

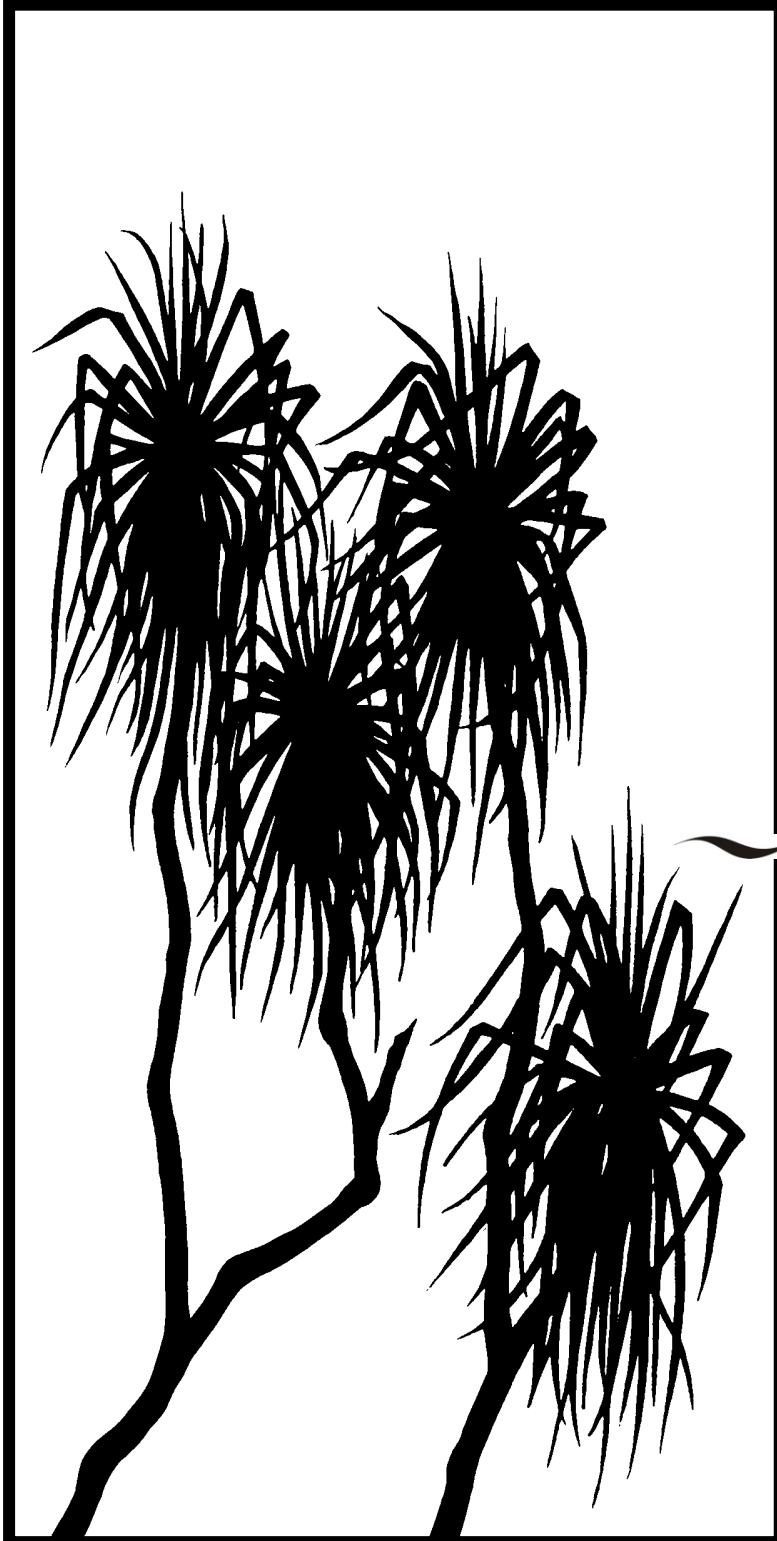


Australian Government

Department of Agriculture, Water and the Environment
Supervising Scientist

*internal
report*

664



Supervising Scientist
Assessment of 2020
Ranger Mine Closure
Plan

Rev #: 1.20.0

December 2020

Release status — Unrestricted

The Department acknowledges the traditional owners of country throughout Australia and their continuing connection to land, sea and community. We pay our respects to them and their cultures and to their elders both past and present.

**Supervising Scientist
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of
2020 Ranger Mine Closure Plan
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1. Assessment scope and structure

This assessment report contains the outcomes of a detailed assessment by the Supervising Scientist of the October 2020 revised Ranger Mine Closure Plan (RMCP, ‘the plan’), submitted by Energy Resources of Australia Ltd (ERA). The main objective of the Supervising Scientist’s assessment of the RMCP is to determine whether the plan demonstrates a reasonable and evidence-based path for the rehabilitation of Ranger satisfying the Environmental Requirements (ERs). This report constitutes the advice of the Supervising Scientist to the Australian Government Minister for Resources, Water and Northern Australia and the Northern Territory Minister for Mining and Industry.

The format of the assessment report has been simplified since the previous (2019) RMCP assessment, to focus on the technical aspects of the plan and the degree to which the Supervising Scientist’s recommendations on previous plans have been addressed. Further details on the statutory framework and how the ERs apply to the assessment of the rehabilitation of Ranger can be found in the Supervising Scientist’s 2019 RMCP assessment report at: <https://www.environment.gov.au/science/supervising-scientist/publications/ranger-mine-closure-plan-assessment-report-2019>

The Supervising Scientist’s assessment of the 2020 RMCP is comprised of:

1. Assessment summary, including general observations/concerns and the status of each rehabilitation theme.
2. Attachment A: Assessment of closure criteria
3. Attachment B: Comments tables, including:
 - i. Previous comments yet to be addressed
 - ii. Previous comments that have been addressed or are closed-out
 - iii. New comments on the 2020 RMCP

2. Assessment Summary

2.1. General observations

2.1.1. Overview

The 2020 RMCP again represents an improvement over the previous version and benefits from the additional knowledge gained through the extensive work undertaken over the preceding year. Nevertheless, the 2020 RMCP does not yet provide sufficient evidence to demonstrate that the rehabilitation works proposed will satisfy the Environmental Requirements. In particular, the predictions of post-closure surface water quality are not yet finalised; significant additional studies are required on ecosystem establishment; a radiation dose assessment is yet to be completed; it is not yet known how the residual contamination beneath the tailings dam will be managed; and it has not yet been determined what level of environmental effect within the Ranger Project Area (RPA) would be considered “As Low as Reasonably Achievable”. However, work to address all these issues is underway, and in many cases well advanced, and is expected to be included in future versions of the plan.

Approval of the high-level rehabilitation plan outlined in the 2020 RMCP is supported; however, it is noted that approval for several major rehabilitation activities will be provided over coming years through stand-alone applications. ERA has foreshadowed separate applications for Pit 3 Closure, Final Landform and Revegetation and the Tailings Storage Facility Deconstruction. Consequently, these aspects of the 2020 RMCP cannot yet be “approved”.

2.1.2. RMCP Structure and Scope

As noted in previous assessments, the RMCP is a generally well-presented document and structured according to the Western Australian guidelines for mining rehabilitation plans. The plan continues to improve as it is populated with additional information from completed studies undertaken by ERA and/or the Supervising Scientist Branch. However, in some cases key information has not been updated when it was available and/or there are discrepancies between sections within the plan (e.g. separation of related material such as Section 5 *Knowledge Base* and its Appendix 5.1 *Revegetation Knowledge Base*). Whilst the section *Summary of Changes to the Ranger MCP since the 2019 submission* identifies some key structural changes to the plan, there have been some significant changes to its content that should be highlighted. For example, several key risks identified in the 2019 RMCP have been either removed or downgraded, with little or no explanation.

In Section 1 of the plan (*Scope and Purpose*), it is suggested that in cases where information will have already been included within the RMCP, the subsequent stand-alone application would include any updates or additional information subsequent to the previous RMCP. While this may be the case, to avoid potential confusion with regulatory approvals, each stand-alone application must include **all** relevant information, even if it has also been previously presented in the RMCP.

2.1.3. Key Knowledge Needs

The Ranger Key Knowledge Needs (KKNs) represent the outstanding knowledge required to ensure that the rehabilitation activities proposed by ERA will achieve the environmental objectives and hence satisfy the ERs. Based on the outcomes of a comprehensive screening-level ecological risk assessment conducted on the rehabilitation of Ranger mine and undertaken in collaboration with key stakeholders, the KKNs are periodically closed out via a formal process by the Ranger Minesite Technical Committee and Alligator Rivers Region Technical Committee. The most recent version of the KKNs, including those that have been closed out, is published on the Supervising Scientist’s website at: <https://www.environment.gov.au/science/supervising-scientist/publications/ssr/key-knowledge-needs>.

While ultimate responsibility for rehabilitation outcomes at Ranger mine rests with ERA, both ERA and the Supervising Scientist maintain active research programs directed at informing these outcomes. ERA or the Supervising Scientist may either lead a KKN or share responsibility for completing the corresponding studies. Research projects to be conducted over the next six years have been established and are scheduled against the mine rehabilitation schedule.

The KKNs are made up of 79 component questions under the five following rehabilitation themes, with the current close-out status as indicated:

- Landform – 0/9 closed-out
- Water and Sediment (includes soils) – 10/30 closed-out
- Radiation – 7/21 closed-out
- Ecosystem Restoration – 1/17 closed-out
- Cross-theme – 0/2 closed-out

2.1.4. Key Assumptions

In order to schedule all rehabilitation activities between now and January 2026, many assumptions have been made, particularly with respect to engineering works and modelling. As stated in the Supervising Scientist's assessment of the 2019 RMCP, the plan would be improved by clearly articulating key assumptions and describing reasonable alternative options should the assumption fail to be achieved.

For example, it is assumed that contaminated groundwater beneath the Tailings Storage Facility (TSF) may remain in place without any remediation and that any contaminated soils below the processing area and land application areas can be disposed of in Pit 3. Evidence has not yet been provided to demonstrate this strategy will pose an acceptable level of risk to the offsite environment, and no contingencies or alternative options to this approach have been presented in the RMCP. Several investigations are being undertaken or are planned by ERA to characterise and quantify the contamination in the TSF wall and floor materials, and groundwater. If these investigations and additional modelling work indicate that the material needs to be remediated, it is likely that this will have significant implications on schedule, costs and potential environmental outcomes.

2.1.5. Contingencies

The RMCP describes the activities and schedule for the successful rehabilitation of Ranger mine, based on the scenario that the project meets budget and timeline. As noted in the assessment of the 2019 plan, the 2020 plan still does not adequately address the uncertainty associated with this scenario and does not present sufficient information to demonstrate that contingency options have been developed with suitable granularity, in consideration of uncertainty and possible failure scenarios for major rehabilitation activities. Examples of such activities include brine injection, remediation of the TSF (including contaminated groundwater) and revegetation. While it is acknowledged that it may not be practicable to develop detailed contingency plans for all potential failure scenarios, they should be developed where possible for the activities with the highest risks and/or uncertainty.

2.1.6. BPT and ALARA

The Supervising Scientist supports the use of Best Practicable Technology (BPT) to determine outcomes for the Ranger mine site that are As Low As Reasonably Achievable (ALARA). To ensure this process aligns with the Section 12.5 of the ERs, which states, "*The BPT analysis must involve consultation with and having regard to the views of the major stakeholders...*", it is crucial that stakeholders are involved throughout all steps of the process. This is especially important given ERA has acknowledged that consideration of 'reasonableness' will be part of the BPT assessment itself.

In assessing the 2019 RMCP, the Supervising Scientist emphasised the need for quantitative values to be included in the closure criteria which relate to ALARA. Quantitative values are required to demonstrate that the chosen rehabilitation approach, as determined through BPT, will meet the environmental outcomes required for the on-site environment. The Northern Land Council and Traditional Owners have also requested this approach. It is expected that quantitative values will be determined through the BPT process and provide definition of what has been agreed by stakeholders as 'reasonable'. ERA should demonstrate that these values have been met for closeout to occur.

2.1.7. Closure Criteria

There has been good progress with derivation of closure criteria and subsequent stakeholder agreement to these in the past 12 months. While many of the high-level, qualitative criteria for ecosystem restoration have been agreed to, there is still work to be done to reach agreement on the metrics and monitoring methods to assess closure criteria and criteria for fauna are yet to be considered in detail.

The status of closure criteria agreement between ERA and the Supervising Scientist is detailed in **Attachment A** and summarised as follows (noting that a closure criterion may comprise up to several indicators for assessment):

- Radiation – all agreed (approval of RMCP Table 8-8 is supported)
- Landform – 5/7 agreed (approval of RMCP Table 8-4 is supported)
- Water and Sediment – 3/7 agreed (approval of RMCP Table 8-6 is supported)
- Soils – all in draft
- Ecosystem Restoration – 20/28 agreed (approval of RMCP Table 8-10 is supported)

Stakeholder consultation to finalise closure criteria is being undertaken via the Water and Sediment Working Group, the Ecosystem Restoration Working Group and regular technical engagement meetings held between the Supervising Scientist and ERA. The Supervising Scientist envisages that all remaining closure criteria should be finalised for inclusion and approval in the 2021 RMCP.

2.1.8. Closure Monitoring

Although the high-level monitoring objectives are clearly articulated in the RMCP and supported by the Supervising Scientist, there has been limited progress over the past 12 months towards the development of more detailed monitoring plans.

As noted in the assessment of the 2019 RMCP, under the current legislative framework (Ranger Authorisation under the Atomic Energy Act 1953 - section 41c (5) of the Authority (Nov 1999)) (Section 3.1.2), access to the RPA will cease on 8 January 2026. Actions are underway to ensure that ERA is able to access the site beyond 2026 to undertake the monitoring and maintenance activities described in the RMCP.

2.2. Landform

The Landform closure theme covers the physical aspects of the final landform that ensure long-term stability of the rehabilitated, disturbed footprint of the minesite. Specifically, it includes rehabilitation activities undertaken to ensure (i) the long-term isolation of tailings and geotechnical stability of the final landform, and (ii) minimising erosion and the dispersion of sediment to the surrounding environment, that if not met could result in impacts to receiving water ecosystems and human health.

Approval of the final landform design will be subject to assessment of a standalone Final Landform and Revegetation Application. This is currently scheduled for submission by ERA in 2022 and information required for the application and to demonstrate that the relevant ER's will be met, is being generated through the relevant KKN research projects being undertaken by ERA and the Supervising Scientist.

Whilst numerous versions of the final landform design have been assessed for erosion and iteratively improved by ERA over recent years, it is yet to be finalised and further information is required in relation to the operation and management of erosion control structures.

Approval of the closure of Pit 3 will be subject to assessment of a standalone Pit 3 Closure Application, currently scheduled for submission in January 2021. This application will need to demonstrate how potential issues related to the segregation of tailings in Pit 3 will be managed. This requires an update of the Pit 3 tailings consolidation model to accurately reflect the tailings properties, the development of a methodology by which tailings consolidation in the Pit 3 can be measured after the pit has been backfilled with waste rock and consideration of the potential impact of differential settlement on landform stability.

Additionally, the area of fine tailings that has now accumulated at the western end of Pit 3 may cause difficulties in placing waste rock over the tailings. ERA is developing a method for the sub-aqueous placement of geofabric and crushed rock over the fine tailings from a barge. This is not a conventional process and there is a risk it may not be successful, which could subsequently delay the closure of Pit 3 and the construction of the final landform.

