

**REFERRAL FOR PROPOSED ACTION
RANGER 3 DEEPS UNDERGROUND MINE**



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Referral of proposed action

Project title: Ranger 3 Deeps Underground Mine

1 SUMMARY OF PROPOSED ACTION

1.1 Short description

This referral outlines Energy Resources of Australia Ltd's (ERA's) proposal to develop and operate an underground mine and associated facilities at the existing Ranger uranium mine, in the Alligator Rivers Region of the Northern Territory (see Figure 1 for regional context).

The resource, referred to as Ranger 3 Deeps, has been defined by a series of successive surface diamond drilling programs from 2005–2009. Additional diamond drilling will be undertaken as part of the Ranger 3 Deeps Exploration Decline project, which was approved for construction on 25 August 2011 (as described in [Section 1.13](#)) and does not form part of the proposed action.

This referral is made in parallel to the Ranger 3 Deeps Exploration Decline project, so that ERA can make its decision about underground mining when it has approvals in place to proceed. The proposed action is to mine and process the uranium bearing ore from the Ranger 3 Deeps mineral resource, which is currently estimated to contain 34,000 tonnes of uranium oxide.¹

Mining will be via a series of stopes accessed via a decline allowing material transport to the surface in trucks. The decline constructed as part of the Ranger 3 Deeps Exploration Decline project will also serve as the primary access to the underground mine and is located adjacent to Pit 3.² The fixed ventilation system³ constructed for Ranger 3 Deeps Exploration Decline project will also be utilised for the proposed action and will be expanded to include additional ventilation shafts.⁴ A paste fill plant (approximately 100 m³/hr capacity) will be constructed within the footprint of the existing operational area for the purpose of backfilling the mined out stopes (see [Section 2.1](#)).

The main mine workings will be greater than 300 m below the surface. Mineralised material will be transported to the surface and processed at the existing processing plant. Due to the selective nature of the proposed underground mining method, only a relatively small quantity of waste rock will be generated (approximately 0.5 Mt of waste rock, compared to greater than 80 Mt of waste from the mined out Pit 3) (see [Section 2.1](#)).

Processing of the Ranger 3 Deeps ore will not require a change to the existing water management strategies implemented at the Ranger mine. Further, the proposed action will result in only small incremental changes to the ERA's process water and tailings inventories, and will not significantly alter overall closure planning for the Ranger Project Area.

¹ More accurate estimates of the resource will be established through the continuing exploration activity and associated geological modelling. These will be reported accordingly. It is likely that within the time frame of the proposed action, and in consideration of mining and processing optimisation only a portion of the defined resource will be extracted.

² Mining in Pit 3 ceased on 28 November 2012.

³ "Phase 1" of the Ranger 3 Deeps Exploration Decline project, approved in August 2011, includes ducted ventilation along the decline with surface based fans. A second phase of this project will include the construction of a vertical ventilation shaft, in a number of segments from surface to intersect with the exploration decline. This shaft would be converted to a passive air intake as a component of the complete ventilation system for the proposed action.

⁴ Ventilation shafts (vent raises) perform two functions: a) taking stale air from the decline and exhausting it into the atmosphere via a return air raise; and b) drawing fresh air into the decline via a fresh air raise.

1.2 Latitude and longitude

The Ranger Project Area is the land described in Schedule 2 to the *Aboriginal Land Rights (Northern Territory) Act 1976*⁵ (Figure 1).

The current mining operation is in the southern portion of the Ranger Project Area and constitutes an area of disturbance, including the Jabiru airport, of approximately 2,270 ha (Figure 2). Figure 2 also outlines the above and underground extent of the proposed action, which is constrained within the heavily disturbed footprint of the existing operational area. The proposed action has a discrete footprint within the same co-ordinates used to identify the matters of national environmental significance (MNES) search area (see [Section 3.1](#)). Therefore the co-ordinates for the proposed action are described as follows:

12°42' 51.36" S, 132°52' 48.72" E;
12°39' 3.52" S, 132°52' 50.60" E;
12°39' 5.16" S, 132°56' 19.57" E; and
12°42' 53.01" S, 132°56' 17.74" E.

1.3 Locality and property description

ERA's Ranger uranium mine is on Aboriginal land, within the Ranger Project Area. It is surrounded by, but separate from Kakadu National Park. The Ranger Project Area lies within the Alligator Rivers Region and is approximately 260 km east of Darwin and 11 km east of the regional centre of Jabiru (Figure 1).

Immediately north of the mine is the Jabiru airport and associated infrastructure, which services the mine (fly-in-fly-out employees and contractors), the tourist industry of Kakadu National Park, and the Jabiru communities.

1.4 Size of the development footprint or work area (hectares)

The existing Ranger mine operations, and area of disturbance, currently occupies approximately 2,270 ha (22.7 km²) or about 30 % of the total area of the Ranger Project Area (78.6 km²).

The portal leading to the underground mine is located immediately adjacent to Pit 3 (see Figure 2). The underground mine will extend to the hanging wall and footwall of the Ranger 3 Deeps mineralised zone: with approximate maximum dimensions of 1200 m (l) x 400 m (w) and a depth of greater than 300 m below the land surface. The surface expression of the proposed action is contained within the current footprint of the existing mining operations (Figure 2).

The approximate area of the proposed action's footprint (excluding existing infrastructure) is:

- Surface footprint: approximately 2 ha (overlies the underground workings)
- Underground extent: approximately 18 ha

A full description of the proposed action and associated infrastructure is provided in [Section 2.1](#). The indicative location of the proposed surface infrastructure is shown in Figure 3.

⁵ The co-ordinates of the Ranger Project Area are based on AGD66 projection datum used at the time (Commonwealth of Australia, 1979).

1.5 Street address of the site

Ranger uranium mine
Arnhem Highway
Jabiru Northern Territory 0886

1.6 Lot description

Not applicable

1.7 Local government area and council contact (if known)

There is no local government planning approval required for the underground mining facilities on the Ranger Project Area.

1.8 Time frame

ERA completed an order of magnitude study for the Ranger 3 Deeps underground mine in April 2012 and commenced a prefeasibility study in July 2012. The construction of the Ranger 3 Deeps Exploration Decline project to conduct underground close-spaced drilling to further define the Ranger 3 Deeps resource commenced in May 2012.

The construction and operation of the proposed Ranger 3 Deeps underground mine will not alter the current operating timeline. Mining and processing will commence as soon as practicable following regulatory approval and feasibility studies and will cease by January 2021 with rehabilitation occurring within the period 2021 to 2026. This timeline is in accordance with the current Section 41 Authority.

1.9	Alternatives to proposed action	Yes The "do nothing" alternative was considered and would be progressed if the proposed action does not proceed. In this option ERA would continue to process progressively lower grade ore from stockpiles up to the required date for cessation of operations under the Section 41 Authority of January 2021, whilst it remains economic to do so; and the Ranger 3 Deeps mineral resource would not be mined. Further detail is provided in Section 2.2 .
1.10	Alternative time frames, etc	Alternative time frames: No The current Section 41 Authority only permits ERA to explore, mine and process uranium ore at the Ranger uranium mine until January 2021. Within this context, the time frame for the proposed action would be subject to market conditions, receipt of all relevant government approvals and ERA Board approval. Alternative locations: No The location of the proposed action is constrained by uranium ore mineralisation, mining tenure and development costs. The final underground configuration will be informed by data obtained from the Ranger 3

		<p>Deeps Exploration Decline project and optimised during detailed mine planning.</p> <p>Alternative activities: Yes Currently two alternatives are being considered for beneficiation and processing of the mined ore; these are listed below preferentially:</p> <ol style="list-style-type: none"> 1) Ore sorting of a portion or all of the mined ore using the existing sorter as a beneficiation process prior to milling and processing through the current processing plant. 2) Direct feed of the mined ore into the current processing plant. <p>These two options do not result in a material change to the existing infrastructure, milling or production activities.</p>
1.11	State assessment	The action is subject to the Northern Territory <i>Environmental Assessment Act</i> and to assessment under the bilateral agreement if the proposed action is deemed a "controlled action".
1.12	Component of larger action	No
1.13	Related actions/proposals	<p>Yes</p> <p><i>EPBC 2009/4860 Ranger uranium mine: Orebody #3 Deeps exploration decline</i> concerned the construction of a decline to conduct closed-spaced underground drilling to further define the Ranger 3 Deeps mineral resource and was determined not to be a controlled action on 17 May 2009.</p> <p>The proposed action described in this referral document is only related to the extent that it is co-located and will utilise existing infrastructure and works at the Ranger mine, including infrastructure established by previous 'actions'.⁶</p>
1.14	Australian Government funding	No
1.15	Great Barrier Reef Marine Park	No

⁶ Further information pertaining to the relevance of EPBC 2009/4860 to this proposed action is provided in Section 2.1 – ["Exclusions to the Proposed Action"](#).

2 DETAILED DESCRIPTION OF PROPOSED ACTION

2.1 Description of the proposed action

INTRODUCTION

ERA's Ranger operations are governed by a comprehensive suite of government Acts and regulations. These include an Authority issued under the Commonwealth *Atomic Energy Act 1953* (Section 41 Authority) and an Authorisation under the Northern Territory *Mining Management Act 2001* (currently the Ranger Authorisation 0108-15⁷ – see Appendix A).

ERA proposes to mine the mineralised material, known as the Ranger 3 Deeps mineral resource using underground mining methods. The Ranger 3 Deeps resource is estimated to contain 34,000 tonnes¹ of uranium oxide and is essentially the structurally modified down-dip equivalent and a continuation of the Ranger Pit 3 deposit, which has been mined since 1997. It has been defined by a series of successive surface diamond drilling programs from 2005 to 2009. These data have been collected and verified in accordance with current 'best practice' ERA geological data handling systems and procedures in place since 2007.

The proposed action will utilise the existing processing plant and related surface facilities at the Ranger uranium mine, as well as infrastructure constructed during the Ranger 3 Deeps Exploration Decline project including: portal, decline development (to a depth of 350–400 m below surface), refuge chambers, ponds, workshops, etc and elements of the ventilation system (see [Exclusions to the Proposed Action](#), below). New infrastructure, to be constructed as part of the proposed action, will include extension of the ventilation system (including vent shafts),⁸ a paste backfill plant and underground drive and stope developments (see Tables 1 and 5).

Figure 4 shows a provisional layout, indicative locations of ventilation shafts and potential underground mining areas relative to Pit 3.

EXCLUSIONS TO THE PROPOSED ACTION

On 16 April 2009, ERA submitted a referral titled "Ranger uranium mine: Orebody #3 Deeps exploration decline (EPBC 2009/4860)". This referral concerned the construction of an exploration decline to conduct further closed-spaced underground drilling to define the Ranger 3 Deeps mineral resource. On 17 May 2009, the then Commonwealth Department of Environment, Water, Heritage and the Arts determined that the proposed action was not a controlled action.

The exploration decline referral foreshadowed that any decision to proceed with underground mining of the Ranger 3 Deeps mineralised zone will be based on exploration data, definitive information on geological, geotechnical and radiological characteristics of the rock sequence and mineralised zone, and relevant engineering designs and costs for a potential mining operation. This remains the case. Rather than making a sequential referral for underground mining, ERA makes this referral in parallel to exploration activities so that the outcomes of the Northern Territory and Commonwealth assessment processes are known to it at the time it makes a decision about the feasibility of underground mining.

⁷ As available at the date of preparation of this referral document.

⁸ Further information of the ventilation system including delineation of existing and proposed infrastructure, number and size of ventilation shafts is provided in Section 2.1 "[Ancillary Facilities](#)".

In May 2012, ERA commenced work on the Ranger 3 Deeps Exploration Decline project, which will be completed in two-phases:

- Phase 1 which involves the construction of a decline from 2,000 m to 2,400 m in length, ducted ventilation along the decline with surface based fans, and ancillary facilities, in addition to exploration and resource definition drilling. Excavation of a box-cut has been completed as part of this Phase and construction of the decline commenced in November 2012. The Supervising Authority (being the Northern Territory Minister for Mines and Energy) approved the construction of Phase 1 of the Ranger 3 Deeps Exploration Decline project in September 2011.
- Phase 2 of the Ranger 3 Deeps Exploration Decline project which will include the extension of the decline up to a maximum length of 3,000 m, consistent with EPBC 2009/4860 to provide closer access to the deeper mineral resources, and the construction of a vertical ventilation shaft from the surface to intersect with the decline at depth for the purpose of enhancing ventilation and the taking of a bulk sample. A 'bulk sample' of mineralised material will be acquired⁹ for the purpose of testing the beneficiation process for carbonate reduction, in support of the Ranger 3 Deeps underground mine feasibility study. The quantity obtained would be only that required for proposed test-work and the material would not be processed through the existing processing plant, and instead stockpiled. No uranium oxide will be produced from the bulk sample.

In accordance with operating processes and EPBC 2009/4860, ERA will submit an application to Supervising Authority (via the Ranger Minesite Technical Committee) for approval to proceed with Phase 2 of the Ranger 3 Deeps Exploration Decline project in 2013.

As mentioned above, this referral is made in parallel to these exploration activities being conducted on site so that ERA is able to consider exploration results and the feasibility of mining at a point in time when key approvals are in place.

Should ERA determine that it is feasible to proceed with an underground mine, the proposed action will be fully integrated with the existing operations and areas of disturbance at Ranger mine. In order to minimise impacts, the proposed action will utilise the existing infrastructure at the Ranger mine (including the processing plant) as well as the infrastructure to be constructed as part of Phases 1 and 2 of the Ranger 3 Deeps Exploration Decline project, which will have been utilised for exploration activities before any decision to mine is taken (further details are outlined in [Section 2.1](#)).

Certain activities and works which would otherwise be needed for a new mine development are not subject to environmental assessment as part of this proposed action. This existing infrastructure and works include:

- Phases 1 and 2 of the Ranger 3 Deeps Exploration Decline project;
- Geotechnical investigations.
- The construction and operation of the brine concentrator, including release of distillate and disposal of concentrated brines.
- The operation of existing pond water treatment plants.
- Rehabilitation activities associated with closure of open Pits 1 and 3, or any progressive rehabilitation works for the existing operation.
- The transfer of tailings from the tailings storage facility to Pit 3.
- The placement of tailings from the existing processing plant into Pit 3.
- Any other activities currently authorised for the Ranger mine.

⁹ Using the extraction method of drive and strip.

MINE DESIGN

An order of magnitude study has been conducted to assess the technical and economic viability of extracting, by underground mining methods, the Ranger 3 Deeps mineral resource. A number of mining and processing methods were assessed to achieve economic production, determine an optimum ore extraction method, whilst minimising radiological risk to workers and avoiding any significant potential for environmental impact. The underground mine designs are based on:

- variants of open stoping with consolidated paste backfill;
- conventional jumbo development and long-hole drill and blast production techniques;
- access to the mine via a single decline and ore handling performed by underground load haul dumps and trucks;
- ventilation shafts for clean air circulation to active work areas and providing a means of emergency egress from the mine; and
- a stoping sequence predominantly driven by ventilation, best practice health and safety, and based on a sequential retreat strategy – e.g. mining the stopes at the extremities of the mineral resource first and retreating to the access and intake airways at the centre of the resource.

Mine production is expected to peak at approximately 1.0 Mtpa¹⁰ of high grade ore, which will be delivered to the mill for processing. Mining and processing will be completed by the end of 2020 with rehabilitation occurring within the period 2021 to 2026, in accordance with the current Section 41 Authority.

Geology and Geotechnical – Major Structures

Several geotechnical studies on the Ranger 3 Deeps mineral resource have been undertaken since 2009, contributing to the current knowledge of the geotechnical environment. A total of 49 geotechnical holes have been drilled in the vicinity of the resource; 42 of these holes have been logged by ERA based on geotechnical properties, while the remaining seven have been logged by either Coffey Geotechnical or Geotechnical Consulting Pty Ltd.

The Ranger 3 Deeps deposit is hosted by the Lower Proterozoic Cahill Formation, which overlies the basement on a structural contact, and constitutes a basal carbonate rich member, referred to as the Lower Mine Sequence, followed by chlorite and muscovite rich schists, which are referred to as the Upper Mine and Hanging-wall Sequence (Figure 5).

A geological block model of the Ranger 3 Deeps resource is shown in Figure 6. Mineralised material in both the Upper Mining Sequence and the Lower Mine Sequence was considered. Material of all levels of geological confidence was included.

The Ranger 3 Deeps mineral resource is a structurally and lithologically controlled uranium deposit localised by a north, north-west trending zone of reverse faulting and deformation, the Deeps Fault Zone. High grade uranium oxide mineralisation occurs in this zone when the right conditions of rock chemistry, rock permeability and fault orientation are met.

Geotechnical studies scheduled to occur during the Ranger 3 Deeps Exploration Decline project will further inform ground conditions and provide for the optimisation of stope size, stability and orientation, and the suitable location for proposed ventilation shafts.

Recently, radar and other instrumentation have detected increased movement in the north eastern wall of Pit 3. Such movement is not uncommon in open pit mining and ERA has put in place rigorous risk management protocols, supported by industry standard monitoring, to ensure continued safe operation and protection of the environment for current operations. A geotechnical specialist has

¹⁰ Mtpa: million tonne per annum.

assessed the potential interaction between the Pit 3 wall instability and the proposed action. In addition to a number of tentative ventilation locations, this assessment considered the schedules associated with backfilling Pit 3¹¹ and the ventilation and underground development associated with the proposed action. This assessment concluded that the impact of movement associated with the northeast wall on vent shaft construction is considered minor to inconsequential. The ventilation corridor has been defined such that this infrastructure is located outside of any zone of geotechnical concern.

Moreover, the underground development associated with the proposed action falls outside of any influence that Pit 3 may exert on the surrounding rock mass. Consequently, it is considered highly unlikely that there will be any deleterious interaction associated with underground drill and blast activity.

MINING METHODS

The proposed mining method has been selected on the basis of the geology block model and geotechnical information, to achieve selective and efficient extraction of mineralised ore, whilst ensuring a safe working environment. The preferred mining method is bottom-up open stoping with paste backfill using a sequential retreat strategy. Stopping will begin at the extremities of the mineral resource or large mineralised zones, adjacent to the return air raises, and retreat to the centre of the resource, where the access and fresh air raise is located. This strategy eliminates the exposure of personnel to air returning from active work areas, and therefore minimises exposure to airborne radiation (see [Section 2.1 Radiation Management](#)). A schematic of the proposed mining method (stopping layout) is shown in Figure 7. The generic arrangement of drives, stope development and ventilation system is shown in Figure 8.

Stopes are expected to be approximately 25 m high and stopes above -400 mRL¹² will be approximately 20 m wide; while stopes below -400 mRL will be approximately 15 m wide. Stope sizing will be optimised once sufficient geotechnical data is available from the Ranger 3 Deeps Exploration Decline project. Each open stope span must be supported by fill in order to stabilise the ground before the adjacent stope can be mined. The method relies on in-ore development for drill drives and mucking horizons.¹³ A combination of downhole and up-hole drilling maximises drilling efficiency. The up-holes would be accessible for charging after backfilling of the stope below is completed.

Production slots to facilitate initial stope blasts would be developed and subsequently widened by conventional drill and blast techniques. Each blast undergoes a detailed design and is monitored to maximise the blast efficiency, minimise the dust, fumes, vibration and air blast, and ensure compliance with site specific blasting conditions (see Figures 9a and 9b).

After a stope is mined, paste is reticulated to the completed stope via 200 mm pipes. In instances where the backfill is creating a working platform, inert (non-mineralised) material will be applied to the upper portion of the backfill to function as radiation shielding. The thickness of the inert backfill layer will be determined by the required reduction in gamma radiation necessary to protect workers. Once cured, the stope above can be mined (see Figure 10).

¹¹ Backfilling will facilitate "buttressing" of the open pit walls, effectively stabilising wall scale movement prior to commencement of the proposed activities.

¹² RL is 'reference level', and denotes a specific height above/below mean sea level, used as an elevation reference point for structures and natural landforms on the Ranger site. The ground surface at the decline portal entrance is approximately +22 m RL.

¹³ The level at which the ore is extracted from the stope after blasting.

Development Design

The portal and decline constructed as part of the Ranger 3 Deeps Exploration Decline project will also be utilised to access to the underground mining area (previously shown in Figure 4). A ramp has been designed that extends from the exploration decline to access the lower levels of the proposed mine, an approximate distance of 2,200 m (Table 1). This is a 5.5 m wide by 6 m high decline developed at a maximum gradient of 1-in-6. The bend radius will be 30 m, suitable for the underground trucks. The ramp and access drives shall be positioned in the hanging-wall of the mineral resource. Ore from the underground mine will be transported from the working face, through the length of the decline to the surface for processing.

The hanging-wall is more accessible from the exploration decline, and retreating stopes toward the hanging-wall will avoid problems with ore loss. However, access on the hanging-wall increases the requirement for remote "mucking" (loading) operation and reduces the average production rate.

Return air raises to surface will be constructed, close to and accessible from the hanging-wall access drives. The ventilations shafts (return air and fresh air raises) are intended to manage ventilation of the total void space/underground mine.

The surface expression of the proposed action is contained within the current footprint of operations (previously shown in Figure 3). At depth (greater than 300 m below the surface), the works may extend beyond this current footprint and partly beneath Magela Creek directly north-east of Pit 3 (see Figure 11). The total lengths of conceptual development, in metres, are given in Table 1.

Table 1: Conceptual development parameters

Scenario	Approximate Dimensions
Stope size	15–20 m (w) x 25 m (h)*
Ramp (extending from the existing exploration decline)	2,200 m
Lateral accesses and access to return air raises and fresh air raises	5,400 m
Ore drives	11,000 m

* **Note:** Ground conditions will be quite variable and stopes will differ in size accordingly. In addition, stope thickness will vary from 10 to 50 m dependent on orebody thickness and geotechnical conditions.

Area Earthworks

The majority of the surface earthworks associated with the proposed action will be constructed as part of the Ranger 3 Deeps Exploration Decline project. Minor additional earthworks will be necessary to construct, for example additional ventilation shafts, which will be located in the Magela Land Application Area (Figure 11).

To prevent ingress of water or process water brines¹⁴ from the open Pit 3, a natural barrier between the Pit 3 eastern wall and the proposed underground mine workings will be retained. The width of the barrier and confirmation of its integrity will be determined through solute transport and hydro-geotechnical studies, which are in progress as a component of ERA's integrated closure study.

¹⁴ Process water brines, generated through treatment of the process water inventory, will be injected into backfilled waste rock in the base of Pit 3. This closure activity is scheduled to occur concurrently with the mining of the Ranger 3 Deeps mineral resource, but is not part of the proposed action.

Stope and Pillar Design

Stope location, orientation and size have been established using the Datamine application Mining Shape Optimiser, an automated stope design tool that maximises the quantity of ore above cut-off grade contained within the stope shapes. Stopes were evaluated against ERA's geological resource block model. No non-recoverable ore pillars were used in the designs. The final stope plan will be optimised on the basis of new geological and geotechnical data arising from the Ranger 3 Deeps Exploration Decline project. However, the general stope design will remain unchanged.

Production Drilling and Blasting

Each stope is required to have a lower and an upper access, to allow blast drilling, ore mucking and backfilling. In this arrangement, production drilling and blasting can be performed from either or both of the stope accesses. The stope dimensions fall within the capabilities of many standard underground drilling rigs. Stopes will be mined via a series of blasts, each of the order of 200 to 10,000 tonnes. Peak drilling demand will be approximately 230 m per day. The fleet will consist of a single high capacity production drill and smaller unit for odd jobs, such as service holes and hole cleaning, and to provide coverage during times of unplanned maintenance on the primary unit.

Long hole charging using emulsion and electronic detonators will be the standard charging method. Pre-charging of all holes in a stope, before the initial stope blast has occurred, is desirable. This will limit the time personnel must spend near stope brows and in close proximity to broken ore, thereby reducing exposure to radiation and mining related hazards.

Noise and Vibration

ERA commissioned a noise and vibration study in May 2012, to assess the potential impacts associated with the activities of ventilation construction and operation, decline development and the excavation of a trial stope. A surface mounted axial fan was assumed in this assessment, as opposed to a "basement" fan installation, as this provides a "worst case" noise source and therefore delivers a conservative input to the modelling. The study assessed activities and infrastructure consistent with those proposed for the underground mine, although initially assessed for the purpose of further exploration activity. Whilst the assessment did not calculate additive impacts, for example of several stopes being simultaneously extracted the data obtained was sufficient to provide indicative noise and vibration outcomes relevant to the proposed action.

The noise sensitive receptors selected for the modelling assessment were Mount Brockman, Mudginberri, Jabiru, Jabiru Airport, ERA contractor camp¹⁵ and the 009 camp (see Figure 12).

The principal noise sources considered in the study included the operation of the ventilation fan and the haulage of material from underground to surface stockpiles (Table 2).

Table 2: Principal noise sources associated with the study

Equipment	Sound Power Level (dBA)
Ventilation fan (standard axial fan)	110 ¹⁶
CAT 785 Haul Truck	110

The study indicated that during the construction phase, only a negligible incremental increase (less than 1 dBA) would be experienced at the nearest affected receivers (e.g. the ERA contractor camp) even under worst case meteorological conditions (i.e. a source to receiver wind or temperature inversion). In addition, the predicted cumulative operational noise levels from the activities

¹⁵ Also known as Ranger mine village.

¹⁶ Noise levels obtained from consultants database of similar equipment measurements.

considered in that study and existing Ranger mining operations for all sensitive receptors were expected to be less than 35 dBA (the intrusive criteria) (Figure 13) (Archer 2012).

The predominant source of vibration associated with the proposed action will be blasting of the ramp, drive and crosscut development and production stope blasts. The study considered blasts for the exploration decline development, typically involving smaller blasts conducted twice daily, and for a trial stope, removing a greater quantity of material using higher charge densities and conducted once per day. Figure 14 shows the predicted vibration impact of each type of blast as a function of distance from the blast. Whilst the ramp and mine development blasts will occur at a greater depth than the exploration decline blasts, these will utilise equivalent charge densities. The trial stope blast parameters were based on the intended mining method for the proposed action. Thus the data provides an appropriate prediction for the proposed Ranger 3 Deeps underground mine.

The nearest surface structures will be at least 300 m vertically above the ramp and drive development blasts. At this distance blast vibration is predicted to be 1 mm/s or less. All stope blasts associated with the proposed action will occur at least 300 m below the surface and with the additional lateral distance to structures at the surface, vibration experienced will be less than 5 mm/s.¹⁷ Consequently the vibration impact is predicted to be negligible at key receptors.

