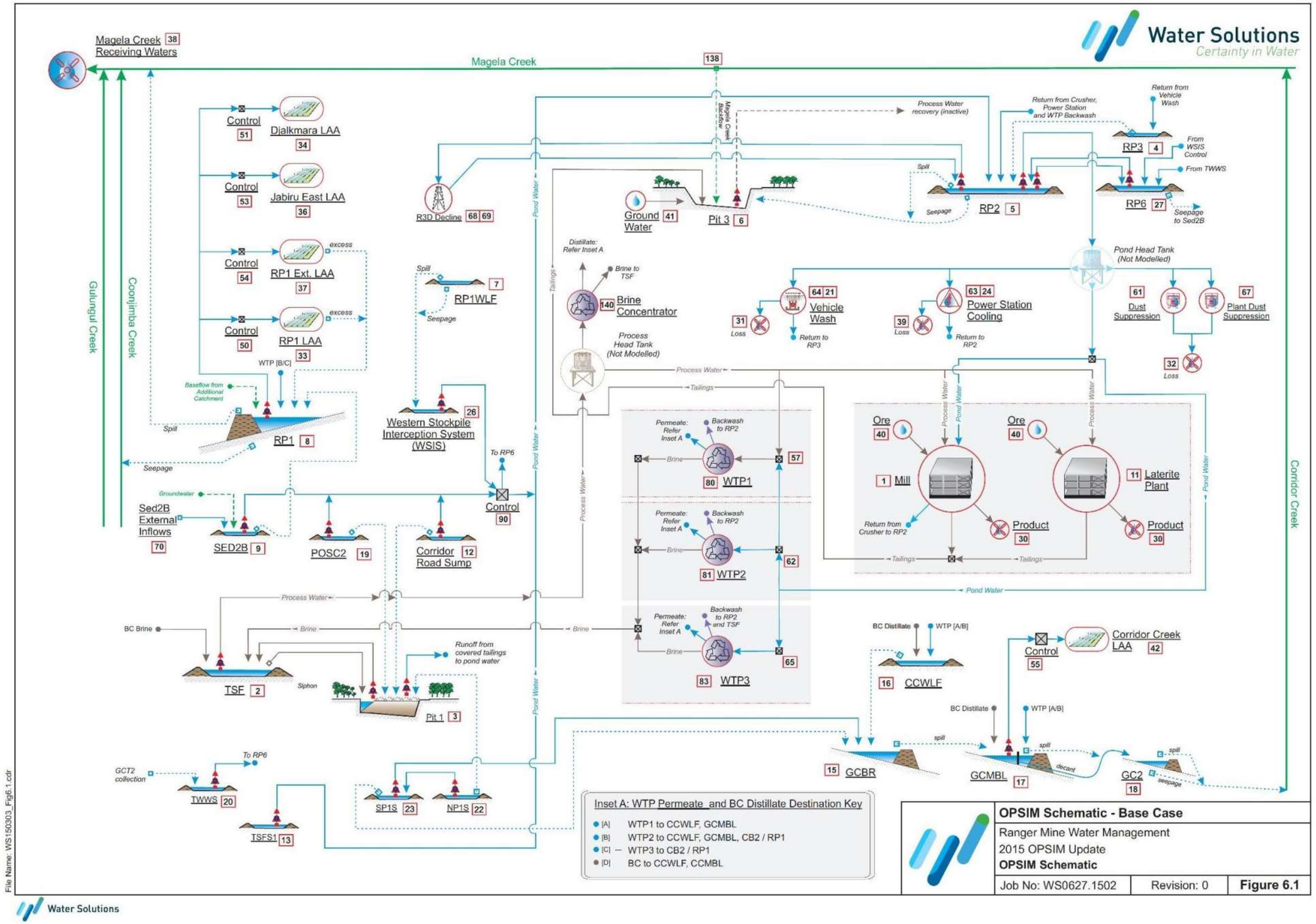


Figure 7-2: Schematic representation of water flows (Water Solutions 2016)