2.3. Water and Sediment

The Water and Sediment closure theme covers the rehabilitation activities undertaken to minimise the release of contaminants (i.e. chemical and physical) and prevent changes to water and/or sediment quality in the receiving environment that might result in impacts to ecosystems and/or human health.

ERA has made good progress since the 2019 RMCP in defining contaminant source terms and updates to surface and groundwater quality modelling to address concerns previously raised by the Supervising Scientist about the veracity of data and modelling approaches. This information is needed to identify and measure the type and extent of contaminant sources across the site, and to predict the future behaviour of contaminants during and after rehabilitation. Whilst the groundwater solute transport model is well advanced and of a high quality, further work remains to be completed on the surface water model. This includes calibration for the reach of Magela Creek adjacent to, and downstream of, Ranger using solute inputs from the site, and validation using the two most recent years of data. Further work is also required on surface water/groundwater interactions, in order to link the surface and groundwater models to provide reliable predictions of post-closure surface water contaminant concentrations. As this work is yet to be finalised, the surface water contaminant predictions provided in the 2020 RMCP should be considered as preliminary only. This work will be a key component of the Pit 3 Closure Application.

It is noted that a delay in tailings consolidation in Pit 3 could require an extension of water treatment beyond the currently forecast cessation date of 2025, which could impact the closure schedule.

Uncertainty remains in relation to the nature and extent of several potential future contaminant sources on the site, including contaminated groundwater plumes in the processing area and Tailings Storage Facility; and contaminated soils in the Land Application Areas and processing area. Much of this information will need to be completed and presented in the Pit 3 Closure Application and/or the TSF Deconstruction Application (scheduled for submission in 2023).

In 2020, a TSF Subfloor Material Management Application was submitted by ERA and received regulatory approval to leave in place the contaminated soil material at the base of the TSF, as opposed to disposing of this material in Pit 3. This application focussed on demonstrating that the transfer of material from the TSF floor to Pit 3 would result in a comparatively worse environmental outcome than leaving the material in-situ. This application did **not** demonstrate how contamination from the TSF will be managed – this will be addressed in the 2023 TSF Deconstruction Application.

It is noted that agreement has not yet been reached amongst stakeholders on any acceptable level of biological effects to aquatic ecosystems outside of the RPA. Throughout mine operations, the Supervising Scientist has adhered to the concept of no observable change in biodiversity compared to that measured in

reference ecosystems. There remains a divergence in views between ERA and other stakeholders in relation to interpretation of the ER 1.2(d);

1.2 In particular, the company must ensure that operations at Ranger do not result in:

(d) change to biodiversity, or impairment of ecosystem health, outside of the Ranger Project Area. Such change is to be different and detrimental from that expected from natural biophysical or biological processes operating in the Alligator Rivers Region;

It is implied by ERA in the RMCP (pg 8-28, “Second Outcome”) that an effect must be regional in nature to be considered detrimental. The Supervising Scientist considers the intent of ER1.2(d) to be clear and without any reference to the spatial extent of effects. The Supervising Scientist will actively engage with ERA and other stakeholders on this issue over the next year, with the objective of reaching a resolution prior to submission of the 2021 RMCP.

In relation to water treatment during the rehabilitation process, it is noted that an ‘Integrated Water Treatment Strategy’ is no longer listed in the 2020 RMCP as a future application but it is understood that ERA may be planning to provide an integrated water strategy as part of the Ranger Water Management Plan. Relevant information from this document should be incorporated into the next RMCP, including a conceptual diagram summarising the various proposed treatment activities.

2.4. Soils

Closely linked to Water and Sediment, the Soils closure theme covers the rehabilitation activities undertaken to minimise the release of contaminated soils, and contaminants from these soils, to prevent changes to water and/or sediment quality in the receiving environment and related impacts to ecosystems and/or human health.

The RMCP states that contaminated site assessments will be used to define the nature and extent of existing soil contamination within the RPA and where remediation is required, the contaminated soil will be recovered and disposed of appropriately. This is in line with the relevant ERs.

The RMCP summarises the results of some soil contamination studies that have been completed since the previous version of the plan, although stakeholders are yet to have the opportunity to conduct a technical review of the relevant reports. Following review of these reports, the Supervising Scientist will consider if further contaminated site assessment work is required, including at the Jabiru Airport. It is expected that the findings of these studies will be used to inform the requirement for area-specific remediation plans and/or closure criteria for soils, to ensure that the potential environmental impacts on the RPA are ALARA and any potential off-site impacts are mitigated.

2.5. Radiation

The Radiation closure theme covers the radiological aspects of the rehabilitated minesite, and the rehabilitation activities undertaken to understand and minimise the level of radiation exposure and impacts to ecosystems and human health.

After construction is complete, the waste rock on the surface of the final landform will be the primary source of radiation. The magnitude of potential radiation exposure along each of the exposure pathways will depend on the uranium activity concentration of the waste rock. Information on the uranium content of the surface waste rock layer on the final landform is needed for dose modelling of various radiation exposure pathways to the public (gamma, dust, radon and bush food) and wildlife (internal and external exposures). The 2018 and 2019 RMCP indicated that the waste rock surface will have an average uranium activity concentration of approximately 0.8 Becquerels per gram. The information on average uranium activity concentration in surface waste rock has been removed from the 2020 RMCP. This information is required and should be re-instated (or revised as appropriate) in the 2021 RMCP and as previously

recommended by the Supervising Scientist include details of the data and analyses used to derive the average activity concentration value.

Whilst the closure criteria for radiation have been agreed, dose assessments are required to demonstrate that the ERs relevant to radiation protection of the public and the environment can be met. The 2020 RMCP indicates that a dose assessment will be undertaken and presented in the standalone Final Landform and Revegetation Application, scheduled for submission in 2022. Information required for the application is being generated through studies being undertaken by ERA and the Supervising Scientist to address the relevant KKNs. The main areas requiring further information include predictions of (relevant KKNs shown in brackets):

- Radionuclides in the rehabilitated site, including activity concentrations of radionuclides in the waste rock, tailings and land application areas (RAD1)
- Radionuclides in aquatic ecosystems, including activity concentrations of radionuclides in the surface water and sediments (RAD2)
- Radon progeny in air (RAD3)
- Radionuclides in bushfoods (RAD5)
- Radiation dose to wildlife, including whole-organism ratios and tissue to whole organism conversion factors for radionuclides in representative wildlife organism groups; and sensitivity analysis for model parameters (RAD6)
- Radiation dose to the public, including the above-background dose from all exposure pathways from the rehabilitated site (RAD7)

2.6. Ecosystem Restoration

The Ecosystem Restoration closure theme covers the restoration of flora and fauna communities on the final landform, aiming to ensure that the relevant ERs for sustainable and similar ecosystems to those in the adjacent areas of Kakadu National Park are met.

The RMCP provides a high-level plan to revegetate the final landform with local species and good progress has been made in reaching agreement on high-level, qualitative closure criteria over the past 12 months for similarity and sustainability. However, a considerable number of studies remain to be completed by both ERA and the Supervising Scientist to develop/finalise quantitative closure criteria (particularly for fauna), address the KKNs and inform the Final Landform and Revegetation Application, scheduled for submission in 2022. Completion of these studies is required to ensure, with high confidence, that restoration will be on the desired trajectory towards achieving the relevant ERs.

The Final Landform and Revegetation Application should include an ecosystem restoration strategy for Ranger, based on an ecosystem restoration trajectory model. It should demonstrate how ERA will develop a functional and sustainable ecosystem at Ranger, including the restoration of key linkages between flora and fauna and the establishment of broader ecosystem processes, as required by ER 2.2(a). It should include the following topics:

Characterisation of the adjacent environment

There is agreement between ERA and stakeholders that the appropriate vegetation community to be established on the final landform is a *Eucalyptus miniata* and *E. tetradonta* dominated savanna. Vegetation community types should not be “blended” through the addition of species which would not normally occur together, and alternative vegetation community types should only be considered for establishment if it is clearly demonstrated that there are constraints (discussed in more detail below) that would prevent the establishment of the *Eucalyptus miniata* and *E. tetradonta* dominated savanna.

ERA and the Supervising Scientist have characterised the *Eucalyptus miniata* and *E. tetradonta* dominated savanna in areas adjacent to Ranger and it is agreed that, with some further revisions, the “2A” reference ecosystem described in the RMCP is a reasonable representation of this community type. It is noted that the 2A reference ecosystem will need to include understory species, and any low-density species of particular cultural or ecological significance.

Restoration trajectory model

- ERA should provide a scientifically-rigorous ecosystem restoration trajectory model which includes:
 - Milestones that will be used to demonstrate that the ecosystem is following the desired trajectory, and
 - Descriptions of the various deviated states which could occur if the ecosystem moves away from the desired trajectory.
- The trajectory model should include details of management strategies required to:
 - Proactively keep the ecosystem on the desired trajectory, and
 - Return the ecosystem to the desired trajectory if a deviation is detected, noting that different strategies may be required for each deviated state identified.

Mapping of constraints to ecosystem establishment

Constraints are any barrier to achieving the full establishment of the agreed reference ecosystem. Constraints which are unable to be mitigated should be included in a BPT assessment to determine the appropriate ecosystem(s) type to be established. The following should be considered in determining constraints:

- Possible ecosystem establishment constraints need to be assessed in a systematic manner and justified by adequate scientific information including trials and monitoring.
- Based on a BPT evaluation of ecosystem establishment constraints, ERA should clearly identify what ecosystem types will be best suited to each area of the rehabilitated landform. A detailed map of the landform should be provided, which clearly demarcates where each ecosystem type will be established.
- The species composition of a given ecosystem type should not be substantially modified (i.e. significant numbers of plant species added or removed) but rather where constraints are identified, a better suited ecosystem type should be selected.

There were some inconsistencies noted in the 2020 RMCP in ERA’s approach to assessing the constraints of waste rock for revegetation. In particular, information was presented to demonstrate that neither plant available water nor rooting depth are limiting to plant survival, while at the same time proposing to select drought-resistant overstorey species for revegetation which are not common in the surrounding area.

Description of each reference ecosystem type

Once it has been determined which ecosystem type(s) will be established, ERA should provide a species list for each reference ecosystem, including the final target density for each species, considering the following

- In accordance with ER 2.2(a) ERA must use only local species of local provenance.
- The establishment of vegetation species required for faunal habitat should be prioritised, particularly for threatened or culturally-significant faunal species.

Logistics and planting plan

ERA should provide detailed plans and timelines for planting, including:

- Planting densities and methods for each species,
- Seed requirements to achieve the required planting density,
- Seed availability, collection plans, storage, viability and germination treatments,

- Nursery details (e.g. capacity, human resources) and propagation studies for tubestock to demonstrate that sufficient plants will be available when they are required,
- Details of proposed irrigation infrastructure and irrigation rates, and
- Implementation and sequencing plan, including planting rates and target dates for the completion of key milestones.

Ecosystem sustainability

ERA should identify how the establishment of key ecosystem processes will be facilitated, including the requirements (e.g. inoculations, ameliorations) necessary for the commencement of nutrient cycling and the colonisation and survival of key soil biota and invertebrates.

Fauna and habitat formation

ERA should identify the measures that will be taken to facilitate the colonisation of fauna. This may include the establishment of key plant species and/or the installation of constructed habitat.

Monitoring and Maintenance Activities

A detailed monitoring and maintenance plan should be provided which is clearly linked to the ecosystem restoration trajectory model and continues until the final achievement of closure criteria, including the following

- Details of the routine, proactive maintenance activities to prevent the ecosystem moving off the desired trajectory.
- Documentation of the key risks identified by the Ecosystem Restoration Trajectory Model that could lead to deviated states.
 - For each risk, identify a monitoring and management plan (TARP) to detect and rectify any deviation away from the desired trajectory.
- A plan for the introduction and management of fire to:
 - Protect revegetation from fire in the early stages, and
 - Progress to a fire-resilient ecosystem over time.
- Details of ecosystem monitoring site selection, survey methods and the quantitative metrics which will be used to assess ecosystem condition and success against closure criteria.

Attachment A – Assessment of Closure Criteria

Landform - Final criteria

Proposed Landform closure criteria	ID	Assessment Outcome
DEM A high-resolution digital elevation model of the constructed landform matches the approved landform design, within applicable construction standards.	L1	Accepted
Landform evolution model (LEM) predictions of gully erosion Modelling of erosion on the constructed landform matches results of erosion modelling conducted on the approved landform design and confirms tailings will not be exposed for 10,000 years.	L2	Accepted
Gully erosion Gully formation will not expose buried tailings.	L3	Accepted
LEM model predictions of denudation rate Modelling of erosion on the constructed landform predicts that the denudation rate will be on a trajectory towards 0.04 mm/year.	L4	Accepted
Bedload Bedload is not being carried away from the constructed landform, in the absence of active management.	L5	Accepted

Landform - Draft criteria

Proposed Landform closure criteria	ID	Supervising Scientist Comment
Suspended Sediment Event-based fine suspended sediment loads, evaluated across the wet season, to Magela and Gulungul creeks, are on a trajectory towards background loads.	L6	The Supervising Scientist is currently updating the Landform Stability Standard, which should be incorporated into the 2021 RMCP. This will include a revised method for assessing suspended sediment loads against this criterion. Wording change needed from 'on a trajectory towards' to 'comparable to' background loads reflecting post-decommissioning and stabilisation expectations.
Sedimentation Accumulation of erosion products in Coonjimba and Georgetown Billabong will be ALARA.	L7	Accepted, noting that the Supervising Scientist expects to be consulted on the metrics and methods to monitor against this criterion.