One archaeological site (designated R34) occurs within proximity to the proposed action. R34 lies immediately above the exploration decline, which will pass approximately 133 m beneath the site (previously shown in Figure 11) at its closest point. During construction of the exploration decline the R34 site is expected to experience a maximum particle velocity of around 2 mm/s. These velocities will diminish as the decline progresses and will be significantly less for all ramp and drive development blasts associated with the proposed action. Vibration associated with stope production is predicted to be less than 5 mm/s at this site. (For contextual purposes, when using the same model, the production blasts for Pit 3 at a level of -165 m on the eastern side would have generated approximately 3 mm/s at R34. This has been confirmed by vibration monitoring in close proximity to this archaeological site.) Vibration that will be experienced at Mt Brockman as a consequence of the proposed action will be orders of magnitude less than that experienced at R34 and nearby receptors.

Mining Equipment

The estimated mobile equipment fleet is shown in Table 3. The peak quantities shown in the table are conceptual numbers which will be optimised during the prefeasibility study.

Table 3: Underground mobile fleet

Description	Peak quantity required	Description	Peak quantity required
Double boom development jumbo	2	Shotcrete delivery agitators	2
Double boom ground support jumbo	1	Cable bolter	1
Load haul dumps	3	Light vehicles	6
Underground haul truck	4	Elevated platforms (integrated tool carrier)	2
Raise borer	1	Underground service truck	1
Longhole top hammer production drill rig	2	Scissor lift	1
Shotcrete spraying unit	1	Charge-up unit	1
Hydroscaler unit	1	Grader	1

¹⁷ Ranger has adopted this particle velocity for sensitive sites from AS 2187.2-2006.

Automation and Technology

Tele-remote¹⁸ load haul dump operation will form an integral part of the production cycle. Full automation of load haul dumps and trucks may not be possible because automated operation currently requires physical isolation of the automated unit from other activities. Hanging-wall drives at the proposed Ranger 3 Deeps underground mine must be simultaneously shared by production, backfill, development and services crews. Exclusion of other activities from a level where production is occurring will impact the mine schedule and adversely affect the production rate.

Electronic detonators allowing for simple, safe and flexible production blasting practises will be utilised. As electronic detonators are all identical units with no intrinsic timing delay, entire stopes could be charged before the first blast is taken. For each blast, charge crews need only return to the stope to hook up and program timing delays in the remaining detonators. The timing delays are not specified until immediately before blasting, so engineers have the flexibility to design and modify the size and timing of each blast as desired. Pre-charging provides a means of reducing the exposure of miners to radiation emitted from broken ore by reducing the time they spend near open stope brows. Pre-charging is currently performed at numerous operations in Australia and overseas.

Semi-automated production drilling will be utilised. This facility allows drilling to continue in the absence of operators, such as during blasting times or through meal breaks. This technology will also provide a means of reducing the net radiation exposure to some of the mine workforce.

Remote activation of auxiliary fans is a proven technology and will be utilised to minimise periods when drives will be unventilated during and immediately after blasting.

Material Handling

The mine design assumes a combination of conventional load haul dump mucking and tele-remote load haul dump operation will be used to retrieve broken ore from stopes.

Stockpiles will be located at intervals along the hanging-wall drive to expedite the loading of trucks.

Trucks will be loaded on the level that ore is collected and ore transported to a surface run of mine stockpile. Due to the small scale of the mine, and to simplify underground radiation management, no ore passes¹⁹ or underground crushing will occur. Waste generated from concurrent development activities will be preferentially used for backfill material.

Backfilling

The proposed method of backfilling is pastefill. The portion of tailings that isn't returned to the disused stopes as pastefill will be deposited directly into Pit 3 (see Section [Rehabilitation and Closure](#)). The intended location of the backfill plant within the operational footprint is previously shown in Figure 3(3).

Pastefill is proven technology and offers environmental advantages as it allows the placement of tailings underground; reduces the amount of tailings reporting to Pit 3; and completely fills the void eliminating future subsidence. It usually comprises total tailings, unless the tailings are very fine, in which case they can be deslimed. Pastefill is a non-draining fill which remains fully saturated after placement, so cement must always be added to eliminate the risk of liquefaction. Pastefill can be prepared by dewatering fresh tailings using a vacuum filter or high compression thickener. Binder

¹⁸ Tele-remote operation requires video cameras to be installed on the load haul dumps to provide the remote operator with clear views forward and backward. An operator can operate only one tele-remote load haul dump at a time. During Ranger 3 Deeps operations, the operator will be located in a cabin, a long distance from the vehicle that is undertaking the complete load haul dump load/dump cycle.

¹⁹ Ore passes are vertical or inclined passages for the downward transfer of ore.

and water are then added in a mixer to produce a product with the required yield stress for reticulation via boreholes and/or pipelines, typically at a solids density of 75–80 %. As outlined previously, in instances where the backfill is creating a working platform, inert (non-mineralised) material will be applied to the upper portion of the backfill to function as radiation shielding. The thickness of the inert backfill layer will be determined by the required reduction in gamma radiation necessary to protect workers.

Mineral Waste Management

The proposed underground mine will produce approximately 0.5 Mt of waste rock, compared to greater than 80 Mt of waste from Pit 3. All underground waste will be monitored and stockpiled in accordance with ERA's Mineral Waste Management Plan.

All ore and most development rock will be hauled to the surface. Underground trucks will go through an existing truck discriminator, which determines the approximate average grade and subsequent stockpile destination for each load: Table 4 shows the expected stockpile quantities.

Table 4: Indicative material quantities to be produced by Ranger 3 Deeps underground mine by January 2021

Grade	Comment	Indicative tonnage (Mt)	Indicative grade % uranium oxide %	Indicative grade % calcium	Indicative grade % sulfur	Destination
5 to 7	High grade	5.0	0.3	<3.5	0.5	Ore sorter/run of mine
3 and 4	Low grade	0.2	0.15	2.0	0.35	Ore sorter/run on mine
2	Mineralised waste	0.3	0.05	5.0	0.35	Existing 2B stockpile or ore sorter
1	Waste rock	0.5	<0.01	5.0	0.2	Existing 1F stockpile, Pit 3 and small amounts to backfill

The sub-grade material extracted from the Ranger 3 Deeps mineral resource will be of similar grade to material that was extracted from the bottom of Pit 3. Most of the waste rock would be from the Upper Mine Sequence and would be chloritic schist with relatively high carbonate content. There will also be carbonate waste from the Lower Mine Sequence and from a small amount of hanging-wall sequence muscovite schist and amphibolite.

The waste rock is unlikely to produce acid drainage as the average sulfur content is 0.2 % and the carbonate content is greater than 5 %. As outlined in Table 4, the majority of the waste rock from the proposed action Ranger 3 Deeps underground mine will be stockpiled on the existing 1F stockpile located between the portal and Pit 3 (previously shown in Figure 11). Small quantities may be used during the backfill of Pit 3 and potentially for the direct backfill of stopes and redundant development of the Ranger 3 Deeps underground mine.

ANCILLARY FACILITIES

As previously discussed, most of the proposed action's ancillary facilities are either existing plant, or infrastructure due to be constructed as part of the Ranger 3 Deeps Exploration Decline project. A breakdown of ancillary facilities is provided Table 5. The ID numbers correspond with the indicative site layout of the aboveground infrastructure provided previously in Figure 3.

Table 5: Ranger 3 Deeps aboveground ancillary facilities (new)

ID No	New Infrastructure
1	Ventilation shafts
2	Refrigeration plant
3	Paste backfill plant
4	Power circulation to fans and paste plant
5	Additional 4–6 MW power generation ²⁰

Paste Fill Plant

The preferred option for a paste fill plant is a modular configuration (Figure 15) located above a vertical bore hole on the eastern side of Pit 3 and overlying the underground mine. This arrangement has the advantages of:

- minimising underground development by avoiding the requirement for dedicated paste reticulation drives;
- avoiding pumping of paste, thereby allowing high strength products to be produced when required and minimising cement consumption; and
- allowing most processing activities to remain close to the mill, where waste products can be handled and mill personnel can oversee the cyclone and blending activities.

The paste fill plant will have a delivery capacity of 100 m³/hr and include an underground paste reticulation system. The main component of the plant would be vacuum filters to dewater the tailings, binder hoppers and mixer. Tailings would be pumped across from the existing processing plant, with excess tailings being deposited into Pit 3. A generic paste backfill flowsheet is provided as Figure 16.

Ventilation and Refrigeration

As noted in [Section 1.1](#), [1.13](#) and earlier in [Section 2.1](#), the proposed action will utilise infrastructure constructed for Phase 1 of the Ranger 3 Deeps Exploration Decline project, and that planned for Phase 2 of the Ranger 3 Deeps Exploration Decline project. This infrastructure will include a vertical ventilation shaft from the surface intersecting the decline and/or cuddies off the decline in the central region of the ventilation corridor. This ventilation shaft will likely be converted to a passive air intake for the purposes of underground mining. The estimated maximum number of ventilation shafts required for the proposed Ranger 3 Deeps underground mine is six, of which one vent shaft will be constructed as a component of the exploration activities. These will comprise both fresh air and return air raises necessary to manage the ventilation requirements for the entire underground mine. However, the final number and size of ventilation shafts will be selected once critical factors such as radiation dose models, geotechnical constraints and power costs are established.

The preferred excavation method for the shafts is a combination of pre-sink through the weathered zone and a raise bore through the underlying rock. A large concrete collar will support the top of the shaft. The pre-sink and raise bore machinery will work off and through this concrete collar. The upper section of the shaft will be either steel lined or supported by remotely sprayed shotcrete. The raised bored section will be remotely shotcreted as required. The design has assumed 3.0–5.0 m diameter shafts; schematics of the raise bore technique and vent raise are shown in Figures 17 and 18, respectively.

Initially, three shafts will be established based on the current understanding of the spatial extent of the minable resource. After the northern and southern return air shafts are established and

²⁰ To be integrated with either the existing Ranger power station or the brine concentrator power station.

commissioned, the central return air shaft, constructed as a component of the Ranger 3 Deeps Exploration Decline project, will be converted into an intake airway (e.g. a fresh air raise). Additional vent shafts may be required for mining below 500 m depth.

The generic ventilation arrangement (previously shown in Figure 7) shows the fresh air direction indicated by green arrows. Airflow that has passed through stopes and is therefore regarded as contaminated is indicated by red arrows. The drive cross sections ventilated with fresh air are shown shaded green while those exhausting contaminated air are shown in red. The arrangement has been devised to ensure air returning from a production area does not enter any active work areas.

The mine ventilation system facilitates radiation management. The exposed surfaces of the stope walls and broken rock in the stopes are expected to contribute relatively high rates of radon release compared to the exploration decline development through non-mineralised material. Due to the volume of the stope voids, ventilating air will potentially spend an extended period within the stopes. This provides conditions where radon and associated decay product concentration may be heightened within the stope void. To mitigate the potential for personnel to approach or exceed annual radiation exposure limits, the contaminated air from the stope void will be exhausted from the void and transported directly to a surface raise. The stope exhaust airways (including exhaust drives) will be exclusively for extracting contaminated air.

Extracting exhaust air from the stope void will cause access points to in-cast fresh air into the stope. In order to ensure that personnel working adjacent to stope voids are not exposed to contaminated stope air, a positive flow of fresh air must be induced to flow into each accessible opening.

The main ventilation circuit will consist of a combination of fresh air raises and return air raises. Airflow will be optimised through the application of ventilation modelling and radiation studies, to provide protection to workers. The number of active stopes will vary depending on the size of the stope to between 1 and 5 operating at any one time. Initially it is estimated that the mine will require 2 exhaust and 1 intake shaft. However additional intake shafts may be required to service the deeper workings and act as a conduit for a cooling system if required to prevent thermal stress to personnel. In addition to the ventilation shafts, a refrigeration system may be required. Further studies will be undertaken during the prefeasibility phase to determine the optimum cooling system specifications for the proposed underground mine.

A range of factors will influence the specific location of the ventilation shafts, for example prevailing ground conditions and geotechnical integrity, location of mineralised material, ventilation requirements, etc. Disturbance will be minimised by situating the shafts within a narrow corridor in the heavily disturbed Magela Land Application Area (previously shown in Figure 11). The final placement of each shaft will be established during the course of the prefeasibility study.

Fuel Facilities

The Ranger mine currently has sufficient fuel storage capacity to accommodate the Ranger 3 Deeps underground mine fuel requirements.

A storage area for drums of hydraulic oils and resins will be located close to the portal. Hazardous materials storage areas will be constructed to the relevant Australian standard (e.g. AS1940 for hydraulic oils). All hazardous materials will be stored appropriately and any spillage contained by bunding. Waste will be collected and disposed of in accordance with the Material Safety Data Sheet and ERA procedures.

Ground Support

Wherever potential exists for exposure of personnel or equipment to ground support hazards, controls will be deployed appropriate to the hazard. For example, holes will be drilled into the ceiling arch of the decline and fully grouted resin bar (grouted bolts) embedded into the host rock, to add tensile and shear strength to the rock surrounding the tunnel. A layer of shotcrete will be applied for

added strength and radiation protection. The grouted bolts will be installed approximately every 1.2 m along the entire length of the decline ceiling to mitigate ground support hazards. Shotcrete has been specified due to its ability to attenuate gamma radiation, while resin bar has been selected as they are able to be installed under tension minimising the potential loosening at stope brows.

Friction bolts installed by mining jumbos will be used in all short-life development heading, such as stope drill drives. Fully encapsulated resin bolts, installed as part of the first pass development cycle, will be used for all other areas including declines, hanging-wall drives and accesses.

PROCESSING

Should a decision to mine be made, Ranger 3 Deeps ore will be processed through the existing processing plant. It is anticipated that the amount of material entering the mill will remain similar to the feed quantity for the existing operations, with the Ranger 3 Deeps ore replacing a portion of lower grade stockpiled ore that would otherwise have been processed. Consequently, whilst production is forecast to increase compared to the levels outlined in Figure 20 if the proposed action proceeded, the tailings and waste streams are expected to remain at similar levels to that produced by the current operations. Therefore the proposed action does not represent a material intensification of operations at the site.

The Ranger 3 Deeps ore is of very similar mineralogy to that of Pit 3 ore, particularly ore extracted from stopes in the Upper Mine Sequence. However, ore in the Lower Mine Sequence is known to have higher levels of carbonate, such that on average, the Ranger 3 Deeps ore will be of higher carbonate content. This has implications for processing. The ore may either be processed directly through the plant accepting higher rates of sulfuric acid consumption, or a beneficiation process may be employed to lower the carbonate content prior to introduction into the plant. Both approaches may be employed at various times concurrent with mine sequencing and stockpiling.

Ore requiring beneficiation to remove carbonate will be subjected to sorting before it is fed to the processing circuit (see Figure 19). Test work indicates that sorting will effectively reduce the carbonate to acceptable levels. The existing radiometric sorter, initially commissioned as a pilot facility in 2008, is of sufficient capacity to process the anticipated portion of high carbonate Ranger 3 Deeps ore. Subject to further testing, the sorter, currently configured for radiometric sorting may be retrofitted to function as an optical sorter. Only the detector instrumentation would be altered with the physical operation unchanged. The general sorting mechanism identifies, and then rejects or accepts individual large particles (greater than 20–25 mm) passing the detector array using air jets and generating two streams of either waste material or beneficiated ore.

Figure 20 shows the estimated Ranger production forecast to 2020, excluding the processing of Ranger 3 Deeps ore, and based on reserves of 13,484 tonnes of uranium oxide as of 31 December 2011.²¹ The development of the proposed Ranger 3 Deeps underground mine will have a favourable impact on these production forecasts.²²

WATER MANAGEMENT

Management of water is an integral part of ERA's Environment, Safety and Health Management System and encompasses all aspects of water capture, storage, supply, distribution, use and disposal at Ranger mine. Water management is the most significant environmental and operational aspect of Ranger mine and as such ERA's water management system is robust and has high levels of monitoring and redundancy.

²¹ Subsequent to the publication of this forecast, ERA has released its 2012 production results of 3,710 tonnes of uranium oxide.

²² Actual annual and total production from both the existing stockpiled and Ranger 3 Deeps ore will be optimised dependent on a range of economic variables, enhanced knowledge of the available Ranger 3 Deeps resource, and detailed mine, stockpile and process sequencing.

To meet the objectives of the water management system, ERA employs various tools including a Release Plan Calculator, an operational water balance model (OPSIM²³), routine monitoring and historic meteorological records. These tools allow ERA to plan, manage, validate and improve water management. Where these tools are predictive in nature, they are validated against actual data as available and are refined for updating of whole of mine systems.

ERA's water management objectives and monitoring programmes are described in the annual ERA Ranger Water Management Plan. All water at the Ranger mine is managed according to quality, as described in the Water Management Plan, which is prepared annually in advance of the wet season, and reviewed and approved by the Minesite Technical Committee.²⁴

A revised Water Management Plan for the Ranger 3 Deeps Exploration Decline project is provided as an example in Appendix B. A Water Management Plan specific to the proposed action will be developed during the prefeasibility study. The two surface water types of most concern for long term planning and risk management are process water and pond water.

Process water is water generated within the processing plant, for example through the interaction of sulfuric acid and ground (milled) ore in the leaching process. Such interaction generates sulfate salts, of a range of metals, but predominantly magnesium sulfate. The total inventory of process water, and the contained salts, is dependent not only on generation within the process, but also the balance of rainfall into process water storage and catchment areas, passive evaporation and active treatment via a brine concentrator currently under construction. The brine concentrator is planned for commissioning in 2013 with a nominal distillate (clean water) production capacity of 1.83 GL per year. The distillate stream will be released to the environment, whilst the concentrated brine waste stream will be circulated to the tailings storage facility initially with the planned long-term management of salts being injection into the "underbed" of Pit 3.

Processing of Ranger 3 Deeps ore will generate additional process water. However ore recovered from the proposed underground mine will replace a significant proportion of lower grade stockpiled ore that would otherwise have been processed if the proposed action did not proceed. The effect is a small incremental change in process water generation relative to the "do nothing" case (i.e. not develop the proposed action), that is manageable with the current process water management infrastructure.

ERA will be undertaking progressive rehabilitation and closure of the current disturbed mining area throughout the duration of the proposed action. During this closure process Pit 3 will become a process water catchment, due to the transfer of tailings from the present tailings storage facility to Pit 3, a process that will take a number of years. The schedule for closure of both Pit 3 and the tailings storage facility are both independent of the proposed action. Thus the proposed action and any incremental production of process water will not impact the closure schedule. This is further discussed in the Section "[Rehabilitation and Closure](#)".

Water Use in Underground Operations

The proposed action is not anticipated to significantly alter the pond water inventory or those aspects of the water management plan that relate to it. Analysis of "in-flow" water volumes and water quality during the development of the exploration decline will enable better estimates of pond water and release water inputs.

Estimated groundwater inflows are 2 ML/day and anticipated water requirements for the proposed action are 1 ML/day. The water will be used for dust suppression, hydro-scaling, muck pile watering, equipment washing, development drilling, diamond drilling, and production drilling. Underground mobile equipment will be washed at the existing mine wash pad located near Retention Pond 2.

²³ OPSIM is the operational water balance model for the Ranger uranium mine. OPSIM is a trademark of Water Solutions Pty Ltd, the owner and licensor of the OPSIM™ software.

²⁴ See [Section 2.4](#), for a detailed description of the Minesite Technical Committee and its respective role.

However the site-wide water balance at the time of intended operation of the Ranger 3 Deeps underground mine will be altered due to a decrease in current inputs and the continued usage by existing operations. The conversion of Pit 3 to a tailings repository and progressive rehabilitation will decrease the pond water catchment.

Table 6 shows the pond water usage across the whole of the Ranger mine's existing operations, estimated by the data review for the OPSIM validation 2011.

Table 6: Estimated pond water usage across Ranger (2011)

Activity	Date	Quantity (kL/d)
Mill		1,800
Dust suppression	Dec – April 2011	600
	May – Nov 2011	1,445
Vehicle washdown	Jan – Mar 2011	220
	April – Dec 2011	110
Power station – cooling water		120

Whilst there will be additional pond water generation due to the underground mine, there will be a decrease from other sources, and with similar levels of pond water usage anticipated, the current pond water management system will be more than adequate.

Groundwater Resources

Groundwater occurrence, monitoring data for nearby groundwater investigation holes and bores, ongoing observations of inflows into Pit 3, and the results of various investigations of recharge-discharge processes, all consistently indicate that the underground development will not intersect significant quantities of groundwater (Coffey Geotechnics 2011).

The decline, which will be constructed during the exploration activity, passing through the upper weathered zone, is expected to contribute the majority of groundwater inflow in the underground mine. Below 60 m, rock permeability is expected to be very low; however, drillhole measurements will provide enhanced estimates as exploration activity proceeds.

Preliminary Packer tests²⁵ show that the hydraulic conductivity of the sub-surface hosting the proposed Ranger 3 Deeps mine is less than 1×10^{-8} m/day. The lugeon tests conducted to-date may be ineffective at resolving hydraulic conductivity below 1×10^{-8} m/day. As the decline is advanced further in-situ testing is expected to demonstrate that the hydraulic conductivity of the host rock is much lower than 1×10^{-8} m/day.

Potential Contaminants and Impacts

It is not expected that the underground mine will have any impact on down-gradient groundwater quality. The hydraulic pressures will be such that it is highly unlikely that water introduced into the decline during operations will ingress surrounding groundwater aquifers. It is expected that groundwater which intersects the mineralised zones will be elevated in uranium and radium. Groundwater inflow which has been in contact with the mineralised zone may have high radon concentrations. To minimise and manage any potential risk of increased radon dose to workers, an

²⁵ "Packer" tests measure the hydraulic conductivity in successive sections of a drill hole, by isolating a discrete section of the borehole between two downhole inflatable packers. The hydraulic conductivity is measured by observing either the pressure response of the isolated section of borehole caused by a perturbation or the rate of flow into the section of borehole under various fluid injection pressures. The tests performed to date in the vicinity of Ranger 3 Deeps have employed the fluid injection technique which is commonly referred to as a lugeon test.

underground pumping system will be installed to pump groundwater inflows to the surface for storage and use as part of the underground and other operations. During construction of the proposed underground mine and during operations, groundwater inflow will be monitored and tested and managed according to water quality.

WORKFORCE

Construction workforce numbers will be confirmed as part of the feasibility study and are anticipated to be around 100–150 during peak times. It has been assumed that the contractor workforce will be working an even time roster²⁶ and that four crews will be required. Workforce numbers will be similar during operation of the underground mine.

ERA employees and contractors accommodated in Jabiru or on the Ranger Project Area agree to strict codes of conduct. All employees and contractors are subject to random drug and alcohol testing when reporting to work at the mine, and there are policies in place and adhered to with respect to drugs and alcohol. Employees and key contractors are required to attend cross-cultural awareness training as part of their Ranger induction; they also attend briefings at Kakadu National Park Headquarters in relation to awareness of the World Heritage values of the National Park.

POWER REQUIREMENTS

Projected power requirements are shown in Table 7. Peak power draw has been estimated to be 7 MW and annual peak power demand 52,000 MWh. Average power draw is estimated to be 4.7 MW and average annual power usage 41,000 MWh.

Table 7: Estimated power requirements for the proposed action²⁷

Activity	Peak Power Draw (kW)	Peak Annual Demand (MWh)
Surface	103	722
Ventilation	3,753	31,351
Pumping	690	5,566
Backfill	350	1,840
Compressed air	185	1,022
Production	1,676	9,974
Other	250	1,511
Total	7,007	51,986

²⁶ For example 7 days on/7 days off; the roster has implications for accommodation requirements and workforce interaction with the local community.

²⁷ Excludes power required for processing, which is an ongoing activity.

Energy Supply and Delivery Options

The existing power station consumes 263 L of diesel for every MWh generated. The proposed action will have an average annual power consumption of 41,000 MWh which equates to an additional 30 kL of diesel per day.

Diesel is transported from Darwin by triple road trains. There are two 3 ML diesel storage tanks onsite. Currently only one of the large storage tanks is in use. Fuel is reticulated by gravity to the:

- main power station
- black start power station (emergency power to leach tanks and compressors)
- fuel bowsers for mobile equipment
- surface mining day tank.

A fuel line will be installed to supply to the underground mobile equipment fuel bay.

Energy Infrastructure

The proposed action may require an additional 6 MW of installed capacity to be added into Ranger's existing power generation capacity.²⁸ Power generation units will have dual diesel/gas capability.

Power is fed from the existing power station to the main substation; from there it is distributed around site via an overhead reticulation system (22 kV) and into Jabiru (66 kV). Power for the proposed action will be drawn from the 22 kV system. Step-down transformers will be required, at vent shafts, paste plant, workshop, etc. 11 kV will be reticulated underground to a main substation and from there 1000 V will be reticulated to working areas.

AIR QUALITY AND GREENHOUSE GAS EMISSIONS

The main sources of emissions to air from the proposed action are:

- dust generated by construction activities²⁹ and truck movements to/from stockpiles, ore sorter, etc;
- exhaust emissions generated from dust, blasting fumes; and
- emissions from the combustion of diesel in the power station.

As previously outlined, the main ventilation circuit will consist of a combination of fresh air raises and return air raises, which will be optimised through the application of ventilation modelling and radiation studies, to provide protection to workers. As the air is exhausted from the shafts, it will vent radon gas and radon decay products, emissions from the exhaust of diesel vehicles which operate underground, as well as dust and fumes following blasting. The emissions will be similar in nature to those that were emitted from Pit 3 during mining, although substantially smaller in quantity. Air quality will be managed to protect workers operating underground and in the vicinity of the exhaust ventilation shafts.

ERA is committed to supplying uranium oxide for the relatively low greenhouse gas nuclear energy fuel cycle in the generation of base load electricity. Greenhouse gas emissions attributable to the proposed action are primarily from diesel fuel consumption. A diesel-fuelled power plant will be used

²⁸ New power generation will be integrated with existing capacity such that it is not necessary for the new installed capacity to match peak demand for the project (approximately 7 MW).

²⁹ All significant non-underground mine digging and blasting will be completed during construction of the exploration decline and prior to commencement of the Ranger 3 Deeps underground mine.

to provide power to drilling machinery, ventilation fans and associated refrigeration unit,³⁰ and water pumps.

The proposed action will result in a marginal increase in greenhouse gas emissions when compared with existing operations. Figure 21 shows the estimated greenhouse gas emissions based on diesel consumption for the underground mine, inclusive of all activities including power generation. The emissions calculations for the proposed action will continue to be refined as feasibility studies progress.

ERA is currently registered as an Energy Efficiency Opportunity participant with the Department of Resources, Energy and Tourism. Registration is required where annual energy use exceeds 0.5 peta joules. ERA have completed the first 5 year assessment and reporting schedule cycle. The second cycle of the Energy Efficiency Opportunity program commenced in the second half of 2012.