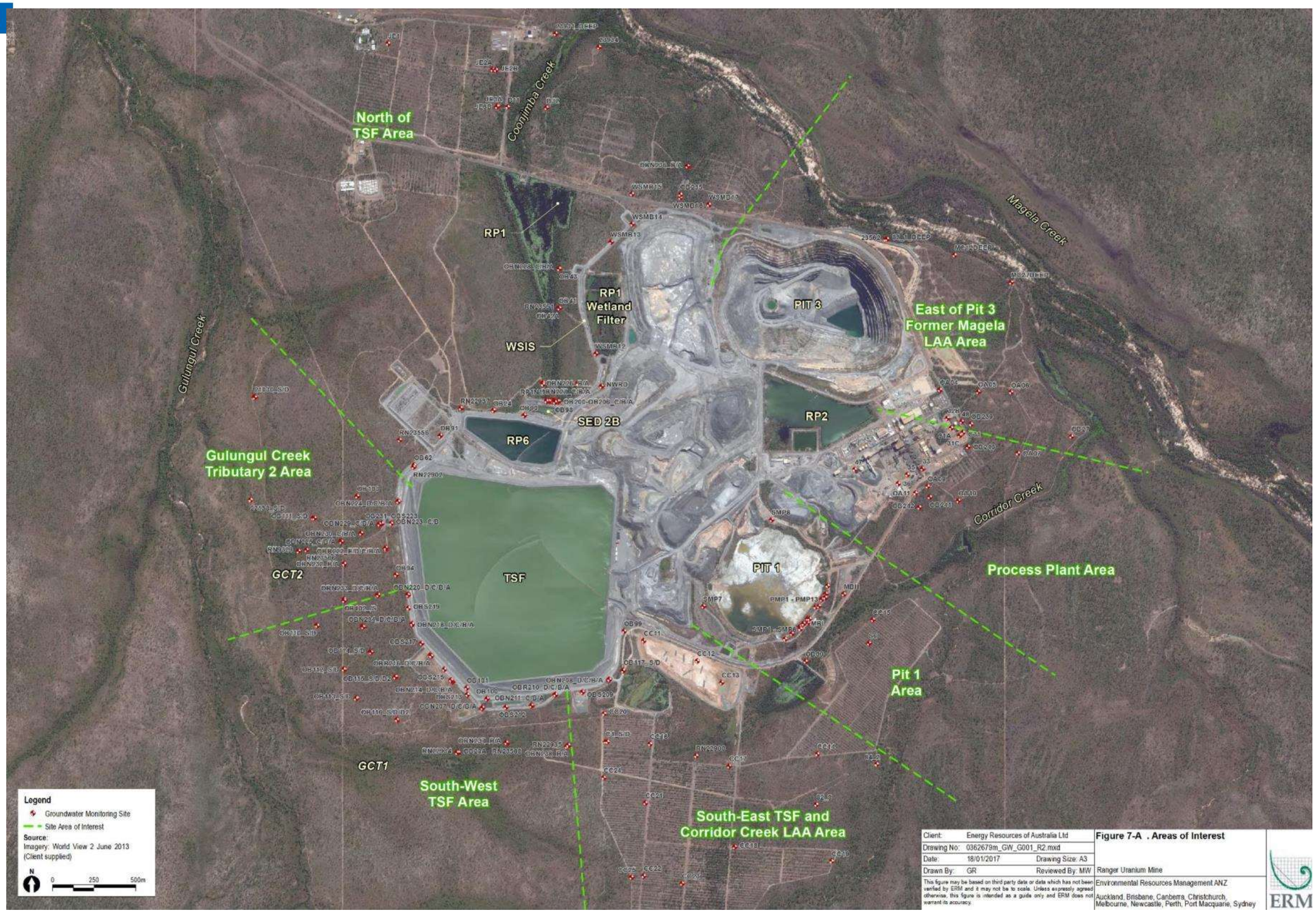


Figure 7-3: Location of groundwater sampling points

Figure 7-4: Location of piezometer monitoring sites

7.3 Environmental Performance

7.3.1 Surface Water Data Review and Interpretation

The Ranger Wet Season Report (RWSR) is prepared annually and submitted to the Supervising Authority in accordance with the ERA annual reporting requirements. The report presents and interprets the results of the statutory and operational surface water monitoring programme. The most recent available report includes surface water quality results recorded over the 2017-18 wet season (as defined by the creek flow).

Full details of the monitoring outcomes are presented in the RWSR.

7.3.2 Groundwater Data Review and Interpretation

The Ranger Annual Groundwater Monitoring Report (RAGWR) is based on the outcome of the groundwater monitoring programme carried out across the RPA and summarises groundwater conditions beneath the site.

Based on the data review conducted for the preparation of the RAGWR, the migration of impacts in groundwater away from potential source areas at the RPA is, overall, limited (ERM, 2017).

For additional groundwater analysis at the RPA, refer to the 2017/18 Annual Ranger Groundwater Report.

7.3.3 Water Account

ERA's water balance is reported to Rio Tinto annually in accordance with the internal Social & Environment Survey Workbook Guidance Documents. The water balance can be described by the total water input from the environment, its output (potentially contaminated) to the same or a different part of the environment and its efficient management and use in between. Table 7—2 and Table 7—3 provide a summary of ERA's reported water inputs and water balance for the reporting period.

Table 7—2: Summary of Water inputs

		2018 (ML)
Water Inputs	On site impounded into process (poor)	10,748
	On site groundwater (fresh)	545
	Diverted Water (fresh)	3679
	Water in ore processed (fresh)	48
Total Water Inputs		15,020

Table 7—3: Summary of Water Balance

		2018 (ML)
Water Balance	Recycled	2,700
	Change in storage	-1,313
	Dewatering water discharged without use	1,983
	Process effluent	4,523
	Entrained in product, by-products or process wastes	682
	Evaporation	5,241
	Seepage	1406
Water Return		10,185
Other losses not accounted for		-1,183
Total Water Output		16,331
Freshwater use		-1,438
Total Water Use		13,321

Key points of note for the water account in 2018 include:

- Water inputs were higher than 2017 based on the annual rainfall of 1914.3mm (reflecting an increase of 489mm in rainfall for the 2018 period when compared to 2017);
- Change in storage volumes are dependent on rainfall and vary significantly based on volumes present at the start and end of each calendar year, as well as pond water treatment and volumes released offsite. As such the change in storage of pond water is very different to 2017 due to higher rainfall, increased water being treated and released (via irrigation);
- Dewatering water discharged without use is release water sent offsite during times of flow in Magela Creek. In 2018 there was a significant increase to 1,983 ML (2017: 1,208ML) due to a larger wet season (more water requiring release offsite) and a longer wet season which allowed for a longer period of time over which water could be released offsite;
- Process effluent includes Water Treatment Plant permeate and Brine Concentrator distillate. In 2018 there was an additional 615ML of process effluent generated compared to 2017. This is due to the continued improved performance of the Brine Concentrator, as well as the larger rainfall, and longer operation of the Water Treatment Plants.
- Other losses not accounted for reflects the increase in 'Dewatering water discharged without use' volume (refer above).

7.4 Key Environmental Activities for Oncoming Period

Key objectives of the RWMP over the reporting period are outlined in Table 7—4. These are provided for reference only, and the RWMP should be referred to for the most up to date list, any additional actions will be reported in statutory reports during the year. The status of ERA's progress against these objectives is reported in the RWSR and the RWMP.

Table 7—4: RWMP objectives tracking table

Area	RWMP Objectives
General	Develop Sampling Analysis and Quality Plans (SAQP)
	Delineation of the Annual Groundwater Report (AGWR) Delivery date
	Delineation of the Annual Ranger Water Management Plan and Groundwater Monitoring Plan Delivery date
	Optimise pond and process water treatment and disposal mechanisms
	Periodically review the site water balance model (OPSIM) to continuously improve this model, including calibration and validation against observed events
	Undertake event based sampling
	Passively release water via RP1 sluice gate.
	The installation of another 14 mechanical evaporators (Turbo Misters)
Pit 1	Pit 1 capping and associated surface water monitoring.
	Improve Pit 1 water catchment management
	Revise the groundwater monitoring programme in this area and review outdated Pit 1 trigger values.
	Undertake MBL dewatering
TSF- general	Continued closure of TSF
	Dredging of tailings from the Tailings Storage Facility
South-East TSF and Corridor Creek LAA	CCLAA and upstream Gulungul Creek influence investigation
	Consider enhancing the groundwater monitoring network in CCLAA to monitor conditions in Aquifer 1.
	Consider installing data loggers in selected CCLAA bores to assess responses in groundwater elevations to irrigation activities.
GCT2 to the west of TSF	Continue groundwater elevation and quality monitoring of groundwater monitoring bores within in the GCT2 channel alignment and of delineation bores.
	Integrate performance monitoring of the barrier wall and the dewatering system into the groundwater monitoring programme to reduce additional data collection and analysis.