Water and Sediment - *Final criteria*

Water and Sediment criteria ¹	ID	Assessment outcome	Supervising Scientist Comment
<p>Water quality: human health <i>Drinking water</i> Water quality off the RPA meets the national drinking water health guidelines (at times when they would be met in non-mine affected local creeks). SO₄²⁻ 500 mg/L, Mn 500 µg/L, NO₃ 50 mg/L, <u>NO₂ 3 mg/L</u>, U 17 µg/L (NHMRC & NRMCC, 2011; v3.5 updated 2018).</p>	W1	Accepted	Noted that diet criteria for human health are covered in W7, which are yet to be determined.
<p>Water quality: amenity and recreation Water quality off the RPA meets the national recreational guidelines for secondary contact (at times when they would be met in non-mine affected local creeks). <i>Toxic or irritant chemicals</i> NO₃ 500 mg/L, NO₂ 30 mg/L, U 170 µg/L (i.e. drinking water CoPC x 10: NHRMC, 2008) SO₄²⁻ 400 mg/L, Mn 100 µg/L (ANZECC & ARMCANZ, 2000 irritants, no guidelines for irritants/toxicants in NHMRC, 2008).</p>	W2	Accepted	
<p><i>Visual clarity and surface films</i> No mine-related change to water quality in Magela and Gulungul creeks causes turbidity to be significantly increased over natural background values. Oil and petrochemicals not to be noticeable as a visible film on the water or be detectable by odour.</p>	W6	Accepted	
<p>Water quality: ecosystem health SSB Rehabilitation Standards are met in Magela and Gulungul creeks off the RPA: <u>Dissolved total ammonia nitrogen; 0.4 mg/L (pH and temperature dependant)</u> <u>Dissolved magnesium; 2.9 mg/L (72-hour moving average)</u> <u>Dissolved magnesium to calcium (Mg:Ca) mass ratio; no greater than 9:1</u> <u>Dissolved sulfate; 10 mg/L (seasonal average)</u> <u>Dissolved uranium; 2.8 µg/L (72-hour moving average)</u> <u>Dissolved manganese; 75 µg/L (72-hour moving average)</u> <u>Turbidity; no statistically significant increase over natural turbidity</u></p>	W3	Accepted	Noted: (i) That concentrations of copper and zinc will be added to this list, once they are finalised. (ii) Nutrient criteria preventing eutrophication are still under review

1. Underlined = most stringent guideline values are taken as the draft W/SQO.

Water and Sediment - *Draft criteria*

Water and Sediment criteria	ID	Supervising Scientist Comment
<p>Water quality: human health</p> <p><i>Diet</i></p> <p>Local diet model demonstrates that ingestion of mine derived constituents of potential concern (COPC) via aquatic and terrestrial bush foods and drinking water does not cause annual intakes to exceed any relevant national/international tolerable intake levels.</p> <p><i>Parameter(s) – TBC with expert opinion</i></p>	W7	Closure criteria for diet are yet to be established for individual parameters.
<p>Water quality: ecosystem health</p> <p>SSB Rehabilitation Standards are met in Magela and Gulungul creeks at the boundary of the Ranger Project Area, downstream of the Ranger Mine:</p> <p><i>Values for copper and zinc: TBC following development of local site specific guideline value</i></p>	W3	The relevant Supervising Scientist rehabilitation standard is close to complete
<p>Sediment quality</p> <p>Uranium in sediments does not exceed 100 mg/kg dry weight (whole sediment; weak acid extractable digestion method)</p>	W4	<p>The uranium guideline value for sediment is being finalised by SSB.</p> <p>A sulfate closure criterion needs to be specified, in accordance with relevant guidelines:</p> <p>EPHC & NRMCC 2011. <i>National guidance for the management of acid sulfate soils in inland aquatic ecosystems</i>. Environment Protection and Heritage Council and the Natural Resource Management Ministerial Council, Canberra.</p>
<p>Water and sediment quality on the RPA</p> <p>Surface water and sediment quality on the RPA is demonstrated to be as low as reasonably achievable.</p> <p>Parameters: As for off the RPA listed above.</p> <p>Impacts on the RPA are ALARA</p>	W5	It is recommended that ERA update closure criteria that refer to ALARA with quantitative values that reflect ALARA.

Radiation - *Final criteria*

Radiation criteria	ID	Assessment outcome
Using the agreed restrictions on land use the total above-baseline radiation dose from external gamma exposure, inhalation of radon decay products (RDP), inhalation of dust and ingestion of bush food (including water), (shall not exceed) 0.3 mSv per year.	R1	Accepted
Should land use restrictions fail the total above-baseline radiation dose from external gamma exposure, inhalation of RDP, inhalation of dust and ingestion of bush food (including water), (shall not exceed) 1 mSv per year.	R2	Accepted
Total above-baseline radiation dose rate to terrestrial plants and animals from internal and external exposures (shall not exceed) 100 $\mu\text{Gy h}^{-1}$ to the most highly exposed terrestrial species.	R3	Accepted
Total above-baseline radiation dose rate to aquatic plants and animals from internal and external exposures (shall not exceed) 400 $\mu\text{Gy h}^{-1}$ to the most highly exposed aquatic species.	R4	Accepted

Soils – *Draft criteria*

Soil criteria	ID	Assessment outcome	Supervising Scientist Comment
Contaminated soil assessment for uranium and manganese in Land Application Areas: demonstrate risk is ALARA	S1	Further information	The assessment of ALARA requires a detailed understanding of the potential impacts to human health and the environment such that these can be balanced against the cost and practicality of remediation options. If current investigations indicate that contaminated soils on the Ranger Project Area do pose a risk to the offsite environment, there may be a requirement in future to develop soil closure criteria with specific concentrations for key contaminants.
Contaminated assessment of identified CoPCs for other soils identified as not being part of the larger decommissioning works: demonstrate risk is ALARA	S2	Further information	

Ecosystem Restoration - *Final criteria*

Proposed criteria	ID	Assessment outcome
<p>Provenance Revegetation has used (100%) local native species from Kakadu NP.</p>	E1	Accepted
<p>Species composition and relative abundance Species composition for all overstorey and midstorey species similar to, or on a trajectory towards, that of the agreed reference ecosystem(s).</p>	E2	Accepted
<p>Species composition for all understorey species similar to, or on a trajectory towards, that of the agreed reference ecosystem(s).</p>	E3	Accepted
<p>Stems per hectare of overstorey and midstorey framework species similar to, or on a trajectory towards, that of the agreed reference ecosystem(s).</p>	E4	Accepted
<p>Total species richness of framework species similar to, or on a trajectory towards, that of the agreed reference ecosystem(s).</p>	E5	Accepted
<p>Total species richness of all overstorey and midstorey similar to, or on a trajectory towards, that of the agreed reference ecosystem(s).</p>	E6	Accepted
<p>Total species richness of understorey species similar to, or on a trajectory towards, that of the agreed reference ecosystem(s).</p>	E7	Accepted
<p>Community structure Vegetation structure similar to, or on a trajectory towards that of the agreed reference ecosystem(s).</p>	E8	Accepted
<p>% Cover of overstorey and midstorey is similar to, or on a trajectory towards, that of the agreed reference ecosystem(s).</p>	E9	Accepted
<p>% Cover of understorey vegetation is similar to, or on a trajectory towards, that of the agreed reference ecosystem(s).</p>	E10	Accepted
<p>Overstorey and midstorey species distribution ('naturalness') is similar to, or on a trajectory towards, that of the agreed reference ecosystem(s).</p>	E11	Accepted
<p>Reproduction (flowering and seeding) Flowering and fruiting of framework species (based on species present), similar to, or on a trajectory towards, that of the agreed reference ecosystem(s).</p>	E12	Accepted
<p>Recruitment / regeneration Recruitment and regeneration of framework species (based on species present), similar to, or on a trajectory towards, that of the agreed reference ecosystem(s).</p>	E13	Accepted
<p>Nutrient cycling Chemical and biological indicators provide evidence that nutrient cycling will sustain ecological processes, similar to, or on a trajectory towards, that of the agreed reference ecosystem(s).</p>	E14	Accepted
<p>Resilience Following implementation of an appropriate fire regime, all other closure criteria must be shown to have been met, demonstrating recovery.</p>	E15	Accepted
<p>In the event of natural disturbances (e.g. wind, drought, or disease), all other closure criteria must be shown to have been met, demonstrating recovery.</p>	E16	Accepted
<p>Weed composition and abundance No Class A weeds or Weeds of National Significance (WoNS).</p>	E17	Accepted

Proposed criteria	ID	Assessment outcome
Abundance of Class B weeds no greater than agreed reference ecosystem(s).	E18	Accepted
Abundance of other introduced flora species would not require a maintenance regime significantly different from that appropriate to adjacent areas of Kakadu NP.	E19	Accepted
Exotic fauna Density of buffalo, horses and pigs on the RPA no greater than adjacent areas of Kakadu NP.	E20	Accepted

Ecosystem Restoration - *Draft criteria*

Proposed criteria	ID	Supervising Scientist Comment
<p>Habitat connectivity Lack of physical barriers (e.g. fences) provides the potential for external exchanges similar to, or on a secure trajectory towards, that of the agreed reference ecosystem(s).</p>	E21	<p>Subject to ongoing studies and stakeholder consultation.</p> <p>This may be better placed under sustainability criteria - external exchanges as in the SSB Ecosystem Restoration standard.</p>
<p>Native fauna species richness and diversity Number of vertebrate species is on a trajectory towards that of agreed reference sites.</p>	E23	<p>Subject to ongoing studies and stakeholder consultation.</p> <p>Species indices should also incorporate composition and abundance.</p> <p>As for flora criteria, fauna trajectories should specify 'similar to, or on a trajectory towards' and incorporate a monitoring timeframe.</p>
<p>Evenness of birds species across sites (Pielou's evenness) is on a trajectory towards that of agreed reference sites.</p>	E24	<p>Subject to ongoing studies and stakeholder consultation.</p> <p>This currently reads as a measure rather than the criteria (e.g. bird diversity is similar to or on a trajectory towards reference ecosystem).</p> <p>As for flora criteria, fauna trajectories should specify 'similar to, or on a trajectory towards' and incorporate a monitoring timeframe.</p>
<p>Functional diversity of native fauna Species richness for each of four Key Functional Groups of ants is on a trajectory towards that of agreed reference sites.</p>	E25	<p>Subject to ongoing studies and stakeholder consultation.</p> <p>Andersen (2019) recommends further research to identify representative invertebrate species for the grass layer. This would be linked to understorey composition and function.</p> <p>Species indices should also incorporate composition and abundance.</p> <p>As for flora criteria, fauna trajectories should specify 'similar to, or on a trajectory towards' and incorporate a monitoring timeframe.</p>
<p>Species richness of nectivorous and frugivorous species is on a trajectory towards that of agreed reference sites.</p>	E26	<p>Subject to ongoing studies and stakeholder consultation.</p> <p>Granivorous birds should be included, as this group are linked to the presence of grasses (understorey) and tree hollows.</p> <p>Species indices should also incorporate composition and abundance.</p> <p>As for flora criteria, fauna trajectories should specify 'similar to, or on a trajectory towards' and incorporate a monitoring timeframe.</p>

Proposed criteria	ID	Supervising Scientist Comment
<p>Target native fauna species Appropriate criteria for culturally significant fauna when identified.</p>	E28	Subject to ongoing studies and stakeholder consultation.
<p>Activity, diversity, and functional diversity of subterranean active termites is on a trajectory towards that of agreed reference sites.</p>	E29	<p>Subject to ongoing studies and stakeholder consultation.</p> <p>As for flora criteria, fauna trajectories should specify 'similar to, or on a trajectory towards' and incorporate a monitoring timeframe.</p>
<p>Number of threatened species are on trajectory towards that which occurs in the agreed reference sites.</p>	E30	<p>Subject to ongoing studies and stakeholder consultation.</p> <p>As for flora criteria, fauna trajectories should specify 'similar to, or on a trajectory towards' and incorporate a monitoring timeframe.</p>

Attachment B – Detailed Comments

Table 1. Recommendations from previous SSB RMCP assessments not yet addressed

(Note: Comments and responses are shown as they have been documented i.e. where there have not been updates/additional responses for a given year, these are not shown)