As the proposed action is yet to be approved and will therefore fall outside of the current assessment and reporting schedule cycle, it does not require assessment under the *Energy Efficiency Opportunity Act*. If approved, the proposed action's contribution to Ranger's energy mass balance would require assessment under future assessment and reporting schedule requirements. While no requirement exists under the Energy Efficiency Opportunity Act pertaining to the proposed action at the present time, opportunities to capture energy efficiency will be explored and where practicable, integrated into the project design.

RADIATION MANAGEMENT

Uranium is a naturally occurring radioactive metal and therefore the mining and mineral processing of uranium ore can present a radiation risk to both workers and the environment. Management of the radiation risk is undertaken according to the ARPANSA (2005) code of practice. This code of practice sets out the radioactive dose limits for both workers and members of the public refer Table 8. The unit of radioactive dose is the Sievert (Sv) with the limits presented in milli Sieverts (mSv).

Table 8: Radioactive dose limits for workers and the public

Group	Annual Limit
Worker	20 mSv per year Averaged over defined 5 year periods (100 mSv in 5 years), with the further provision that the effective dose should not exceed 50 mSv in any single year.
Member of the public	1 mSv per year In special circumstances, a higher value of effective dose could be allowed in a single year, provided that the average over 5 years does not exceed 1 mSv per year.

People are exposed to radiation every day from natural and medical sources. In Australia the average person receives 2.3 mSv per year from a range of different sources, refer Figure 22. To place this in perspective, other places in the world have a background from natural sources ranging from 1 to 10 mSv per year (UNSCEAR 2000) depending upon the soil type, altitude and climate. For medical sources, radiation doses range significantly depending on the procedure. Examples of every day procedures are 0.1 mSv for a standard chest X-Ray and 10 mSv for a single whole body

³⁰ Further studies will be undertaken during the prefeasibility phase to determine the optimum cooling requirements for the underground mine and specifications for the refrigeration system if one is required.

CT scan³¹ (UNSCEAR 2000). The radiation doses limits presented in Table 8 apply to radiation received above both the natural background in the area and that from medical sources.

The proposed action will involve the extraction of uranium using underground mining techniques as described above. The three major pathways in which radiation exposure could occur at the proposed Ranger 3 Deeps underground mine include:

- Internal exposure from inhalation of radon decay products.
- External exposure from gamma radiation.
- Internal exposure from inhalation of radioactive dusts.

Radiation exposure via these pathways will be minimised, where possible, through design and construction. The primary radiation design controls that are planned as part of the proposed action include:³²

- a single-pass ventilation system;
- shotcrete shielding of high gamma dose rate working areas;
- placing non-mineralised material on top of paste backfill to provide shielding;
- using remote handling techniques for areas of higher radiation exposure; and
- use of sealed, air-conditioned cabs for all trucks, loaders, drilling rigs and other underground equipment where practicable.

The main aims of the ventilation system are to prevent the build-up of radon decay products (radon daughters) and dilute the concentration of radioactive dust in the underground atmosphere. A fixed ventilation system, pre-existing from the exploration activity, will be expanded to include additional exhaust ventilation shafts and intake shaft(s) to provide clean air conditions for workers. In addition to the design controls, other ancillary radiation protection measures will form part of the overall radiation management system for the proposed action ([Section 4](#)).

Dust monitoring has commenced for the duration of the Ranger 3 Deeps Exploration Decline project, the results of which will inform predictive modelling and provide baseline data for the Ranger 3 Deeps underground mine prefeasibility study.

Within the order of magnitude study a prediction of the radiation doses expected to be received by workers on the proposed action was made. These have been presented in more detail in [Section 4](#) but show that radiation doses will be well below the prescribed limits and similar to that received elsewhere in the world from natural background or from some standard medical procedures.

CONSUMABLES

Table 9 shows the estimated consumables required for the proposed action, compared to the forecasted requirements for the period 2013 to 2015, inclusive for the existing Ranger mine operations. The transport of consumables, including dangerous goods like concentrated sulfuric acid, diesel, sodium hydroxide, kerosene (ShellSol), alamine and lime will remain relatively constant.

The primary reagents that contribute to traffic on the Arnhem Highway are diesel and sulfuric acid. Traffic movements for diesel will peak in 2017 to 2018 increasing to an average of 435 trips³³ per annum, over the two years, when compared to an average of 365 trips over the 2013 to 2015 period.

³¹ CT scan: computed tomography (CT) scan.

³² The nature and need for particular measures will be confirmed during the pre-feasibility studies.

³³ A trip is defined as the delivery of the consumable to Ranger and the return to depot.

The annual traffic movements for sulfuric acid in 2013 will be approximately 1,200 trips and remain relatively constant through to 2020.

The consumables forecast indicate that annual deliveries will remain relatively stable³⁴ for most reagents with the exception of pyrulosite and Magnafloc 139 DS, which decline from 2018 onwards.

Annual estimates for other project consumables are at order of magnitude and based on a 1 Mt underground operation and include:

- 670 tonnes of explosive per year (bulk emulsion)
- 12,500 tonnes of shotcrete to support 5,000 m of development per year
- 33,000 tonnes of cement and binder for paste fill (5 % by weight)

Further work to refine these quantities will be undertaken during prefeasibility and feasibility.

Table 9: Ranger 3 Deeps consumables forecast and traffic movements per annum

Reagent	Unit	Operations			Forecast usage incl. Ranger 3 Deeps				
		2013	2014	2015	2016	2017	2018	2019	2020
Alamine 336 (extractant)	kL	44	29	26	37	45	38	33	33
	Deliveries	6	4	3	5	6	5	4	4
Ammonia gas (@ 99.5 % w/w)	Tonnes ('000)	2	1	1	2	2	2	1	1
	Deliveries	37	24	22	31	38	32	27	27
Diesel	ML	42	51	50	52	60	53	51	51
	Deliveries	321	389	386	396	460	410	396	396
Kerosene (ShellSol 2045 diluent)	ML	1	1	0	1	1	1	1	1
	Deliveries	13	8	7	10	13	11	9	9
NT Flocculant (Magnafloc 139 DS)	Tonnes	352	352	352	352	352	198	103	92
	Deliveries	88	88	88	88	88	49	26	23
Pyrulosite	Tonnes ('000)	17	17	17	17	17	10	5	4
	Deliveries	213	214	214	214	214	2	1	1
Quicklime neutralant (@ 100 % CaO)	Tonnes ('000)	36	32	27	26	37	39	38	38
	Deliveries	383	334	279	268	393	411	402	402
Sodium hydroxide (50 % w/w solute)	kL	36	23	21	29	36	31	26	26
	Deliveries	4	3	2	4	5	4	3	3
Sulfuric Acid	Tonnes ('000)	124	110	93	86	121	124	122	122
	Deliveries	1178	1048	889	816	1156	1182	1161	1161
Tri-isodecanol (modifier)	kL	29	19	17	24	30	25	22	21
	Deliveries	4	2	2	3	4	3	3	3

³⁴ On average, cumulative annual traffic movements associated with consumables deliveries (when compared with 2010 as a base line year), will result in an average increase of approximately 13 % or around 330 additional deliveries per annum.

REHABILITATION AND CLOSURE

Rehabilitation of the existing mine landforms forms part of long term mine closure planning for the Ranger mine. Rehabilitation of the proposed underground mine will generally follow the approach employed in the closure and rehabilitation of the Jabiluka decline. Project specific closure criteria for the rehabilitation of the proposed underground mine will be developed in consultation with the Ranger Minesite Technical Committee. Further development of the closure strategy for the proposed action will be undertaken at the prefeasibility stage, to ensure alignment with closure planning for the current Ranger mine operations. The key tasks associated with closure of the proposed underground mine are outlined below:

- **Grouting of underground drill holes:** Underground diamond drill holes will be grouted progressively after the holes have been gamma logged.
- **Infrastructure removal:** Surface infrastructure will be removed includes fans, pumps and the electrical reticulation system. Vent bags will be retrieved as backfilling advances. Poly pipe and electrical cabling might be salvaged if there is an immediate use for it elsewhere on the mine.
- **Decline and ventilation shaft backfill:** The decline and ventilation shafts are to be tightly backfilled with appropriate material.
- **Neutralisation of acidic waste (if required):** There may be potential for acidic conditions to develop in the backfilled mine if sulfidic materials are exposed. If the pH has to be adjusted, lime will be added as backfilling proceeds.
- **Bulkhead construction to isolate aquifers:** If any groundwater aquifers are intersected during construction of the decline, low pressure water control bulkheads may be required to isolate them during backfilling. The bulkheads will be 2 m thick concrete or shotcrete reinforced with 24 mm galvanised rebar. The rebar will typically consist of two layers embedded one metre into the wall rock.

ERA has commenced a prefeasibility study to develop a fully integrated and fit of purpose process water, tailings and progressive rehabilitation plan to enable adherence to stakeholder expectations and statutory requirements. ERA will be undertaking progressive rehabilitation and closure of the current disturbed mining area throughout the duration of the proposed action. The proposed action would not substantially change the closure methodology, the schedule, or the likelihood of achieving closure objectives, based on the following:

- Ore derived from Ranger 3 Deeps underground mine will generate tailings, however approximately 50 % will be returned to the underground void as paste; further given a fixed capacity of the existing processing plant, if the proposed action proceeds the underground ore will displace a portion of lower grade stockpiled ore that would otherwise have been processed. The outcome would be a probable small net decrease in tailings deposited in Pit 3, with a small increment in the amount of existing low grade ore buried in Pit 3. Both the tailings and waste ore increment generated by the proposed action would constitute a small fraction of that deposited in Pit 3.
- A small waste to ore ratio with an estimated 0.5 Mt of non-mineralised waste which can be incorporated in landform and void.
- No significant impact on water management when compared to key options under consideration within the closure prefeasibility study options.

In regard to this latter point, it is well recognised that reduction and ultimate elimination of the process water inventory is an important element of the closure process. This will be achieved through active treatment via the brine concentration unit. Whilst a small net increase in process water inputs is expected (as discussed previously) as a result of the proposed action, the key determinant of the closure schedule is the closure and rehabilitation of Pit 3. This involves the sequential placement of a

waste rock and unprocessed low grade ore “underbed”, transfer of tailings from the tailings storage facility to Pit 3, over-placement of further unprocessed low grade ore and waste rock, landform construction and revegetation. Subsequently process water will be expressed from the surcharged tailings as they consolidate. The small fraction of tailings attributable to the proposed action will not significantly alter this consolidation time frame or quantity of expressed water.

At conclusion of the closure prefeasibility study, and as part of the environmental component of the prefeasibility studies, the proposed action's closure strategy will be assessed to a similar level, more precisely quantifying incremental changes.

It should be noted that undertaking the proposed action will not significantly impede the progressive rehabilitation of the Magela Land Application Area. The rehabilitation would likely include removal of contaminated soils and revegetation of surface-based exploration and past land application (pond water irrigation) areas. It is anticipated that the ecological community surrounding the surface infrastructure will be improved during the operational time frame of the proposed action.

2.2 Alternatives to taking the proposed action

"NO PROPOSED ACTION" OPTION

The only significant alternative is that the proposed action does not proceed. In such a circumstance the existing Ranger mine operations would continue to be managed according to current approvals. The processing plant would continue to operate, utilising ore (nominally greater than 0.08 % uranium oxide) from existing stockpiles. In the absence of the proposed action, Ranger will continue to process ore, although production of uranium oxide will decrease as ore grades progressively fall towards a cut-off grade where it will be uneconomic to continue to operate the processing plant. While the proposed action may extend the conduct of mining activities at Ranger to January 2021, the timing of the proposed underground mining activities and therefore the proposed action is not expected to materially intensify operations at the site.

The proposed action may provide an opportunity to continue processing lower grade material through the blending of high and lower grade feed material. As cut-off grades are dependent on future market and cost conditions, it is not possible to precisely define the “no proposed action” scenario. Based on current assumptions it is forecast that Ranger's production would dramatically decline from present levels to less than 1,500 tonnes of uranium oxide per year from 2016. As exploration is yet to be completed, defining available Ranger 3 Deeps grade, blending scenarios of stockpiled and new ore cannot be established in detail.

At the end of processing, below cut-off grade ores will remain untreated in stockpiles. After tailings from the operation of the existing processing plant and those reclaimed from the tailings storage facility are deposited in the Pit 3 void, the remaining mineralised materials will be placed as low as possible in the Pit 3 backfill profile minimising the leaching of contaminants.

The potential regional and global opportunities to be derived from the proposed action include:

- participation in ongoing social partnerships to develop the capacity of local indigenous populations to deliver services and opportunities;
- contribution of economic benefits to Jabiru and broader regional communities; and
- provision of low carbon energy production in overseas markets.

These aspects are discussed in more detail in [Section 3](#) in the context of potential social impacts. To not proceed with the proposed action would result in a significant uranium resource remaining unmined. Whilst processing of lower grade stockpiles would continue for a period of time, ERA's production profile would significantly contract with at least a commensurate decrease in contribution to the regional community and Northern Territory economy.

OPEN CUT MINING

Pre-feasibility and feasibility studies into the expansion of Pit 3 were conducted in 2007. These studies established the basis for the current, approved Ranger Pit 3 design, known as "Shell 50".³⁵

The Ranger 3 Deeps mineral resource can be considered an extension of the Pit 3 resource at depth and to the east. As such it is conceivable that an expansion of open cut mining could be used to recover this resource. However such an expansion is not viable on economic or environmental grounds. Key issues are:

- Substantially increased mining costs due to high waste to ore strip ratio.
- The eastern expansion would significantly expand the surface footprint, and would require excavation of the mine access road and adjoining infrastructure corridor such that the road and services, including the power lines, would need to be moved further to the east.
- Proximity of the expanded pit to Magela Creek. Designs would not honour the nominal 130 m standoff distance from the creek.
- A new storage facility for tailings would be required unless further wall lifts on the current tailings storage facility were completed.
- A new waste dump would be required to the west of the western dump and Retention Pond 1.
- An expanded open Pit would likely be subject to increased risks associated with geotechnical stability.
- It would not be possible to undertake the Pit expansion and subsequently backfill it within the time frame of the Ranger Section 41 Authority.

In summary, expanding Pit 3 beyond the current Shell 50 would provide additional high grade ore for treatment in the existing processing plant as well as additional low grade ore. However, as well as having a low economic value, further extension of the current pit would generate significant additional volumes of waste rock with attendant environmental and water management challenges. This option would also be difficult to achieve within the current time frame of the Ranger Section 41 Authority and is therefore not a feasible alternative to the proposed action.

2.3 Alternative locations, time frames or activities that form part of the referred action

LOCATION

Exploration will define the probable underground extent of the proposed action. The final number and location of ventilation shafts will be optimised through detailed assessment of resource distribution, access, mine scheduling and modelling of potential impacts such as air emissions. However, the location of the mine is effectively fixed and thus no alternative locations exist.

TIME FRAMES

As part of the Ranger 3 Deeps Exploration Decline project, ERA intends to undertake exploration and resource drilling to both define the known resource and identify additional resources in the open directions of the known mineral resource. This may establish the existence of ore that could theoretically extend the duration of the proposed action.

³⁵ "Shell 50" is the 3-dimensional shape of Pit 3 agreed to be the final maximum void under the Ranger Authorisation.

However, under the current Section 41 Authority and Ranger Authorisation, ERA is only permitted to explore, mine and process uranium ore at Ranger mine until January 2021 (see Sections [1.8](#) and [1.10](#)).

Commencement of the proposed action is estimated to be in Quarter 2 2015. This is based on projected schedules for exploration, metallurgical testwork and approvals (internal and regulatory). Opportunities for earlier delivery of these activities, including acceleration of prefeasibility and feasibility studies, may be pursued, which could expedite the proposed action.

ACTIVITIES

Potential options exist for some aspects of the proposed action (including mining, processing and ventilation).

- In regard to mining methodology, the typical size of mined stopes may vary as a consequence of enhanced knowledge of the spatial irregularity of the mineralisation and geotechnical complexity. However, the essential approach will be unchanged.
- In regard to processing, the existing plant will be utilised with minimal modifications. For a portion of the ore, a new beneficiation process may be applied. Whilst alternatives have been assessed, only sorting using Ranger's existing sorter infrastructure is planned.
- The principle choice of ventilation systems is fixed.

Thus no significant alternative activities form part of the proposed action.

2.4 Context, planning framework and state/local government requirements

NORTHERN TERRITORY AND COMMONWEALTH LEGISLATION, STRATEGIES AND POLICIES

Legislation

The Commonwealth and Northern Territory Governments have enacted many Acts and regulations relating to the Ranger Project Area. In addition to legislation covering day to day operations, specific requirements are in place to address material changes to operations at Ranger.

All changes to Ranger operations, beyond the activities approved in the Ranger Authorisation (currently the Ranger Authorisation 0108-15; Appendix A), require approval by the Supervising Authority (the Northern Territory Minister for Mines and Energy) on advice from the Ranger Minesite Technical Committee. The Minesite Technical Committee is the key forum to discuss and resolve technical environmental management issues relating to the operation of Ranger mine. It is chaired by the Northern Territory Government Department of Mines and Energy and includes representatives from ERA, the Northern Land Council and the Office of the Supervising Scientist, which is part of the Commonwealth Government's Supervising Scientist Division in the Department of Sustainability, Environment, Water, Population and Communities. Representatives of the Gundjeihmi Aboriginal Corporation have, in the past, attended meetings as observers but now hold permanent representation on the committee.

Much of the specific regulation relating to ERA's operations at Ranger mine focuses on environmental, social, community and cultural heritage issues. There are three major reasons for this level of regulation:

- The product: uranium oxide, which is owned by the Commonwealth Government, is classed as a "prescribed substance";
- The location: surrounded by but separate from a World Heritage National Park; and,
- Land ownership: ERA's operations are on Aboriginal land.

Appendix C sets out the key legislation and regulations influencing operations at Ranger and pertaining to each of the three spheres of regulation outlined above. Key stakeholders and their respective roles are described in [Section 2.4 – Land Owners and Key Stakeholders](#).

In addition to the acts listed in Appendix C, other Northern Territory and Commonwealth Acts (and associated amendments and regulations) relevant to the proposed action include:

- Building Act;
- Building Regulations;
- Bushfires Act;
- Bushfires Regulations;
- Control of Roads Act;
- Dangerous Goods Act;
- Dangers Goods Regulations;
- Dangerous Goods Act; Dangerous Goods Regulations;
- Darwin Port Corporation Act;
- Electricity Reform Act;
- Environmental Assessment Act;
- Environmental Offences and Penalties Act;
- Fire and Emergency Act; Fire and Emergency Regulations;
- Industrial Chemicals (Notification and Assessment) Act 1989 (Commonwealth); Industrial Chemicals (Notification and Assessment) Regulations 1990 (Commonwealth);
- Local Government Act;
- Motor Vehicles Act;
- Motor Vehicles Regulations;
- National Environment Protection Council (Northern Territory) Act;
- National Greenhouse and Energy Reporting Act 2007 (Commonwealth);
- National Trust (Northern Territory) Act;
- Ozone Protection and Synthetic Greenhouse Gas Management Act 1989 (Commonwealth); Ozone Protection and Synthetic Greenhouse Gas Management Regulations 1995 (Commonwealth);
- Poisons and Dangerous Drugs Act;
- Poisons and Dangerous Drugs Regulations 1985;
- Soil Conservation and Land Utilisation Act;
- Territory Parks and Wildlife Conservation Act;
- Territory Parks and Wildlife Conservation Regulations;
- Traffic Act; Traffic Regulations;
- Water Act; Water Regulations;
- Water Supply and Sewerage Services Act;
- Water Supply and Sewerage Services Regulations;
- Weeds Management Act 2001;
- Weeds Management Regulations;
- Workplace Health and Safety (National Uniform Legislation) Act; and,
- Workplace Health and Safety (National Uniform Legislation) Regulations.

Strategies and policies

ERA also references a number of strategies, policies and best practice principles in managing its operations, as listed below.

Australian strategies and policies

- Australia's Uranium Industry Fact Sheet (RET 2009a);
- High-Level Principles for Indigenous Engagement (RET 2009d);
- Radiation Protection, First Aid and Safety Measures (RET 2009b); and,
- Leading Practice Sustainable Development Program Handbooks (RET 2009c):
 - Airborne Contaminants, Noise and Vibration;
 - Biodiversity Management;
 - Community Engagement and Development;
 - Evaluating Performance: Monitoring and Auditing;
 - Hazardous Materials Management;
 - Managing Acid and Metalliferous Drainage;
 - Mine Closure and Completion;
 - Mine Rehabilitation;
 - Risk Management;
 - Land Stewardship;
 - Tailings Management;
 - Water Management; and,
 - Working with Indigenous Communities.

International Strategies and Policies

International Atomic Energy Agency – Published Safety Standards (IAEA 2010):

- Management of Radioactive Waste from the Mining and Milling of Ores Safety Guide
- Occupational Radiation Protection Safety Guide; and,
- International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources.

Existing Approvals for Ranger Mine

Operations at Ranger mine are subject to the oversight of the Northern Territory Minister Mines and Energy via the Ranger Authorisation (Appendix A). The current document is entitled 'Schedule: Conditions of Authorisation Number 0108-15' and sets out the approved conditions under which ERA must operate Ranger mine in a number of sub-schedules, including:

- Authorised operations at the Ranger mine;
- Mining operations;
- Treatment plant operations;
- Operations of tailings repositories;
- Other services, operations and requirements;
- Water management;
- Decommissioning and rehabilitation; and,
- Environmental and radiation monitoring and reporting.

Three annexures to the Authorisation describe the environmental monitoring program, the radiation monitoring program and reporting requirements.

Land Owners and Key Stakeholders

Summaries of roles and responsibilities of the traditional land owners and key stakeholders are provided below. Dialogue between ERA and its regulators and land owners occurs regularly in both formally scheduled review meetings and informal discussions.

Mirarr Traditional Aboriginal Owners

Aboriginal people have a long and continuing history with Kakadu; some archaeological dating suggests the arrival of people to the region to be between 50,000 and 60,000 years (Roberts, *et al.* 1990). The Mirarr people are the traditional Aboriginal owners of the land encompassing the Ranger Project Area and the Jabiluka mineral lease. Mirarr country extends to the Town of Jabiru and parts of Kakadu National Park, including the wetlands of the Jabiluka billabong country and the sandstone escarpment of Mount Brockman. Mirarr exercise their rights as traditional land owners under two Aboriginal Land Trusts and benefit from fee simple title to most of the estate. Mirarr interests are legally represented by the Northern Land Council.

Gundjeihmi Aboriginal Corporation

At the request of the Mirarr, the Gundjeihmi Aboriginal Corporation was established in 1995 by the Northern Land Council to receive royalties from the Ranger mine. In addition to this role, the Gundjeihmi Aboriginal Corporation now functions as a not-for-profit organisation that assists members and other Aboriginal people affected by Ranger mining operations, consistent with Mirarr cultural obligations, across a range of areas from housing to community services to distribution of financial benefits. The Gundjeihmi Aboriginal Corporation assists the Mirarr to protect and advance their rights and interests and to ensure that Mirarr responsibilities and obligations to other Aboriginal people are met.

Northern Land Council

The Northern Land Council was established under the *Aboriginal Land Rights (Northern Territory) Act 1976* to represent Mirarr and affected Aboriginal people in the Top End of the Northern Territory. The Northern Land Council is also the representative body for native title claimants in its area under the *Native Title Act 1993*. The Ranger Project Area is not subject to any claims under the *Native Title Act 1993*. One of the key roles of the Northern Land Council is to consult with the Mirarr and affected Aboriginal people with an interest in the land. This consultation is undertaken to ensure the landowners as a group have the chance to express their views and to give their informed consent before the Land Council or a Land Trust enters into any agreement, or takes any action affecting Aboriginal interests in their land.

The representative role of the Northern Land Council does not preclude direct dialog between ERA and Mirarr and other affected Aboriginal people.

Regulatory Bodies

Regulatory responsibility for uranium mining in the Northern Territory is shared between the Commonwealth and the Northern Territory Governments. Relevant documents 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; and,
- 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 Mines and Energy in the performance of their legislative functions. The 'Working Arrangements' also set out the functions of the Minesite Technical Committee (see [Section 2.4 – Committees and Fora](#), below).

Northern Territory Department of Mines and Energy

The Northern Territory Department of Mines and Energy is the regulator for the Mineral Titles Act (Northern Territory) and the Mining Management Act (Northern Territory) and, hence, is responsible for ensuring adherence to the Ranger Authorisation. The Northern Territory Minister for Mines and Energy will have responsibility for formal approval of applications for major works at Ranger and for approval of closure criteria that have been negotiated in the forum of the Minesite Technical Committee (see [Section 2.4 – Committees and Fora](#), below).

Following acceptance of advice from the relevant Commonwealth Minister at the time, the Northern Territory Minister for Mines and Energy will have responsibility for approving relinquishment of the lease under the terms of the agreed closure criteria.

Commonwealth Department of Resources, Energy and Tourism

The Commonwealth Minister for Resources, Energy and Tourism administers the Section 41 Authority under the Atomic Energy Act which authorises ERA to mine, recover, treat and process uranium oxide. The Ranger Environmental Requirements are attached to the Section 41 Authority. The Minister issues ERA's permit to export uranium oxide under the Customs Act 1901 and the Customs (Prohibited Exports) Regulations 1958. The Commonwealth Government Minister approves the Plan of Rehabilitation which is prepared in accordance with the requirements of the *Ranger Uranium Mining Project – Deed (1999)* between the Commonwealth Government and ERA. The Deed stipulates that a Plan of Rehabilitation is to be prepared annually and forms the basis for setting the required value of the Ranger Rehabilitation Trust Fund.

Supervising Scientist Division

The Supervising Scientist Division was established following recommendations of the Fox inquiry³⁶ and is part of the Department of Sustainability, Environment, Water, Population and Communities. The head of the Division is the Supervising Scientist, who advises the Commonwealth Government on the effects of uranium mining in the Alligator Rivers Region. Reporting to the Supervising Scientist are the facilities of the Office of the Supervising Scientist and the Environmental Research Institute of the Supervising Scientist (ERISS). ERISS provides advice based on research and monitoring undertaken by the institute, while the Office of the Supervising Scientist provides supervision, audit, policy and business support.

The functions of the Supervising Scientist Division include providing advice to the Commonwealth Government Minister for Sustainability, Environment, Water, Population and Communities on environmental matters associated with uranium mining in the Alligator Rivers Region, as well as developing and coordinating research and monitoring programs and devising and developing standards, practices and procedures in relation to uranium mining aimed at protecting the environment. In addition, ERISS conducts independent research and monitoring into the effects of uranium mining on the environment in the Alligator Rivers Region. This supports the work of the Supervising Scientist.