Area	RWMP Objectives
Area to the North of TSF	Assess anomalous groundwater elevations in a number of Aquifer 2 and Aquifer 3 at the SED2B fence (OB200 series) including through the installation of data loggers. To further inform the assessment of potential preferential pathways for groundwater movement, to assess the potential influence of Pit 3 and to evaluate the validity of groundwater quality data from these bores.
	Based on the previous assessment, remove selected groundwater monitoring bores at the SED2B fence from the groundwater monitoring programme, maintaining approximately 2-3 nested locations in this area.
	Continue to monitor WSIS performance and groundwater elevations and quality in nearby bores given impacts and trends in groundwater COPCs to the north and west of the WSIS trench.

8 CLOSURE PLANNING AND REHABILITATION

8.1 Closure Planning

This section was informed by the latest version of the Ranger Mine Closure Plan (MCP) available at the time of submission. An updated MCP will be submitted in October 2019, detailing the progress on planned activities over the 2019 and 2020 periods

ERA released the Ranger mine closure plan (MCP) for stakeholder review in June 2018, concurrent with the public release of the document. On 9 October 2018, following initial feedback from the SSB, the Northern Territory (NT) Department of Primary Industries and Resources (DPIR) formally invited MTC members to comment on the document, in accordance with the Ranger Authorisation, Annex B. On 21 December 2018, following MTC feedback, ERA received advice that the Commonwealth Minister for Resources had approved the 2018 MCP.

To avoid potential issues such as unnecessary duplication, misinterpretation and/or misalignment of information caused by different reporting periods/dates it was decided not to include this detail in the Ranger MMP. Notwithstanding this, as discussed at the Routine Periodic Inspection 21 June 2018, a significant effort will be made to align future annual submissions of the Ranger Mining Management Plan with closure/rehabilitation activities.

As outlined above, the MCP is publically available on the ERA website at http://www.energyres.com.au/sustainability/closureplan/. The MCP is the statutory document that details the status of the Ranger closure strategy and activities; for example, Chapter 7, Section 7.10, lists the future closure studies either underway or scheduled to commence in 2018. Updates on the closure studies will be included in each annual submission of the MCP, which is required on or before 1 October each year.

8.1.1 Pit 3 Closure

Approval of Pit 3 Closure will be subject to a standalone assessment via the MTC. A separate application detailing all the components of Pit 3 closure is scheduled to be submitted to the MTC [redacted] (refer Chapter 1, Section 1.4.3 and Appendix 1.2 of the MCP). The information outlined in this section provides an overview of the Pit 3 rehabilitation and closure activities based on closure studies completed to date

8.1.2 Tailings Dam (TSF)

Approval of the tailings dam closure will be subject to a standalone assessment via the MTC. A separate application detailing all the components of the tailings dam deconstruction is scheduled to be submitted to the MTC [redacted] (Refer Chapter 1 Appendix 1.2 of the MCP). The information outlined in this section provides an overview of the broader tailings management closure activities based on closure studies completed to date.

8.1.3 Contaminated Sites

The assessment of contaminated sites commenced in 2018 and remediation and/or infill revegetation, where determined to be required, is scheduled for 2019 onwards. The staged removal of infrastructure in LAAs is ongoing and will continue, as required, to 2025.

Table 8—1: Progress toward contaminated sites milestones

Milestone 1	Milestone 2	Milestone 3	Milestone 4
Assessment of radiation contamination in LAA soils indicates doses are below exemption level	Determine need for remediation and/or revegetation strategy for contaminated sites (including LAAs and processing plant area).	Commencement of staged removal of infrastructure in LAAs (ongoing to 2025). Remediation and/or infill revegetation of LAA area as required (ongoing to 2025)	Remediation of temporary landfill site near Pit 3 and any other contaminated soils within the mine footprint, and placement of material into Pit 3

Green – milestone reached: Orange – activity underway: Unfilled – activity not commenced

8.1.4 Water Storage

Retention Pond 6 (RP6) was constructed in 2012 to provide additional water storage and management capacity. RP6 has a capacity of 1 gigalitre, is double lined with a high density polyethylene liner, and connects to the existing RP2 via a two way pumping transfer system.

The retention ponds hold surface water run-off that has come into contact with mineralised materials such as low grade ore stockpiles and is managed according to quality. Pond water is treated to high standards by ERA's micro filtration reverse osmosis (MF/RO) treatment system prior to controlled release via constructed wetland filters or irrigation on LAA's. If required, RP6 will be converted to a process water storage area any time from 2018.

8.1.5 Final Landform

Approval of the final landform will be subject to a standalone assessment via the MTC. A separate application detailing all components of the final land form construction is scheduled to be submitted to the MTC [redacted] (refer Chapter 1, section 1.4.3 and appendix 1.2 of the MCP). The information provided in this section provides an overview of the final landform closure activities based on closure studies completed to date.

8.1.6 Revegetation

Approval of the final landform will be subject to a standalone assessment via the MTC. A separate application detailing all components of the revegetation plan is scheduled to be submitted to the MTC in 2018 (refer chapter 1, section 1.4.3 and Appendix 1.2 of the MCP). The information provided in this section provides an overview of current revegetation plan based studies completed to date.

There is approximately 950 hectares of land to rehabilitate and revegetate for the successful closure of Ranger Mine, including 759 hectares of waste rock covered area. Assessments of radiation risk and chemical contamination risk will determine whether the LAA's (approximately 200 hectares will need remediation before revegetation.

8.1.7 Provision of seeds and seedlings

ERA has been working extensively with Kakadu Native Plants Pty Ltd, a locally owned and run indigenous supplier, to provide seedlings for much of the revegetation projects that have occurred both at Ranger and Jabiluka over the past 15 years. Kakadu Native Plants Pty Ltd has extensive expertise in local plants including seed biology, propagation, revegetation, weed, and fire management.