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
All	Introduction purpose and scope	Stand-alone applications	<p>SSB 2019 RMCP Assessment:</p> <p>Recommendation: The RMCP should include a table detailing the application, the expected date for submission, the date approval is required by, a description of the scope of the application and the information it will provide.</p> <p>ERA Response 2020 RMCP:</p> <p>This was an accidental omission from the 2019 MCP and has now been again included in the 2020 MCP (Section 1).</p> <p>SSB 2020 RMCP Assessment:</p> <p>While the 2020 RMCP includes a list of future planned applications (Table 3-2), it only describes those applications that will require Ministerial approval, as opposed to all planned or potential future standalone applications (e.g. no HDS sludge disposal or RP6 remediation).</p> <p>The list of standalone applications should include all planned applications, noting (as appropriate) any that may be subject to change.</p>
All	Risk assessment and management	Risk assessment	<p>SSB 2018 RMCP Assessment:</p> <p>To justify the assignment and ranking of risks, risk classes, controls and control effectiveness, the risk assessment should include:</p> <ul style="list-style-type: none"> • evidence to justify the likelihood and consequence rankings, including key assumptions and the level of certainty associated with the information informing this evaluation • a clear distinction between existing and proposed controls, and evidence to support control effectiveness rankings including consideration of control applicability or availability during the three closure phases (i.e. decommissioning, stabilisation and monitoring and post-closure) • a clear plan to obtain additional information to inform the assessment of each risk, to improve the control effectiveness, or to identify new risks as further information is obtained, where required. <p>ERA Response 2019 RMCP:</p> <p>The 2019 MCP includes further information to justify the assignment and ranking of risks, risk classes and controls. It is acknowledged that further development and refinement will be achieved in the 2020 risk assessment update, and these continual improvements will be included within each MCP update.</p> <p>SSB 2019 RMCP Assessment:</p> <p>Noted that the 2019 MCP does not appear to include further information to justify assignment and ranking of risks, classes and controls.</p> <p>ERA Response 2020 RMCP:</p> <p>The 2020 MCP has included more details on the closure risks. This is now in Section 7. The risk register provided in Appendix 7.1 has been updated to provide additional clarity.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The 2020 RMCP Risk Assessment still doesn't include adequate information to justify assignment and ranking of risks, classes and controls. Further comments are provided in Table 3.</p>
All	Risk assessment and management	Risk assessment	<p>SSB 2018 RMCP Assessment:</p> <p>Additional discussion around control effectiveness and contingencies should be provided for existing controls that:</p> <ul style="list-style-type: none"> • might be removed during decommissioning • are known to be ineffective at the time of reporting. <p>ERA Response 2020 RMCP:</p> <p>See response to comment 1 above.</p> <p>Additional information on contingencies for each of the closure execution activities is provided in Section 9.</p> <p>SSB 2020 RMCP Assessment:</p> <p>There is no detail on control effectiveness, either in the Risk Assessment and Management section or contingencies in Closure Implementation section. Further, there are many risks where no control effectiveness has been assigned – specific comments are provided in Table 3.</p>
All	Risk assessment and management	Risk assessment	<p>SSB 2019 RMCP Assessment:</p> <p>The ongoing review process for the closure-related risks is not clear in terms of frequency, scope and how it informs future iterations of the RMCP.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			<p>Recommendation: Detail the ongoing risk assessment review process, including a plan to obtain additional information to update the risk assessment over time, and what would trigger an update of the risk assessment.</p> <p>ERA Response 2020 RMCP:</p> <p>Details of ERAs closure risk management processes have been included in Section 7.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Whilst the RMCP has been updated with details of risk assessments that have been undertaken, the minimum frequency of risk reviews (e.g. annual) isn't explicitly stated, or what other factors may trigger an update to the risk assessment.</p>
All	Risk assessment and management/Closure implementation	Contingencies	<p>SSB 2019 RMCP Assessment:</p> <p>Pit 1 (11.2.3) – states that <i>no contingency plans are required</i> i.e. missing contingencies for potential issues such as differential tailings consolidation, revegetation success, higher seepage rates, etc.</p> <p>Pit 3 (11.3.3) - only includes contingencies for the risk of tailings rising above -15 mRL i.e. missing contingencies for potential issues such as tailings consolidation taking longer than expected (e.g. extended water treatment as identified in BPT section 9.2.7.4), differential tailings consolidation, revegetation success, higher seepage rates, etc.</p> <p>Tailings Storage Facility (11.4.3) - only includes contingencies for the risk of dredge disposal i.e. missing contingencies for risks for potential issues such as Tailings Storage Facility wall breach while still in use, management of contaminated materials (i.e. residual tailings on inside walls, floor, clay core, rip rap), and the contaminated groundwater plume.</p> <p>Water treatment (11.5.4) and Water management (11.9.3) - only includes contingencies for treatment of process water i.e. missing contingencies for treatment of pond water and risks associated with water quality closure criteria not being met (i.e. ongoing treatment).</p> <p>Waste and hazardous material (no section) and Contaminated sites (11.5.3) - no contingencies included, noting it is acknowledged in 11.5.3 that contingencies for contaminated sites will be identified by future BPT assessments.</p> <p>Ecosystem restoration (no section) – no contingencies included for the potential failure of the rehabilitated landform to become a self-sustaining ecosystem, which are also not included in the RMCP risk assessment (i.e. states <i>Ping to Add</i>).</p> <p>Recommendation:</p> <p>Ensure that all contingencies associated with risks listed in the Ranger Closure Risk Assessment (Appendix 10.1) are included or referenced within the relevant areas within Section 11.</p> <p>Further detail should be provided for each contingency, including:</p> <ul style="list-style-type: none"> • level of confidence in its likely effectiveness • timing of implementation • impact on the overall closure schedule, including consequential effects on other related activities <p>Include contingencies for the potential failure of ecosystem restoration (i.e. rehabilitated landform does not become a self-sustaining ecosystem).</p> <p>ERA Response 2020 RMCP:</p> <p>Additional information has been included on contingencies within each domain of the implementations Section of the MCP (Section 9).</p> <p>Where possible the details requested have been provided, however in most cases this level of detail is not available and ERA believe not required. Contingency plans are developed to order of magnitude level and then are parked pending need. If need develops the various options are then assessed and progressed to engineering</p> <p>SSB 2020 RMCP Assessment:</p> <p>There are very few additional contingencies, or further detail added since the 2019 RMCP. The Supervising Scientist does not accept ERA's response that details on contingencies are 'not required' and it is particularly concerning that there are still no post-2026 contingencies presented in the 2020 RMCP for ecosystem restoration.</p> <p>Additional comments on contingencies presented in the 2020 RMCP are provided in Table 3.</p>
All	Best Practicable Technology (BPT)	Best Practicable Technology (BPT)	<p>SSB 2018 RMCP Assessment:</p> <p>In the next version of the RMCP identify the full range of planned (or potentially required) BPT assessments.</p> <p>ERA Response 2019 RMCP:</p> <p>The BPT Section of the MCP has been expanded to make reference to all BPT assessments completed and planned.</p> <p>SSB 2019 RMCP Assessment:</p> <p>The BPT assessments to date are adequately detailed and a list of future BPT assessments described. All BPT assessments should include a wide range of options, taking into account relevant national and international experience and precedents where they exist.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			<p>SSB 2020 RMCP Assessment:</p> <p>The HDS sludge disposal activity has been removed from the list of future BPT assessments since the 2019 RMCP, without explanation.</p> <p>Recommendation: Justify why HDS sludge disposal is no longer considered as a future BPT assessment.</p>
All	Monitoring and maintenance	Trigger Action Response Plan (TARP)	<p>SSB 2018 RMCP Assessment:</p> <p>Update the TARP.</p> <p>ERA Response 2019 RMCP:</p> <p>This section will be continually improved with each update of the MCP and with further monitoring information available.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Additional specific comments on the TARP presented in the 2020 RMCP are provided in Table 3.</p>
Landform	Knowledge base	Landform stability	<p>SSB 2018 RMCP Assessment:</p> <p>Provide information on the background bedload yields, to assess the potential impacts associated with bedload transport to Magela and Gulungul creeks (should this occur).</p> <p>ERA Response 2019 RMCP:</p> <p>This KKN is planned to be completed in 2020, and the results will be incorporated into the next MCP update, and will supply the details requested in the comment.</p> <p>SSB 2019 RMCP Assessment:</p> <p>Note that the primary relevant KKN is LAN1B.</p> <p>ERA Response 2020 RMCP:</p> <p>KKN LAN1B is now a SSB KKN. SSB have allocated new projects to address the knowledge need (RES-2019-022).</p> <p>SSB 2020 RMCP Assessment:</p> <p>Information from KKN LAN1B should be incorporated into the RMCP when it is completed.</p>
Landform	Knowledge base	Landform stability	<p>SSB 2018 RMCP Assessment:</p> <p>Assess the potential risks of extreme events and landscape-scale processes on landform stability.</p> <p>ERA Response 2019 RMCP:</p> <p>These risks were considered under Category B, C & D of the August 2019 Risk Assessment. This also included consideration of greater than expected rainfall events, variation of predicted Pit 1 & 3 consolidation, excessive erosion impacting landform stability and the potential effects of large scale fire or cyclone events.</p> <p>SSB 2019 RMCP Assessment:</p> <p>This will be addressed with completion of relevant ERA/SSB projects allocated to KKN LAN2.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Information from KKN LAN2 should be incorporated into the RMCP when it is completed.</p>
Landform	Knowledge base	Landform stability	<p>SSB 2019 RMCP Assessment:</p> <p>The landform flood study does not take into consideration the impacts of major flood events on long-term landform stability and could be improved by incorporating the synthetic rainfall datasets that have been supplied to ERA by the Supervising Scientist.</p> <p>Recommendation: Consider the impacts of major flood events on long-term landform stability and incorporate the synthetic rainfall datasets in landform flood modelling.</p> <p>ERA Response 2020 RMCP:</p> <p>The landform flood studies are completed in order to appropriately design the short term erosion and sediment controls structures. These structures are required to manage the higher sediment loads expected in the first few years post landform construction. It is expected that many of these structures will not be required after the first 10 years. Once they are no longer required plans for either their infilling or removal will be agreed with stakeholders.</p> <p>The landform flood studies, being a short term focus, do not require the use of a synthetic rainfall data set.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			<p>The assessment of long term landform stability can only be completed with a landform evolution model (e.g. CAESER or SIBARIA). Landform evolution modelling has historically been completed by the Supervising Scientist and the results reported in the MCP. ERA, supported by RioTinto are completing sensitivity testing of key LEM model parameters including climate sequences, rainfall losses, particle size distribution and vegetation cover.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Results of long-term landform stability modelling being undertaken by both ERA and the Supervising Scientist should be included in the RMCP as they are completed.</p>
Landform	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Use the BACIP method described by Moliere and Evans (2010) to assess suspended sediment loads in closure criteria L11.</p> <p>ERA Response 2019 RMCP:</p> <p>The BACIP method is utilised for TSS as described in Section 8.2 and Section 12.4. It is intended that all methodologies will be assessed and selected accordingly for TSS, and other monitoring requirements, and will be specified within the MCP monitoring section as decisions are finalised.</p> <p>SSB 2019 RMCP Assessment:</p> <p>Noted that SSB is currently reviewing the Landform Rehabilitation Standard, which will provide ERA updated advice on the approach to assessing suspended sediments.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The assessment approach to closure criterion L7 is being finalised in consultation with ERA and will be reflected in the updated SSB Rehabilitation Standard and the next version of the RMCP should be updated accordingly.</p>
Landform	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2019 RMCP Assessment:</p> <p>While the closure criterion related to denudation rate (L4) has been proposed in accordance with the Landform Rehabilitation Standard, it is noted that the clarifying text averaged over the entire landform that was proposed in the 2018 RMCP (i.e. previously L5) has been removed in the 2019 RMCP. The previous text allowed for some degree of variation across the landform.</p> <p>Recommendation: Reconsider the requirements for denudation rate.</p> <p>ERA Response 2020 RMCP:</p> <p>Noted. The Landform closure criteria submitted were reviewed and updated by ERA to match the Supervising Scientist Standard for Landform.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Note that the denudation rate has been revised and will be reflected in the updated SSB Rehabilitation Standard. The next version of the RMCP should be updated accordingly.</p>
Landform	Closure implementation	Landform design	<p>SSB 2018 RMCP Assessment:</p> <p>The final landform design should be revised to avoid gully formation over tailings for both Pit 1 and Pit 3.</p> <p>ERA Response 2019 RMCP:</p> <p>The landform model - FLv6.2 - was provided to SSB at the completion of FS study.</p> <p>SSB 2019 RMCP Assessment:</p> <p>SSB is currently assessing FLv6.2.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The Supervising Scientist recently provided landform modelling technical advice to ERA (i.e. after submission of 2020 RMCP), indicating that although gullies may form over Pit 3 under some scenarios wouldn't be deep enough to expose tailings. This information should be summarised in the 2021 RMCP.</p>
Landform	Closure implementation	Landform design	<p>SSB 2019 RMCP Assessment:</p> <p>This section (7.5) includes information on model development being undertaken by the Supervising Scientist that is either out of date or incorrect. For example, the Supervising Scientist is not integrating a dynamic vegetation model linking soil moisture to biomass growth.</p> <p>Recommendation: Ensure that information on landform modelling being undertaken by the Supervising Scientist is correct and up to date.</p> <p>ERA Response 2020 RMCP:</p> <p>Noted. Section 5 has been updated with up to date information.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			<p>SSB 2020 RMCP Assessment:</p> <p>Section 5.5.1.1 of the 2020 RMCP contains the following text from the 2018 RMCP, which is either incorrect or has been completed:</p> <p><i>A number of limitations of the modelling work were identified by the SSB. The following improvements are being implemented to ensure model outputs are both plausible and scientifically defensible. These improvements include:</i></p> <ul style="list-style-type: none"> • <i>the development of a stochastic synthetic rainfall dataset to generate a series of unique rainfall scenarios which may occur within a period of 10,000 years. This has allowed uncertainty in predictions to be better accounted for and will provide a range or probability of likely outcomes.</i> • <i>an enhancement of the effect of vegetation community growth (vegetation has a major effect on the erosion potential of the landform surface) on landscape evolution within the landform model. The vegetation parameter values used in the CAESAR-Lisflood model have been better defined and continue to be reviewed to better account for the effects of developing vegetation cover over the area of the Ranger minesite.</i> • <i>consideration of the role of fire, given its role in the northern Australian landscape and potential to disrupt or prevent the development of specific vegetation communities</i> • <i>integration of a dynamic vegetation model linking soil moisture to biomass growth</i> • <i>implementation of an effective weathering function into the model to reflect the natural rate of both physical and chemical weathering and to ensure the models do not prematurely predict sediment exhaustion from the environment</i>
Landform	Closure implementation	Landform design	<p>SSB 2019 RMCP Assessment:</p> <p>Although denudation rates on the landform are unlikely to reach background denudation rates for at least 1000 years, under higher rainfall scenarios and on different areas of the final landform, it may take significantly longer for the denudation rate to reflect background rates (i.e. >10,000 years).</p> <p>Recommendation: Acknowledge the uncertainty in the erosion modelling and ensure that plausible worst-case scenarios are considered in the design of the final landform and surface erosion control structures.</p> <p>ERA Response 2020 RMCP:</p> <p>Noted. The synthetic rainfall data set already considers higher rainfall scenarios. Note that all existing/current LEM modelling is being undertaken by SSB. ERA is continuing to work on an optimised landform design to present for modelling of scenarios. ERA is currently working on a sensitivity analysis on some of the parameters used in the modelling completed as described in Section 5.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Results of work being undertaken by ERA on landform design optimisation should be included in the RMCP as they are completed.</p>
Landform	Closure implementation	Infrastructure disposal	<p>SSB 2018 RMCP Assessment:</p> <p>Provide a detailed backfill plan for Pit 3 including:</p> <ul style="list-style-type: none"> • types and volumes of contaminated material that will require disposal (e.g. hydrocarbons, soil, waste from HDS plant) • plans for material segregation (if required) • disposal methods to be used (e.g. mixing with waste rock, layering, cells, etc.) • schedule for plant demolition and disposal. <p>ERA Response 2019 RMCP:</p> <p>This information will be received in the Pit 3 backfill application due to be submitted in October 2020, and will therefore appear in the 2021 MCP update.</p> <p>SSB 2020 RMCP Assessment:</p> <p>This information should be included in the RMCP following approval of the Pit 3 Backfill Application.</p>
Landform	Closure implementation	Tailings disposal	<p>SSB 2019 RMCP Assessment:</p> <p><i>This will, in turn, mean that remnant tailings on the floor under beached equipment would not be able to be removed.</i></p> <p>This is not in accordance with the environmental requirement ER11.2</p> <p>Recommendation: Consult with stakeholders regarding the proposal for some remnant tailings, which is not in accordance with the environmental requirements.</p> <p>ERA Response 2020 RMCP:</p> <p>ERA is currently completing work on the plan for cleaning of the floor and walls of the Tailings Dam at the completion of dredging, prior to its longer term use as a process water storage facility. This plan will form the basis of how ERA will demonstrate to stakeholders how it intends to comply with ER11.2. The outcomes of this will be included in the 2021 MCP.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Prior to inclusion in the 2021 RMCP, ERA should consult stakeholders via the Minesite Technical Committee on the proposed plan for cleaning of the floor and walls of the Tailings Dam at the completion of dredging.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
Landform	Closure implementation	Landform construction	<p>SSB 2018 RMCP Assessment:</p> <p>Improve the scheduling for disposal of contaminated material into the pits, including the 4.6 million tonnes of mineralised material from the northern wall of the Tailing Storage Facility that will be placed in Pit 3 in 2025, and the other <i>mineralised</i> material that will be placed in the lower sections of the pits. It should be clarified how this material will be placed below the <i>low-grade 2 rock cap</i>.</p> <p>ERA Response 2019 RMCP:</p> <p>Current implementation plans are summarised within the implementation Section 11. The Tailings Storage Facility deconstruction will be subject to an application proposed to be submitted in October 2021. Detailed quantities and scheduling will be included within this application.</p> <p>SSB 2020 RMCP Assessment:</p> <p>This information should be included in the RMCP as it is generated and following approval of the Tailings Storage Facility Deconstruction application.</p>
Landform	Closure implementation	Landform construction	<p>SSB 2019 RMCP Assessment:</p> <p>There is insufficient information on planning/ monitoring of material movements and proposed surface structures.</p> <p>Recommendation: Provide more detailed information to demonstrate adequate planning and monitoring of material movements, including a basis on which the progress of landform construction can be assessed over time.</p> <p>ERA Response 2020 RMCP:</p> <p>A mine plan has been developed for material movement over the closure period. This model uses a full suite of parameters as is standard in the mining industry to plan material movement by a truck and shovel fleet and includes parameters such as truck and shovel hours, Fleet Availability and Effective Utilisations plus a suite of standard mine planning parameters. The output of this mine plan is a detailed execution plan for material movement from the various stockpiles on site to their ultimate destination across site. This plan is updated at least every year.</p> <p>Material movement is tracked on a shift by shift basis against plan by the mine team against plan. There is also a weekly material movement tracking metric that is discussed at the Manager/GM level against the weekly plan.</p> <p>Refer to Section 9 in the MCP.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The planning aspect of the recommendation has been adequately addressed in the 2020 RMCP but details of the monitoring to verify the landform during construction still needs to be included.</p>