Committees and Fora

Alligator Rivers Region Technical Committee

The Alligator Rivers Region Technical Committee was established under *Environment Protection (Alligator Rivers Region) Act 1978 (Commonwealth)* and reviews the appropriateness and quality of scientific research conducted by Northern Territory and Australian Government agencies, ERA and others relating to protection of the environment from the potential impacts of uranium mining in the Alligator Rivers Region. Members of the Committee are appointed by the Commonwealth Government Minister for the Environment and include an independent Chairperson, the Supervising

³⁶ Royal Commission into the approval of mining for uranium in the Alligator Rivers Region.

Scientist, independent scientific members with specific expertise nominated by the Federation of Australian Scientists and Technological Societies, and representatives of the Northern Land Council, Northern Territory Department of Mines and Energy, ERA, Uranium Equities Limited (current holder of the Nabarlek lease), and Parks Australia.

The committee recommends research programs and promotes strategies for the efficient coordination and integration of research through agreed Key Knowledge Needs. It meets twice yearly and provides advice to the Commonwealth Minister for the Environment. Committee meeting minutes are available from their website.³⁷

Alligator Rivers Region Advisory Committee

The Alligator Rivers Region Advisory Committee 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 Northern Territory Government departments, Charles Darwin University, Office of the Administrator of the Northern Territory, several Commonwealth Government departments (including Parks Australia and the Supervising Scientist Division), Australian Radiation Protection and Nuclear Safety Agency, ERA, Cameco Australia, Uranium Equities Pty Ltd, Koongarra Pty Ltd, Northern Land Council, Gundjeihmi Aboriginal Corporation, Environment Centre Northern Territory and West Arnhem Shire Council.

The Alligator Rivers Region Advisory Committee formally convenes twice a year and offers a forum for stakeholders to exchange views and information relating to the protection and rehabilitation of the Alligator Rivers Region environment from any potential effects of uranium mining. Committee meeting minutes are available from their website.³⁸

Minesite Technical Committee

The Ranger Minesite Technical Committee is the formal forum for regulators, including representatives of the Northern Territory Department of Mines and Energy (Chair), Office of the Supervising Scientist, ERA, Gundjeihmi Aboriginal Corporation and the Northern Land Council, to discuss and resolve technical environmental management issues relating to the operation of Ranger mine. The committee discusses matters relevant to the regulatory functions of the Northern Territory 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.

All changes to Ranger operations, beyond the activities approved in the Ranger Authorisation (currently the Ranger Authorisation 0108-15; Appendix A), require approval by the Supervising Authority (the Northern Territory Minister for Mines and Energy) on advice from the Ranger Minesite Technical Committee. Such approval is initiated by a formal "Application" for change process. The requirement means that there is regular consultation and review of issues between ERA and its regulators on relevant matters before they can be implemented.

In recent years the Committee has met monthly. Technical meetings of representatives of the Committee are often held outside the framework of the Minesite Technical Committee meetings to discuss specific issues: these outcomes are reported back to the Minesite Technical Committee.

In addition to general business relating to Ranger operations, the committee addresses:

- practices, procedures and measures for the management, storage and disposal of water, tailings and waste materials;
- performance of the approved water and tailings management systems and structures;

³⁷ www.environment.gov.au/ssd/communication/committees/arrtc/index.html

³⁸ www.environment.gov.au/ssd/communication/committees/arrac/meeting.html

- radiological exposures to workers and members of the public;
- environmental monitoring programs, reports and the environmental impact of mining operations;
- applications for changes to the Authorisation, including approval to implement site works, where practicable, within the required time frame for action; and,
- rehabilitation planning and works.

The Minesite Technical Committee makes recommendations for changes to operating and rehabilitation practices at the Ranger mine to the Northern Territory Minister for Mines and Energy. Part of the committee's objective is to devise and agree standards and measures for rehabilitation of the Ranger site.

Kakadu National Park Board of Management and Director of National Parks

Kakadu National Park surrounds ERA's Ranger Project Area and Jabiluka lease. Kakadu National Park is Commonwealth land for the purposes of the EPBC Act. It also encompasses several "matters of national environmental significance". Actions that may be taken outside the Park that may have a significant impact on the environment inside the Park are subject to assessment under the EPBC Act.

The Board, the Director and Park staff manage the Park in accordance with the EPBC Act and Regulations, the lease conditions, and, in consideration of Aboriginal cultural protocols and practices. These are contained within the Kakadu National Park Plan of Management guided by three primary principles: to protect the interests of traditional land owners; conserve the values of the park; and, encourage visitors to appreciate, enjoy and understand the park.

The majority of Board members must be indigenous persons nominated by the Traditional Aboriginal Owners of the land in the park.

West Arnhem Shire and town of Jabiru

The town of Jabiru was established in 1978 and is located on the traditional lands of the Mirarr. Jabiru was originally designed and constructed to house people directly or indirectly associated with uranium mining in the region but a change was made in 1986, allowing tourist accommodation to be established. The Jabiru town area is leased from the Director of National Parks to the Jabiru Town Development Authority. The Jabiru Town Development Authority is a statutory corporation established pursuant to the Jabiru Town Development Act 1979, and is responsible to the Northern Territory Minister for Local Government, to maintain, administer and develop Jabiru. Following local government reform, the town lies within the West Arnhem Shire, which provides a number of services and functions to Jabiru in conjunction with Jabiru Town Development Authority. Jabiru serves West Arnhem region as a centre for mining, tourism and community services. The current town lease, referred to as the "head lease", was issued in July 1981 and is due to expire in 2021.

Other Stakeholders

The Gagudju Association is an association of Aboriginal people from clans that originally occupied the lands of central and northern Kakadu National Park and the adjoining ERA mining leases. It was established in 1980 to manage royalties payable to these people from uranium sales from Ranger mine. Its role in this regard has been taken over by Gundjeihmi Aboriginal Corporation, which was established by the Northern Land Council in 1995. It is now an incorporated body and has become the central Aboriginal service and business organisation for its members, as well as investing in tourism ventures including hotels, the Jabiru service station and construction projects.

The Djabulukgu Association was originally formed in 1982, to represent its members in relation to the newly established, jointly managed Kakadu National Park and to receive royalties from park

operations and mining. The Djabulukgu Association now has business operations in Kakadu National Park and Jabiru, including a caravan park, and provides services to its members.

2.5 Environmental impact assessments under Commonwealth, state or territory legislation

In the event that the proposed action is determined to be a "Controlled Action", the proposed action will be subject to environmental assessment under the bilateral agreement between the Commonwealth and the Northern Territory Governments. Approval for the proposed action is being sought through a separate referral/notice of intent under the Commonwealth EPBC Act and the Northern Territory Environmental Assessment Act, respectively.

2.6 Public consultation (including with indigenous stakeholders)

The Ranger uranium mine has been in operation for over 30 years, and as such, ERA has a significant understanding of its stakeholders, their specific interests in the operation and how ERA interacts with each stakeholder. ERA's stakeholders can be classified into the following groups:

- Land owners and their representatives
- Indigenous associations
- Government (Commonwealth, Northern Territory and local)
- Regulatory committees
- Workforce
- Alligator Rivers Region (community, business and tourism)
- Investors

ERA has prepared an Overview of Communication and Consultation for the Ranger 3 Deeps underground mine, which is provided as Appendix D. The purpose of the document is to:

- outline ERA's communication objectives and guiding principles;
- identify the stakeholders for the proposed action; and
- summarise the stakeholder engagement on the proposed action to date.

Existing stakeholder interaction including indigenous stakeholders relating to the proposed action is undertaken using a number of forums and tools. Additionally, project specific tools will be developed such as fact sheets, information packages and public display material. Consultation and engagement relating to the project will continue throughout the assessment process.

2.7 A staged development or component of a larger project

Not applicable – see [Section 1.12](#).

3 DESCRIPTION OF ENVIRONMENT & LIKELY IMPACTS

3.1 Matters of national environmental significance (MNES)

Approach to assessment of "Likely impacts to MNES"

ERA recognises that a determination regarding the requirement for assessment and approval under the EPBC Act is dependent on whether an action will have, or is likely to have, a significant impact on a matter of national environmental significance. A search of the Commonwealth Environmental Reporting Tool and Protected Matters Search Tool, of the area described in [Section 1.2](#), was conducted in September 2011 and again in July 2012.

Nuclear actions require approval under the EPBC Act where they will or may have a significant impact on the environment. Nuclear actions include the mining and milling of uranium and therefore the proposed action is a 'nuclear action'. The determination of "significant" impact of this MNES requires a consideration of whole of environment and as such ERA sought to undertake a broad based environmental risk identification and assessment via a facilitated workshop. This also supports an assessment of matters relevant to the Northern Territory *Environmental Assessment Act*, and especially social and cultural factors that may not be of the same relevance to the EPBC Act determination.

This section provides the outcome of the MNES search tool analysis, an overview of the broader interactions between MNES and the Ranger Project Area and the subsequent assessment of both direct and indirect impacts (e.g. changes to traffic, emissions, etc) of the proposed action on MNES. A summary of the methodology and key outcomes of the facilitated environmental risk assessment is also provided, categorised by environmental components. Section [3.1\(a\)](#) through [3.1\(h\)](#) then describe each of the specific MNES and the nature and extent of likely direct and indirect impacts, if any, on these in the context of the proposed action.

Project Area and MNES Search

The Ranger Project Area is the area of land described in [Section 1.2](#). The Ranger uranium mine has impacted the environment within the area of operations on the Ranger Project Area as an inevitable part of open cut mining. These activities have been carried out in accordance with approvals and authorities under Northern Territory and Commonwealth legislation.

The proposed action will take place within the existing footprint of disturbance and is predominantly an underground activity, which will be managed under the same strict regulatory and environmental controls that currently exist for the Ranger operation. The decline constructed as part of the Ranger 3 Deeps Exploration Decline project will also be utilised to access to the proposed underground mine, which is located adjacent to Pit 3 (see Figure 11).

A report, generated via the Environmental Reporting Tool and Protected Matters Search Tool on MNES, as recognised under the EPBC Act, and is provided as Appendix E. The report was generated using the co-ordinates for the area shown as the white boundary on Figure 2, which extends past the area affected by the proposed action to include a substantial buffer zone, thus providing a more comprehensive identification of relevant environmental matters pertaining to the immediate surrounds of the Ranger Project Area. The results of the MNES search are summarised in Table 10. These data are further supplemented by the results of biodiversity surveys undertaken on both disturbed and undisturbed areas of the Ranger Project Area since mining commenced (see [Section 3.1\(d\)](#)).

In addition to the discussion provided in Sections [3.1\(a\)](#) to [3.1\(h\)](#) of this referral, an assessment of the potential impacts of the proposed action on listed threatened species and ecological communities; Commonwealth marine environment; and, migratory species protected under international agreements is provided as Appendix F. The assessment criteria are derived from those defined in the EPBC Act *Significant impact guidelines 1.1* (DEWHA 2009). Terminology used in the

assessment reflects the known state of species' existence within the immediate vicinity of, and/or on, the Ranger Project Area. For example: "not possible" indicates species that are known not to occur on the Ranger Project Area.

Appendix F also provides an assessment of the impacts of the proposed action on listed Northern Territory threatened species (see Tables 4 to 7 of Appendix F). The threatened species criteria are sourced from the revised Northern Territory Threatened Species List (DLRM 2012) and the International Union for Conservation of Nature Red List Guidelines (IUCN 2012.2). Distribution and ecological descriptions are sourced from the revised Northern Territory Threatened Species List (DLRM 2012), Woinarski, *et al.* (2007), and the International Union for Conservation of Nature Red List Guidelines (IUCN 2012.2).

Table 10: Summary of MNES, as recognised under the EPBC Act

MNES	Number	Comments
World heritage properties	1	Kakadu National Park surrounds the Ranger Project Area within which Ranger mine is located.
National heritage properties	1	Kakadu National Park surrounds the Ranger Project Area within which Ranger mine is located.
Wetlands of international significance	2	Kakadu (stage 1 & 3) Kakadu (stage 2) Ranger is located within the catchment areas of the 2 Ramsar sites identified by the MNES search.
Commonwealth lands	2	Kakadu National Park surrounds the Ranger Project Area within which Ranger mine is located. Alligator Rivers Region, Northern Territory
Threatened ecological communities	1	Arnhem Plateau Sandstone Shrubland Complex This ecological community does not occur on the Ranger Project Area.
Threatened species	14	
Migratory species	20 ³⁹	

Facilitated Environmental Risk Assessment

An environmental risk workshop has been conducted for the proposed action, facilitated by an external consultant. Relevant standards that informed the environmental risk assessment included:

- ISO 31000:2009, Risk Management – Principles and Guidelines
- HB 203:2012, Managing Environment-related Risk
- ISO 14001:2004, Environmental Management Systems – Requirements.

The report is provided as Appendix G.

A number of potential threats to the biophysical environment were identified across a range of environmental aspects. For each potential threat, the "causes" giving rise to the threat were listed,

³⁹ Note that two species (*Ardea alba* and *Ardea ibis*) occur in more than one migratory category.

along with the potential impacts and the existing and/or planned⁴⁰ controls. For each impact, the potential consequence rating ranging from "low" to "very high" was established through consideration of the severity, extent and duration. Consideration of the likelihood⁴¹ of the potential impact occurring then generated an overall risk ranking from "low" to "very high".

It should be noted that this risk ranking does not directly correlate to impact "significance" in the context of MNES assessment. Rather the purpose of the risk ranking within the risk assessment was to identify those environmental risks that may need further attention and consideration during the evaluation and design phases of the proposed action. A risk of "high" ranking does not infer a "likely significant impact on an MNES", but rather just a requirement to ensure appropriate mitigations or controls are implemented and/or actions taken to reduce the severity of the consequence and/or the likelihood of occurrence.

All of the identified potential impacts on the biophysical environment were ranked as "low", "moderate" or "high" with no "very high" ranked impacts. The potential impacts with a risk ranking of "high" are discussed in this section, together with all those potential impacts of "moderate" overall risk ranking, where the potential consequence was rated above "moderate".⁴² These "high" and "moderate" risks are distributed across the following environmental aspects:

- groundwater quality (2)
- air quality and radiation (1)
- transportation (1)
- cultural heritage (2)
- social and community (6)

A discussion of each potential impact for these environmental aspects is provided below. The discussion outlines the relationship between the potential impact and MNES; the available information from past and proposed action-specific studies; and an overview of the controls and monitoring that will mitigate potential consequences and reduce the likelihood of impacts. All of the identified potential impacts are considered to have very low likelihood for significant impact on the environment and MNES. Description of the relevant environment, the nature and extent of likely impacts on each of the MNES is provided in Sections [3.1 \(a\)](#) to [3.1\(h\)](#) and [Section 3.3](#).

Groundwater Quality

The risk assessment identified two potential impacts of moderate risk ranking:

- (TE01) Contamination of groundwater via a loss of containment of tailings deposited as cemented paste backfill in underground stopes
- (TE03) Accelerated solute transport via the underground workings acting as a conduit and providing a preferential pathway from Pit 3 backfill.

These identified risks may be considered most relevant to the MNES "Wetlands of International Importance (declared Ramsar wetlands)" and "World Heritage Properties" as the receiving environment for contaminants could be Kakadu National Park and its wetland systems. However, on the basis of the extensive knowledge of groundwater provided below, the scale of the proposed

⁴⁰ For the purposes of the risk analysis it is assumed that any controls documented in Appendix G would be implemented within the design and construction of the proposed action or be active during the operation of the activity as appropriate.

⁴¹ Likelihoods ranged from "unlikely" to "almost certain". No "remote" or "rare" category was used. This has a consequence of ranking most potential impacts of "very high" potential consequence as a minimum of "high" ranking even where the potential impact is very "unlikely" to occur.

⁴² All lower ranked risks are provided in the consultant report and risk table in Appendix G.

action and specifications of the cemented paste these risks are very unlikely to result in a significant impact on MNES.

The movement of groundwater at Ranger is largely influenced by:

- Soil and rock properties, especially the permeability, or more technically the “transmissivity”, a measure of the propensity to allow passage of water through the rock/soil;
- Topographic gradients, whereby groundwater will typically flow downhill under the influence of gravity;
- very low rates of groundwater recharge;
- mine landforms such as the stockpiles and the tailings storage facility, which may cause localised groundwater mounding, where groundwater may be drawn closer to the original surface, toward the artificial structures; and
- the mine pits which act as groundwater sinks drawing down groundwater from the immediate surrounds.

All these influences are relevant to the proposed underground mine operating from the surface to the zone of underground stopes and drives at depth. The upper portion of the decline will pass through the upper weathered zone and interact with groundwater subject to each of the influences described above. The proposed action will lie predominantly beneath the Pit 3 groundwater sink.

The shallow groundwater characteristics surrounding Pit 3 in the region of the proposed action are well understood through analysis of extensive bore monitoring data. These data and observations of groundwater in-flow into Pit 1 and Pit 3 show that key pathways for groundwater movement are highly weathered rocks in fault zones. Such inflows therefore only occur in the upper weathered zone. Groundwater in rocks below the weathered zone is compartmentalised with low hydraulic gradients and permeability; and with very little or no interactions with surface water systems. As an example, there have been no observations of groundwater inflow into Pit 1 from the unweathered rock sequences. Similarly, greater than 90 % of groundwater inflows to Pit 3 are from weathered rocks.

Piezometric⁴³ levels near Pit 3 and below around 100 m depth show little or no variations in response to changes in the pit excavation. The absence of a large cone of depression in piezometric levels surrounding Pit 3 is indicative of the low permeability of the subsurface rocks. Field hydrogeological investigations and groundwater modelling studies, using both historical and current data, have identified subsurface pathways for waters from Magela Creek to flow into Pit 3 via shallow sand layers and underlying weathered rock units in the north-eastern area of the pit at depths of around RL-10 m. However, airborne electromagnetic data suggest that there is no continuous, deep groundwater pathway or connected aquifers extending north of Pit 3 and beneath Magela Creek.

There is little connection between aquifers in the weathered and underlying unweathered rock sequences and Magela Creek. This finding is based on the results of a significant number of studies over many years, including creek flow behaviour, groundwater recharge-discharge in the region of Magela Creek and Georgetown Billabong, recharge rates to weathered rocks that discharge to Magela Creek, groundwater age-dating, and computer model predictions of changes to Magela Creek flow due to mining Pit 3. The studies confirm that surface runoff and evapotranspiration are the most significant elements of the hydrological balance in the region. In particular, creek discharge measurements and modelling indicate that 6 mm/year of Magela Creek flow is derived from groundwater (average rainfall is around 1,530 mm/year). This correlates well with estimates by other researchers of groundwater inflow to Gulungul Creek (7–21 mm/year) and Georgetown Billabong (22 mm/yr).

⁴³ The piezometric level is the imaginary level in a confined aquifer to which the water level will rise in bores penetrating the aquifer. If this level is above the ground surface, the bore is a free-flowing or artesian bore. (Source: <http://content.alterra.wur.nl/Internet/webdocs/ilri-publicaties/publicaties/Pub57/pub57-h2.pdf>).

Groundwater discharge rates are directly related to groundwater recharge rates. Estimates of mean groundwater residence time at Ranger using the results of ¹⁴C isotope analyses are between 950–11,000 years and in some areas much greater, suggesting that recharge rates are very low.

These recharge-discharge studies are very consistent and confirm that groundwater recharge rates and discharge rates to Magela Creek are of the order of 1–2 % of average annual rainfall. Given that the Pit 3 groundwater catchment covers an area of less than 1 km² and the Magela Creek catchment covers an area of approximately 620 km² (upstream of the boundary between the Ranger Project Area and the national park), interception of all potential groundwater inflows to Magela Creek through in-pit backfilling and the proposed underground mine in the Pit 3 catchment would have an insignificant impact on flows in the creek. This estimate has been validated by model simulations of the impact of dewatering Pit 3 on Magela Creek flows showing that leakage from the creek might be of the order of 0.01–0.02 % of peak wet season flows.

Probably groundwater inflows to the proposed underground mine are estimated to be 2 ML/d. Although these are very low rates, groundwater inflows to the underground mine will be informed by data collected during the Ranger 3 Deeps Exploration Decline project. ERA also plans to undertake further hydrogeological test work in 2012–2013 to enhance hydrogeologic knowledge within the region of the Ranger 3 Deeps mineral resource and Pit 3 – Magela zone (see Figure 23). Four core holes will be drilled from ground surface to the Ranger 3 Deeps mine depth to:

- measure permeability at discrete intervals to verify current assumptions;
- identify any structures, i.e. faults and fractures, with exceptional flow; and

Additional holes to the north side of Pit 3 will be drilled to measure the permeability between Pit 3 and Magela Creek. However, based on considerable bore testing, monitoring and electromagnetic data, risks to water quality and seasonal flow rates in Magela Creek, and to the surface and groundwater quality in Magela Creek and downstream from the proposed action, are considered to be negligible.

In summary, the two potential impacts identified are unlikely to occur on the basis of the current knowledge of groundwater, particularly the low permeability of the surrounding rock and the intention for cemented paste to be engineered such that it exhibits low permeability characteristics. In the absence of pathways for contaminants to enter the surface water systems in any significant quantities there is negligible likelihood that the proposed action would result in impacts such as a measurable change in the water quality of the wetland, significant impact on the habitat or lifecycle of native species dependant on the wetland or any other significant impact on the ecological character of the wetland. It is equally unlikely that the proposed action would cause World Heritage values to be lost, degraded or damaged, or notably altered, modified, obscured or diminished through changes to groundwater.

Air Quality and Radiation

The risk assessment identified one potential impact of moderate risk ranking:

- (TA06) Increased radiation dose to public, flora and fauna from ventilation emissions.

This risk has relevance to those MNES in proximity to the proposed action, namely "Wetlands of International Importance (declared Ramsar wetlands)", "World Heritage Properties", "National Heritage Places", "Listed threatened species and ecological communities" and "Listed migratory species". However contaminant dispersion modelling, discussed below predicts negligible increases in levels of contaminants within and beyond the immediate area of the proposed action. At locations where the public may be exposed, such as Jabiru, the airport and Mudginberri, radiation dose is predicted to be orders of magnitude⁴⁴ below that resulting from current operations and natural

⁴⁴ "Order of magnitude" means "factor of ten". For example 1 kg is an order of magnitude less than 10 kg and two orders of magnitude less than 100 kg. Thus in the context here doses are "tens" or "hundreds" of times less than would be of concern.

background. Sections [3.1\(d\)](#) and [3.1\(e\)](#) discuss the very low potential for interaction of listed and migratory species with the proposed action due to the very small footprint and lack of suitable habitat in the zone of infrastructure. For these reasons the proposed action is not likely to result in a significant impact on MNES.

Air Quality

ERA commissioned an ambient quality assessment to develop an understanding of the spatial dispersion of emissions associated with the operation of a ventilation stack (Quinn 2012). The principal emission sources associated with activities are:

- Underground blasting;
- Underground diesel trucks; and
- Radon emissions from mineralised rock faces.

The modelling assumed that 100 % of all emissions associated with the activities are emitted by the ventilation system to atmosphere. The air study assessment included the following three computer models (AUSPLUME, CALPUFF and CSIRO TAPM).

- AUSPLUME:⁴⁵ A Gaussian dispersion model that is strong in simulating near field air concentrations and the deposition of target particulates.
- CALPUFF:⁴⁶ An advanced dispersion model that incorporates calculations to handle multi-level meteorology and three dimensional terrain features as a non-steady state “puff” dispersion model, individual puffs are considered separately which allows for changes in both wind speed and direction over time. CALPUFF is highly suited to modelling the dispersion behaviour of gases and so it has been adopted for radon, sulfur dioxide and other gaseous contaminants.
- CSIRO TAPM: provides upper air meteorological data to compliment surface wind data available from Jabiru Airport.

For the purposes of the air study, the National Environment Protection Measures pollutants included sulfur dioxide,⁴⁷ PM₁₀, and PM_{2.5}. Total suspended particulates emissions are principally required to establish radionuclides deposition. These pollutants and their respective criterion are listed in Table 11. In addition, radon dispersion has also been modelled based on calculated rock emanation.

Table 11: National and New South Wales assessment criteria

Species	Criterion at 25°C	Averaging time	Source
Sulfur dioxide	0.20 ppm (524 µg/m ³)	1 hour	National Environment Protection Measures
Sulfur dioxide	0.08 ppm (210 µg/m ³)	24 hours	National Environment Protection Measures
Sulfur dioxide	0.02 ppm (52.4 µg/m ³)	1 year	National Environment Protection Measures

⁴⁵ Recommended by state environmental protection agencies for this type of assessment.

⁴⁶ The latest version of CALPUFF used for this assessment has been adopted by the International Atomic Energy Agency (IAEA) as the preferred model for dispersion simulations of radioactive substances. The U.S. Environmental Protection Agency recommends CALPUFF as the preferred model for assessing the long range transport of pollutants.

⁴⁷ Associated with Ammonium Nitrate Fuel Oil (ANFO) and diesel combustion engines.

Species	Criterion at 25°C	Averaging time	Source
Particulates (PM ₁₀)	50 µg/m ³	24 hours	National Environment Protection Measures
Particulates (PM _{2.5})	25 µg/m ³	24 hours	National Environment Protection Measures
Particulates (PM _{2.5})	8 µg/m ³	1 year	National Environment Protection Measures
Particulates (total suspended particulates)	90 µg/m ³	1 year	ARPANSA ⁴⁸
Total particulates deposition	4 g/m ²	1 month	New South Wales Department of Environment and Climate Change
Radon (Reference Level) ⁴⁹	100 Bq/m ³	not applicable	World Heritage Organization
Radon	45 Bq/m ³	1 year	ARPANSA ⁵⁰

Model simulations were based on 2008 meteorological data, which was determined by the consultant (ECS Assist Pty Ltd) to be the most accurate representation of Ranger site conditions.

The modelling was based on a single exhaust ventilation shaft and blasting and excavation of one stope. Variables for the modelling included vent shaft location (Figure 24), height of the ventilation stack (5 m and 10 m), pollution control on major equipment, meteorology including worst case conditions and blast times. Figures 24 and 25 show predicted total suspended particulates particulate deposition at a selection of receptor locations; Figure 26 shows the predicted airborne particulate contaminants with relevant criteria at various receptors; Figure 27 shows the predicted radon concentration contours. This assessment shows:

- All particulates (deposition and concentrations) are localised to within a few 100 m of the source.
- All contaminants are significantly below criteria at sensitive receptors (by orders of magnitude).
- Incremental radon is negligible when compared to the natural background and emissions from the current operations and well below applicable limits.
- Airborne radioactive dust is an order magnitude less compared to the natural background and emissions from the current operations and well below applicable limits.
- Deposited radionuclides in dust over the life time of the proposed action are five orders of magnitude less than current background.
- Member of the public radiation exposures will remain low and well below the limits detailed in [Section 2](#).