Seed collection of agreed local native species provided in the species list in table 7.27, in Chapter 7, section 7.6.3 of the Mine Closure Plan will be acquired from Kakadu Native Plants Pty Ltd. Kakadu Native Plants Pty Ltd will raise the tube stock using biodegradable pots. In later years when demand intensifies, it may be necessary to use additional, approved nurseries to raise tube stock to supplement the tube stock production. [redacted]

Closure Feasibility Study

On 6 December 2018, ERA announced an update on the closure feasibility study. The study commenced in the Q4 2017 and is expected to be completed in Q1 2019.

The preliminary findings highlight an increase in the estimated cost of the rehabilitation program with a likely rise in the rehabilitation provision [redacted] largely due to:

- Costs associated with tailings transfer to Pit 3, additional water treatment and related infrastructure, and revegetation requirements;
- Higher forecast costs relating to site services and owners' costs; and
- An increase in contingency.

The preliminary findings of the feasibility study further increase confidence to stakeholders that ERA's planned rehabilitation strategy will satisfy regulatory obligations, including the January 2026 milestone. As a result of the likely rehabilitation provision increase, ERA is reviewing all funding options in collaboration with Rio Tinto and implementing a business transformation program to increase cash flow.

Further information regarding this announcement is available on the ERA website at: http://clients3.weblink.com.au/pdf/ERA/02057349.pdf.

8.1.8 Closure/Rehabilitation Reporting

In drafting the MMP a cut-off date comes into effect prior to submission. It is also noted that the project understanding including closure is dynamic and stakeholders are updated frequently via numerous processes including RPI, MTC and other forums. ERA considers the RPI, MTC and other forums are the best medium to inform Stakeholders of emerging or changed applications, plans, and status of feasibility studies. It is noted that an update to the RMCP is in development and will be submitted in October 2019.

8.2 Unplanned Closure

In the event of unplanned closure during the reporting period covered by this MMP, the most recent approved version of the Ranger Annual Plan of Rehabilitation (APR) will be enacted. The Ranger APR provides a conceptual specification for rehabilitation works and methodology, with cost estimates, for an assumed premature cessation of mining along with outlining the required rehabilitation works, exclusive of post rehabilitation monitoring. The Annual Plan of Rehabilitation is not intended to provide an estimate of closure methodology or costs for projected closure at end of mine life.

The APR is submitted annually to the responsible minister for assessment and approval. Having accepted the Ranger APR, the minister appoints an independent assessor to review the cost of rehabilitation which then forms the basis of the Ranger Rehabilitation Trust Fund value. Accordingly, details contained within the Ranger APR are not provided in the MMP.

9 ENVIRONMENTAL COMMITMENTS FOR THE ONCOMING PERIOD

ERA is committed to delivering a high standard of environmental and social performance into the future and has established commitments for the next reporting period. These commitments will be closely monitored and an update on the status of each will be reported in the next MMP.

ERA has established the following commitments for the next reporting period, CY2019:

Table 9—1: Environmental Commitments

Area	
Air Quality	Continue to implement existing dust controls
	Install and commission new ammonia scrubber
	Continue to manage air quality in accordance with the authorisation legislative requirements
Radiation Management	Continue to manage radiation in accordance with the authorisation and relevant legislative requirements
	Radiation dose assessment will be undertaken to confirm that the radiation closure criteria will be met in the post closure phase
Greenhouse Gas and Energy	Continue to manage greenhouse gases and energy in accordance with the authorisation and relevant legislative requirements
Weed Management	Assess the presence (and if present control) of Gamba grass at the Jabiru Airport at monthly intervals during the wet season as planned in the 2018/19 Annual Weed Control Program
	ERA will continue to manage weeds in accordance with the authorisation and relevant legislative requirements.
	Continue to engage with herbicide supplier to identify and trial target specific and residual herbicides to improve weed management performance
	Assess presence of Gamba grass on RPA and MLN01 both through annual weed mapping and day to day field work activities (and if present control)
	Undertake a trial to investigate optimal herbicide application rates (Sulphomac and Clomac) in the presence of saplings
Fire Management	Coordinate the early approval of the Fire Management Plan (Q1 2019)
	Continue to manage fire in accordance with the authorisation and relevant legislative requirements

Area	
	Coordinate a programme of wet season burns;
Feral Animal Control	Minimisation of risks to health, safety, environment and cultural heritage to employees and contractors on the RPA and MLN1
	Ensure all feral animal control works comply with the relevant policies and procedures and Northern Territory codes and legislation
Hazardous Material and Contamination Control	Eliminate, as far as practicable, high risk chemicals and hazardous substances
Waste Management	ERA will continue to manage domestic and industrial waste in accordance with the authorisation and legislative requirements
Water Management	Protect the wider environment, especially Magela Creek and Gulungul Creek from the impacts of ERA operations
	Meet all current statutory requirements
	Manage water according to quality rather than origin
	Ensure data is collected to inform both operational and closure based decisions
	Strategically manage process and pond water inventories in accordance with the current closure model

Table 9—2 outlines the ongoing environmental commitments that will be progressed during the next reporting period; this table also shows commitments that were completed in the 2018 reporting period:

Table 9—2: Performance against commitments contained in the previous MMP

Commitment	Status	Performance against commitment
Pit 1 backfill and rehabilitation	Ongoing	Pit 1 bulk backfill commenced in April 2017 (refer Section 0 and 4.2.3).
Complete works to make underdrain bore operational and commence brine injection	Ongoing	
Submit an application for the placement of the un-mineralised waste rock layer in Pit 1;	Complete	Application submitted and approval pending
Commence sub-aqueous deposition of the tailings slurry into Pit 3;	Complete	
Construct and operate a demonstration High Density Sludge plant to inform future process water studies	Ongoing	Commissioning in progress
Install a new water treatment plant called a brine squeezer	Ongoing	Construction in progress. Commissioning and operation will commence in 2019.
Install an additional 12 mechanical evaporators;	Ongoing	14 more units put in place waiting approved application from MTC and subsequent amendment of the RWMP
Undertake a radiation dose assessment to confirm that the radiation closure criteria will be met in the post closure phase;	Ongoing	
Undertake a trial to investigate optimal herbicide application rates in the presence of saplings;	Ongoing	Trial commenced March 2019.
Coordinate the early approval of the Fire Management Plan (Q1 2018);	Completed	
Coordinate a programme of wet season burns	Completed	
Implementation and progress toward completion of the activities within the Ranger MCP.	Ongoing	
Continue to treat Gamba Grass as a priority	Ongoing	This area will continue to be a priority in the weed control programme for 2019 (refer Section 6.5.3).