Landform	Closure implementation	Landform construction	<p>SSB 2018 RMCP Assessment:</p> <p>Develop a water balance for Pit 1 to support the statement that > 99% of the process water expressed by consolidation will be recovered for treatment by January 2026.</p> <p>ERA Response 2019 RMCP:</p> <p>Solute and volume balance studies conducted on Pit 1 from January 2017 to December 2018 indicate that all tailings consolidation flux is being recovered by the decant structures. Recovery of all the tailings consolidation flux is expected to continue while Pit 1 decant structures are operated. Refer to Section 7.1.2.</p> <p>SSB 2019 RMCP Assessment:</p> <p>Further comments are provided in the 2019 RMCP Assessment Report in relation to tailings consolidation vs process water removal.</p> <p>SSB 2020 RMCP Assessment:</p> <p>It remains to be demonstrated by ERA that the removal of process water from Pit 1 is consistent with that used in solute transport modelling.</p>
Landform	Closure implementation	Surface ripping	<p>SSB 2019 RMCP Assessment:</p> <p>Recommendation: Present a consistent and justified approach to surface ripping of the final landform that considers requirements for erosion control, infiltration (i.e. ecosystem establishment vs contaminant transport) and the views of Traditional Owners.</p> <p>ERA Response 2020 RMCP:</p> <p>In order to assess the various aspects affected by ripping and obtain input from all stakeholders, ERA has planned a ripping trial for the Pit 1 final landform. Details of this trial have been provided in Section 9 and discussions with stakeholders are ongoing.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Inconsistencies on ripping have been removed from the 2020 RMCP. The RMCP should be updated once the approach for the overall landform has been agreed amongst stakeholders.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
Landform	Monitoring and maintenance	Landform monitoring	<p>SSB 2018 RMCP Assessment:</p> <p>Provide further details on monitoring method to demonstrate how relevant information will be collected to assess landform performance over time, including:</p> <ul style="list-style-type: none"> • how gully formation will be measured on the revegetated landform • details of monitoring data required for ongoing validation of erosion modelling • water quality monitoring methods to be used for assessing landform erosion (e.g. turbidity as a surrogate for suspended sediment in surface water). <p>ERA Response 2019 RMCP:</p> <p>Suspended sediment/turbidity will be monitored on the constructed Pit 1 landform to assist in the calibration/validation of future model predictions of suspended sediment transport. Thus KKN LAN3E: How much suspended sediment will be transported from the rehabilitated site (including land application areas) by surface water? will be finalised in 2020 to provide the requested information to be included in the MCP update when available. LAN 4 & 5 are SSB KKNs.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Information from relevant monitoring programs should be incorporated into the RMCP as they are developed. Noted that KKN LAN3E is in the process of being removed.</p>
Landform	Monitoring and maintenance	Landform monitoring	<p>SSB 2019 RMCP Assessment:</p> <p>The RMCP mentions the use of vibrating piezometers to monitor excess pore pressures within tailings but it is not clear whether or how they may be used to inform tailings consolidation in the final landform. It is understood from consultation with ERA that it may not be possible to utilise the settlement plate method (i.e. as used in Pit 1) in Pit 3.</p> <p>Recommendation: Provide further information on tailings consolidation monitoring, including Pit 3 and during the post-closure phase.</p> <p>ERA Response 2020 RMCP:</p> <p>The Pit 3 tailings monitoring instruments will provided information on tailings pore pressure and hence settlement. The measured data for tailings settlement versus time will be utilised to track the predicted data obtained from the consolidation model. The settlement and corresponding time for a given degree of consolidation (for example 95%) can be determined. The appropriate type of monitoring instruments based on the tailings in Pit 3 will be provided as part of the Pit 3 closure application and summarised in the 2021 MCP.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The commitment to include further detail on tailings consolidation monitoring methods in the Pit 3 closure application and subsequent inclusion in the 2021 RMCP is acknowledged.</p>
Landform	Monitoring and maintenance	Landform maintenance	<p>SSB 2019 RMCP Assessment:</p> <p>There is insufficient information on planning/ monitoring of material movements and proposed surface structures.</p> <p>Recommendation: Provide more detailed information to justify the proposed surface structures, including up to date flood modelling, engineering designs and long-term management plans.</p> <p>ERA Response 2020 RMCP:</p> <p>Provided in Section 9 of the MCP.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Updated flood modelling and engineering designs are included in the 2020 RMCP but long-term management plans for surface structures will still need to be incorporated into the RMCP.</p>
Landform	Monitoring and maintenance	Landform maintenance	<p>SSB 2018 RMCP Assessment:</p> <p>Provide further detail on time frames that sediment control infrastructure is expected to remain in place (i.e. criteria for removal) and any ongoing maintenance requirements (e.g. sediment removal and disposal locations).</p> <p>ERA Response 2019 RMCP:</p> <p>Further planning is required to assess the option to retain sediment control infrastructure as permanent. This involves assessing the impacts of re-disturbing areas for removal. The Water Solutions (2017) Preliminary Flood Modelling and Hydraulic Design report suggests that "once the monitoring program identifies that the vegetation on the site has been well established and that erosion processes have been reduced to acceptable levels, the temporary erosion protection measures may be decommissioned...Attempts to remove these erosion limitation features would likely re-disturb the environment, which is undesirable. It is recommended that these features remain in place."</p> <p>SSB 2020 RMCP Assessment:</p> <p>Long-term management plans for sediment control infrastructure will need to be incorporated into the RMCP.</p>
Water & Sediment	Knowledge base	Contaminant sources	<p>SSB 2018 RMCP Assessment:</p> <p>Further information is required on the rehabilitation of the Tailings Storage Facility, including on the extent of contamination within the walls of the dam and the long-term movement of contaminated groundwater from beneath the dam.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			<p>ERA Response 2019 RMCP:</p> <p>This information will become available following submission of relevant applications to address Tailings Storage Facility contaminated material and Tailings Storage Facility deconstruction. A drilling program is currently being undertaken to assess the extent of contamination within the Tailings Storage Facility walls in order to inform the appropriate strategy. Groundwater monitoring for contamination is ongoing.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Information relevant to the nature and extent of contamination associated with the Tailings Storage Facility should be incorporated into the RMCP as it is acquired.</p>
Water & Sediment	Knowledge base	Contaminant sources	<p>SSB 2018 RMCP Assessment:</p> <p>Further work is required to quantify contaminant source terms and factors that influence their mobilisation on a whole-of-site basis, including existing groundwater contamination and contaminants predicted to arise from the waste rock landform, the buried tailings and contaminated soils and sediments disturbed during rehabilitation.</p> <p>ERA Response 2019 RMCP:</p> <p>ERA has numerous projects underway to address this. Refer to the summary of activities against KKN WS1A <i>What contaminants (including nutrients) are present on the rehabilitated site (e.g. contaminated soils, sediments and groundwater; tailings and waste rock)?</i></p> <p>SSB 2019 RMCP Assessment:</p> <p>Additional information should be presented in the Pit 3 Closure application to demonstrate that all contaminant sources onsite, including contaminated groundwater and material associated with the Tailings Storage Facility and processing area, have been well characterised, are adequately represented in contaminant transport modelling and will not result in environmental impacts.</p> <p>ERA Response 2020 RMCP:</p> <p>An update to the Ranger source term model has been undertaken during 2020 in order to inform the solute transport model and uncertainty analysis. The work completed to June 2020 has been included in the 2020 MCP (Section 5) and the completed works will be included in the Pit 3 closure application.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The information presented on source terms has been updated in the 2020 RMCP and once completed and approved in the Pit 3 application, further updated source term information should be incorporated into the 2021 RMCP.</p>
Water & Sediment	Knowledge base	Contaminant sources	<p>SSB 2019 RMCP Assessment:</p> <p>Further information is required to support the approach to remediating contaminated groundwater and soils across the site.</p> <p>Recommendation: Provide more detailed information on the nature and extent of the existing contaminated groundwater and soil, demonstrating that the:</p> <ul style="list-style-type: none"> • level of contamination has been adequately measured (i.e. that samples are representative) • volumes of contaminated material have been reliably estimated • environmental risk associated with leaving the contaminated material in place has been assessed, and where necessary, compared against the risk of remediation and disposal of the material in the upper levels of Pit 3 during the late stages of waste rock backfill (which according to the current schedule is when much of the material will be placed in the pit) <p>ERA Response 2020 RMCP:</p> <p>Detailed contaminated sites investigations were completed in late 2019 and results are being analysed. Studies into contamination in soils and groundwater are captured within KKN WS1 with multiple studies currently underway. Updates on studies completed to date have been provided in Section 5.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Information from the relevant studies should continue to be summarised in the RMCP as they are completed. It is expected that detailed contaminated site assessment reports will be provided for stakeholder review, in support of proposed site remediation plans.</p> <p>Note that additional comments on soil contamination are provided in this table under the 'Soils' closure theme below.</p>
Water & Sediment	Knowledge base	Contaminant sources	<p>SSB 2019 RMCP Assessment:</p> <p><i>This lack of impact to nearby downgradient bores suggests that migration of contaminants from the processing plant area is extremely slow....</i></p> <p><i>...The contaminant plume that is present in the processing plant area has migrated to the south and south east, towards Corridor Creek, consistent with local groundwater flow directions.</i></p> <p><i>However, the lack of recent water quality data throughout much of the processing plant area leaves uncertainty about current groundwater conditions.</i></p> <p>These statements appear to be inconsistent and there has been impact identified in downgradient bores, as identified through recent groundwater reports.</p> <p>Recommendation: Remove inconsistencies in relation to groundwater contamination in the processing area and update to reflect what the latest groundwater monitoring has identified in terms of downgradient groundwater impacts.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			<p>ERA Response 2020 RMCP:</p> <p>Inconsistencies have been revised and updated. The work completed to June 2020 has been included in the 2020 MCP (Section 5.4.3) and the completed works will be included in the Pit 3 closure application.</p> <p>SSB 2020 RMCP Assessment:</p> <p>It is acknowledged that inconsistencies have been removed in the 2020 RMCP. Completed works to be included in the Pit 3 closure application should also be summarised in the 2021 RMCP.</p>
Water & Sediment	Knowledge base	Contaminant sources	<p>SSB 2018 RMCP Assessment:</p> <p>For the waste rock source term:</p> <ul style="list-style-type: none"> • ensure that an appropriate infiltration rate is used to understand vadose zone behaviour and to determine the concentrations of contaminants in waste rock seepage, and update contaminant transport modelling accordingly • improve the estimate of sulfide minerals and associated oxidation potential in the waste rock landform • improve assessment of solute release subsequent to the consumption of all of the sulfide minerals. <p>ERA Response 2019 RMCP:</p> <p>ERA has numerous projects underway to address this. Refer to the summary of activities against KKN WS1A What contaminants (including nutrients) are present on the rehabilitated site (e.g. contaminated soils, sediments and groundwater; tailings and waste rock)?</p> <p>SSB 2020 RMCP Assessment:</p> <p>The method for determining infiltration rate has been presented to SSB and ARRTC and assessed as part of the Conceptual model update with no major issues identified. It is also included as a key parameter in the uncertainty analysis. The sulfide material knowledge should be addressed in the source term model update.</p>
Water & Sediment	Knowledge base	Contaminant sources	<p>SSB 2018 RMCP Assessment:</p> <p>For the tailings and pore water source term, additional data are required to update the tailings consolidation modelling and water balance accounting for both pits, taking into account the heterogenous nature of the tailings in the pits, and the effect this may have on the amount of contaminants mobilised from tailings and the direction and rate of solute expression</p> <p>ERA Response 2019 RMCP:</p> <p>Model was updated in 2015 by Fitton (Figure 7 5). Ongoing measurements of tailings settlement have been undertaken on a monthly basis to confirm the model is still valid. Available measurements relevant to flows in and out of the waste rock cap on top of Pit 1 have been used to construct a solute mass balance, using magnesium as the representative solute, and a water (volume) balance. The solute balance indicates that the measured mass of solute recovered through the decant towers matches the mass of solute estimated to have been expressed from tailings (Figure 7-6). The consolidation model for Pit 3 has recently been reviewed with the results obtained from the cone penetration test (CPT) by Fitton (2019a). It was noted that the pore pressure profiles measured in the last CPTs closely agree with those predicted by the consolidation model. Expression of tailings pore water with respect to local scale and regional scale ground water impacts is to be assessed within the groundwater solute transport modelling being undertaken by INTERA.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The updated source term modelling takes into account the heterogeneous nature of tailings in the two pits. Results of ongoing tailings consolidation modelling work will need to be considered in further updates (if required) to the source term modelling and summarised in the RMCP.</p>
Water & Sediment	Knowledge base	Contaminant sources	<p>SSB 2018 RMCP Assessment:</p> <p>Tailings consolidation modelling should be reviewed to provide greater certainty on consolidation time frames, the volume of contaminants which will express into the groundwater and the ability to capture and treat 99% of the expressed pore water. This should consider the heterogeneous nature of the tailings mass and the direction of solute expression</p> <p>ERA Response 2019 RMCP:</p> <p>Consolidation model for Pit 1 was reviewed in 2012 and 2015. The 2015 model has been and is being validated with settlement plates data installed in Pit 3. It is demonstrated that the average tailing settlement predicted by the model is in close agreement with the measured average settlement, as shown in Figure 7-5 in the MCP. The consolidation model for Pit 3 was reviewed in 2019 with cone penetration test data. It was noted that the measured porewater pressure profiles within the tailings closely matched those predicted by the consolidation model. A typical pore pressure profile comparison is given in Figure 7-7 of the MCP. It is planned to conduct the next cone penetration test, to review the Pit 3 consolidation model, in the last quarter of 2019. The impact of the expressed tailings pore water, from the revised consolidation model, will be assessed within the groundwater solute transport modelling by INTERA. Refer to Sections 7.1.2 and 7.1.3.</p> <p>SSB 2019 RMCP Assessment:</p> <p>Tailings permeability estimates have been updated from heterogenous tailings characteristics and used to inform solute transport modelling for Magnesium only. Other contaminants predictions are yet to occur.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Tailings consolidation modelling continues to be revised by ERA and it is expected this will be included in the upcoming Pit 3 application and summarised in the 2021 RMCP.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
Water & Sediment	Knowledge base	Contaminant sources	<p>SSB 2018 RMCP Assessment:</p> <p>For the groundwater source term:</p> <ul style="list-style-type: none"> • characterisation the existing groundwater contamination onsite, including beneath the Tailings Storage Facility, and update the Ranger Conceptual Model and contaminant transport models accordingly • proposed remediation and active management options for groundwater during and after the rehabilitation of contaminated sites (e.g. the processing area, stockpiles and the Tailings Storage Facility) • to demonstrate that Land Application Areas will not result in a significant groundwater contamination source, include data from bores representing all aquifers and areas of the Ranger Project Area that could be impacted (i.e. Aquifer 1 and Aquifer 2). <p>ERA Response 2019 RMCP:</p> <p>No additional characterisation of groundwater contamination has occurred within the last 12 months. Project planning and scoping is underway to support future studies specifically to quantify the contamination below the Tailings Storage Facility and processing area. These studies will support the development of the remediation plan and will be detailed in future MCP updates. The Tailings Storage Facility contaminated materials application will specifically address contamination as a result of operation of the Tailings Storage Facility. Section 7.10.9 identifies planned future studies relating to contaminated sites.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The updated source term modelling considers the existing groundwater plumes (TSF, processing area, LAAs, RP2 etc). Proposed remediation options should be detailed in the RMCP once all the studies and modelling are completed.</p>
Water & Sediment	Knowledge base	Contaminant sources	<p>SSB 2018 RMCP Assessment:</p> <p>The potential risks associated with the generation of acid sulfate sediments due to mine-derived sulfate needs to be assessed, particularly in Coonjimba, Georgetown and Gulungul billabongs.</p> <p>ERA Response 2019 RMCP:</p> <p>The 2018 MCP addresses acid sulfate soil risk assessment that was undertaken with regard to the Coonjimba Billabong. Further assessments are planned to be carried out for the Georgetown and Gulungul billabongs (2020). It was planned that EcOZ undertake assessments in 2018, however this was deferred until the ERM Conceptual model has been finalised.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The acid sulfate soil conceptual model has been completed and reported to stakeholders' satisfaction (ARRTC45) in the 2020 RMCP. The Supervising Scientist has indicated to ERA that an acid sulfate soil risk assessment should be presented in the Pit 3 Application, scheduled for submission in late 2020. Sediment sampling has been planned and the results of ensuing phases of this work should be summarised in the RMCP when completed.</p>
Water & Sediment	Knowledge base	Contaminant transport modelling	<p>SSB 2018 RMCP Assessment:</p> <p>All numerical modelling should be based on:</p> <ul style="list-style-type: none"> • the data-driven Ranger Conceptual Model, which needs to include sufficient detail and confidence for high-risk areas (e.g. the Magela Creek bed, the Djalkmarra sands and the MBL zone) • detailed and reliable quantification of all potential contaminant source terms onsite, including existing groundwater contamination on the minesite • a calibration period that is sufficient to stress the model to the extent that its behaviour during pre-mining, operational and post-mining conditions can be assessed, including mine-impacted and baseline variability in groundwater levels, stream flow and associated processes • all available data, including pre-mine data if available, with clear justification for the exclusion of data not used • surface water and groundwater interactions at a temporal scale appropriate for the baseline variation in groundwater levels and surface water flow. <p>ERA Response 2019 RMCP:</p> <p>ERA agrees that all numerical modelling should be based on the points identified. ERA has committed to the development and update of the sitewide groundwater model to predict post-closure solute loading to creeks from all sources using uncertainty analysis. A detailed update on the progress of modelling to date was provided by INTERA at ARRTC41. A subsequent update on the completed conceptual model was provided at ARRTC42.</p> <p>SSB 2019 RMCP Assessment:</p> <p>Further comments on contaminant transport modelling are provided in the 2019 RMCP Assessment Report.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Once completed in accordance with the recommendations provided by the Supervising Scientist, results of all contaminant transport modelling should be summarised in the RMCP.</p>
Water & Sediment	Knowledge base	Contaminant transport modelling	<p>SSB 2018 RMCP Assessment:</p> <p>To enable more reliable predictions of contaminant concentrations in surface water, the contaminant transport modelling, particularly the surface water model, needs to be refined using more relevant and appropriate data and assumptions, including:</p> <ul style="list-style-type: none"> • undertaking contaminant transport modelling at increased temporal and spatial resolution (particularly around the period of peak solute delivery to the surface water system) • developing better understanding of groundwater/surface water interactions that will control the location and timing of delivery of contaminated groundwater to the surface water system