⁴⁸ Total suspended particulates concentration that would deliver a radiation dose equivalent to the ARPANSA member of the public limit of 1 mSv per year. Assuming an average ore grade of 0.3 % uranium oxide and 100 % occupancy of the reference individual at that concentration and the Ranger prescribed dose conversion factors (Ranger Authorisation 0108-15).

⁴⁹ The World Health Organization Reference Level represents the maximum accepted radon concentration in a residential dwelling. For homes with radon concentrations above these levels remedial actions may be recommended or required.

⁵⁰ Radon concentration that would deliver a radiation dose equivalent to the ARPANSA member of the public limit of 1 mSv per year. Based on 100 % occupancy of the reference individual at that concentration with an equilibrium factor of 0.4 (ICRP 1993).

- The risk to non-human biota (plants and animals) from radionuclides in dust deposition will be negligible.

In order to understand the sensitivity associated with the location of ventilation shafts within the proposed vent corridor, additional predictive modelling was undertaken over 500 m to the north of the previous vent option 1 (Yu 2012). As illustrated in Figure 24, the difference in dispersion and deposition characteristics between the two vent locations is negligible and still orders of magnitude lower than the prescribed criteria.

The outcomes listed above can be reasonably expected to hold for the proposed action. Whilst the output and dispersion of airborne contaminants will not necessarily scale directly with the number of active stopes and ventilation shafts it is very unlikely that the ten, hundred or thousand -fold increases required to exceed criteria would occur when activity is only doubled or tripled compared to the preliminary scenario that has been modelled. The likelihood of air emissions having a significant impact on MNES is therefore considered negligible.

Radiation Management

The International Atomic Energy Agency recommends that pre-operational studies should be performed for all practices to establish 'baseline' environmental radiation levels and activity concentrations for the purpose of subsequently determining the impacts of the source (IAEA 2005). Knowledge of baseline environmental conditions is important for two reasons. First, to form a basis for estimating the potential impacts of the proposed action on the local environment; and second, to provide a record of initial conditions, which will be essential both during operations, and when project decommissioning takes place.

"Baseline data collected prior to the development of waste management facilities should be used to provide a reference by which the results of post-closure monitoring can be compared." (IAEA 2002)

Initial baseline data was collected prior to commencement of operations at Ranger uranium mine in the 1970s; however the amount and quality of data, while adequate for the time of collection was found to be less than that of today's standards. In order to better determine the pre-mining radiological conditions at Ranger, several studies have been conducted by the Supervising Scientist Division.

As part of the environmental studies undertaken within the prefeasibility study for the proposed action, the current environmental radiological conditions are being determined. This will add to the knowledge obtained about pre-mining radiological conditions by the Supervising Scientist Division.

The International Atomic Energy Agency (2005) recommends that pre-operational studies should be designed to provide basic environmental data for use in the prediction of doses to the public and discharges to the environment. The specific parameters to be monitored depend upon types of radionuclides expected to be present in the operations and the possible discharge pathways. The pathways for transport of radionuclides into the environment from uranium operations have been shown diagrammatically in Figure 28.

A pathways analysis for potential radionuclide transport into the environment from the operation of the proposed Ranger 3 Deeps underground mine was undertaken in order to determine the monitoring parameters for the pre-operational studies. A summary of each pathway, the potential risk, monitoring technique and radionuclides analysed has been provided in Table 12. Monitoring outlined in this table will be obtained from both a literature search of historically collected information and a new monitoring program that has recently commenced.

Table 12: Selection of radionuclides for analysis for each pathway based on potential risk

Emission	Incremental sources for Ranger 3 Deeps	Potential pathway	Potential risk	Sampling technique	Radionuclides
Dust	<ul style="list-style-type: none"> Dust from blasting and general underground operations emitted from ventilation stacks Dust from general trucking of ore and waste rock to the processing plant and stockpiles Dust re-suspension from run of mine pad and stockpiles 	Inhalation of long lived alpha emitters	Increased radiation dose to public	Long lived alphas in airborne dust	U-238, Th-230, Ra-226, Pb-210
		Accumulation of radionuclides in surface soils and up take into bush foods	Increased gamma exposure to public	Thermo luminescent dosimeters and gamma survey meter	External dose (mSv)
			Increased radiation dose from ingestion of bush foods	Collection of bush foods	U-238, Th-230, Ra-226, Pb-210, Po-210
			Exposure of terrestrial biota	Surface soil scrapes	U-238, Th-230, Ra-226, Pb-210, Po-210
Water	Groundwater ingress into mining operations added to general site water inventory	Deposition of long lived radionuclides in creek sediments	Exposure of terrestrial biota	Creek sediment samples	U-238, Th-230, Ra-226, Pb-210, Po-210, Th-234
		Accumulation of long lived radionuclides in aquatic biota	Increased radiation dose from ingestion of bush foods	Collection of bush foods	U-238, Th-230, Ra-226, Pb-210, Po-210
			Exposure of terrestrial biota	Surface water samples	U-238, Th-230, Ra-226, Pb-210, Po-210, Th-234
		Ingestion of radionuclides from drinking water from local creeks	Increased radiation dose		
Radon	Radon emissions from ventilation stacks	Inhalation of radon decay products	Increased radiation dose to public	Passive airborne radon	Radon

The selection of radionuclides to be analysed for each pathway was dependent upon the following:

- potential for emission from operations (e.g. blasting, dust from truck movements);
- potential for uptake into plants and animals;
- half-life
 - potential to accumulate in the environment over time if long lived;
- radiation type;
 - alpha emitters deliver higher radiation doses for internal pathways;
- the natural abundance of the radionuclide;
 - U-238 and its decay products have a natural abundance of approximately 99.3 % by mass compared to U-235 and its decay products which only accounts for 0.7 % by mass. Therefore U-238 and its decay products have more significance;

- higher dose conversion factors for humans or biota;
 - some radionuclides delivering higher doses per unit activity, for example Po-210 and Ac-227 in humans and Th-234 in aquatic biota (IAEA 1996) .

The radiation risk assessment being conducted as part of the Ranger 3 Deeps underground mine prefeasibility study will quantify each of these pathways using a variety of models, including the expanded ambient air quality model outlined earlier in this section. This information will then be used to more accurately predict the potential radiation exposure to members of the public and confirm the preliminary prediction of very low risk to the environment from the operation of the Ranger 3 Deeps underground mine.

Part of the assessment of risk to members of the public will be to determine the representative person⁵¹ and set an appropriate dose constraint. For the current Ranger operation the representative person is an adult living in Jabiru. Assuming the representative person was to remain the same as for current operations and using the data from the initial ambient air quality assessment⁵² then member of the public incremental doses from ventilation stack emissions are expected to be less than 0.001 mSv per year, similar to existing operations (refer [Section 4](#) and Figure 36). This is well below the member of the public limit of 1 mSv per year.

The radiation risk to non-human biota (plants and animals) will be assessed using the ERICA⁵³ tool. The assessment tool is structured around a three tiered approach: generic screening, detailed screening and site-specific analysis. Recently there has been increasing awareness of the potential vulnerability of the environment and of the need to be able to demonstrate that it is protected against the effects of industrial pollutants, including radionuclides. The International Commission on Radiological Protection (2007; 2008), has addressed this by recommending that assessments be undertaken of the risk from radiation to animals and plants. The pathway for exposure of non-human biota will be predominately via dust deposition. The air quality modelling, detailed in the previous section, has demonstrated that the incremental radionuclide concentration building up in the soil over the life of the proposed action will be less than 1 mBq/kg, compared to the background concentrations in the order of tens of Bq/kg. Based on this the risk to non-human biota is expected to be negligible.

In summary, the potential impact of increased radiation dose to public and environment is very unlikely based on preliminary air dispersion and radiation modelling, and as such this environmental component of the proposed action is not likely to have a significant impact on MNES.

Transportation

The risk assessment identified one potential impact of high risk ranking:

- (TP01) Increased traffic on access highways, results in a spill of hazardous materials/waste causing environmental harm.

This risk has relevance to MNES in proximity to the highway over which consumables and products are transported, predominantly "World Heritage Properties", however any incremental traffic is also a potential risk to public safety. The transport of consumables, including dangerous goods like concentrated sulfuric acid, diesel, sodium hydroxide, kerosene (ShellSol), alamine and lime is a recognised and ongoing risk to the current operation.

⁵¹ A representative person is an individual member of the public receiving a radiation dose that is representative of the most highly exposed individuals in the population.

⁵² Assumed emissions were a conservative ten times greater for the mine compared to the exploration decline that was modelled.

⁵³ Environmental Risk from Ionising Contaminants Assessment Tool.

ERA has developed a strong partnership with Orica and Chemtrans, accredited specialist transport companies, to foster best practice in delivery of sulfuric acid to the Ranger mine. Key transport safety elements include: specially engineered truck and trailer configurations and braking systems, route evaluations, continuous driver training and assessment, global positioning satellite tracking of truck location and speed, satellite telephones for emergency contact and emergency response facilities. A similar focus on safety has been developed with all other accredited transport companies that deliver consumables to the Ranger mine and transport product from site.

With respect to the proposed action, the traffic profile will remain relatively constant, there will be no changes to the reagents used in processing, and all existing controls will be maintained, and therefore the risk profile remains unchanged. The likelihood of incremental transportation directly associated with the proposed action having a significant impact on a MNES is, therefore considered negligible.

Cultural Heritage

The risk assessment identified one potential impact of moderate risk ranking (TC01) and one potential impact of high risk ranking (TC03):

- (TC01) Disturbance or damage to a known cultural heritage site.
- (TC03) Intersection or discovery of an anthropological site during mining leads to an impact on cultural significance

For detail pertaining to cultural and heritage significance on the Ranger Project Area and ERA's cultural heritage management system, see [Section 3.3\(i\)](#).

In summary, the construction and operation of the surface infrastructure related to the proposed action will not impact on the known cultural heritage sites with the existing mitigation measures in place. These measures include for example a cultural exclusion zone fence around site R34. In addition, preliminary vibration modelling indicates that blast vibration, experienced at known cultural heritage sites, from the proposed underground mining activity will be much less than that associated with open cut operations.

In regard to the possible intersection with material of anthropological significance, ERA will mitigate potential impacts after direct consultation with land owners, as to the preferred course of action.

Whilst ERA will continue to manage these risks in the immediate vicinity of the proposed action, there are no potential impacts of this type on MNES as the proposed action is fully contained within the Ranger Project Area.

Social and Community

The risk assessment identified two potential impacts of moderate risk ranking (TJ03 and TJ04):

- (TJ03) Increased workforce leads to increased local social nuisance.
- (TJ04) The requisite skills for underground mining may increase reliance on interstate recruitment and may reduce local and regional employment opportunities.

The risk assessment also identified four potential impacts of high risk ranking (TJ01, TJ02, TJ07 and TJ09):

- (TJ01) The design of vent and fans generates noise nuisance incompatible with traditional lifestyle and access, leading to decreased incentive for land owners to use nearby areas.
- (TJ02) The design of vent and fans, and thus changes to visual amenity is incompatible with traditional lifestyle and access, leading to decreased incentive for land owners to use nearby areas.

- (TJ07) Lack of co-ordination of engagement between ERA and land owners resulting in a loss of richness of information sharing, loss of land owner confidence in our strategy and a lack of respect for cultural values.
- (TJ09) Perceived higher health, safety and environment risk with underground mining, leads to a lack of public support for the proposed action.

None of these risks have any potential to impact on MNES, however preventing or mitigating such impacts will be important to traditional land owners, and local and regional stakeholders. As such the following information on employment, ERA's community contributions, workforce behaviour and visual amenity is relevant to the proposed action and these risks.

Employment Opportunities

The Jabiru economy is characterised by a relatively specialised industrial structure, with mining being the town's principal provider of jobs and the driver of Jabiru's economic development. While other sectors such as accommodation, cafes and restaurants and education are significant, they are also highly dependent on economic activity generated by the Ranger uranium mine.

Construction and operation of the proposed Ranger 3 Deeps underground mine will ensure the high existing levels of private sector employment will continue in Jabiru. ERA is committed to increasing the participation of local Aboriginal people in private sector employment. ERA will endeavour to maintain high levels of indigenous employment, likely to be in the order of 20 % of the workforce. ERA also has training programmes to establish and develop capability in the local region.

In summary, ERA believes the current regional demographics will not be significantly altered by the proposed action. The proposed action stands to extend Ranger's profitable operation within the time frame for closure specified in the Section 41 Authority.⁵⁴ This sustained business activity will enable ERA to continue contributing to the development of local indigenous populations to deliver services and opportunities. ERA is working closely with traditional land owners and governments to develop a vision for the future of Jabiru.

Community Contribution

The potential regional and global opportunities to be derived from the proposed action include:

- through partnerships and royalties, contributing to the development of the capacity of local indigenous populations to deliver services and opportunities;
- contribution of economic benefits to Jabiru and broader regional communities; and
- provision of low carbon energy production in overseas markets.

ERA currently participates or contributes to the following partnerships or services to the community:

- Supply of power to the Jabiru, Jabiru East and Mudginberri communities
- Management and maintenance of the Jabiru Airport: ERA does not currently charge landing or operating fees to non-ERA airport users who make up 82 % of airport traffic (including tourism, charter and freight flights). In addition, while emergency flights are approximately only 1 % of the airport usage, Jabiru it is the only airport located within Kakadu National Park suitable for 24 hour emergency flight response.
- ERA supports indigenous rock art research in the Alligator Rivers Region of the Northern Territory through its partnership with the Museum and Art Gallery of the Northern Territory Foundation. The George Chaloupka Fellowship provides support for a research fellow to work in the area of rock art preservation and research

⁵⁴ As previously noted in the absence the proposed action, processing of ore from stockpiles will only continue whilst it is economic to do so.

- Ownership and sub-leasing of residential and commercial property in Jabiru:
 - ERA holds sub-leases over 287 dwellings in Jabiru, 52 are on-leased to third parties and 235 are occupied by ERA employees.
 - ERA holds and on-leases 8 commercial buildings including 6 small retail shops within Jabiru Plaza, the Jabiru Sport and Social Club building and the Supermarket building.
- Continued support to a partnership with the Northern Territory Department of Education and Training and the West Arnhem College to help improve the region's education system. The partnership programme offers all students in Jabiru, Gunbalanya and the surrounding region greater education opportunities and access to important pathways for future career options and training.
- Continued support to the National Indigenous Music Awards. ERA is a major sponsor of the National Indigenous Music Awards and is pleased to support an event which helps develop established and emerging artists.
- Continued community contributions through community partnerships, in-kind support and donations of equipment and resources. The community partnerships are developed through the ERA Community Partnership Fund (the Fund) which aims to contribute to the development of a healthy and positive community in the Alligator Rivers region.
 - Preference is given to applications seeking support for projects which build meaningful partnerships with local business and communities, demonstrate a value-add to the local community, or enhance sustainable, educational and employment opportunities for the community.
- A recent economic assessment of ERA's current economic impact determined the following: ERA's combined gross regional value added in 2011 for both direct and indirect contribution was:
 - 87 % of Jabiru's gross regional value added;
 - 52 % of the Alligator region gross regional value added (statistical region for the 2011 Census); and
 - 3.6 % of the Northern Territory's gross value added.
- ERA is directly and indirectly responsible for generating 71 % of jobs in Jabiru and 2.6 % of the Northern Territory's total employment.
- ERA directly employs approximately 100 indigenous employees, corresponding to 18 % of ERA's total direct workforce.
- ERA's royalty payments are a major source of income for the indigenous community as well as the Northern Territory Government:
 - In 2011 ERA paid a total of \$16.35 million including \$12.68 million benefiting indigenous community and \$3.67 million in royalty payments distributed by the Commonwealth to the Northern Territory Government.

Workforce Behaviour

ERA employees and contractors accommodated in Jabiru or on the Ranger Project Area agree to strict codes of conduct. All employees and contractors are subject to random drug and alcohol testing when reporting to work at the mine, and there are policies in place and adhered to with respect to drugs and alcohol. Employees and key contractors are required to attend cross-cultural awareness training as part of their Ranger induction, as well as briefings by Kakadu National Park staff in relation to awareness of the World Heritage values of Kakadu National Park.

Noise Nuisance

Preliminary noise and vibration studies indicate levels will be well below prescribed criteria at sensitive receptors. However, noise reduction technology may be implemented if necessary, and in consultation with land owners.

Visual Amenity

The placement of fans and ventilation shafts are an unavoidable component of the proposed action, which will create some measure of localised visual amenity impact for the duration of the proposed action. The proposed ventilation shafts are the only additional aboveground infrastructure associated with the proposed action in the region of the Magela Land Application Area. ERA is currently reviewing both a 5 m and 10 m stack height. This has predominately been driven by a need to understand the associated dispersion characteristics for these alternatives. The optimal stack height will be identified as part of the ventilation system Best Practicable Technology assessment of which visual amenity will be a consideration. ERA will also undertake a visual amenity assessment and discuss the outcomes in consultation with traditional land owners. Where alternative locations are technically feasible, ERA will consider traditional land owner preferences and/or other mitigating measures.

Summary: Potential Social and Community Impacts

ERA will mitigate the potential for, and severity of, the workforce-related threats through continuation of its general and indigenous specific employment strategies and training programs; and through robust enforcement of behavioural policies.

To address threats and impacts associated with noise nuisance and visual amenity which may be incompatible with traditional land owner access, preliminary noise and vibration and visual amenity studies will be extended and the outcomes discussed in consultation with traditional land owners. Where technically feasible, infrastructure location will consider traditional land owner preferences and/or other mitigating measures as required.

The potential impacts relating to traditional land owner and community engagement, and concerns relating to underground mine health and safety, will be mitigated through continued implementation of a company-wide and project specific communication plan. In addition, a strong and continued "zero harm" safety focus and comprehensive environmental management system will continue to be implemented.

3.1 (a) World heritage properties

Description

Kakadu National Park is inscribed on the World Heritage List under the World Heritage Convention for its outstanding natural and cultural values, and is one of only 23 World Heritage sites listed for both its natural and cultural heritage. For a detailed description of the cultural and natural world heritage criteria against which the property is listed, see the United Nations Educational, Scientific and Cultural Organization website: <http://whc.unesco.org/en/list/147>.

Art and cultural sites within Kakadu National Park represent a unique artistic achievement and demonstrate past environments (including illustrations of species now extinct) in Northern Australia, having had a continuous temporal span from the Pleistocene Epoch (more than 12,000 years ago) until the present. Kakadu National Park also contains examples of ongoing ecological and geological processes, biological evolution and evidence of human interaction with the natural environment. The park incorporates almost the entire catchment of a tropical river system (the South Alligator) and has the widest range of habitats and the greatest species diversity of any similar-sized area in monsoonal Northern Australia. It also contains many endemic flora and fauna species.

Nature and extent of likely impact

Ranger uranium mine has impacted the environment within the area of operations on the Ranger Project Area as an inevitable part of exploration, open cut mining and processing of uranium ore. The current operation is managed under a complex suite of Commonwealth and Northern Territory regulations. The existing regulatory and operating systems, together with the Commonwealth Environmental Requirements attached to the Section 41 Authority, ensure that appropriate controls are in place to manage impacts and mitigate any potential for additional risks to the surrounding environment.

Ranger uranium mine has demonstrated a high level of ongoing environmental protection over its 30 year operational life. The proposed action is not expected to result in a significant material change to the existing operation. For example, ore will be processed using the existing mill and current operational systems (e.g. water, waste, radiation management, etc) will apply to the proposed action. In addition, the strict regulatory and environmental controls that currently exist for the Ranger operation will also apply to the proposed underground mine.

Whilst the Ranger Project Area is surrounded by the world heritage property Kakadu National Park, the proposed action is fully contained within the Ranger Project Area. Across all environmental aspects the proposed action has a much lower potential to have harmful interactions with the surrounding environment compared to open pit mining.

Preliminary modelling has shown that dust and gaseous emissions, including radioactive elements, are likely to be well below criteria even in the immediate vicinity of the proposed action. The known hydrogeology of the Ranger Project Area, and particularly the measured very low permeability of the rock at the depth of the proposed underground mine would indicate that waterborne solute contaminants from the mine will not enter surface waterways in any quantities that could pose a risk to the surrounding environment. Whilst process water and pond water inventories will have small incremental changes the current system of water management, with enhanced treatment capacity delivered by the brine concentrator, will robustly protect the surrounding environment. The disturbance area for both construction and ongoing operation will be less than 2 ha and close to existing infrastructure and distant from the riparian zone of Magela Creek. Thus the proposed action is not likely to have a significant impact on any natural heritage values of the world heritage property.

Construction and operational activities will deliberately avoid all known archaeological sites, and there are robust controls such as fencing, and a buffer zone, to protect the important cultural site in the near vicinity of the proposed action. The most significant new infrastructure relevant to visual amenity, the ventilation raises will not be visible from the Ranger Project Area boundary due to the vegetation of the area. Rehabilitation and revegetation of the previously disturbed area, in which the activity will be located, will occur during the time frame of the proposed action, such that incentive for use of near-by areas for cultural purposes may be enhanced rather than diminished. Thus the proposed action is not likely to have a significant impact on heritage values, including indigenous heritage values of the world heritage property.

For these reasons and consistent with the risk assessment, it is very unlikely that the proposed action will result in a significant impact on the world heritage values of the Kakadu National Park.

3.1 (b) National heritage places

Description

Kakadu National Park was included in the National Heritage list on 21 May 2007 and meets 8 of the 9 National Heritage criteria.⁵⁵ For further information see the National Trust of Australia and SEWPaC websites.⁵⁶ Table 13 shows all the areas in the Alligator Rivers Region that are currently listed under these registers and their approximate distance from the Ranger uranium mine.

Table 13: Areas in the Alligator Rivers Region that are listed under Australian registers

Name	Status	World Heritage List	Register of National Estate	National Heritage List	C/wealth Heritage List	Approximate distance from Ranger (km)
Alligator Rivers Region Arnhem Highway	Registered		*			encircling
Ballyangardy Spring Jungles	Registered		*			50
Gimbat/Goodparla Pastoral Leases, (former) Kakadu Highway	Registered		*			100
Kakadu National Park, Arnhem Highway	Declared Property* Listed place†	*		*		encircling
Kakadu National Park and (former) Gimbat and Goodparla Leases Arnhem Highway	Registered		*			100
Koolpin Gorge Area	Registered		*		*	90
Nourlangie Rock or Mount Brockman Massif Nourlangie Road	Registered		*			20
Rainforest Gorge Jungle	Registered		*			70
Upper East Alligator River	Registered		*			20
Wildman River Catchment Arnhem Highway	Registered		*			70
Woolwonga Wildlife Sanctuary (former) Nourlangie Camp Road	Registered		*			35
* The World Heritage Committee has inscribed the property in the World Heritage List.						
† The Council has sent an assessment to the Minister and the Minister has entered the place in the National Heritage List.						

⁵⁵ Commonwealth of Australia (2007). Determination Regarding Including World Heritage Places in the National Heritage List. *Gazette Special No S99, Monday, 21 May 2007*.
<http://www.environment.gov.au/heritage/places/national/index.html>

⁵⁶ Australian Council of National Trusts (2007): The National Heritage System:
<http://www.nationaltrust.org.au/NationalHeritageSystem.htm>

Nature and extent of likely impact

The National Heritage Values and Criteria are analogous to the World Heritage Values for Kakadu National Park.

The proposed action will occur within the footprint of the Ranger Project Area under a strict regulatory framework. Gaseous and dust emissions are predicted to be well below criteria even in the immediate vicinity of the proposed action. Incremental noise at sensitive receptors within the Ranger Project Area is predicted to be negligible (less than 1 dBA). The disturbance area associated with construction is small and located adjacent to existing infrastructure and the underground mining activity has a substantially lower potential for interaction with the environment compared to open pit mining. Processing is effectively unchanged. Thus most of the areas listed in Table 11 on the Register of National Estate are too distant for any conceivable impact from the proposed action and whilst Kakadu National Park encircles the Ranger Project Area, there is still separation from the proposed action. Thus consistent with the risk analysis, the proposed action is very unlikely to have any significant impact on the National Heritage values of any National Heritage place.

3.1 (c) Wetlands of international importance (declared Ramsar wetlands)

Description

The wetlands of Kakadu National Park are listed as Wetlands of International Importance under the Ramsar convention, based on a combination of ecological, botanical, zoological criteria and because they contain a representative, rare, or unique example of a natural or near-natural wetland type. Kakadu National Park Ramsar site meets all nine criteria and supports approximately 3 million waterbirds as well as large populations of many other vertebrate and invertebrate species. A detailed description of the attributes and features of the wetlands is provided on the SEWPaC website.⁵⁷

Nature and extent of likely impact

There are no sensitive environments (significant breeding sites, seasonal habitats or wetlands areas) of special significance including Ramsar sites in the footprint of Ranger operations or within the Ranger Project Area. Ranger uranium mine is excluded from the boundaries of the National Park and relevant Ramsar boundaries and is located upstream of the Magela Creek catchment.

The Ranger uranium mine maintains a Water Management Plan, approved annually by regulators, which describes the methodology used to control water on site and fulfil the requirements of the Section 41 Authority. The plan outlines the approach ERA takes to:

- protect the wider environment and especially Magela Creek from the impacts of mining and processing operations;
- meet all current statutory requirements; and,
- manage water inventories and discharge mechanisms based on quality according to a "whole of mine" approach, rather than the origin of the water.

For a description of Ranger's water management strategies and potential changes to the current operational inventories resulting from the proposed action, see [Section 2.1 Water Management](#). For a description of potential impacts to downstream water quality, see [Section 3.1](#), above.

The Supervising Scientist Division has conducted extensive monitoring and research in Magela and Gulgung Creeks bounding the existing Ranger operations, as well as in creeks away from the Ranger Project Area, based on benthic macro-invertebrate and fish communities.⁵⁸ Responses of *in situ* aquatic animals that are exposed to waters from the existing Ranger mine operations have also

⁵⁷ See <http://www.environment.gov.au/parks/kakadu/culture-history/heritage/ramsar-convention.html>

⁵⁸ See Supervising Scientist Annual Reports:
<http://www.environment.gov.au/ssd/publications/index.html#latest>

been regularly evaluated to check for toxicity. These data indicate that there is no significant effect on the test aquatic animals due to waters derived from the Ranger uranium mine.