Commitment	Status	Performance against commitment
Develop a scope of works for the treatment and disposal of radiation-contaminated hydrocarbon waste	Ongoing	(Refer Section 6.9.3).
Develop a Cultural Heritage Management Plan specific to closure.	Ongoing	Final draft completed awaiting GAC review and to be finalised in 2019 (refer Section 6.10.3).
Progress the Ranger Water Management Plan objectives	Ongoing	Progress against these objectives is reported in the RWSR and the RWMP (refer Section 7.4).
Investigate and, where feasible, implement projects to reduce process water inventory.	Ongoing	Various projects were implemented in 2017 resulting in a reduction in process water inventory (refer Section 4.3.2 and 4.3.3).

10 ENVIRONMENTAL RESEARCH

Research by ERA to support the closure strategy is directed by the Alligator Rivers Region Technical Committee (ARRTC) Key Knowledge Needs and ERA/Rio Tinto assessments undertaken as part of the past Integrated Tailings, Water and Closure Pre-Feasibility study and Brines Management Feasibility study, and the recent Closure Feasibility study to optimise the closure strategy. The environmental research to inform these assessments and the strategy optimisation are reported in ERA's recently released Mine Closure Plan which is available at:

http://www.energyres.com.au/sustainability/closureplan/

The ARRTC KKNs were recently consolidated and updated under a collaborative effort by the SSB and ERA. During the reporting period, the ARRTC held a two-day meeting, on 14 – 16 November 2018. The major themes of the meeting were an update on the closure plans and associated schedules for activities and research, plant available water and ecosystem reestablishment, an update on ERA groundwater research and feedback from the ARRTC review of the mine closure plan. ARRTC generally meets twice a year. The summary records of the meetings are available at:

http://www.environment.gov.au/science/supervising-scientist/communication/committees/arrtc/meetings

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APPENDIX A: ERA ENVIRONNENT POLICY

APPENDIX B: HSE RISK MATRIX

APPENDIX C: ENVIRONMENTAL INCIDENTS

Incident Summary	Actual Consequence	Maximum Reasonable Consequence	Stakeholder Notification (Y / N)
3rd February 2018 At 4.08pm on the 3rd February 2018, ERA was notified of an incident on the Kakadu Highway near the Mary River Ranger Station. A ChemTrans truck driver noticed Sulphuric Acid dripping from the "roll over vent" from a trailer which had been stopped on the side of the road Earthen bunds were used to contain the spill. Soda ash and water were applied to the spill to neutralize the acid. Kakadu Hwy was also washed down with water where soda ash had spread onto the bitumen by tyres when the trailer was moved. Contaminated soil was recovered and returned to the Ranger Mine for disposal.	**1 Minor**	**2 Moderate**	Y s29 submitted 3rd February 2018
21st February 2018 A minor amount of lube oil was found on RP2 creating a film in an area contained to ~1m^2. The lube oil was contained (via floating oil and fuel absorbent boom) and fully recovered from RP2 Contaminated material and surface waters recovered for disposal in Pit 3.	**1 Minor**	**2 Moderate**	Y s29 submitted 21st February 2018
24th February 2018 20L of laterite slurry leaked outside of bund All material was recovered. Radiation team checked and confirmed clean-up was appropriate	**Minor**	**1 Minor**	Y s29 submitted 26 February 2018
24th February 2018 The fuel line from the RP6 pontoon pump to the fuel pod broke. Approximately 500L of fuel was siphoned from the fuel pod to rp6	**1 Minor**	**1 Minor**	Y s29 submitted 26th February 2018

Incident Summary	Actual Consequence	Maximum Reasonable Consequence	Stakeholder Notification (Y / N)
27th March 2018 On the morning 27 March, a diesel fuel spill was identified beneath the service truck from a damaged high flow fill hose Approximately 30L* of diesel leaked from the hose onto the gravel surface below the truck. The spill was confined to the immediate footprint of the truck	**1 Minor**	**1 Minor**	Y s29 submitted 28th March 2018
02nd April 2018 A hydraulic hose on a Positrac bobcat failed while slashing in CCLAA Module 7. Approximately 30 L of hydraulic oil spilled to ground.	**1 Minor**	**1 Minor**	Y s29 submitted 03rd April 2018
17th April 2018 Approximately 25 L of diesel leaked onto earthen ground on the GCMBL dam crest. No diesel entered GCMBL or any waterway. Once observed immediate action taken to apply hydrocarbon spill absorbent material. Spill was cleaned and impacted spill absorbent and earthen ground recovered for disposal onsite. All 25 L of diesel was recovered for disposal onsite	**1 Minor**	**1 Minor**	Y s29 submitted 19th April 2018
23rd April 2018 In the process of moving a 500L diesel fuel pod, approximately 15L has been spilled via the filler cap. The spill was contained to the direct vicinity and clean up occurred immediately. All 15L of diesel was recovered for disposal onsite	**1 Minor**	**1 Minor**	Y s29 submitted 23rd April 2018
10th May 2018 During cleanout tasks in SX a slow leak from the bund wall was identified by adjacent damp patches. It is estimated that a maximum of 20L of process liquor leaked outside of the bund.	**1 Minor**	**1 Minor**	Y s29 submitted 11th May 2018

Incident Summary	Actual Consequence	Maximum Reasonable Consequence	Stakeholder Notification (Y / N)
10th May 2018 An annual test of the SX plant dump system is required to ensure its functionality. During this test process liquor leaked from a flange in the pipeline to the ground below (outside of the bunded area) . Approximately 15L of process liquor leaked onto earthen ground. The spill was contained to the direct vicinity and clean up occurred immediately.	**1 Minor**	**1 Minor**	Y s29 submitted 11th May 2018
11th May 2018 During maintenance activities approximately 5 litres of process water leaked from pipework. The process water leaked onto bitumen road outside of the bunded area.	**1 Minor**	**1 Minor**	Y s29 submitted 11th May 2018
07th June 2018 Water Treatment Plant 3 (WTP3) permeate discharged to MG001 for the period 12 April 2018 to 7 June 2018. WTP3 permeate to MG001 releases include: • 24 hour release 12 April – 15 May 2018; and • ~10 hour release / day 22 May – 7 June 2018. WTP3 permeate electrical conductivity typically ranges 5 – 15 uS/cm. A total of 215.08 ML of WTP3 permeate was discharged to MG001. Routine surface water monitoring (comprising sampling and telemetry) in the Magela Creek shows negligible impact or very low risk of impact at compliance site MG009 (refer attached Magela Creek – Continuous and Event Based Electrical Conductivity chart).	**2 Medium**	**1 Minor**	Y s29 submitted 14th June 2018