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			<ul style="list-style-type: none"> implications of groundwater recovery as groundwater levels return to a stable state after rehabilitation improved understanding of the role of groundwater/surface water interactions in solute migration assessment of confidence in modelled outputs using statistical, sensitivity and uncertainty analyses for each model, as well as analysis of cumulative uncertainty where multiple models are interconnected. <p>ERA Response 2019 RMCP:</p> <p>The surface water contaminant transport modelling is currently being updated and refined to improve outputs with consideration of the relevance and appropriateness of data and assumptions. Updated information will be provided within the future update of the MCP.</p> <p>SSB 2019 RMCP Assessment:</p> <p>Further comments on contaminant transport modelling are provided in the 2019 RMCP Assessment Report.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The Supervising Scientist has provided ERA with feedback on the final scope of work for surface water modelling, including the need to address the above recommendations from SSB's assessment of the 2018 RMCP. This information has not been captured in the 2020 RMCP.</p>
Water & Sediment	Knowledge base	Contaminant transport modelling	<p>SSB 2018 RMCP Assessment:</p> <p>Develop an understanding of the spatial and temporal (seasonal) interactions between groundwater and surface water. This work is required as a priority, particularly in light of the significant concerns related to water quality in Magela Creek raised in Appendix 8.1 of the RMCP (2011–12 ITWC PFS BPT Assessment).</p> <p>ERA Response 2019 RMCP:</p> <p>The updated monitoring section discusses closure monitoring, which has been designed to support further refinement of key hydrogeological units and groundwater / surface water interaction via collection of groundwater quality and high resolution water level data using dataloggers.</p> <p>SSB 2019 RMCP Assessment:</p> <p>It is noted that ERA is currently developing a finer resolution temporal model to inform knowledge on groundwater delivery to the surface water.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The scope for groundwater-surface water interactions work has been included in 2020 RMCP. However, further detail on how the groundwater model results are fed into the surface water model should be included in the Pit 3 application and in the 2021 RMCP.</p>
Water & Sediment	Knowledge base	Contaminant transport modelling	<p>SSB 2018 RMCP Assessment:</p> <p>A robust analysis of model uncertainty will need to be undertaken to quantify and understand the level of uncertainty associated with the modelled outputs.</p> <p>ERA Response 2019 RMCP:</p> <p>The Ranger Mine sitewide modelling process complies with the guiding principles from the Australian Groundwater Modelling Guidelines. The Ranger Mine groundwater calibrated model will meet all indicators for the Level 3 confidence level (highest confidence level) after completion of the planned peer review by an independent hydrogeologist with modelling experience. Furthermore, ERA have made a commitment to have INTERA update minor sections of the report to address comments made by SSB. The outstanding concerns relate to development of a formal uncertainty analysis which ERA has committed to undertake (and will be included in future MCP when complete).</p> <p>SSB 2019 RMCP Assessment:</p> <p>It is noted that uncertainty analysis will also need to be undertaken for the surface water model.</p> <p>ERA Response 2020 RMCP:</p> <p>The preliminary surface water model as described in Section 5 provides probabilistic predictions of concentrations of COPCs in surface waters downstream of the mine site.</p> <p>The surface water modelling update will assess a range of solute transport loading predictions identified through the uncertainty analysis completed as part of the groundwater solute transport modelling by INTERA. Key parameters within the surface water model will also be examined and tested to assess model prediction sensitivity as part of the surface water modelling update.</p> <p>The completed surface water modelling update will be included in the Pit 3 closure application.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Results of the completed surface water modelling to be included in the Pit 3 closure application should be summarised in the 2021 RMCP.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
Water & Sediment	Knowledge base	Contaminant transport modelling	<p>SSB 2018 RMCP Assessment:</p> <p>Reactive transport modelling is required for calcium so that its effect on magnesium toxicity in the receiving surface waters can be understood (calcium has been shown to ameliorate magnesium toxicity).</p> <p>ERA Response 2019 RMCP:</p> <p>ERA project 1260-02 - Mg:Ca input into Surface Water Model - is underway to address this. Outcomes will be reported in the next MCP and inform inputs to the surface water model. This project is listed against KKN WS3C. What factors are likely to be present that influence contaminant (including nutrients) transport in the surface water pathway?</p> <p>SSB 2020 RMCP Assessment:</p> <p>The ERA study specified above has been completed but not yet summarised in the RMCP. ERA has acknowledged that updates to water and solute transport models (or corrections to previously reported results) may be required, depending on the outcome of updated surface water modelling (with Ca turned off from the mine sources).</p>
Water & Sediment	Knowledge base	Predicted surface water quality	<p>SSB 2018 RMCP Assessment:</p> <p>Further work is required to provide reliable predictions of surface water contaminant concentrations post- rehabilitation; including (i) the characterisation of contaminant source terms, (ii) verifying the conceptualisation of key groundwater contaminant pathways, (iii) additional information on the interactions between surface water and groundwater, and (iv) more detailed ground and surface water modelling.</p> <p>ERA Response 2019 RMCP:</p> <p>Progress on each of these areas has been made and described in the section 7 Supporting studies. It is agreed that further work is required, and work on each of the relevant KKNs is progressing.</p> <p>Updates to the surface water monitoring are currently underway by Water Solutions, and is described in future studies in section 7.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The updated summary of information presented in the 2020 RMCP is acknowledged and current work to update the predicted nature and extent of surface water contamination following rehabilitation should be incorporated into the 2021 RMCP.</p>
Water & Sediment	Knowledge base	Aquatic ecosystem protection	<p>SSB 2018 RMCP Assessment:</p> <p>Organism assemblages for all stages of creek flow should be characterised and assessed for their sensitivity to contaminants</p> <p>ERA Response 2019 RMCP:</p> <p>KKN WS7c addresses this issue and is assigned to SSB. The SSB project 'Seasonal sensitivity' (to Mg) profile for organisms in the Magela creek channel' commenced in July 2018 and is due for completion in late 2019.</p> <p>SSB 2020 RMCP Assessment:</p> <p>KKN WS7C is currently in the process of being closed out and results of the above SSB project have been provided to ERA. This information should be summarised in the 2021 RMCP.</p>
Water & Sediment	Knowledge base	Aquatic ecosystem protection	<p>SSB 2018 RMCP Assessment:</p> <p>Assess the potential contribution of subterranean fauna in Magela Creek sand beds to ecological processes and the biodiversity of the ARR and if significant, then determine the potential impact of contaminants on these communities.</p> <p>ERA Response 2019 RMCP:</p> <p>As per the KKN, ERA is responsible for assessing contaminants on ecological communities and processes. This requires input from SSB to establish contribution of subterranean fauna in order to determine potential impacts. The MCP will be updated as information becomes available.</p> <p>SSB 2020 RMCP Assessment:</p> <p>ERA's commitment to include the above information in the RMCP is acknowledged and it is noted that the Supervising Scientist has provided ERA with some of the relevant information via the KKN WS7C.</p>
Water & Sediment	Knowledge base	Aquatic ecosystem protection	<p>SSB 2018 RMCP Assessment:</p> <p>Provide additional details on remediation of onsite waterbodies.</p> <p>ERA Response 2019 RMCP:</p> <p>Results of surface water modelling and the numerous assessments based on those results, including ERA project 1221-09 - <i>Surface Water Pathway Risk Assessments (release pathways onsite)</i>, is scheduled for 2020. This will assess the risks related to onsite water bodies and inform BPT and ALARA assessments of water management options, including remediation of off-site water bodies.</p> <p>SSB 2020 RMCP Assessment:</p> <p>There does not appear to be any update provided by ERA in the 2020 RMCP. Outcomes of the above assessments should be incorporated into the RMCP when they are completed.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
Water & Sediment	Knowledge base	Aquatic ecosystem protection	<p>SSB 2018 RMCP Assessment:</p> <p>Assess the risk of eutrophication to on and offsite waterbodies after surface water model results for nutrient concentrations become available.</p> <p>ERA Response 2019 RMCP:</p> <p>A project has been scheduled to address this. Refer to details included within ERA project 1260-04 Eutrophication Risk Study listed against KKN WS6C.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The following text was included in the 2020 RMCP but not in the ERA response table:</p> <p><i>SSB and ERA have agreed that the current AALL are not suitable for closure criteria and that KKN WS6b can be removed. ARRTC45 agreed to this KKN removal.</i></p> <p><i>ERA is working with SSB to conduct a third tier risk review based on an expanded literature review of biological effects of nutrients and initial results of modelling predicting post closure surface water quality.</i></p> <p>SSB notes progress against this item. Outcomes of the above work should be incorporated into the RMCP when they are completed.</p>
Water & Sediment	Knowledge base	Aquatic ecosystem protection	<p>SSB 2018 RMCP Assessment:</p> <p>Assess the risk of contaminated groundwater on riparian and aquatic vegetation.</p> <p>ERA Response 2019 RMCP:</p> <p>SSB is assessing this through their project Ecohydrology and Sensitivity of Riparian Vegetation. Field work commenced in late 2018 and pot trials to determine possible toxicity of magnesium to riparian tree species commenced in shade-house facilities at CDU in April 2019. A SSB groundwater project has also been linked to this study. ERA has provided advice and information to inform future assessments.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The above-mentioned studies being conducted by NESP (CDU researchers) for the Supervising Scientist are nearing completion and results will be provided to ERA for incorporation into the 2021 RMCP.</p>
Water & Sediment	Knowledge base	Aquatic ecosystem protection	<p>SSB 2018 RMCP Assessment:</p> <p>Assess the potential risk of contaminant plumes in creek channels forming a barrier that inhibits organism migration and connectivity.</p> <p>ERA Response 2019 RMCP:</p> <p>This KKN is assigned to SSB. SSB are conducting a collaborative project with Charles Darwin University and the National Environmental Science Program (NESP). The project effects of surface and groundwater egress of mining-related solutes on aquatic ecological connectivity, Magela Creek, commenced in November 2018. Completion is expected in mid-2020. Updates will be incorporated into the next MCP.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The above-mentioned study being conducted by NESP (CDU researchers) for the Supervising Scientist is nearing completion and results will be provided to ERA for incorporation into the 2021 RMCP.</p>
Water & Sediment	Knowledge base	Aquatic ecosystem protection	<p>SSB 2018 RMCP Assessment:</p> <p>Assess whether there are additional key aquatic organisms for which water quality guidelines need to be developed (e.g. flow-dependent insects, hyporheic biota and stygofauna).</p> <p>ERA Response 2019 RMCP:</p> <p>This KKN is assigned to SSB (KKN WS7c). SSB have two projects listed against this in their project description paper submitted to ARRTC May 2019.</p> <p>SSB 2020 RMCP Assessment:</p> <p>KKN WS7C is currently in the process of being closed out and results of the above SSB project have been provided to ERA. This information should be summarised in the 2021 RMCP.</p>
Water & Sediment	Knowledge base	Risks to human health	<p>SSB 2018 RMCP Assessment:</p> <p>Determine potential levels of exposure of humans to contaminants from drinking water from onsite waterbodies (i.e. consumption rates, locations, concentrations) and assess the risk to human health.</p> <p>ERA Response 2019 RMCP:</p> <p>Concentrations of contaminants in surface water will be predicted by the surface water model. The human health risk associated with this is addressed under KKN RAD9D: What is the dietary exposure of, and toxicity risk to, a member of the public associated with all contaminant sources, and is this within relevant Australian and/or international guidelines? ERA has an initial assessment project 1260-08 Bush tucker Diet Assessments and two update projects (1260-09 and 1260-10) scheduled to address this KKN.</p> <p>SSB 2020 RMCP Assessment:</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			Relevant information from the above-mentioned studies being conducted by ERA should be incorporated into the 2021 RMCP.
Water & Sediment	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>It is incorrectly asserted that the ERs require an effect to be regional in nature to be considered detrimental. ER1.2(d) states that to be considered detrimental a change must be in excess of that observed naturally in the region (i.e. outside the range of natural variability), not that changes must be regional in nature.</p> <p>ERA Response 2019 RMCP:</p> <p>ER1.2d states: "...the company must ensure that operations at Ranger (Mine) do not result in: change to biodiversity or impairment of ecosystem health outside of the Ranger Project Area. Such change is to be different and detrimental from that expected from natural biophysical or biological processes operating in the Alligator Rivers Region." So it is considered there is no conflict in ERA's assumptions. ERA does consider the scale of change as an important issue, and this is recognised in the project on ecosystem vulnerability. The two outcomes for the water and sediment management objective are stated as: First outcome - mine derived sedimentation or analytes from surface or ground waters discharged to surface waters off the RPA do not cause detrimental impact to the ecosystem health of the Alligators River Region, and that there will be no detrimental environmental impact off the RPA from tailings contaminants for at least 10,000 years.</p> <p>SSB 2019 RMCP Assessment:</p> <p>Further clarification of this comment was provided in the 2019 RMCP Assessment Report:</p> <p>ERA provides an interpretation of ER 1.2(d) in the second outcome of the Water and Sediment Objectives 2 (RMCP: Table 8-2) that contaminants off the RPA <i>do not cause detrimental impact to the ecosystem health of the Alligators River Region</i> which would imply an effect to be regional in nature to be considered detrimental. Rather, ER 1.2(d) states that to be considered detrimental a change must be in excess of that observed naturally in the region, which the Supervising Scientist interprets as outside the range of natural variability, not that changes must be regional in nature.</p> <p>SSB 2020 RMCP Assessment:</p> <p>ERA has not responded to this concern in the 2020 RMCP, and has applied the same interpretation in the 2020 RMCP. The Supervising Scientist remains concerned with ERA's interpretation of the ERs and will actively engage with ERA on this issue, with the objective of reaching a resolution prior to the 2021 RMCP.</p>
Water & Sediment	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Provide evidence that the proposed closure criteria are applicable to contaminant mixtures.</p> <p>ERA Response 2019 RMCP:</p> <p>KKN WS7A assigned to SSB and is being addressed by their project Assessing the toxicity of mine water mixtures for operational and closure scenarios.</p> <p>SSB 2020 RMCP Assessment:</p> <p>KKN WS7A is currently in the process of being closed out and results of the above SSB project have been provided to ERA. This information should be summarised in the 2021 RMCP.</p>