Additional research has been carried out intermittently on mussels in downstream billabongs, as well as in control billabongs elsewhere in Kakadu National Park, from 1981 to the present. The objective of the program has been to ensure that mussels are fit for human consumption and that there are no elevated levels of metals and/or radionuclides in mussel tissues and organs that could have been derived from mining operations. Analysis of all the data lead Supervising Scientist Division, in its 2009 annual report,⁵⁹ to conclude there is no significant mining influence on mussels in Mudginberri Billabong. In addition, a 2007 longitudinal study along the Magela Creek catchment (also measuring uptake of radium and uranium in mussels) showed that radium uptake was largely due to natural catchment influences rather than a mining-related feature. The proposed Ranger 3 Deeps underground mine will represent a new form of mining, however consistent with the risk analysis, through application of water management consistent with the existing Ranger mine operations, and the advantages of minimal surface expression, the potential for impact to the wetlands is negligible.

The potential impacts to groundwater quality relating to tailings containment and solute transport facilitated by the underground workings are considered unlikely due to the known very low hydraulic permeability of the surrounding rock at the depth of the proposed mine, and the backfill strategy of utilising low permeability cemented paste. Further, the lack of any significant interaction between deep groundwater and near surface aquifers greatly decreases the potential for contaminants to enter the wetlands.

Modelling of air dispersion of contaminants has predicted that deposition of particulates and concentrations of airborne contaminants from the proposed mine would be orders of magnitude below criteria levels in the near vicinity of the ventilation raises and at sensitive receptors. Consequently delivery of any significant quantity of such contaminants to the surrounding wetland is highly unlikely.

In summary, the proposed action will utilise the existing water management strategy and infrastructure which has been effective in safeguarding the wetlands. The potential for contaminants to enter the wetlands through interaction with groundwater or via air dispersal is negligible. Thus the proposed action is very unlikely to have a significant impact on the Ramsar wetlands.

3.1 (d) Listed threatened species and ecological communities

Description

In March 2012, the Arnhem Plateau Sandstone Shrubland Complex or Arnhem Shrubland Complex became a nationally protected ecological community, and is listed in the results of the MNES search, (summarised previously in Table 10). The Arnhem Shrubland Complex occurs mainly on the Arnhem Plateau and outliers such as Ubirr, Nawurlandja (Little Nourlangie Rock) and Burrungui (Nourlangie Rock).⁶⁰ However, this EPBC-listed threatened ecological community is not present on the Ranger Project Area. Vegetation characteristics of ecological communities found on the Ranger Project Area are further discussed under [Section 3.3 – Vegetation Characteristics](#).

Extensive vegetation surveys have been undertaken on the Ranger Project Area. Surveys undertaken have been focused on identifying floristic species of conservation significance as noted under the EPBC Act. Results of these surveys support the basis that there are no conservation significant flora species on the proposed action site – (e.g. Brennan 2005; Firth, *et al.* 2010; Firth & Davey 2011; Hollingsworth & Meek 2003).

⁵⁹ See Annual Report of the Supervising Scientist 2008-2009:
<http://www.environment.gov.au/ssd/publications/ssr/201.html>.

⁶⁰ See <http://www.environment.gov.au/biodiversity/threatened/publications/pubs/arnhem-plateau-shrubland-complex-factsheet.pdf>.

The fauna likely to be found in the vicinity of the Ranger operation, and on the Ranger Project Area, are typical of the fauna found throughout Kakadu National Park.

Table 14 sets out the conservation significant species derived from the MNES search tool (Appendix E) and their occurrence on the Ranger Project Area and the site of the proposed action.

Table 14: MNES search EPBC-listed threatened species and their occurrence on the Ranger Project Area and the site of the proposed action

Common name	Scientific name	EPBC Act	Habitat	Recorded on Ranger Project Area (1994–2010)	Recorded on the site of the proposed action
Threatened Ecological Communities					
Arnhem Plateau Sandstone Shrubland Complex		EN	Sandstone	No	No
Plants					
	<i>Hibiscus brennanii</i>	VU	Lowland woodland	No	No
	<i>Sauropus filicinus</i>	VU	Sandstone	No	No
Sharks					
Freshwater sawfish	<i>Pristis microdon</i>	VU	Estuarine	No	No
Reptiles					
Arnhem Land Egernia	<i>Bellatorias obiri</i>	EN	Sandstone	No	No
Birds					
Red goshawk	<i>Erythrotriorchis radiatus</i>	VU	Lowland woodland	No	No
Partridge pigeon	<i>Geophaps smithii</i>	VU	Lowland woodland	Yes	No
Masked owl	<i>Tyto novaehollandiae kimberli</i>	VU	Lowland woodland	No	No
Yellow chat	<i>Epthianura crocea tunneyi</i>	EN	Floodplain	No	No
Gouldian finch	<i>Erythrura gouldiae</i>	EN	Lowland woodland	No	No
Mammals					
Northern quoll	<i>Dasyurus hallucatus</i>	EN	Sandstone; lowland woodland	Yes	No
Brush-tailed rabbit-rat	<i>Conilurus penicillatus</i>	VU	Lowland woodland	Yes	No
Golden-backed tree-rat	<i>Mesembriomys macrurus</i>	VU	Sandstone	No	No
Northern Brush-tailed Phascogale	<i>Phascogale piranta</i>	VU	Tall open forests dominated by <i>Eucalyptus miniata</i> and <i>E. tetradonta</i> ⁶¹	No	No
Arnhem rock-rat	<i>Zyzomys maini</i>	VU	Sandstone	No	No
EN: Endangered, VU: Vulnerable					

⁶¹ (Woinarski, *et al.* 2007)

Nature and extent of likely impact

The proposed action includes clearing small (approximately ¼ ha) areas of previously disturbed vegetation for the construction of each ventilation shaft, with subsequent placement and operation of vent raises for the duration of the proposed action. These will all be located within a defined corridor, close to current operations, in a highly disturbed zone. All other activities associated with the proposed action (e.g. waste management, milling, processing, etc) will be performed in the same manner as they are currently performed at Ranger using existing infrastructure.

A desktop review of terrestrial flora and terrestrial vertebrate fauna surveys, and monitoring programmes that have been undertaken on the Ranger Project Area was completed by ENV Australia Pty Ltd in June 2012. The report is provided as Appendix H.

In regard to terrestrial flora, there has been a substantial survey and monitoring effort undertaken across the Ranger Project Area over the last 10 to 15 years (18 documents). Significantly, no flora species of conservation significance listed under the *Territory Parks and Wildlife Conservation Act 2000* and/or the EPBC Act have been recorded during these surveys (see Table 1, Appendix H). All of the species recorded are common and widespread on the Ranger Project Area and in the Top End.

In the case of fauna, a number of conservation significant species have been recorded on the Ranger Project Area during previous surveys (including bird species which are listed under various migratory agreements (see [Section 3.1\(e\)](#)). The two most notable of these fauna species are listed under both the EPBC Act and *Territory Parks and Wildlife Conservation Act 2000* (Northern Quoll and Partridge Pigeon).

The Northern Quoll 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. It has not been recorded on the Ranger Project Area since 1998, despite recent surveys (2007, 2008, 2010), suggesting that it is most probably locally extinct on the Ranger Project Area. The cane toad has been recorded on the Ranger Project Area during several surveys and is regarded as abundant, particularly in and around areas with water (seasonal and permanent water bodies). Additionally, whilst the Northern Quoll does inhabit open eucalypt forest, its most suitable habitat appears to be rocky areas, of which there are none in the ventilation corridor. Further, only small areas (¼ ha for each ventilation shaft, totalling less than 2 ha) of already disturbed, marginal habitat is proposed to be cleared.

The only EPBC Act listed fauna species (Partridge Pigeon) still known with certainty to occur on the Ranger Project Area, is a mobile species and will therefore be unaffected by the clearing of such small areas of vegetation associated with the proposed action (e.g. ventilation infrastructure).

The brush-tailed rabbit-rat has also been recorded on the Ranger Project Area. In 2003 one specimen was collected as road kill near Jabiru Airport, however subsequent surveys of the Ranger Project Area and other evidence⁶² suggest that it may have been a "stow-away" on aircraft from the Tiwi Islands. Rabbit-rats display a strong preference for tall eucalypt forests with less bare ground and annual grasses and a lower density of dead trees than occurs near Ranger and, where the impact of fires is less severe than on the Ranger Project Area or in Kakadu National Park. Thus Ranger operations are not likely to have had any impact on this species and they will not be located within the footprint of the proposed action.

⁶² The specimen possessed a white tail tip as do 76 % of Melville Island specimens, whereas none of the Northern Territory mainland populations have this feature.

All of the activities as part of the proposed action will be performed and managed in accordance with strict regulatory and environmental controls. Thus consistent with the risk analysis, it is therefore very unlikely that the proposed action will have any significant impact on listed threatened species and/or ecological communities of the region.

3.1 (e) Listed migratory species

Description

The EPBC search identified 18 migratory species,³⁹ all bird species with the exception of the saltwater crocodile (*Crocodylus porosus*), and these are listed in Appendix E. Eleven of the species have never been recorded on the Ranger Project Area despite extensive surveys. Seven birds listed under the various migratory agreements (CAMBA, JAMBA, ROKAMBA and as migratory under the EPBC Act) have been recorded on the Ranger Project Area. However seasonally these species are widespread and common throughout Kakadu (and much of continental Australia with suitable habitat), as a consequence of the extensive wetlands that occur in the Park (Director of National Parks 2007). For a detailed description of the migratory species that have been found on the Ranger Project Area during faunal surveys, see Appendix H. An assessment of each species identified by the search, against significant impact criteria is provided in Appendix F.

Nature and extent of likely impact

Migratory species reside in suitable habitats throughout KNP. There are no known population foci of EPBC Act listed migratory species on or adjacent to the Ranger mine operations where the proposed action will be located.

In addition to the ongoing monitoring by the Supervising Scientist, the desktop review completed by ENV Australia Pty Ltd in June 2012 (Appendix H) indicates that there is no significant potential for impact on listed migratory species or their habitat from the proposed action. Construction and infrastructure associated with the proposed underground mine will be constrained to the existing operational footprint and vicinity of the decommissioned Magela Land Application Area. In the Magela Land Application Area, disturbance will consist of discrete footings or foundations for each vent shaft (totally 2 ha), for the purpose of maintaining air quality in the underground facility; and power and access tracks to each vent shaft to undertake repairs and maintenance. Existing tracks in the Magela Land Application Area would be used where practical to reduce the need for further clearing. The potential to substantially modify, destroy or isolate an important habitat is highly unlikely for all species identified in the EPBC search. The proposed action has not been identified as important habitat for any of these species. No breeding sites have been identified on the Ranger Project Area and it is highly unlikely the proposed action would disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of any ecologically significant proportion of the population of a migratory species.

In summary the risk of a significant impact on any listed migratory species from the proposed action is very unlikely.

3.1 (f) Commonwealth marine area

No Commonwealth marine areas were identified by the EPBC Act search (Appendix E).

3.1 (g) Commonwealth land

Description

Land tenure is quite complex, however in simple terms the Ranger Project Area, and the proposed action, are situated on Aboriginal land.

ERA holds an Authority issued by the Commonwealth Minister under Section 41 of the *Atomic Energy Act 1953*, which permits ERA to conduct mining and processing operations on the Ranger Project Area until January 2021. The Ranger mine and the Ranger Project Area are on land belonging to the Kakadu Aboriginal Land Trust, and access to the Ranger Project Area has been agreed in accordance with the *Aboriginal Land Rights (Northern Territory) Act 1976*. Conditions of access include compliance with the Environmental Requirements attached to the Ranger Section 41 Authority.

As discussed above, ERA also holds an Authorisation under Section 38(2) of the *Mining Management Act (Northern Territory)*, which specifies operations that can be conducted within the Ranger Project Area.

See [Section 3.3 \(k\)](#) for further discussion on land tenure.

Nature and extent of likely impact

Construction of the proposed underground mine will have no significant impact on Commonwealth land. Details of the nature of the proposed action are set out in [Section 3.1\(a\)](#) in relation to the World Heritage area surrounding ERA's Ranger Project Area.

For the reasons identified in the sections above, any environmental risks associated with the proposed action will be effectively managed by means of the requirements attached to current approvals. On the basis of historic and recent biological surveys and its location within the footprint of disturbance at the mine, the proposed action will not have any significant impact on MNES in the vicinity. Further, the work of ERA, and monitoring and reporting of the Supervising Scientist to the Commonwealth Minister for the Environment enable the ongoing protection of the environment surrounding ERA's mining operations.

Consistent with the risk analysis, the proposed action is not expected to generate any significant added risk to the land or the environment.

3.1 (h) The Great Barrier Reef Marine Park

Description

Not applicable

Nature and extent of likely impact

Not applicable

3.2 Nuclear actions, actions taken by the Commonwealth (or Commonwealth agency), actions taken in a Commonwealth marine area, actions taken on Commonwealth land, or actions taken in the Great Barrier Reef Marine Park

3.2 (a)	Is the proposed action a nuclear action?	<input checked="" type="checkbox"/>	No
			Yes (provide details below)
<p>The proposed action will not result in additional potential for significant impact to the surrounding environment. In fact the potential to impact the surrounding environment will be substantially reduced relative to the previous open pit mining at the Ranger mine. An assessment of the nature and extent of likely impact on "whole environment" was conducted and is described in terms of each major environmental component in Section 3.1.</p>			
3.2 (b)	Is the proposed action to be taken by the Commonwealth or a Commonwealth agency?	<input checked="" type="checkbox"/>	No
			Yes (provide details below)
3.2 (c)	Is the proposed action to be taken in a Commonwealth marine area?	<input checked="" type="checkbox"/>	No
			Yes (provide details below)
3.2 (d)	Is the proposed action to be taken on Commonwealth land?	<input checked="" type="checkbox"/>	No
			Yes (provide details below)
3.2 (e)	Is the proposed action to be taken in the Great Barrier Reef Marine Park?	<input checked="" type="checkbox"/>	No
			Yes (provide details below)

3.3 Other important features of the environment

The general setting for the existing Ranger uranium mine and the proposed action is described below. However, the area affected by the proposed action is confined to the current operational footprint and Magela Land Application Area. As such, this information is provided for further background and context for this referral. As outlined in [Section 2.3](#) there are no alternate locations or time frames and the alternative activities discussed are constrained to minor variants of ore processing. These activities do not result in a material change to the environmental aspects of the proposed action and affected area.

3.3 (a) Flora and fauna

Please see Section [3.1\(d\)](#) and Appendices F and H.

3.3 (b) Hydrology, including water flows

GENERAL DESCRIPTION

The existing Ranger mine operations area is bounded on the north by Magela Creek (previously shown in Figure 2), a major system which drains the Arnhem Escarpment located to the south-east, and on the west by Gulungul Creek, a tributary to Magela Creek draining escarpment areas located to the south. Both are ephemeral creek systems which flow only during the wet season but constitute significant waterways at this time.

The undulating landscape typically comprises slopes of between 1 to 4 %, with hill crests around 20 m above the Magela Creek bed levels. Water quality monitoring in surface water systems on and around the operations has been undertaken by ERA, Supervising Scientist Division and the Northern Territory Department of Mines and Energy (to a lesser extent) since mining commenced in 1979. This monitoring program has generated a large database from which to assess patterns and trends in water quality. Statutory and operational bores are used to monitor the shallow and deeper groundwater systems at Ranger (Figure 29). Statutory bores are located within the various sub-catchments (Gulungul, Coonjimba, Djalkmarra and Corridor creeks) at locations near their confluence with Magela Creek. The bores screen weathered and fractured rock aquifers to monitor groundwater quality downstream of the operations. Other bores are located within alluvial and weathered-rock aquifers within and near the mine and are monitored to provide early indication of impacts on shallow groundwater levels and quality. There is ongoing monitoring of seepage plumes in the vicinity of mine landforms and infrastructure in the weathered aquifers, and strategies are in place to recover these groundwaters as part of the planned closure and rehabilitation of the mine site.

The specific project area relevant to the proposed action is to the east of Pit 3 and lies between the pit and Magela Creek. The area is characterised by open eucalypt woodland and open forest, presently heavily disturbed by irrigation, exploration activity and frequent fires. (For a detailed description of the Magela Land Application Area, see [Section 3.3\(g\)](#)). The area has east sloping topography such that water flow from rainfall onto the project area would be toward the creek, partially attenuated by vegetation. Throughout the operational phase of the proposed action it is anticipated that significant revegetation of previously disturbed area will occur, providing further attenuation of surface water flow.

Groundwater

The degree and extent of weathering is the most significant determinant of the occurrence and movement of groundwater at Ranger, with groundwater flow gradients strongly influenced by topography. In the deeper aquifers there is a high degree of compartmentalisation, with geological structures and zones of fracturing and faulting constituting controls over groundwater movement. Weathered rock aquifers typically show little or no hydraulic connection with surface water systems. Water quality data in the deeper aquifers, together with other data, suggest that groundwater levels in the deeper aquifers respond essentially to 'pressure' due to changes in groundwater levels within overlying units.

The Ranger 3 Deeps mineral resource is located within and beneath the Pit 3 groundwater sink, which is largely contained within the near surface higher permeability weathered rocks and to a lesser extent in the underlying unweathered rock sequences.

The proposed action will result in minor, highly localised groundwater depressurisation (Jacobsen 2011). Data from groundwater monitoring bores indicate that the proposed action is unlikely to intersect with and will be well below regions of known groundwater aquifers.

The depth of weathering in the region of the proposed action is highly variable but generally extends to depths of around 50–80 m below the ground surface. Considerable bore testing and monitoring data, along with observations of groundwater inflows to Pit 1 and Pit 3, indicate that highly weathered rocks in fault zones are key pathways for groundwater movement. There is little connection between aquifers in the weathered and underlying unweathered rock sequences and Magela Creek. This conclusion is based on a number of studies over many years that have evaluated creek flow behaviour, groundwater recharge/discharge in the region of Magela Creek and Georgetown Billabong, recharge rates to weathered rocks that discharge to Magela Creek, groundwater age dating, and computer model predictions of changes to Magela creek flow due to mining Pit #3 (Kalf 2007; Pillai, *et al.* 2007; Turner & Leaney 2009).

Surface Water

Magela Creek is an ephemeral tributary of the East Alligator River which originates in the Arnhem Land Plateau. Creek flow occurs between December, coinciding with the onset of the Wet Season, and August annually. The Magela Creek catchment, which encompasses the Ranger Project Area, covers an area of approximately 160,000 ha (Figure 30). Magela Creek and its tributaries flow north from the extensive sandstone Arnhem Plateau. The catchment has three major flow regimes:

- the upper catchment sandstone escarpment to the south-east of the Ranger Project Area rising 200 m above sea level and associated fractured gully systems making up around one third of the catchment area. These systems are fed by groundwater seeping into the fractured rock of the escarpment and can flow nearly all year round. Rainforest vegetation types are found in the gullies due to year round water supply;
- the middle catchment comprised of undulating low hills from 40 m elevation. This is the area in which Ranger mine is located. Here, Magela Creek flows through sandy soils that may be more than 5 m deep along the creek channels; and,
- the lower catchment Magela Creek floodplains and estuary of the East Alligator River around 40 km to the north.

The Magela catchment discharges to the Magela floodplain and, ultimately, the Van Diemen Gulf via the East Alligator River. The seasonal pulse of the wet season monsoon controls the regional hydrology (Wasson 1992) with flows beginning in an average year in mid-December, after the onset of the monsoonal wet season, which usually occurs in November. The sand aquifers in the channel of Magela Creek in the middle catchment fill with shallow groundwater and begin flowing as interflow within the creek channel, before surface flow commences in the creek.

Prior to mining, the local hydrology included four separate sub-catchments, namely Gulungul to the west and southwest, Coonjimba in the centre west, Djalkmarra in the centre east and Corridor Creek in the east and south. Within the sub-catchments, backflow billabongs sit on the margins of Magela Creek creating complex localised hydrological relationships.

With the conduct of operations at the Ranger mine, the mine landforms have been divided into a number of catchments that are managed according to water quality (Figure 31). Rainfall runoff from non-mineralised parts of the mine landscape is managed as release water to wetlands (Retention Pond 1 and Corridor Creek). Seepage and runoff from mineralised materials is captured in Retention Pond 2 and Pit 3 and wetland-polished before irrigating forest areas or treated before discharge into wetlands. Process water is predominantly retained in the tailings storage facility, with small quantities of process water reporting to Pit 1 to facilitate evaporation and dust suppression while Pit 1 continues to be rehabilitated. Process water reporting to the tailings storage facility is evaporated or, treated and discharged into onsite wetlands.

The proposed underground mine will not have any appreciable incremental impact on surface water, particularly given that the decline passing through the weathered zone, which is part of the Ranger 3 Deeps Exploration Decline project will be constructed in advance of the proposed action.

Downstream Water Quality

Based on extensive studies of groundwater and surface water, any additional environmental impacts caused by the proposed action are considered to be unlikely, and would be managed effectively within existing levels of controls and contingencies. As outlined in [Section 3.1\(a\)](#), the underground mine will be constructed well below known subsurface water pathways and shallow groundwater aquifers. The hydrogeological conditions in the region of Pit 3 are well understood and the decline is not expected to intersect significant groundwater. Groundwater inflows into the decline are likely to be of the order of 5–20 L/s on average. Rates of groundwater recharge to deep aquifers are relatively low, and there is little or no direct connectivity between fresh and weathered or fractured rock aquifers underlying the surficial aquifers and Magela Creek.

Surface exploration drill holes and boreholes above the Ranger 3 Deeps mineral resource will be grouted. Holes that can't be grouted from the surface will be plugged and grouted from underground.

Higher short-term inflows are possible if the mine intersects open faults, joints or non-grouted surface drillholes. A series of sumps established during the Ranger 3 Deeps Exploration Decline project will be retained to return inflow water to the surface where it can be managed, based on quality, according to the existing water management system and plan.

3.3 (c) Soil and vegetation characteristics

GEOLOGY

The Ranger operation and the Ranger Project Area lie in the north-easternmost part of the Pine Creek Geosyncline. Uranium mineralisation occurs within a lower Proterozoic meta-sedimentary sequence (Cahill Formation) of gneisses, schists and carbonates above lower Proterozoic gneisses and schist of the upper Nanambu Complex. The mineralisation is confined to structures dominated by low-angle imbricate thrusts with zones of brecciation and veinlet networks.

Orebody #3 is adjacent to Magela Creek but plunges to the east at depth. Rock units mined from Pit 3 included the Cahill Formation, the overlying and younger Kombolgie Formation, various intrusive rocks (both acidic and basic), so-called 'laterite' which is a complex of weathered rock units near the land surface, and surficial sediments and soils. In the mine pits, the Cahill Formation is divided into Lower Mine Sequence, Upper Mine Sequence and Hanging Wall Sequence.

Uranium mineralisation is dominantly finely disseminated uraninite, although there are a number of minor primary and secondary uranium minerals also present in parts of the sequence, including the weathered materials ('laterite') near the land surface.

As previously discussed under [Section 2](#), the proposed underground mine will be constructed to recover uranium oxide from the Ranger 3 Deeps mineral resource. The Ranger 3 Deeps resource is estimated to contain approximately 34,000 tonnes of uranium oxide¹ and is a continuation of the Ranger Pit 3 deposit, which was mined from 1997 to 28 November 2012. The Ranger 3 Deeps mineral resource has been defined by a series of successive surface diamond drilling programs from 2005–2009.

CLIMATE

The climate of the region is typical of the wet-dry tropics with the large majority (approximately 80 %) of annual rainfall occurring in the months November to March. Rainfall is often intense and commonly exceeds 25 mm/h over short duration events reaching intensities of around 120 mm/h per five minute duration with probable annual occurrence. Monsoonal rain tends to be less intensive but more prolonged than that associated with convective storms.

Mean annual rainfall at Jabiru Airport (1979–2011) is 1,576 mm;⁶³ the average pan evaporation at Jabiru Airport (1971–2011) is 2,540 mm. Humidity ranges from around a daily average of 24 % in July to 80 % in December. Winds are predominantly from the south-east and east from April–September, coinciding with cooler weather (mean monthly minimum of 18 °C in July at Jabiru Airport). Westerly and northerly winds prevail during the wet season from November–February (mean monthly maximum temperature of 32 °C in January at Jabiru Airport) with March and October tending to be transitional months with variable wind direction.

SOILS

The type (class) and distribution of soils across the land surfaces of the Ranger Project Area are influenced by geology, topographic position and seasonal change in the amounts 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. Much of the Mount Brockman Massif is almost entirely devoid of soil. Soils that occur are mainly skeletal, coarse and sandy in dissected and sloping sections and can be up to 1.5 m deep in flatter areas. On the other hand, a variety of soils have formed on the Koolpinyah Surface. These are dominated by lateritic red and yellow earths formed by deep and pervasive weathering with similar structure and bearing strengths. They commonly overlie extensive sheets of ferricrete and strongly weathered rock. Differences in soil type can be attributed to the underlying bedrock material.

Soil surveys around the Ranger operations include those of White and McLeod (1985), Chartres *et al.* (2012; 1991), Fitzpatrick *et al.*, (2012), Hollingsworth (1999), Hollingsworth & Meek (2009) and Coffey Environments (2010). The key for classification of soils (Table 15) was developed by Hollingsworth, based on the studies of White and McLeod (1985). In general:

- upper slopes are underlain by well-drained loamy sand to sandy loam red earths;
- mid-slopes are dominated by moderately well-drained to imperfectly-drained gravelly yellow earths with mottled B horizons, indicating impeded drainage for at least part of the year; and,
- lower slopes are underlain by shallow, sandy and gravelly siliceous sand (bleached upper layers) over a ferricrete layer.

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.

The general soil distribution around the Ranger operation is shown in Figure 32. Land units are defined on the basis of landform, geology, vegetation features and soils information. Table 15 provides the key for soil classes and Table 16 sets out brief descriptions of the soil characteristics. Units A0, C2 and C5 occur in the Magela Land Application Area and proposed location of the ventilation shafts.

⁶³ <http://www.bom.gov.au/climate/data/index.shtml>

Table 15: Soils Key for classification of soils at Ranger mine. Soils are labelled B5, C3, C5 and so on according to morphological and textural properties

Textural Trend
A. Siliceous Sands – weak horizon differentiation, sand/loamy sand at surface; sand/clayey sand at depth.
B. Earthy Sands – Sand/loamy sand at surface to sandy loam at depth.
C. Sandy Earths – Sandy/loamy sand at surface to sandy clay loam at depth.
D. Loamy Earths – Sandy loam at surface to at least sandy clay loam at depth.
E. Duplex Soils – Contrast of at least 1.5 texture grades between A and B horizons over 0.1 m or less (i.e. Podosols or Podzols).
F. Polygenetic Soils – Two or more profiles clearly identified within 0.15 m.
Textural Organisation
1. Soils ≥ 0.6 m deep with no gravel.
2. Soils ≥ 0.6 m deep with a gravel pan base.
3. Soils ≥ 0.6 m deep with gravel throughout the profile.
4. Soils < 0.6 m deep with no gravel but a gravel pan base.
5. Soils < 0.6 m deep with gravel throughout the profile.