Incident Summary	Actual Consequence	Maximum Reasonable Consequence	Stakeholder Notification (Y / N)
2nd August 2018 Approximately 8000L of process water leaked from a process water line to the leach tank causing water to spill outside the bunded area on to bare earth. The line valve prior to the failed fitting was closed and a dirt bund was put in place to contain the spill and prevent water from entering the stormwater drain the area was cleaned up using a bobcat. Nil impact to wildlife or vegetation.	**1 Minor**	**1 Minor**	Y s29 submitted 3rd August 2018
12th August 2018 Ball mill 2 pump box overflowed and spilt process material outside of the bunded area Approximately 25L of process material spilt outside of the bunded area. The spill was contained and subsequently cleaned up. Material from spill recovered Area checked by radiation team and confirmed levels are consistent to background	**1 Minor**	**1 Minor**	Y s29 submitted 14th August 2018
13th & 14th September 2018 On the 13th September 2018 a wildfire encroaching from the North-East (Magela North) moved into Land Irrigation Area. ERA Emergency Services Team were mobilised to contain the fire. This activity took place over the 13th and 14th September 2018. The fire was contained on the 14th September. Damage to the Koonjimba Billabong Pontoon, telemetry station float and redundant poly piping has resulted from the fire.	**1 Minor**	**1 Minor**	Y s29 submitted 18th September 2018

Incident Summary	Actual Consequence	Maximum Reasonable Consequence	Stakeholder Notification (Y / N)
25th September 2018 On the 21st September, an A.M Cranes hire franna (crane) had been cleaned and radiation cleared in preparation for float transportation from Ranger Mine to AM Cranes Equipment Yard. On Tuesday 25th September at 2:20 pm, ERA received a complaint from A.M Cranes about the condition of the franna. The complaint related to build up soil material on the franna – the complaint extended to concerns around missing parts and bodywork condition. ERA was also informed that two A.M Cranes employees had reported itching and burning sensation after being under the franna to take photos. On Wednesday 26th September at approximately 11am, two members from the ERA Radiation Team attended to the A.M Cranes premises to undertake an inspection of the soil material reported on the franna. The inspection revealed that there was soil material present within a 'hydraulic' compartment. The Radiation Team conducted a survey of the material (utilising an SCM). The survey did not detect any radioactivity. Notwithstanding, ERA's procedures require that that soil material must be cleaned from plant and equipment before leaving Ranger Mine.	**2 Medium**	**2 Medium**	Y s29 submitted 28th September 2018
16th October 2018 The Murphy control switch on the DA 6 oil day tank failed to recognise the high oil level and consequently product oil was continuously pumped to DA6 and overflowed. The product oil then overflowed into the bunded engine canopy. Approximately 400 L overflowed the bund and spilled onto adjacent earthen hardstand and bitumen ground. A shift electrician observed the oil spill and stopped the transfer pump. No oil entered any stormwater drain.	**1 Minor**	**1 Minor**	Y s29 submitted 17th October 2018

Incident Summary	Actual Consequence	Maximum Reasonable Consequence	Stakeholder Notification (Y / N)
01st November 2018 1 Litre of Hydraulic oil leaked to ground following a seal failure on EWP. Spill was contained to sealed surface of the road way. There was no spill to any drainage areas	**0 Near Miss**	**1 Minor**	Y s29 submitted 02nd November 2018

APPENDIX D: ENVIRONMENTAL MANAGEMENT PLANS

Appendix D.1: AMP001 Air quality protection management plan

Appendix D.2: GEP001 Greenhouse gas and energy efficiency plan

Appendix D.3: LUP001 Land use management plan, including:

Appendix D.4: HMP001 Hazardous materials and contamination control plan

Appendix D.5: MWP001 Mineral waste management plan

Appendix D.6: NMP001 Non-mineral waste management plan

APPENDIX E: REPORTING REQUIREMENT CHECKLIST

Section addressed in the Ranger Mining Management Plan	**Mining Management Plan and Operational Performance Report (Section 40 of the Mining Management Act)**	**ER18: Environmental Management Plan and Annual Environment Report (Annex C.2 of the Ranger Authorisation 0108)**
Page ii Document Approval and Revision Table	Has the plan been endorsed by a senior representative of the company?	*No specific relatable requirement*
1 Introduction		
Page 1	Has the Operator confirmed in writing that the operational activities and disturbances are consistent with the previously approved MMP?	*No specific relatable requirement*
1.1 Operator Details	Have Operator details been included? Have contact details been updated? Is the company structure described?	
1.2 Summary Of Existing Operations	Are title details included? Is there a project summary and description improvements?	
Figures 1-1 to 7-4	Maps and Plans: Maps and plans have scale, scale bar, legend and north point? Datum's used are MGA94 or GDA 94 (expressed in decimal degrees) with elevations based on AHD?	
2 Site Conditions		
2.1 Physical Environment	Have all the physical environment conditions for the site and surrounds been identified?	*No specific relatable requirement*
2.2 Socio-Economic Environment	Have the current land uses and users and stakeholders been identified? Have Community Affairs been described?	
3 Statutory and Non-Statutory Requirements		
3.1 Statutory Requirements	Has all legislation relevant to the operation and associated permits and approvals been identified?	*No specific relatable requirement*
3.2 Non-Statutory Obligations	Have all non-statutory obligations been identified and included?	
3.3 Sacred, Archaeological And Heritage Sites	Have Aboriginal and heritage sites been identified?	10. Protection of cultural sites and social impact monitoring