Water & Sediment	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Define the process for ALARA in the context of closure criteria and provide examples of water and sediment criteria that are ALARA.</p> <p>ERA Response 2019 RMCP:</p> <p>The MCP has been updated to clarify use of ALARA, as a process, in respect to closure criteria. ANZG (2018) supports the use of narrative statements for guideline values and water quality objectives. Several examples of narrative draft water quality objectives are used in Table 6-3, eg demonstrating what water quality is ALARA, and for aesthetic water values.</p> <p>SSB 2019 RMCP Assessment:</p> <p>It is noted that there don't appear to be any examples, or a Table 6-3.</p> <p>ERA Response 2020 RMCP:</p> <p>The closure criteria chapter changed from chapter 6 in the 2018 MCP to chapter 8 in the 2019 MCP. The table reference should have been to Table 8.2 where there are examples of narrative criteria.</p> <p>The stakeholder Water and Sediment Working Group has been discussing how ALARA can be assessed using the BPT and risk management frameworks. ERA have finalised a report on this and the information included in the 2020 MCP as Appendix 6.2.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Use of BPT to determine outcomes for the Ranger site that are ALARA is supported by SSB but, and in accordance with ER 12.5, requires consultation with, and having regard to the views of, the major stakeholders (including SSB, NLC and Traditional Owners). Stakeholders have also sought <i>quantitative</i> values as closure criteria associated with ALARA in order to demonstrate the environmental outcomes for on-site have been achieved. Future RMCPs will need to describe the outcomes of these stakeholder consultations, including agreed quantitative closure criteria.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
Water & Sediment	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Undertake modelling of the potential contaminant accumulation in sediments post-closure, based on the results of surface water contaminant modelling, to demonstrate that sediment closure criteria are likely to be met.</p> <p>ERA Response 2019 RMCP:</p> <p>Surface water contaminant modelling is currently being developed. This will inform modelling of the potential accumulation of contaminants in sediments and likelihood of achieving sediment closure criteria. ERA has several projects assessing the risk associated with sediment contamination. The section of the MCP will be updated when results become available.</p> <p>SSB 2020 RMCP Assessment:</p> <p>This comment is yet to be addressed, noting that the Supervising Scientist and ERA have recently completed work against KKN WS3G that should be summarised in the 2021 RMCP.</p>
Water & Sediment	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Reassess closure criteria for nutrients, as the currently proposed criteria are less than baseline water quality values.</p> <p>ERA Response 2019 RMCP:</p> <p>The concentration criteria for nutrients have been removed. The annual additional load limits are proposed instead (Table 8-3). These have applied at the Ranger Mine for several decades and are based on natural distributions of nitrate and phosphate. Work to assess the same approach for ammonia is scheduled. See projects listed against KKN WS6B. <i>Can Annual Additional Load Limits (AALL) be used to inform ammonia closure criteria?</i></p> <p>SSB 2020 RMCP Assessment:</p> <p>Comments to the separate Supervising Scientist recommendation, "Assess the risk of eutrophication to on and offsite waterbodies when surface water model results predicting nutrient concentrations become available", are directly relevant to this topic. Thus, it is noted that closure criteria for eutrophication are currently being developed (i.e. KKN WS6C). Further, KKN WS6B has been removed, with ARRTC45 agreement, on the basis that AALLs are not applicable as closure criteria.</p>
Water & Sediment	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Develop a sedimentation closure criterion for aquatic ecosystem protection in billabongs.</p> <p>ERA Response 2019 RMCP:</p> <p>The development of a sediment closure criterion for aquatic ecosystem protection is dependent on further studies. There is a KKN dedicated to effects of sedimentation on ecosystem health (KKN WS5). In addition, SSB has published a rehabilitation standard for sedimentation. This section of the MCP will be updated when information becomes available.</p> <p>SSB 2019 RMCP Assessment:</p> <p>The Supervising Scientist's Turbidity and Sedimentation Rehabilitation Standard is currently under preparation.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The Supervising Scientist's Turbidity and Sedimentation Rehabilitation Standard is close to completion and should be incorporated into the 2021 RMCP.</p>
Water & Sediment	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2019 RMCP Assessment:</p> <p>The rationale for proposed metals and sulfate in sediments closure criteria is not detailed.</p> <p>Recommendation: Provide the rationale for proposed metals and sulfate in sediments closure criteria.</p> <p>ERA Response 2020 RMCP:</p> <p>The criteria proposed for metals in sediment in the MCP were the ANZG (2018) guideline values. A hazard assessment has shown that these are not contaminants of environmental concern for the Ranger site.</p> <p>Updated water and sediment closure criteria are provided in Section 8.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The draft closure criteria for sediments presented in the 2020 RMCP includes uranium but should also include sulfate, in accordance with relevant guidelines:</p> <p>EPHC & NRMCC 2011. <i>National guidance for the management of acid sulfate soils in inland aquatic ecosystems</i>. Environment Protection and Heritage Council and the Natural Resource Management Ministerial Council, Canberra.</p> <p>It is noted that there also are surface water closure criteria for uranium and sulfate, which aim to protect sediments from accumulating levels of these contaminants that could result in environmental impacts.</p>
Water & Sediment	Closure implementation	Water management	<p>SSB 2018 RMCP Assessment:</p> <p>Additional information should be provided to support the site wide water balance model, including:</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			<ul style="list-style-type: none"> detailed plans and timelines for all activities related to water management, storage and treatment and brine disposal availability, rates, capacities of key plant and equipment (e.g. water treatment plants, brine injection bores, etc.) updated modelling assumptions and modelling uncertainty analyses. <p>ERA Response 2019 RMCP:</p> <p>Additional information regarding the Water Balance Model are routinely provided to stakeholders at MTC meetings/stakeholder forums. Detailed information is now available within the Ranger Water Management Plan. The scope of the MCP is to describe the broader process by which the model is maintained and validated. The predominant uncertainty with respect to the water model is rainfall variance. This is captured in model outputs which show the range of possible outcomes consequence of input of rainfall datasets representing increments from the range of historical data. Whilst additional uncertainty analysis is employed for example to compare alternate strategies and understand contingency requirements, such analysis is outside of the scope for the MCP. An Integrated Water Treatment Strategy application will be submitted in January 2020 and this information will be provided in updated MCPs.</p> <p>SSB 2020 RMCP Assessment:</p> <p>An 'Integrated Water Treatment Strategy' is no longer listed in the 2020 RMCP as a future application but it is understood that ERA may be planning to provide an <i>Integrated Water Strategy</i> as part of the Ranger Water Management Plan. Relevant information from this document should be incorporated into the next RMCP, including a conceptual diagram summarising the various proposed treatment activities.</p>
Water & Sediment	Closure implementation	Water management	<p>SSB 2018 RMCP Assessment:</p> <p>Demonstrate that the Tailings Storage Facility is able to be used as a process water storage post-2020, and provide relevant contingencies options for the event the Tailings Storage Facility is determined to be unsuitable for water storage.</p> <p>ERA Response 2019 RMCP:</p> <p>Further studies are required to demonstrate that the Tailings Storage Facility will be suitable for use as a water storage facility. Relevant contingency options will be considered in the event that the studies demonstrate that the Tailings Storage Facility is unsuitable for water storage.</p> <p>SSB 2020 RMCP Assessment:</p> <p>There is no acknowledgement in the RMCP of the need to demonstrate the suitability of the TSF for process water storage.</p>
Water & Sediment	Closure implementation	Water management	<p>SSB 2018 RMCP Assessment:</p> <p>Further details of the Pit 3 brine injection system should be provided in the RMCP, including:</p> <ul style="list-style-type: none"> the expected lifespan of brine injection bores and factors that may affect this time frames and potential issues associated with the construction of additional brine injection bores, should they be required any other brine disposal methods that might be used in the case that the brine injection system fails (i.e. failure of all bores, or the underbed drain extraction system). <p>ERA Response 2019 RMCP:</p> <p>Five brine injection bores have been installed to enable brine concentrator brine to be injected into the underfill layer in the base of Pit 3. It is not possible to definitively estimate the lifespan of injection wells as the system has yet to be operated since the substantial improvement in brine concentrator utilisation from 2017 to the present. However the four remaining wells are thought to be adequate. Noting the critical role of this system, contingency wells have been included in the budget for rehabilitation. A trial has been conducted for the necessary directional drilling method required for installation of such wells from the exterior of Pit 3. There is sufficient time to construct these contingency wells as the existing wells are intended to be used sequentially. Alternate brine disposal methods have been considered at a concept level, as have a range of options for restoration of the underdrain bore system. These will be further developed in the very unlikely circumstances require.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Section 9.3.2.4 of the 2020 RMCP states:</p> <p><i>ERA is currently engaging with contractors to complete a broad investigation of alternatives across the industry for current best practice. This work will build on the previous options analysis completed in 2012. Options selected will be subjected to a best practical technology assessment with any viable contingencies included in the 2021 MCP.</i></p> <p>Further details on brine injection contingencies should be included in the 2021 RMCP, as stated by ERA above.</p>
Water & Sediment	Closure implementation	Water management	<p>SSB 2018 RMCP Assessment:</p> <p>Provide further information to demonstrate that there are sufficient appropriate disposal options for treated water throughout the rehabilitation process, as irrigation areas are decommissioned.</p> <p>ERA Response 2019 RMCP:</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			<p>Further assessment is required to demonstrate that there are sufficient appropriate disposal options for treated water throughout the rehabilitation process. This will require assessing the capacity within release storages, expected evaporative losses from storage surfaces, capacity in the remnant application areas, rehabilitation requirements and turbomister capacity. This information will be updated in future iterations of the MCP. An integrated water treatment strategy application is planned to be submitted to regulators in early 2020.</p> <p>SSB 2020 RMCP Assessment:</p> <p>An 'Integrated Water Treatment Strategy' is no longer listed in the 2020 RMCP as a future application but it is understood that ERA may be planning to provide this as part of the Ranger Water Management Plan. Relevant information from this document in relation to pond water disposal should be incorporated into the next RMCP.</p>
Water & Sediment	Closure implementation	Water management	<p>SSB 2019 RMCP Assessment:</p> <p>Although it is acknowledged in the RMCP that further assessment is required to demonstrate there are sufficient disposal options for treated pond water throughout rehabilitation, further consideration is needed of the future capacity of the remnant Land Application Areas, and whether or not there will be an increase in associated environmental risks (e.g. waterlogging, unseasonal runoff, and alteration to groundwater levels).</p> <p>Recommendation: Provide further information on the future capacity of the remnant Land Application Areas, and whether or not there will be an increase in associated environmental risks (e.g. waterlogging, unseasonal runoff, and alteration to groundwater levels).</p> <p>ERA Response 2020 RMCP:</p> <p>ERA will be completing OPSIM-based water balance studies to determine the ability to dispose of treated pond and process water, throughout closure and as Land Application Areas are removed from service and rehabilitated. This water balance will also assess the balance between other disposal methods and demand from revegetation irrigation. This work is expected to be completed during 2021 and will be provided in an updated MCP.</p> <p>SSB 2020 RMCP Assessment:</p> <p>ERA's commitment to include the above information in the 2021 RMCP is acknowledged.</p>
Water & Sediment	Closure implementation	Water management	<p>SSB 2019 RMCP Assessment:</p> <p><i>Process water treatment required beyond closure date to treat process water to achieve 95% consolidation for Pit 3.</i></p> <p>No details have been provided to describe how consolidation of tailings in Pit 3 will be measured over time, nor how achievement of the 95% consolidation target will be verified.</p> <p>Recommendation: Detail how consolidation of tailings in Pit 3 will be measured over time and how achievement of the 95% consolidation target will be verified.</p> <p>ERA Response 2020 RMCP:</p> <p>The Pit 3 tailings monitoring instruments will provide information on tailings pore pressure and hence settlement. The measured data for tailings settlement versus time will be utilised to track the predicted data obtained from the consolidation model. The settlement and corresponding time for a given degree of consolidation (for example 95%) can be determined. The appropriate type of monitoring instruments based on the tailings in Pit 3 will be provided as part of the Pit 3 closure application and summarised in the 2021 MCP.</p> <p>SSB 2020 RMCP Assessment:</p> <p>A methodology for monitoring consolidation in Pit 3 should be included in the Pit 3 application and the 2021 RMCP, as committed to above.</p>
Water & Sediment	Closure implementation	Contaminated site remediation	<p>SSB 2019 RMCP Assessment:</p> <p><i>(Table 7-39) Once tailings are removed, assumption that no remediation is required</i></p> <p><i>(p 7-210) Natural attenuation is assumed to allow for plume remediation</i></p> <p>These statements appear to be out of date, when INTERA's current body of work is already assessing what to do with contaminated materials below the Tailings Storage Facility.</p> <p>Recommendation: Ensure statements in relation to remediation of Tailings Storage Facility contaminated groundwater are consistent with current knowledge and planned work.</p> <p>ERA Response 2020 RMCP:</p> <p>An assessment to inform material management strategy for the TSF sub floor material and the Pit 3 closure application was undertaken in late 2019. The key finding of the study was that removing the subfloor material from below the TSF and placing it in Pit 3 would result in higher solute loadings to the environment. Refer to Section 9.3.3.3.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The ERA response above refers to the contaminated material management but how the contaminated groundwater will be managed still needs to be determined and reported. This will be informed by groundwater modelling, surface water modelling and the TSF deconstruction application.</p>
Water & Sediment	Closure implementation	Contaminated site remediation	<p>SSB 2019 RMCP Assessment:</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			<p><i>Reclamation is expected to remove much of the CoPC sources in the shallow soil, so groundwater concentrations are expected to decrease over time</i></p> <p>While it is agreed that source removal will eventually result in lower concentrations in groundwater, it is unclear over what period of time this might occur, or the fate and transport of the CoPC that remain in the soil and groundwater.</p> <p>Recommendation: Provide further information to demonstrate how removal of soil contamination in the processing area will address groundwater long term contamination (i.e. predicted concentrations, timeframe, fate of residual soil/groundwater contamination).</p> <p>ERA Response 2020 RMCP:</p> <p>Detailed contaminated sites field investigations were completed in late 2019 and results are being analysed. Studies into contamination in groundwater are captured within KKN WS1 with multiple studies currently underway. An update to the Ranger source term model has been undertaken during 2020 in order to inform the solute transport model and uncertainty analysis. The work completed to June 2020 has been included in the 2020 MCP (Section 5) and the completed works will be included in the Pit 3 closure application.</p> <p>Results from the 2019 contaminated sites drilling program will be interpreted against known knowledge gaps identified during the Feasibility Study. These results will then inform BPT assessments to select an appropriate management option, based on what impact is ALARA.</p> <p>Updates on studies completed to date have been provided in Section 5. As assessments are completed, they will continue to be provided in the annual MCP updates.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The 2020 RMCP (Section 5.5.2.5) provides an update on contaminated soil assessments in the processing area, indicating that a contaminated site drilling program and bore installation program was undertaken in late 2019/early 2020 to target areas where there are knowledge gaps. A summary of the results is provided and it is expected that this information will be used to update remediation plans (i.e. volumes of soil/water, recovery methods and placement for disposal) for the processing area in the 2021 RMCP.</p>