Table 16: Brief description of characteristics of soils around the Ranger operations (see Figure 32)

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 cm; in-situ gravels may occur within the lower horizons and the firm clay clod nodules may become hard; 10-15 mm, 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.

Map Unit (Hollingsworth, 1999)	Map Unit Description
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 cm; and, gravel contents ranging between 5 % and 50 % 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.

Soil Hydrogeology

Field investigations of soil hydraulic conductivity (Table 17) have identified that individual soil horizons range from very pervious, on account of the presence of naturally occurring piping, to impervious. The A and B horizons support a shallow, unconfined surface aquifer that rests on a low conductivity C 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 dry entirely down to the confining C horizon. Hydraulic conductivities in the A and B horizons can range from 0.01 to 10 m/day. In the immediate area of the proposed underground mine, the soil types identified at the surface include A0, C2 and C5 units.

Table 17: 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

Erosion

Depending on vegetation cover and the presence or absence of a surface rock lag, erosion is highly seasonal and dominated by sheet erosion in the wet season. At the beginning of the wet season, the 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, they help protect 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 18. ERA is required to manage the Ranger operation such that erosion does not lead to increased turbidity due to suspended sediment in bounding creeks (Magela, Gulungul).

Table 18: 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

VEGETATION CHARACTERISTICS

Recent studies have established information and data in relation to vegetation in the region (understanding vegetation communities for rehabilitation purposes) and the environmental risk associated with vegetation disturbance. In addition, ERA has conducted surveys of existing vegetation communities immediately surrounding the operations and determined there are no plants of conservation significance (see also [Section 3.1](#) and Appendix H).

3.3 (d) Outstanding natural features

There are no outstanding natural features on the Ranger Project Area. The Arnhem escarpment dominated by Mount Brockman, a significant cultural feature, occurs approximately 2 km south of the southern-most limit of the Ranger Project Area.

3.3 (e) Remnant native vegetation

The operating Ranger uranium mine site is a substantially disturbed area in the south-western corner of the Ranger Project Area. Areas on the Ranger Project Area immediately surrounding the Ranger operations are little-disturbed and contain intact habitats and ecosystems. A summary of the vegetation types present on the Ranger Project Area is provided in Table 19.

Table 19: Summary description of vegetation types present on the Ranger Project Area (based on Schodde, *et al.* 1987)

Habitat	Summary Description
1	<p>Myrtle-Pandanus Savannah/ Paperbark Forest/ Coastal Deciduous Rainforest</p> <p>For a description of Myrtle-Pandanus Savannah see below. Paperbark forests line freshwater creek systems and the edges of billabongs and are dominated by <i>Melaleuca</i> spp. Canopy can be 15 to 20 m in height and can vary greatly from open to almost closed. The shrub layer varies from sparse to dense and comprises <i>Acacia</i> spp., <i>Ficus</i> spp. on marginal areas and the ubiquitous freshwater mangrove <i>Barringtonia acutangula</i>. <i>Pandanus aquaticus</i> and <i>B. acutangula</i> line streams and channels. In zones edging woodland (which is often the case on the Ranger Project Area), 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 Ranger Project Area according to the description of Schodde <i>et al.</i> (1987); therefore a summary description will not be given.</p>

Habitat	Summary Description
2	<p>Myrtle-Pandanus Savannah</p> <p>Consists of grassland with small open pockets of woodland, mixed shrubland and rainforest trees, interspersed with strips of Pandanus (<i>Pandanus spiralis</i>) along the edges of floodplains and with paperbarks <i>Melaleuca</i> spp., along creeks and streams. Tall trees from such as <i>Corymbia</i> spp. and <i>Eucalyptus</i> spp. are sparingly present. A very patchy shrub layer of <i>Melaleuca viridiflora</i>, <i>M. nervosa</i> and <i>P. spiralis</i> occur. Common grasses include annuals from genera such as <i>Digitaria</i>, <i>Ectrosia</i>, <i>Panicum</i>, <i>Schizachyrium</i> and <i>Sorghum</i> and perennials grasses including those from genera such as <i>Eriachne</i> and <i>Themeda</i>. Sedges (Cyperaceae) are also a common component of the ground cover.</p>
3	<p>Open Forest</p> <p>Tall (12 to 20 m) open forest dominated by <i>Eucalyptus miniata</i> and <i>E. tetradonta</i> and there are other species of eucalypts present in the canopy. The only frequent non eucalypt that occurs in the canopy is Ironwood <i>Erythrophleum chlorostacys</i>. The shrub layer consists of <i>Acacia</i> spp., <i>Calytrix exstipulata</i>, <i>Croton arnhemicus</i>, <i>Gardenia</i> sp., <i>Livistona humilis</i>, <i>Petalostigma quadriloculare</i>, <i>Planchonia careya</i>, <i>Terminalia</i> spp. and <i>Xanthostemon paradoxus</i>. Ground cover is usually sparse, inconspicuous, and comprises mostly annual grasses of <i>Sorghum</i> spp. and other herbaceous plants are present.</p>
4	<p>Woodland</p> <p>This habitat typically lacks a distinct canopy and is more stunted (usually less than 12 m) than open forest, being dominated by bloodwoods (<i>Corymbia</i> spp.) but also contains eucalypts such as <i>E. miniata</i>, <i>E. tetradonta</i> and <i>E. tectifera</i>. However it is quite variable in structure 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, <i>L. humilis</i> is common and pockets of <i>P. spiralis</i> may also be present. The ground cover is much denser than in open forest, containing mainly annual grasses, e.g. <i>Sorghum</i> spp. In stunted woodlands perennial grasses <i>Heteropogon triticeus</i> and <i>Sehima</i> sp. dominate.</p>

In the immediate area of the proposed underground mine habitats 3 and 4 are present, although each habitat within the footprint of the proposed action is heavily disturbed.

3.3 (f) Gradient (or depth range if action is to be taken in a marine area)

The Ranger Project Area is situated within an extensive landscape of broad shallow valleys, long low-angle slopes and isolated hills forming the Koolpinyah Surface. Generally, the elevation over the area of the current Ranger mine operations ranges from between 40 m (above sea level) at the highest point to 10–12 m in Magela Creek. The gradient is between 1 to 4 per cent with some isolated, steeper sections varying in height to as much as 38 m above the Magela Creek bed level. The slopes are surfaced by medium to coarse sand and some gravel. Drainage from south, east and north of the current operations runs into Magela Creek, and from the southwest and west into Gulungul Creek and then into Magela Creek.

3.3 (g) Current state of the environment

The operating Ranger uranium mine site is a substantially disturbed area in the south-western corner of the Ranger Project Area. Since the commencement of construction of the mine in 1979, management of the site has been carried out in accordance with current authorisations and approvals. Oversight of the effectiveness of ERA's management in relation to environmental issues and impacts is undertaken by the Supervising Authority in the context of the Minesite Technical Committee (chaired by the Director Mining Performance, Department of Mines and Energy and including representatives of the Office of the Supervising Scientist, ERA, Northern Land Council and Gundjehmi Aboriginal Corporation) and advice from the Commonwealth Supervising Scientist Division.

Notwithstanding disturbance due to mining, ERA has continued to manage the Ranger mine site effectively and in a manner that has protected the surrounding environment. Areas on the Ranger

Project Area immediately surrounding the Ranger operations are little-disturbed and contain intact habitats and ecosystems.

Magela Land Application Area

Aboveground disturbance associated with the proposed action will consist of the construction of ventilation shafts (in addition to the ventilation shaft constructed as part of the Ranger 3 Deeps Exploration Decline project), located in the Magela Land Application Area which is immediately adjacent to Pit 3 (Figure 11).

The habitat of the Magela Land Application Area is predominantly eucalypt woodland and open forest. These habitats are the most widespread on the Ranger Project Area and account for at least 180,000 km² in the Northern Territory alone (Woinarski, *et al.* 2005). Specifically, the Magela Land Application Area tends to be dominated by *Eucalyptus miniata*, *E. porrecta* or *E. tetradonta* in the overstorey, with *Planchonia careya* and *Terminalia* sp. in the midstorey. Juvenile *Acacia holosericea* and suckering midstorey shrubs were also common. The understorey composition tends to vary; however, *Sorghum* sp. and *Setaria* spp. grasses are common (along with some introduced grasses like *P. polystachion*). In adjacent areas within the vicinity of the Magela Land Application Area, the overstorey is more diverse, with *Syzygium* spp. and *Cochlospermum fraseri* included in the mix, and greater diversity of native grasses.

However, the Magela Land Application Area has undergone prolonged irrigation and exploration activities and has been subject to recent uncontrolled fires.

3.3 (h) Commonwealth heritage places or other places recognised as having heritage values

Refer [Section 3.1\(b\)](#).

There are no Commonwealth heritage places or other places recognised as having heritage values located on the Ranger Project Area.

3.3 (i) Indigenous heritage values

Kakadu National Park

Kakadu National Park (part of the Alligator Rivers Region) which surrounds but is separate to the Ranger Project Area is listed for its cultural and environmental values as a World Heritage listed site. Kakadu National Park was first inscribed on the World Heritage List in 1981 and was subsequently expanded and re-inscribed in 1987, and again in 1992. The World Heritage criteria current in 1992 and against which Kakadu National Park was most recently inscribed remain the formal criteria for this property. The World Heritage Convention definitions for the Cultural Heritage terms are described in [Section 3.1\(a\)](#).

A search of the World Heritage List, Register of National Estate, National Heritage List and the Commonwealth Heritage List was undertaken. The National heritage places registered within the Alligator Rivers Regions are identified in [Section 3.1\(b\)](#). No listed sites were identified within the Ranger Project Area. The nearest registered place is Mount Brockman located approximately 2 km from the Ranger Project Area. The proposed action will have no significant impact on the nearest registered place.

Places of Cultural and Heritage Significance on the Ranger Project Area

The Ranger Project Area contains several significant Aboriginal sites, including recorded sacred sites, and additionally a distribution of archaeological sites and archaeological background scatters.

ERA and the Gundjeihmi Aboriginal Corporation entered into a draft Interim Cultural Heritage Protocol for the Ranger Project Area in 2006. This protocol outlines a process for the protection of

archaeological sites via a land disturbance permit. The protocol outlines that archaeological surveys are undertaken prior to new disturbance by an independent archaeological specialist (approved by the Gundjehmi Aboriginal Corporation) with Mirarr in attendance. If archaeological sites are identified, management controls are recommended by the independent archaeological specialist that is then implemented by ERA. Figure 33 shows the extent of archaeological surveys completed, including the area of the proposed action.

In addition to the cultural heritage surveys undertaken, a cultural heritage baseline assessment was completed for the Ranger Project Area in 2010 (Cressweller, 2010). This assessment was undertaken in order to identify all pre-recorded and known sites of cultural significance to Aboriginal people. This assessment was conducted in consultation with Mirarr, through their representative the Gundjehmi Aboriginal Corporation by the independent archaeological specialist. This assessment included an examination of heritage registers including:

- The Archaeological Site Register held by Heritage Branch, (Department of Lands, Planning and Environment)
- The Northern Territory Heritage Register held by Heritage Branch, (Department of Lands, Planning and Environment)
- The Register of the National Estate, held by the Australian Heritage Council
- World Heritage List held by the Australian Heritage Council
- The National Heritage List held by the Australian Heritage Council
- The Register of Significant Places maintained by the National Trust of Australia (Northern Territory Branch)
- The register held Aboriginal Areas Protection Authority
- The register held by the Northern Land Council

An application is currently under consideration with Aboriginal Areas Protection Authority for the entire Ranger Project Area.

Based on the cultural heritage surveys, cultural heritage baseline assessment and the Aboriginal Areas Protection Authority field surveys, the cultural heritage within the Ranger Project Area is documented and managed in accordance with relevant legislation and ERA's cultural heritage management system. The cultural heritage for the Ranger Project Area can be described as follows:

Sacred sites

A sacred site is defined as a site that is sacred to Aboriginal people or is otherwise of significance according to Aboriginal tradition. Archaeological objects are relics pertaining to the past occupation by Aboriginal or Macassan people and can include secret and ceremonial objects, log or bark coffins, human remains, portable rock or wood carvings, engravings or stone tools.

There is currently one recorded sacred site on the Ranger Project Area. This site is 5 km from the current operations area and as such would not be impacted by the proposed action. This site is protected subject to the requirements of an Aboriginal Areas Protection Authority certificate and the ERA Cultural Heritage Management system. This site is in an area of undisturbed bushland with strict internal controls which prohibits entry to the specific area.

Another sacred site was identified in 2010 and is currently undergoing a process for registration on the Aboriginal Areas Protection Authority register. This site is approximately 750 m from the closest point of current operations and the proposed action will not have any incremental impact. This site is protected subject to the requirements of the ERA Cultural Heritage Management system with additional management requirements expected on receipt of the Aboriginal Areas Protection Authority certificate currently being considered. Though located close to current operations this site is

in an area of undisturbed bushland with strict internal controls which prohibits entry to the specific area.

Archaeological sites

An archaeological site is a place pertaining to the past occupation by Aboriginal or Macassan people that has been modified by the activity of such people and, in or on which, the evidence of such activity exists. Archaeological surveys carried out on the Ranger Project Area are conducted by an external archaeological specialist with the assistance of traditional land owners and ERA cultural heritage employees.

In the Ranger Project Area an archaeological site is defined as:

"a concentration of artefactual material with an average density that is 5 times greater than the average density of the background scatter and there are more than 10 artefacts, which cover an area of at least 2 msq. A site will have an identifiable boundary where either artefact densities decrease to the extent as to be classified as background scatter or environmental features determine the boundary...Background scatter is generally a very low density, more or less continuous distribution of isolated artefacts over the landscape" (Crassweller 2009).

A total of 100 archaeological sites have been identified on the Ranger Project Area. All are managed according to the recommendations of the independent archaeological specialist and in accordance with the ERA Cultural Heritage Management system.

Archaeological Background Scatters

An archaeological background scatter is generally a very low density more or less continuous distribution of isolated artefacts over the landscape. Although these artefacts do not constitute an archaeological site they are recorded during the archaeological surveys. The methods used during the survey ensure that the artefact's location, dimensions, type and raw material are documented. Consequently the isolated artefacts have little potential for contributing to further knowledge.

Surveys have recorded 40 archaeological background scatters on the Ranger Project Area. All of these sites remain protected under the ERA Cultural Heritage Management System and are subject to protection requirements under Northern Territory legislation.

Places of Cultural and Heritage Significance within the area of the proposed action

There is one archaeological site (R34) identified within the area of the proposed action (shown previously in Figure 11). It is described as a quartz quarry with grinding holes and in consultation with traditional land owners has been ranked of high cultural significance.

The majority of surface infrastructure related to the proposed action will be constructed as part of the Ranger 3 Deeps Exploration Decline project with the exception of additional vent shafts. All of this pre-existing infrastructure will be located within the immediate mine footprint, inside the current access road, and is exempt from cultural heritage clearance due to the high level of pre-existing disturbance. The vent raises, constructed during the Ranger 3 Deeps Exploration Decline project and the proposed action, will be located outside and immediately adjacent to this area, still located in a brownfields area and outside the buffer zone of any cultural heritage sites. Taking the most conservative approach the closest the vent raises could be located is 50 m from the boundary fence of the exclusion zone for the R34 archaeological site.

Surface infrastructure for the proposed action during construction or operation will not impact on R34.

As shown on Figure 11, the R34 site lies directly above the decline. As discussed in [Section 3](#) the risk of damage to R34 from decline or stope blast induced vibration is negligible.

3.3 (j) Other important or unique values of the environment

The Ranger uranium mine is located in the southern portion of the Ranger Project Area, which is separate from but surrounded by Kakadu National Park. The Park is an area of national and world heritage significance. Large areas of Kakadu are listed as wetlands of international importance under the Ramsar Convention (including areas used by migratory shorebirds). Numerous migratory species that occur in Kakadu are protected under international agreements such as the Bonn Convention for conserving migratory species, and Australia's migratory bird protection agreements with China (CAMBA) and Japan (JAMBA). Kakadu is also part of a Tri-National Wetlands Conservation Project which operates under an agreement between the Director of National Parks and the management authorities of Wasur National Park in Irian Jaya and Tonda Wildlife Management Area in Papua New Guinea.

The cultural sites of Kakadu National Park exhibit several key attributes, including the fact that they are of great antiquity and have a continuous temporal span from the Pleistocene Epoch until the present, that they exhibit great diversity in space and time and yet represent continuous cultural development, and that the cultural tradition demonstrated in the art and archaeological record is a living tradition that continues today.

There are numerous archaeological and cultural heritage sites on the Ranger Project Area. ERA has been advised by the Aboriginal Areas Protection Authority that one registered sacred site occurs on the Ranger Project Area, approximately 3 km north of the Jabiru Airport, on the northern side of Magela Creek. Archaeological clearance surveys have been conducted by the traditional land owners over approximately 44 % of the Ranger Project Area. No archaeological or heritage sites will be disturbed by the proposed action. All surface infrastructure will be placed within an area which has been surveyed, and outside of the buffer zone of the one significant archaeological site in the project area.

A cultural heritage management system has been implemented and a draft Interim Protocol regarding cultural heritage management on the Ranger Project Area has been developed in collaboration and agreement with the Gundjeihmi Aboriginal Corporation.

3.3 (k) Tenure of the action area (e.g. freehold, leasehold)

The Ranger Project Area is situated on Aboriginal freehold land. Figure 34 shows both the regional land tenure and local land tenure in the area. The most significant Northern Territory land portions relevant to the proposed action are: Northern Territory Portions 2273, 2376, 1656, 1657, 1662, 1685, 1686, 1690.

Aboriginal freehold title exists across most of the land in the area of the Ranger Project Area. Aboriginal freehold titles granted under the *Aboriginal Land Rights (Northern Territory) Act* (Cth) are held by the Kakadu Aboriginal Land Trust. Northern Territory Portion 2376 is leased back to the Director of National Parks with the lease expiring on 31 December 2077. However, not all of Northern Territory Portion 2376 is included in the declaration of Kakadu National Park. Northern Territory portions 1656, 1657, 1685, 1686 and 1690⁶⁴ are not included in the declaration of Kakadu National Park and are not included in any lease to the Director of National Parks. The Ranger Project Area section of Northern Territory portion 1662 is not included in the declaration of Kakadu National Park and is not included on the lease to the Director of National Parks.

⁶⁴ Northern Territory portion 1690 is not shown on the map as it occurs a significant distance to the southwest.

3.3 (l) Existing land/marine uses of area

The Ranger Project Area is 78.6 km² in area. Approximately 70 % of the Ranger Project Area is relatively undisturbed. The operating Ranger mine site is located in the south western part of the Ranger Project Area.

Other facilities within the disturbed areas of the Ranger Project Area, adjacent to and associated with the mining operations include the Jabiru Airport and associated service and tourist facilities, the Gagudju Association workshop, a temporary camp occupied by ERA contractors, a field station belonging to the Commonwealth's Supervising Scientist Division, former ERA nursery and environmental workshops, and land once occupied by the Northern Territory Department of Mines and Energy.

3.3 (m) Any proposed land/marine uses of area

There are no other known or proposed land/marine uses of the area.

4 MEASURES TO AVOID OR REDUCE IMPACTS

The proposed action involves the development of an underground mine utilising much of the pre-existing infrastructure constructed for exploration purposes. The main mine workings will be greater than 300 m below the surface. A fixed ventilation system, including a vertical ventilation shaft, constructed for the exploration activity will be expanded to include additional ventilation infrastructure. Mineralised material will be transported to the surface and processed at the existing on site processing plant. A paste fill plant (approximately 100 m³/hr capacity) will be constructed within the footprint of the existing operational area for the purpose of backfilling the mined out stopes. Due to the selective nature of the underground mining method, only a relatively small quantity of waste rock will be generated (e.g. less than 0.5 Mt of waste rock, compared to greater than 80 Mt of waste from the open Pit 3) (see [Section 2.1](#)).

Processing of the Ranger 3 Deeps ore will not change the water management strategies of the existing Ranger mine operation. Further, the proposed action will result in only minor incremental changes to the existing operation's process water and tailings inventories, and will not significantly alter the Ranger mine's overall closure planning.

There is a very low likelihood that the proposed action will have any significant impact on matters protected under the EPBC Act. Transition from open cut to underground mine will have no significant impact on downstream environments, threatened species or any threatened ecological community, or their habitat. The action itself can readily be demonstrated to have lower actual and potential impacts on the environment compared to the current open pit mode of mining at Ranger.

The proposed action will be managed as part of the existing operation and as such will be subject to existing regulatory controls, including the Ranger Section 41 Authority, the Ranger Authorisation, the Commonwealth's Environmental Requirements under the *Atomic Energy Act 1953*, agreements and obligations under the *Aboriginal Land Rights (Northern Territory) Act 1976*, and the obligations and arrangements established by the *Environment Protection (Alligator Rivers Region) Act 1978*.

Across each of the key environmental aspects of downstream water quality, ambient air quality, noise and vibration; and flora and fauna the inherent potential for impact to the environment will be reduced compared to current open pit mining. Therefore and to a large extent, application of current mitigation measures, systems for monitoring, and application and adherence to the existing Ranger environmental management system will provide improved protection of the environment. Naturally in some aspects, additional mitigation and control measures specific to underground mining will be applied, such as to afford appropriate radiation protection, air quality and temperature control for workers through designed ventilation systems, shielding and other measures.

Measures which ERA currently undertakes as well as new and/or specific additional measures to avoid or significantly minimise any risks to: groundwater quality; air quality and radiation; transportation; cultural heritage; and, social and community as identified in the risk analysis, in relation to the proposed underground mine and processing operation, are described in Table 20.

Table 20: Summary of risk/impact and mitigation measures

Risk and impact	Mitigation measure
<p>Groundwater quality:</p> <ul style="list-style-type: none"> (TE01) Contamination of groundwater via a loss of containment of tailings deposited as cemented paste backfill in underground stopes. (TE03) Accelerated solute transport via the underground workings acting as a conduit and providing a preferential pathway from Pit 3 backfill. 	<ul style="list-style-type: none"> Known geology is of low permeability. Cemented paste will be engineered such that it exhibits low permeability characteristics. Stopes will be below 300 m and progressively backfilled as mining progresses. Solute transport modelling will continue supported by packer testing. Cover hole drilling to provide advanced knowledge of water quality and quantity before advancing the decline. (This is a component of the Ranger 3 Deeps Exploration Decline project.) At the completion of mining all the underground workings, including ore drives, exhaust drives, crosscuts, ventilation shafts and the decline will be backfilled in a manner which attains a similar or lower potential for passage of water containing contaminants as compared to the surrounding rock. This will be achieved by a combination of rock fill and engineered low permeability barriers.
<p>Air quality and radiation:</p> <ul style="list-style-type: none"> (TA06) Increased radiation dose to public, flora and fauna from ventilation emissions. <p>(The mitigation measures listed here also address protection of workers)</p>	<p><u>Ambient Air Quality</u></p> <p>The main sources of emissions to air from the underground mine are:</p> <ul style="list-style-type: none"> dust generated by construction activities and truck movements to/from stockpiles, ore sorter, etc; exhaust emissions generated from dust, blasting fumes; and emissions from the combustion of diesel in the upgraded power station. <p>The emissions will be similar in nature, but at substantially decreased quantities, compared to those that are currently emitted from Pit 3 and subsequent mining activities. Modelling of a 10 m ventilation stack indicates that cumulative deposition is well below New South Wales Dept of Environment and Climate Change deposition criterion.</p> <p>To reduce vehicle emissions underground, ERA intends to use equipment such as the low-profile Sandvik TORO underground trucks, which use a 14-litre 392 kW diesel engine. The Detroit diesel series 60 engine in the TORO trucks employs a unique water-cooled system to reduce emissions by 50 % and a particulate filtration system which reduces diesel particulates by 90 %.</p> <p>In summary, air quality will be managed through ventilation, dust suppression and equipment selection to protect workers operating underground and in the vicinity of the portal. The operators' cabins will have noise suppression and be air conditioned.</p> <p><u>Radiation Management</u></p> <p>ERA has core values relating to the safety and wellbeing of its employees and the protection of the environment. Radiation safety and protection are included in these core values. Our goal is to minimise radiation exposures to workers, the public and the environment to as low as reasonably achievable. ERA's radiation protection framework is to:</p> <ul style="list-style-type: none"> Manage the radiation exposure of individuals in the workforce, the general public and the surrounding environment;

Risk and impact	Mitigation measure
	<ul style="list-style-type: none"> • Continuously improve our radiation management system and implement leading practices in radiation protection as part of our commitment to minimise doses and adopt the ALARA principal.⁶⁵ • Comply with, and where practical, endeavour to exceed all applicable legislation. <p>The system of radiation management at ERA's operations is based on the principals of radiation protection as recommended by the International Commission on Radiological Protection, standardised by the International Atomic Energy Agency and adopted in a joint Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) and National Occupational Health and Safety Commission document. These principles are defined as follows:</p> <ul style="list-style-type: none"> • The Principle of Justification: Any decision that alters the radiation exposure situation should do more good than harm. • The Principle of Optimisation of Protection: The likelihood of incurring exposure, the number of people exposed, and the magnitude of their individual doses should all be kept ALARA, taking into account economic and societal factors. • The Principle of Application of Dose Limits: The total dose to any individual from regulated sources in planned exposure situations other than medical exposure of patients should not exceed the appropriate limits specified by the Commission. <p>The application of these principals on the proposed action is outlined below:</p> <p><u>Justification</u></p> <p>The proposed action will continue to provide the social benefits currently derived from Ranger, including income to the Northern Territory and supply of fuel for global nuclear power.</p> <p><u>Dose Limits</u></p> <p>The radiation dose limits, recommended by the International Commission on Radiological Protection and adopted by ARPANSA and National Occupational Health and Safety Commission are applied to ERA's operations, these are detailed in Section 2.</p> <p>ERA employees and contractors whose occupational exposure to radiation may exceed 5 mSv per year are declared 'designated' works and their exposure is more stringently monitored. During Ranger's existing operations, extensive monitoring has been carried out of radiation parameters for exposures to the workforce, nearby members of the public and the environment generally. Monitoring is undertaken by ERA and independently by Commonwealth and Northern Territory Government agencies.</p> <p>Radiation exposures resulting from the existing mine operations are measured under a comprehensive monitoring program that is approved by regulators and written into ERA's Authorisation. The results of the monitoring program are reported to regulators quarterly and summarised annually. The radiation exposures to workers and member of the public</p>

⁶⁵ ALARA – As Low as Reasonably Achievable, economic and societal factors being taken into account.