Section addressed in the Ranger Mining Management Plan	Mining Management Plan and Operational Performance Report (Section 40 of the Mining Management Act)	ER18: Environmental Management Plan and Annual Environment Report (Annex C.2 of the Ranger Authorisation 0108)
4 Operational Activities		
The following sub-headings are provided for operational activities relating to exploration, mining and processing: Activities Overview of the processes that are followed in order to undertake an activity Performance Against Previous MMP Details of the activities undertaken in the previous reporting period (assessment against what was proposed) Activities For The Oncoming Period Outline of the activities proposed to be undertaken in the oncoming reporting period		
4.1 Exploration	Have changes in activities been described? Have all operational activities exploration and any related activities for the site been addressed in the MMP?	*No specific relatable requirement*
4.2 Mining	Have changes in activities been described? Have all operational activities relating to mining, and any related activities for the site been addressed in the MMP? Waste Rock Characterisation: Have results of waste rock characterisation been included and discussed? Has a waste characterisation report been included? Does the MMP include a waste rock management plan?	3. Excavated material management
4.3 Processing	Have changes in activities been described? Have all operational activities relating to processing and any related activities for the site been addressed in the MMP?	2. Tailings management
5 Environmental Management Framework		
5.1 Management System And Certification	Has the Environmental Management structure and responsibilities been outlined?	11. Environmental planning and operating systems, including employment and training programs
5.2 Environmental Policy	Has the Has Environmental Policy been included?	
5.3 Hazard Identification And Risk Management	Have all environmental aspects and potential impacts been identified? Has a risk assessment been carried out?	
5.4 Objectives And Targets	Has a register of environmental commitments been included?	

Section addressed in the Ranger Mining Management Plan	Mining Management Plan and Operational Performance Report (Section 40 of the Mining Management Act)	ER18: Environmental Management Plan and Annual Environment Report (Annex C.2 of the Ranger Authorisation 0108)
5.5 Environmental Training And Education	Has training and induction been addressed?	
5.6 Non-Conformance And Corrective Action	Incident Reporting: Has a table of all incidents recorded on site been included and discussed? Have environmental incidents been detailed? Have non-conformances been identified? Have corrective actions taken and improvements made been detailed?	
5.7 Environmental Emergency Preparedness And Response	Is there an Environmental Emergency and response plan?	12. Counter disaster and emergency procedures
5.8 Implementation, Monitoring And Review Appendix D Environmental Management Plans • AMP001 Air quality protection management plan • GEP001 Greenhouse gas and energy efficiency plan • LUP001 Land use management plan, including: • HMP001 Hazardous materials and contamination control plan • MWP001 Mineral waste management plan • NMP001 Non-mineral waste management plan	Have Environmental Management Plans (EMP's) for identified risks been developed and included? EMPs: Do all EMP's include: • objectives and targets • management and mitigation strategies • monitoring and measurement • discussion and analysis of results • non-conformances and corrective actions?	8. Environmental monitoring
6 Environmental Management and Performance		
6.1 Environment Management System And Certification	Environmental Performance: Has performance against all the Environmental Management Plan's (EMP) identified in the full MMP been detailed? Is a discussion analysis and interpretation of data included? Have graphs showing performance against trigger levels or benchmarks been included? Have changes made to monitoring programs been identified and detailed?	*No specific relatable requirement*
6.2 Air Quality		5. Air quality management
6.3 Radiation Management		7. Radiation monitoring and management
6.4 Greenhouse Gas And Energy		*No specific relatable requirement*
6.5 Weed Management		4. Land management
6.6 Fire Management		
6.7 Feral Animal Management		
6.8 Hazardous Materials And Contamination Control		6. Hazardous substances and industrial waste management

Section addressed in the Ranger Mining Management Plan	Mining Management Plan and Operational Performance Report (Section 40 of the Mining Management Act)	ER18: Environmental Management Plan and Annual Environment Report (Annex C.2 of the Ranger Authorisation 0108)
6.9 Waste Management (Domestic And Industrial)		
6.10 Cultural Heritage Management		10. Protection of cultural sites and social impact monitoring
7 Water Management		
7.1 Objectives And Targets	Has a comprehensive description of surface water conditions been included? Has a comprehensive groundwater model been described? Have information or knowledge gaps been identified and described for water management?	1. Water Management
7.2 Environmental Management	Are there comprehensive details (including scopes of work) on actions proposed to be taken to respond to any identified information or knowledge gaps? Have hazards been identified that could result from activities related to the operation and rank the associated risks of impacts to both surface and groundwater? Are all strategies and actions that will be undertaken to manage any risks identified included?	
7.3 Environmental Performance	Has the water monitoring program been detailed? Has all monitoring data been included? Has an interpretation of data by a suitably qualified person been included? Has a discussion of trends over time been detailed?	
7.4 Key Environmental Activities For Oncoming Period	Have details of remedial/corrective strategies and scopes of work been included? Have proposed actions been detailed?	
8 Closure Planning and Rehabilitation		

Section addressed in the Ranger Mining Management Plan	Mining Management Plan and Operational Performance Report (Section 40 of the Mining Management Act)	ER18: Environmental Management Plan and Annual Environment Report (Annex C.2 of the Ranger Authorisation 0108)
8.1 Closure Planning	Closure Planning: Has a Life of Plan – Unplanned Closure plan been included? Are all disturbances described? Are remediation activities that would be required in the event of unplanned closure described? Are activities required to achieve end land use objectives, described?	13. Rehabilitation
8.2 Life Of Plan – Unplanned Closure	Does the MMP include a detailed costing of closure activities for the life of plan? Have all past disturbances and those proposed for the next reporting period been identified and included?	
9 Environmental Commitments For The Oncoming Period		
9 Environmental Commitments For The Oncoming Period	Has a register of environmental commitments been included?	*No specific relatable requirement*
10 Environmental Research		
10 Environmental Research	*No specific relatable requirement*	9. Environmental Research

APPENDIX F: AUTHORISATION REQUIREMENTS 0108-18

Annex D – Reporting Requirements Authorisation 0108-18

Report Name	Submission Date	Date submitted	Date of Approval
Mine Management Plan	16 March	16 March 2018	5 June 2019
Annual Radiation and Atmospheric Monitoring Interpretative Report	By 31 March	29 March 2019	6 June 2019
Tailings Dam Surveillance Reports	By 30 September	30 September	N/A
Water Management Plan	By 1 October	Submission date changed to 15th November	
Annual Groundwater Report	By 30 November	Submission date changed to 1st November	
Whole of Site Groundwater Conceptual Model	By 1 November	Submitted with closure documents October	
Groundwater Monitoring Plan	By 1 December	Now submitted with RWMP 15 November	
Provision of Monitoring Data, Including routine Water Quality Reports	Weekly during flow and monthly at all other times	Compliance evidence submitted with Wet and Dry Season Reporting Requirements as per Authorisation 0108-18	
Surface water wet season report	Within 6 weeks of flow ceasing Magela Creek or Gulungul Creek at the end of the wet season, whichever is later	Draft 29/08/2018 Final 21/01/2019	
Rehabilitation Progress report	At least Biannually	Progressive Rehabilitation Metrics Summary Presented Feb 2018 MTC. Progressive Rehabilitation (Revegetation) Presented June 2018 MTC. Rehabilitation Progress Report Presented December 2018 MTC.	