Risk and impact	Mitigation measure
	<p>over the past 19 years are presented in Figures 35 and 36, respectively.</p> <p><u>Optimisation</u></p> <p>The application of optimisation of radiation protection involves achieving the best level of protection under the prevailing circumstances and will be the main focus of the radiation protection program for the proposed action. The same rigorous optimisation processes, which have matured at Ranger over the past 30 years, will now be applied to the design of the proposed Ranger 3 Deeps underground mine. The best practice radiation control and management systems adopted for the current operations will be applied to, and become an integral part of the mine design, scheduling and roster selection.</p> <p>Optimisation is an ongoing iterative process where:</p> <ul style="list-style-type: none"> • The radiation risk (sources, pathways and potential exposures) in a workplace or to individuals are assessed; • Specific dose constraints or control levels are set for each work area to form the upper bound for the optimisation process; • Options for reducing exposures are identified; • Each option is reviewed according to the hierarchy of controls and also by considering the net exposure reduction versus the economic and societal factors; and • Selected options are implemented. <p>Over time the ongoing iterative process will see exposures optimised to ALARA.</p> <p>As part of the application of optimisation, ERA has elected to follow the standard safety and risk management methodology termed “the hierarchy of controls”. This has been adapted to a radiation protection situation as follows:</p> <ul style="list-style-type: none"> • Elimination: Not exposing individuals to radiation so far as is practicable; • Isolation: Isolating sources of radiation, so far as is practicable, through shielding, containment and remote handling techniques; • Engineering: Providing engineering controls to reduce radiation exposures and radioactive contamination levels in workplaces; • Administrative: Adopting safe work practices; and • Personal Protective Equipment: If other means of controlling exposure are not practicable or adequate, by providing personal protective equipment. <p>By applying this hierarchy, specific measures will be implemented to prevent any unlikely exposures of the workforce to radiation. The nature and need for particular measures will be confirmed during the pre-feasibility studies but are likely to include, for example: the designing of a single-pass ventilation system and shotcrete shielding of mineralised zones.</p> <p>As previously discussed, the main aims of the ventilation system are to prevent the build-up of radon decay products (radon daughters) and to dilute the concentration of radioactive dust in the atmosphere.</p>

Risk and impact	Mitigation measure
	<p>Monitoring of underground air quality will be undertaken on a daily basis to confirm the ventilation system is operating to design specifications and radon decay product concentrations remain below trigger levels. In addition to the ventilation system and shielding programs, other ancillary radiation protection measures may include:</p> <ul style="list-style-type: none"> • Using remote handling techniques for areas of higher radiation exposure; • Use of sealed, air-conditioned cabs to all trucks, loaders, drilling rigs and other underground equipment where practicable; • General mine dust suppression; • Logging of blast drill holes to provide an indication of uranium mineralisation; • Use of electronic personal dosimeter on workers in higher gamma exposure areas; • Classification of the underground mine as a radiation controlled area;⁶⁶ • Classification of workers who have the potential to receive greater than 5 mSv per year as "designated";⁶⁷ • Implementation of the current Ranger system to manage surface contamination; • Compulsory laundering of work clothing daily, after each shift; • Provision of clean crib rooms for meal breaks; • Implementation of general hygiene requirements for working, including washing of hands and face before eating and drinking; • Development of standard operating procedures and work instructions for radiation protection management and monitoring; • Use of the Ranger Job Hazard Analysis system that includes the assessment of radiation hazards; • Implementation of a permit to work system that includes referral to the Radiation and Hygiene department for all radiation related risks; • Use of signage to inform workers of radiation hazards;⁶⁸ • Education and training of relevant personnel; and • Use of airstream helmets outside air conditioned cabins if monitoring indicates that it is a requirement. <p>Prior to the commencement of operations a complete underground radiation monitoring program will be designed, approved by the regulatory authority and implemented at site. The program will be risk based but will include the monitoring of gamma exposure to underground workers using personal thermo-luminescent dosimeters badges, conducting personal dust sampling of long lived alpha activity in dust for each underground workgroup and the routine daily monitoring of radon decay products in all occupied areas.</p> <p>In keeping with the latest trends in radiation protection principles, ERA has implemented the concept of dose constraints into its radiation</p>

⁶⁶ A "controlled area" is an area to which access is subject to control and in which workers are required to follow specific procedures aimed at controlling exposure to radiation.

⁶⁷ All **designated workers** will monitored individually for radiation exposure and have their total annual effective dose recorded and reported.

⁶⁸ All signage will conform to the Australian Standard AS 1319-1994 Safety Signs for the occupational environment.

Risk and impact	Mitigation measure
	<p>optimisation program. Dose constraints are used in conjunction with the optimisation of protection to restrict individual doses. The International Commission on Radiological Protection recommends that a dose constraint be set for every operation to serve as an upper bound for the optimisation program, with the intention to remain at or below this constraint and to reduce all doses to ALARA.</p> <p>Order of magnitude studies were conducted setting an initial dose constraint of 10 mSv per year. Annual maximum radiation doses were calculated for various work groups (Figure 37); this shows the major exposure pathway to be from gamma radiation exposure and that all the doses will be below the initial dose constraint. However, the calculated doses are still relatively high compared to the current Ranger operation (Figure 35).</p> <p>As part of ERA's optimisation process, opportunities to lower exposures overall, and to specific worker groups, will be considered throughout the prefeasibility study.</p>
<p>Transportation:</p> <ul style="list-style-type: none"> (TP01) Increased traffic on access highways, results in a spill of hazardous materials/waste causing environmental harm. 	<p>ERA has developed a strong partnership with Orica and Chemtrans, accredited specialist transport companies, to foster best practice in delivery of sulfuric acid to Ranger. Key transport safety elements include: specially engineered truck and trailer configurations and braking systems, route evaluations, continuous driver training and assessment, global positioning satellite tracking of truck location and speed, satellite telephones for emergency contact and emergency response facilities. A similar focus on safety has been developed with all other accredited transport companies that deliver consumables to Ranger and transport product from site.</p>
<p>Cultural heritage:</p> <ul style="list-style-type: none"> (TC01) Disturbance or damage to a known cultural heritage site. (TC03) Intersection or discovery of an anthropological site during mining leads to an impact of cultural significance. 	<ul style="list-style-type: none"> Cultural heritage management system, which includes physical barriers to identify the sites; signage; land disturbance permit system; general induction; cultural awareness training; code of conduct; and cultural heritage site management plan. In regard to discovery of an anthropological site during mining the potential impacts will be mitigated after direct consultation with land owners, as to the preferred course of action.

Risk and impact	Mitigation measure
<p>Social and community:</p> <ul style="list-style-type: none"> • (TJ01) Design of vent and fans generates noise nuisance which is incompatible with traditional lifestyle and access, leading to decreased incentive for land owners to use nearby areas. • (TJ02) Design of vent and fans, and thus changes to visual amenity are incompatible with traditional lifestyle and access, leading to decreased incentive for land owners to use nearby areas. • (TJ03) Increased workforce leads to increased local social nuisance. • (TJ04) The requisite skills for underground mining, may increase reliance on interstate recruitment and may reduce local and regional employment opportunities. • (TJ07) Lack of co-ordination of engagement between ERA and land owners resulting in a loss of richness of information sharing, loss of land owner confidence in our strategy and a lack of respect for cultural values. • (TJ09) Perceived higher health, safety and environment risk with underground mining, leads to a lack of public support for the project. 	<p><u>Employment opportunities</u></p> <ul style="list-style-type: none"> • ERA is committed to increasing the participation of local Aboriginal people in private sector employment. • ERA will endeavour to maintain high levels of indigenous employment, likely to be in the order of 20 % of the workforce. • ERA also has training programmes to establish and develop capability in the local region. <p><u>Community engagement</u></p> <ul style="list-style-type: none"> • Communication management plan; formal accountabilities for communication are allocated within ERA. • Cultural heritage protocol. • Quarterly stakeholder and community updates, include information pertaining to Ranger 3 Deeps. <p><u>Workforce behaviour</u></p> <ul style="list-style-type: none"> • Strict codes of conduct are applied to all employees and contractors accommodated in Jabiru. • Drug and alcohol policy in place, including all employees and contractors subject to random testing. • Cross-cultural awareness training and requirement to attend briefings by Kakadu National Park staff in relation to awareness of World Heritage values. <p><u>Increased nuisance</u></p> <ul style="list-style-type: none"> • Preliminary noise and vibration studies indicating levels below prescribed criteria at sensitive receptors; if necessary and in consultation with land owners, noise reduction technology may be implemented. • Tenancy agreements, inductions – e.g. cross cultural training, code of conduct, cardinal rules. <p><u>Visual amenity</u></p> <ul style="list-style-type: none"> • ERA will undertake a visual amenity assessment and discuss the outcomes in consultation with land owners. Where alternative locations are technically feasible, ERA consider land owner preferences and/or other mitigating measures. • Further dispersion modelling to assess the appropriate location for ventilations shafts.

5 CONCLUSION ON THE LIKELIHOOD OF SIGNIFICANT IMPACTS

Identify whether or not you believe the action is a controlled action (ie. whether you think that significant impacts on the matters protected under Part 3 of the EPBC Act are likely) and the reasons why.

5.1 Do you THINK your proposed action is a controlled action?

- | | |
|-------------------------------------|---------------------------|
| <input type="checkbox"/> | No, complete section 5.2 |
| <input checked="" type="checkbox"/> | Yes, complete section 5.3 |

5.2 Proposed action IS NOT a controlled action

Not applicable.

5.3 Proposed action IS a controlled action

Matters likely to be impacted

- | | |
|-------------------------------------|--|
| <input type="checkbox"/> | World Heritage values (sections 12 and 15A) |
| <input type="checkbox"/> | National Heritage places (sections 15B and 15C) |
| <input type="checkbox"/> | Wetlands of international importance (sections 16 and 17B) |
| <input type="checkbox"/> | Listed threatened species and communities (sections 18 and 18A) |
| <input type="checkbox"/> | Listed migratory species (sections 20 and 20A) |
| <input checked="" type="checkbox"/> | Protection of the environment from nuclear actions (sections 21 and 22A) |
| <input type="checkbox"/> | Commonwealth marine environment (sections 23 and 24A) |
| <input type="checkbox"/> | Great Barrier Reef Marine Park (sections 24B and 24C) |
| <input type="checkbox"/> | Protection of the environment from actions involving Commonwealth land (sections 26 and 27A) |
| <input type="checkbox"/> | Protection of the environment from Commonwealth actions (section 28) |
| <input type="checkbox"/> | Commonwealth Heritage places overseas (sections 27B and 27C) |

As a consequence of mining and processing uranium bearing ore, the proposed action falls within the definition of a "nuclear action". However, on the basis of the potential interaction between the proposed action and the surrounding environment (detailed in [Section 3](#)), and with the mitigation measures (discussed in [Section 4](#)), the proposed action is very unlikely to have a significant impact on the environment and other MNES.

The current Ranger operations are managed under a comprehensive suite of regulations at both the Commonwealth and Northern Territory level. Notwithstanding disturbance due to mining, ERA has managed the Ranger mine site for over 30 years, since initial construction, in a manner that has protected the downstream environment. Areas on the Ranger Project Area immediately surrounding the Ranger operations are little-disturbed and contain intact habitats and ecosystems.

Major infrastructure constructed as components of the Ranger 3 Deeps Exploration Decline project, will also be utilised for the proposed action. The proposed action is an extension of the concepts and operations previously contemplated, considered and approved by the Commonwealth and Northern Territory. The action will focus on targeted extraction of economic grade ore and processing using existing processing infrastructure, thus significantly reducing the surface operational footprint of the mine and further minimising environmental impacts. Activities associated with the proposed action will be managed appropriately under relevant legislation and in accordance with the existing

regulatory controls in the Ranger Authorisation and the Ranger Section 41 Authority Environmental Requirements, to ensure that the surrounding environment remains protected.

As described in detail in [Section 3.1](#), based on ERA's extensive understanding of the hydrogeology of the Ranger site, the proposed action is unlikely to intersect or impact upon groundwater aquifers or surface water. The very low permeability of the rock at the depth of the proposed mine and the intention to backfill stopes with cemented paste will protect the surrounding environment from potential groundwater contamination and solute transport impacts. Assessment of the dispersion of airborne contaminants predicts these will be orders of magnitude below criteria levels and therefore the likelihood of air emissions having a significant impact on the surrounding environment is negligible.

As discussed in detail in [Section 3.1 \(d\)](#) and [Section 3.1 \(e\)](#) the very small area of disturbance (2 ha), the very few listed threatened or migratory species that have been reported in the area of the proposed action and/or may be present or interact with the proposed action and the lack of appropriate habitat within the heavily disturbed Magela Land Application Area support a conclusion that it is very unlikely that the proposed action would have a significant impact on these listed threatened species or migratory species.

Given that it is not likely that the surrounding environment will be significantly impacted, and there are substantial and effective mitigations proposed to protect cultural values, it follows that the wetlands of international importance, world heritage values and national heritage places are also not likely to be impacted. The arrangements under the various Acts and associated "Environmental Requirements" are discussed in [Section 3.1 \(g\)](#). The proposed action is not expected to require any change to the existing arrangements nor generate any significant added risk to the land or the environment.

The other matters of "Commonwealth marine environment", "Commonwealth land" and the "Great Barrier Reef Marine Park" are not relevant to the proposed action.

In summary, the proposed action will not have a significant impact on downstream environments, threatened species or any threatened ecological community, or their habitat; nor will it have any significant impact on World Heritage values, National Heritage places or wetlands of international importance. The action itself can readily be demonstrated to have lower actual and potential impacts on the environment and MNES compared to the recently completed open pit mode of mining at Ranger. Consequently, it is very unlikely that the proposed action will have a significant impact on matters protected under the EPBC Act.

6 ENVIRONMENTAL RECORD OF THE RESPONSIBLE PARTY

NOTE: If a decision is made that a proposal needs approval under the EPBC Act, the Environment Minister will also decide the assessment approach. The EPBC Regulations provide for the environmental history of the party proposing to take the action to be taken into account when deciding the assessment approach.

	Yes	No
<p>6.1 Does the party taking the action have a satisfactory record of responsible environmental management?</p> <p>Provide details</p> <p>Ranger uranium mine operates under a comprehensive and complex suite of environmental regulations and has been recognised for its world-class environmental management system, first achieving certification under ISO 14001 in December 2003.</p> <p>During September 2005 ERA's Safety Management System was certified as being compliant with the requirements of Australian Standard AS4801 OHS Management System. Certification has been maintained since that time. The Radiation Management System developed by ERA is part of that certification.</p> <p>Annual reporting requirements are comprehensive, and include Wet Season Reports (detailing water management and water quality evaluations), Environment Reports (general operations), Plans of Rehabilitation, and Radiation and Atmospheric Monitoring. Since 2000, ERA has provided regulators and stakeholders with information on environmental incidents or events which:</p> <ul style="list-style-type: none"> • could result in significant risk to ecosystem health; or • has the potential to cause harm to people living or working in the area; or • is of, or could cause concern to Aboriginal people or the broader public as they occur at Ranger. <p>The regulators, including the Supervising Authority and the Commonwealth's Supervising Scientist Division, investigate all such incidents or events.</p> <p>Monthly inspections of the mine operations are carried out by regulators and stakeholders (Routine Periodic Inspections), and an annual stakeholder audit is also undertaken. These programs are focussed on environmental management and environment protection systems.</p> <p>The annual reports of the Supervising Scientist to the Commonwealth Minister for the Environment have consistently stated that Ranger mine has been operating since 1979 without significant impact or lasting environmental detriment to the surrounding environment of the World Heritage listed Kakadu National Park.</p>	X	

<p>6.2 Has either (a) the party proposing to take the action, or (b) if a permit has been applied for in relation to the action, the person making the application - ever been subject to any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources?</p> <p>If yes, provide details</p> <ol style="list-style-type: none"> 1. On 6 May 2005, ERA pleaded guilty to two offences under Section 39 of the Northern Territory <i>Mining Management Act</i> for two separate breaches of the Ranger Authorisation, in respect of an incident involving the potable and process water systems at the Ranger processing plant in March 2004, and separate incidents involving the radiation clearance of certain mobile equipment between November 2003 and March 2004. ERA was convicted and fined \$75,000 for each of the two offences. 2. On 28 September 2005. ERA was prosecuted by the Northern Territory's Department of Business, Industry and Resource Development under Section 23 (4), Safety and Health Offences, of the Northern Territory's Mining Management Act for an injury to a fitter in the processing plant. ERA pleaded guilty and was fined \$82,500. 	X	
<p>6.3 If the party taking the action is a corporation, will the action be taken in accordance with the corporation's environmental policy and planning framework?</p> <p>If yes, provide details of environmental policy and planning framework</p> <p>ERA's Environmental Policy is attached (see Appendix I). In addition, ERA's Environmental Management System has been certified to ISO 14001 since 2003.</p>	X	
<p>6.4 Has the party taking the action previously referred an action under the EPBC Act, or been responsible for undertaking an action referred under the EPBC Act?</p> <p>Provide name of proposal and EPBC reference number (if known)</p> <ol style="list-style-type: none"> 1) Ranger uranium mine: Transportation of concentrated sulfuric acid through Kakadu National Park (2006): determined Not a Controlled Action. 2) Heap leach facility for Energy Resources of Australia Ltd's Ranger uranium mine. EPBC reference number 2009/4794, received 16 March 2009: withdrawn. 3) Ranger uranium mine: Orebody #3 Deeps exploration decline. EPBC reference number 2009/4860, received 17 April 2009: determined Not a Controlled Action. 	X	

7 INFORMATION SOURCES AND ATTACHMENTS

7.1 References

- **Highlighted documents** are available to the public, including web references if relevant.

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7.2 Reliability and date of information

The information is based on the references in [Section 7.1](#) and findings from field surveys conducted by specialist environmental consultants over a period of 30 years, with the most recent surveys occurring in 2010.

The field survey work was conducted in accordance with recognised professional survey methods and practices. The published documents cited in this referral are considered reliable and credible. The information has been subject to technical review by specialist environmental consultants.

7.3 Attachments

	✓ attached	Title of attachment(s)
You must attach figures, maps or aerial photographs showing the project locality (Section 1)	✓	<p>Fig 1: Location of the Ranger Project Area</p> <p>Fig 2: Contextual overview of the Ranger 3 Deeps mineral resource and indicative footprint of key infrastructure within the Ranger Project Area, including matters of national environmental significance (MNES) search co-ordinates</p> <p>Fig 3: Indicative location of the proposed action infrastructure in relation to existing infrastructure</p> <p>Fig 4: Provisional layout: Potential mining areas, plan view showing the extent of mineralisation relative to Pit 3</p>
figures, maps or aerial photographs showing the location of the project in respect to any matters of national environmental significance or important features of the environments (Section 3)	✓	<p>Fig 2: Contextual overview of the Ranger 3 Deeps mineral resource and indicative footprint of key infrastructure within the Ranger Project Area, including matters of national environmental significance (MNES) search co-ordinates</p> <p>Fig 11: Ranger 3 Deeps (including primary infrastructure) relative to the location of the R34 cultural heritage site</p> <p>Fig 12: Noise and vibration modelling nearest sensitive receptors</p> <p>Fig 23: Location of planned hydrogeology test work for Ranger 3 Deeps</p> <p>Fig 25: Predicted total suspended particulates deposition (mg/m²) from a 10 m ventilation stack, combined blast and diesel (with pollution reduction technology)</p> <p>Fig 27: Predicted 24-hour average radon concentration (mBq/m³) from a 10 m ventilation stack in and around the Ranger Project Area</p> <p>Fig 28: Potential pathways for transport of radionuclides into the environment</p> <p>Fig 29: Location of groundwater monitoring sites (statutory monitoring sites shown in red)</p> <p>Fig 30: Magela catchment showing gauging stations</p> <p>Fig 31: Current mine sub-catchments and water type. (NB: Pit 3 will become a process water catchment during transfer of tailing from the tailings dam during 2014-2020.)</p> <p>Fig 32: Dominant soil types in areas surrounding the</p>

		✓ attached	Title of attachment(s)
			<p>Ranger operations based on a land mapping approach to define boundaries between soil types (modified from Hollingsworth 1999). (The proposed location of proposed Ranger 3 Deeps underground mine infrastructure within the Magela Land Application Area is shown in red.)</p> <p>Fig 33: Ranger Project Area showing the extent of archaeological surveys and sites (unshaded)</p> <p>Fig 34: Land portions relevant to the Ranger Project Area, shown in grey</p>
If relevant, attach	copies of any state or local government approvals and consent conditions (Section 2.5)	✓	<p>Appendix A – Ranger Authorisation 0108-15</p> <p>Appendix C – Legislation & Regulations Influencing Operations at Ranger Mine</p>
	copies of any completed assessments to meet state or local government approvals and outcomes of public consultations, if available (Section 2.6)	✓	<p>Appendix D – Ranger 3 Deeps underground mine Overview of Communication and Consultation</p>
	copies of any flora and fauna investigations and surveys (Section 3)	✓	<p>Appendix E – MNES search tool report, 20 July 2012</p> <p>Appendix F – Assessment of threatened and migratory species</p> <p>Appendix H – Env Australia flora and fauna literature review, 25 June 2012</p>
	technical reports relevant to the assessment of impacts on protected matters that support the arguments and conclusions in the referral (Section 3 and 4)	✓	<p>Appendix A – Ranger Authorisation 0108-15</p> <p>Appendix B – Water management plan (example only)</p> <p>Appendix G - Environmental Risk Assessment - Ranger 3 Deeps Underground Mine Project</p> <p>Appendix I – ERA's Environmental Policy</p>
	report(s) on any public consultations undertaken, including with Indigenous stakeholders (Section 3)	✓	<p>Appendix D – Ranger 3 Deeps underground mine Overview of Communication and Consultation</p>

8 CONTACTS, SIGNATURES AND DECLARATIONS

Project title: Ranger 3 Deeps underground mine

8.1 Person proposing to take action

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Declaration I declare that the information contained in this form is, to my knowledge, true and not misleading. I agree to be the proponent for this action.

Signature



Date

16/1/2013

8.2 Person preparing the referral information (if different from 8.1)

Name Dr Peter Anderson
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Declaration I declare that the information contained in this form is, to my knowledge, true and not misleading.

Signature



Date

16/1/2013

Abbreviations and acronyms

ALARA	as low as reasonably achievable Used to describe the radiation safety philosophy of minimizing occupational radiation exposure.
ANFO	ammonium nitrate/fuel oil
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
AS	Australian Standard
CAMBA	China-Australia Migratory Bird Agreement
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EN	endangered species status
EPBC Act	(Commonwealth) <i>Environment Protection and Biodiversity Conservation Act 1999</i>
ERA	Energy Resources of Australia Ltd
ERICA	Environmental Risk from Ionising Contaminants Assessment Tool
ERISS	Environmental Research Institute of the Supervising Scientist
HB	handbook
ISO	International Organization for Standardization
JAMBA	Japan-Australia Migratory Bird Agreement
MNES	matters of national environmental significance
N/A	not applicable
OPSIM	The operational water balance model for the Ranger uranium mine. OPSIM is a trademark of Water Solutions Pty Ltd, the owner and licensor of the OPSIM™ software.
RL	Reference Level
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
SEWPaC	Commonwealth Dept of Sustainability, Environment, Water, Population and Communities
VU	vulnerable species status

Chemical symbols and formulae

²²⁷ Ac	Actinium-227, or Ac-227
¹⁴ C	carbon-14, or radiocarbon
CaO	calcium oxide, or quicklime
²¹⁰ Pb	lead-210 or Pb-210
²¹⁰ Po	polonium 210 or Po-210
²²⁶ Ra	radium-226 or Ra-226
Rn	radon
²³⁰ Th	thorium-230 or Th-230
²³⁴ Th	thorium-234 or Th-234
²³⁸ U	uranium-238 or U-238

Units of measurement

The units of measurement used are those recommended by the International System of Units (SI). They also however, include the following:

- non-SI units that are based on the SI (e.g. hectare, litre and tonne)
- non-SI units that are recognised as having to be retained because of their practical importance (e.g. day, hour, minute)
- various other non-SI units or specialist units in combination with SI units (e.g. decibel)
- non-SI units used in the mining industry (millions of tonnes per annum)

Bq	becquerel(s)	mBq/kg	milli-becquerel(s) per kilogram
Bq/kg	becquerel(s) per kilogram	m ²	metres squared
Bq/L	becquerel(s) per litre	mm	millimetre(s)
°C	degree(s) Celcius	mm/s	millimetre(s) per second
dB	decibels	mm/yr	millimetre(s) per year
dBA	decibels measured using the "A weighting filter"	mRL	metres reference level
GL	gigalitre(s)	mSv	milli Sievert The Sievert is the unit of absorbed radiation dose, taking into account the differing biological effects of different types of radiation.
h	height or hour(s)	Mt	million tonnes
ha	hectare(s)	Mtpa	million tonnes per annum
kL	kilolitre(s)	MW	megawatt(s) Measure of power output/requirement.
km	kilometre(s)	MWh	megawatt hours Measure of energy usage.
km ²	square kilometre(s)	pH	The measure of the acidity of a solution. Solutions with a pH less than 7 are said to be acidic and solutions with a pH greater than 7 are said to be basic or alkaline.
kV	kilovolt(s)	PM _{2.5}	Particulate matter less than 2.5 micrometers in diameter.
kW	kilowatt(s)	PM ₁₀	Particulate matter less than 10 micrometers in diameter.
L	litre(s)	Sv	Sievert
L/s	litre(s) per second	t/day	tonnes per day
ML/d	megalitres per day	V	Volt
m	metre(s)	w	width
m ²	square metre(s)	%	percent
m ³	cubic metre(s)	% w/w	weight for weight The weight of one component as a percentage of the total weight.
m ³ /hr	cubic metre(s) per hour	µg	microgram(s)
m ³ /s	cubic metres per second		

LIST OF APPENDICES

- Appendix A: Ranger Authorisation 0108-15
- Appendix B: Ranger 3 Deeps Exploration Decline: Water Management Plan – example only
- Appendix C: Legislation & Regulations Influencing Operations at Ranger Mine
- Appendix D: Ranger 3 Deeps Underground Mine: Overview of Communication and Consultation
- Appendix E: EPBC Act Protected Matters Report, 20 July 2012
- Appendix F: Threatened and migratory species assessment
- Appendix G: Hatch Report: Environmental Risk Assessment – Ranger 3 Deeps Underground Mine Project, 20 November 2012
- Appendix H: Flora and Fauna Literature Review of the Ranger Uranium Mine Project Area – Report 1
- Appendix I: ERA Environment Policy