Annex E Environmental Monitoring Program Authorisation 0108-18

Compliance evidence for all portable water, groundwater, and surface water monitoring requirements set out in Authorisation 0108-18 can be sourced in the annual Ranger Wet Season Report, Quarterly Reports, and Weekly Reports submitted during the reporting period

E.4 Atmospheric Monitoring	**Measurement**	**Frequency**	**Dates completed**
Calciner Stack Emissions	Uranium	Quarterly	7/2/2018,10/04/2018, 10-11/07/2018, 09/10/2018
Product packing area stack emissions	Uranium	Quarterly	7/2/2018, 10/04/2018, 10/07/2018, 09/10/2018
Power Station emissions*	SO2	Annually	14/03/2018

**Calculated amounts of SO2 from approximate fuel content NPI Reporting*

Annex F Radiation Monitoring

Dose Delivery Pathway/Sample point	Monitoring/Reporting Frequency	Dosimetry/Comments	Compliance Evidence located in Section of Annual Radiation Protection Monitoring Plan – Approved 6 June 2019
External Gamma			
Designated Workers	Monitors worn for up to three (3) months	Assessed via individual PRDs or if unavailable using time weighted average of work Category dose	Page 39; Section 5.7[1]
Most exposed group of non-designated workers	Monitors worn for up to three (3) months	Used to assess Non-Designated worker gamma	Page 47; Section 5.8[1]
Radon Decay Products (RDP)			
Controlled areas			
Mine: Inside Mine Offices	Monthly (sampler to run one (1) week per month in each fixed location	Average levels to be used to calculate doses to designated mine workers (annual basis for dose reporting) and to determine the effectiveness of engineering controls	Page 58; Section 6.2[1] Page 65; Figure 6.9[1] Page 66; Figure 6.10[1]
Supervised areas			
Adjacent to Processing Plant	Monthly (sampler to run one (1) week per month in each fixed location	Average levels to be used to calculate doses to designated and non-designated workers on annual basis (sampler to run 1 week per month in each fixed location for dose reporting and to determine the effectiveness of engineering controls	Page 60; Section 6.3[1] Page 67; Figure 6.12[1]
Tailings Disposal	Monthly (sampler to run one (1) week per month in each fixed location	To determine the effectiveness of engineering controls	Page 60; Section 6.3[1] Page 66; Figure 6.11[1]

Dose Delivery Pathway/Sample point	Monitoring/Reporting Frequency	Dosimetry/Comments	Compliance Evidence located in Section of Annual Radiation Protection Monitoring Plan – Approved 6 June 2019
Environmental areas			
Jabiru, jabiru East	Monthly (sampler to run one (1) week per month in each fixed location)	For annual report for public reassurance	Page 63; Section 6.4[1] Page 68; Figure 6.14[1] Page 68; Figure 6.15[1]
Long Lived Alpha Activity (LLAA) – Radioactive Dust			
Controlled areas			
Dose Delivery Pathway/Sample point	Monitoring/Reporting Frequency	Dosimetry/Comments	Compliance Evidence located in Section of Annual Radiation Protection Report 29 March 2018
Designated Workers	Monitoring Frequency sufficient to be statistically viable	Annual dose assessments based on work group average and exposure time with monitoring frequency sufficient to be statistically viable	Page 94; Section 6.15[2] Page 94; Table 6.19[2] Page 46; Figure 5.7[2]
Mine	Monthly high volume (HiVol) sampler to run one week per month in fixed locations	To determine the effectiveness of engineering controls	Page 90; Section 6.38[2]
Supervised areas			
Dose Delivery Pathway/Sample point	Monitoring/Reporting Frequency	Dosimetry/Comments	Compliance Evidence located in Section of Annual Radiation Protection Report 29 March 2018
Adjacent to Processing Plant	Monthly high volume (HiVol) sampler to run one week per month in fixed locations	Average levels to be used to calculate doses to non-designated workers (annual basis for does reporting) and to determine	Page 90; Section 6.39[2]

Dose Delivery Pathway/Sample point	Monitoring/Reporting Frequency	Dosimetry/Comments	Compliance Evidence located in Section of Annual Radiation Protection Monitoring Plan – Approved 6 June 2019
		the effectiveness of engineering controls	
Tailings disposal	Monthly high volume (HiVol) sampler to run one week per month in fixed locations	To determine the effectiveness of engineering controls	Page 91; Figure 6.40[2]
Environmental areas			
Jabiru, Jabiru East	Monthly high volume (HiVol) sampler to run one week per month in fixed locations	For annual report for public reassurance	Page 92; Figure 6.42[2] Page 93; Figure 6.43[2]
Surface contamination			
Plant including vehicles and equipment leaving site	Randomly and on demand before equipment leaves site	As per ERA surface contamination protocols and clearance procedures	Page 111; Section 6.18.6[2]
Accessible surfaces (including brine concentrator, ore crushing areas, product packing, control rooms, crib and ablutions and sample preparation areas)	Quarterly	As per ERA surface contamination protocols and clearance procedures	Page 105; Section 6.18.1[2] Page 106; Table 6.28[2] Page 106; table 6.29[2]
Meteorology			
Ranger Project Area (RPA)	Wind Speed and Direction	Hourly average wind direction and wind speed in 10 degree sectors for calculating the annual dose assessment in Jabiru	Page 115; Section 7[2] Page 119; Figure 7.3[2] Page 120; table 7.5[2]

[1] Compliance Evidence located in Section of Annual Radiation Protection Monitoring Plan – Approved 6 June 2019

[2] Compliance Evidence located in Section of Annual Radiation Protection Report 29 March 2018