Water & Sediment	Monitoring and maintenance	Water monitoring	<p>SSB 2018 RMCP Assessment:</p> <p>Provision should be made for a periodic review of contaminants measured in the post-closure monitoring program outlined in the RMCP, and closure criteria developed where required in the future.</p> <p>ERA Response 2019 RMCP:</p> <p>CoPC are discussed in 8.4.3.3 Step 3. Define relevant indicators. In that section it is noted that a review of CoPC for all sources on the Ranger Mine is being conducted by ERM Ltd as part of the background concentrations of CoPC in groundwater project (refer Section 7 Supporting Studies). A project to review CoPCs again following sampling of contaminated sites is scheduled and listed against KKN WS1.</p> <p>Further detail has been provided within the Pit 3 Tailings Application (Iles & Humphrey 2014 Draft Water Quality Closure Criteria). A discussion paper was also submitted to the MTC water and sediment working group.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The post-closure monitoring section of the RMCP should include a commitment to periodically review contaminants.</p>
Water & Sediment	Monitoring and maintenance	Groundwater monitoring	<p>SSB 2018 RMCP Assessment:</p> <p>Recommendation: Revise the groundwater monitoring program to clearly demonstrate that monitoring will be undertaken at an appropriate spatial and temporal scale to:</p> <ul style="list-style-type: none"> • observe trends in groundwater level recovery and contaminant transport post-closure that can be used to validate groundwater models, and recalibrate if necessary • detect significant increases in contaminant concentrations in aquifers surrounding Pit 1, Pit 3 and the Tailing Storage Facility, to enable downstream mitigation of impacts if required (i.e. groundwater interception or abstraction). <p>Additional information obtained from ongoing post-closure solute transport modelling or new monitoring bores (including those planned to be installed in vicinity of Pit 1 and Pit 3 during 2019), should be used to refine and optimise the long-term groundwater monitoring plan.</p> <p>ERA Response 2019 RMCP:</p> <p>The post-closure solute transport modelling being undertaken by INTERA will inform the development of specific long-term groundwater monitoring beyond that currently detailed in Section 12.5.2. Updates on the development of a site wide groundwater monitoring plan will be included in future MCP updates.</p> <p>ERA Response 2020 RMCP:</p> <p>The groundwater monitoring program has evolved over time to address operational and environmental concerns and risks at the Ranger Mine site. The post-closure monitoring plan has also evolved as the closure planning and modelling has progressed with the closure studies.</p> <p>Additional information informing the rationale for the post closure groundwater monitoring plan is detailed in Section 10.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The groundwater closure monitoring plan remains subject to stakeholder agreement and the RMCP should be updated when agreement is reached.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
Water & Sediment	Monitoring and maintenance	Surface water monitoring	<p>SSB 2018 RMCP Assessment:</p> <p>The surface water monitoring program should include:</p> <ul style="list-style-type: none"> • acknowledgment that additional contaminants that have not been previously identified as a risk may need to be considered in future (e.g. findings from contaminated site investigations) and include provision in the post-closure monitoring program for periodic review of contaminants • key sites on the Ranger Project Area (e.g. Georgetown Billabong, Coonjimba Billabong, RP1 and other onsite waterbodies, while they are present) for demonstration that concentrations of contaminants are as low as reasonably achievable • acknowledgment that grab sampling may need to be conducted more frequently than monthly in the initial period after completion of rehabilitation works • sampling for Ra-226. <p>ERA Response 2019 RMCP:</p> <p>These sites are included in the revised monitoring program and the potential use of event triggered monitoring is discussed in addition to monthly grab sampling. The CoPC list is currently being reviewed and a project to review again following contaminated sites sampling is scheduled. Project 1221-07 <i>Acid Sulfate Sediments Conceptual Model</i> is underway to address this. Previous studies have also addressed this.</p> <p>SSB 2019 RMCP Assessment:</p> <p>The monitoring program should be refined and agreed between ERA and the Supervising Scientist via the Water and Sediment Quality Working Group.</p> <p>ERA Response 2020 RMCP:</p> <p>Noted. All monitoring commitments will be updated and reviewed via the Water and Sediment Working Group (WASWG) or MERRG as the Ranger Mine transitions to closure. The WASWG has recognised this as one of their objectives.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The RMCP should be updated when agreement is reached on the surface water closure monitoring plan. The Supervising Scientist recommends the inclusion of nutrients and pesticides to the water and sediment analysis suite during the early phases of revegetation establishment, when fertiliser is being added to revegetation and large-scale weed spraying is occurring. The monitoring should be <u>periodic</u>, not “opportunistic” (Section 10.3.1) and during the early period following rehabilitation, the surface water monitoring should be continued as event-based sampling, rather than monthly sampling (Table 10-4). The sampling intensity/frequency could be reduced in the long term, once it has been demonstrated that the risk of downstream contamination is acceptably low.</p>
Radiation	Knowledge base	Activity concentrations	<p>SSB 2018 RMCP Assessment:</p> <p>Provide estimates of radionuclide activity concentrations in surface water surrounding the minesite.</p> <p>ERA Response 2020 RMCP:</p> <p>Radionuclide concentrations in surface water are predicted within the surface water model (Section 7.8). ERA are in the process of updating the surface water model, the results of which will be available in the 2021 MCP.</p> <p>SSB 2020 RMCP Assessment:</p> <p>ERA's commitment to include the above information in the RMCP is acknowledged.</p>
Radiation	Knowledge base	Activity concentrations	<p>SSB 2018 RMCP Assessment:</p> <p>Provide information on radon and radon progeny concentrations in the air due to the final landform.</p> <p>ERA Response 2020 RMCP:</p> <p>Radiological parameters required for the radiation dose assessment will be outlined in future iterations of the MCP and provided in detail within ERA's application for approval to construct the final landform. See Section 7.10.1 for further detail.</p> <p>SSB 2020 RMCP Assessment:</p> <p>ERA's commitment to include the above information in the RMCP is acknowledged.</p>
Radiation	Knowledge base	Activity concentrations	<p>SSB 2018 RMCP Assessment:</p> <p>Provide information on the activity concentration of radionuclides in dust due to the final landform.</p> <p>ERA Response 2020 RMCP:</p> <p>Radiological parameters required for the radiation dose assessment will be outlined in future iterations of the MCP and provided in detail within ERA's application for approval to construct the final landform. See Section 7.10.1 for further detail.</p> <p>SSB 2020 RMCP Assessment:</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			ERA's commitment to include the above information in the RMCP is acknowledged.
Radiation	Knowledge base	Gamma dose rates	<p>SSB 2018 RMCP Assessment: Provide information on gamma dose rates on the final landform.</p> <p>ERA Response 2020 RMCP: Radiological parameters required for the radiation dose assessment will be outlined in future iterations of the MCP and provided in detail within ERA's application for approval to construct the final landform. See Section 7.10.1 for further detail.</p> <p>SSB 2020 RMCP Assessment: ERA's commitment to include the above information in the RMCP is acknowledged.</p>
Radiation	Knowledge base	Human dose assessment	<p>SSB 2018 RMCP Assessment: Provide information on concentration ratios for uranium and actinium decay series radionuclides in bush foods.</p> <p>ERA Response 2020 RMCP: Radiological parameters required for the radiation dose assessment within ERA's application for approval to construct the final landform due for submission in 2022. See Section 7.10.1 for further detail.</p> <p>SSB 2020 RMCP Assessment: ERA's commitment to include the above information in the RMCP is acknowledged.</p>
Radiation	Knowledge base	Human dose assessment	<p>SSB 2018 RMCP Assessment: Provide an estimate of radiation doses to the public from the final landform.</p> <p>ERA Response 2020 RMCP: The radiation dose assessment is contingent upon the completion of current and future closure studies. The completed dose assessment will be included in future iterations of the MCP. See Section 7.10.1 for further detail.</p> <p>SSB 2020 RMCP Assessment: ERA's commitment to include the above information in the RMCP is acknowledged.</p>
Radiation	Knowledge base	Wildlife dose assessment	<p>SSB 2018 RMCP Assessment: Provide whole-organism concentration ratios for the representative organisms.</p> <p>ERA Response 2020 RMCP: The prediction of radiation dose to wildlife forms part of the radiation dose assessment. This study is underway and will be included in future iterations of the MCP. See Section 7.10.1 for further detail.</p> <p>SSB 2020 RMCP Assessment: ERA's commitment to include the above information in the RMCP is acknowledged.</p>
Radiation	Knowledge base	Wildlife dose assessment	<p>SSB 2018 RMCP Assessment: Provide tissue to whole-organism conversion factors for converting tissue-specific activity concentrations to whole-organism activity concentrations.</p> <p>ERA Response 2020 RMCP: The prediction of radiation dose to wildlife forms part of the radiation dose assessment. This study is underway and will be included in future iterations of the MCP. See Section 7.10.1 for further detail.</p> <p>SSB 2020 RMCP Assessment: ERA's commitment to include the above information in the RMCP is acknowledged.</p>
Radiation	Knowledge base	Wildlife dose assessment	<p>SSB 2018 RMCP Assessment: Provide an estimate of radiation dose rates to wildlife from the final landform.</p> <p>ERA Response 2020 RMCP:</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			<p>The prediction of radiation dose to wildlife forms part of the radiation dose assessment. This study is underway and will be included in future iterations of the MCP. See Section 7.10.1 for further detail.</p> <p>SSB 2020 RMCP Assessment:</p> <p>ERA's commitment to include the above information in the RMCP is acknowledged.</p>
Radiation	Monitoring and maintenance	Radionuclide monitoring of terrestrial bushfoods	<p>SSB 2019 RMCP Assessment:</p> <p>Information currently provided in Table 12-9 suggests that the only terrestrial bushfood group to be monitored for radionuclides is fruit. There are several other terrestrial bushfood groups in the model diet (e.g. buffalo, pig, wallaby, goanna and yam) through which radionuclides can be ingested.</p> <p>Recommendation: Provide a list of the terrestrial bushfood groups to be targeted for post-closure monitoring of radionuclides or if fruit is the only group to be targeted, then justification for this needs to be provided.</p> <p>ERA Response 2020 RMCP:</p> <p>ERA will be undertaking a terrestrial and aquatic bushfood sampling program which is described in Section 5. ERA's permits and approvals for collection of bushfoods expire in 2025 and therefore terrestrial bushfood will be collected prior to expiry.</p> <p>SSB 2020 RMCP Assessment:</p> <p>A list of terrestrial bushfood groups to be targeted for post-closure (i.e. beyond 2026) monitoring of radionuclides has not been provided.</p> <p>Also, given that ERA's permits and approvals to collect bushfoods expire in 2025, this does not address the aspect of post-closure monitoring of radionuclides in bush foods nor is it consistent with the intended duration set out in Table 10-9 "Until demonstrated progression towards closure criteria, i.e. low levels have been confirmed".</p>
Radiation	Monitoring and maintenance	Radionuclide monitoring of aquatic bushfoods	<p>SSB 2019 RMCP Assessment:</p> <p>Table 12-9 indicates that there will be no post-closure monitoring of radionuclides in aquatic bushfoods (i.e. only water).</p> <p>Recommendation: Consider the inclusion of monitoring of radionuclides in aquatic bushfood, especially for on-site waterbodies potentially contaminated by mining operations (e.g. Georgetown Billabong), to confirm dose estimates based on water radionuclide measurements.</p> <p>ERA Response 2020 RMCP:</p> <p>ERA will be undertaking a terrestrial and aquatic bushfood sampling program which is described in Section 5. ERA's permits and approvals for collection of bushfoods expire in 2025 and therefore terrestrial bushfood will be collected prior to expiry.</p> <p>SSB 2020 RMCP Assessment:</p> <p>ERA's permits and approvals to collect bushfoods expire in 2025. ERA should seek further approval for the collection of bushfoods to enable post-closure (i.e. beyond 2026) monitoring of radionuclides in aquatic bushfoods in potentially contaminated waterbodies.</p>
Soils	Knowledge base	Soil contamination	<p>SSB 2018 RMCP Assessment:</p> <p>Although the RMCP acknowledges that soils in the processing plant area will require remediation, no data indicating the extent (e.g. depth and surface area/volume) of contaminated soil in this area are presented, or referenced. The RMCP needs to indicate the volume of contaminated soil, as well as the proposed method for recovery and placement of this soil into the Pit.</p> <p>ERA Response 2019 RMCP:</p> <p>Data including depth, surface area and volume of contaminated soil will be provided following the contaminated soil assessment of the processing area. When completed, this information will be included in future updates of the MCP.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The 2020 RMCP (Section 5.5.2.5) provides an update on contaminated soil assessments in the processing area, indicating that a contaminated site drilling program and bore installation program was undertaken in late 2019/early 2020 to target areas where there are knowledge gaps. A summary of the results is provided and it is expected that this information will be used to update remediation plans (i.e. volumes of soil/water, recovery methods and placement for disposal) for the processing area in the 2021 RMCP.</p>
Soils	Knowledge base	Soil contamination	<p>SSB 2018 RMCP Assessment:</p> <p>To support the risk assessment that soils in the Land Application Areas pose a low risk as a source of potential contamination, information should be presented on relevant contaminants and suspended sediments (e.g. if soils are disturbed as part of any required remediation).</p> <p>ERA Response 2019 RMCP:</p> <p>Additional information will be provided within future updates to the MCP.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			<p>SSB 2020 RMCP Assessment:</p> <p>The 2020 RMCP (Section 5.5.2.4) provides an update on contaminated soil assessments in the land application areas, indicating that the information will inform the approach to remediation of each LAA, if required.</p>
Soils	Knowledge base	Soil contamination	<p>SSB 2018 RMCP Assessment:</p> <p>Assess the risk of contaminated soils within the Ranger Project Area impacting the environment outside the Ranger Project Area.</p> <p>ERA Response 2019 RMCP:</p> <p>A risk review was held as part of the Feasibility study to identify further work required to scope and assess potentially contaminated sites to the correct level to satisfy the closure objectives and relevant legislation. The Contaminated Site Register was updated throughout 2018 and has been reviewed to identify contamination volume, clean up requirements, and the potential impact of the contamination outside of the Ranger Project Area. (Refer to Section 7.10.9)</p> <p>SSB 2019 RMCP Assessment:</p> <p>It is not clear how the contaminated sites assessment will inform off-site risks, or demonstrate that on-site risks are ALARA.</p> <p>Information on contamination volumes, clean up requirements and potential off-site impacts should be included in the RMCP – the section referenced in ERA's response does not exist in the document.</p> <p>ERA Response 2020 RMCP:</p> <p>Noted. Appendix 12.2 of the 2019 MCP details the proposed process for contaminated sites assessment, including data quality objectives. Results from the 2019 contaminated sites drilling program will be interpreted with informed relevant guideline levels to better understand the risk associated with each contaminated site. This will inform the BPT assessment to select an appropriate management option. The ALARA framework in Section 6 will assist in informing the BPT assessment.</p> <p>Details on the contaminated sites assessment completed in the past 12 months are provided in the 2020 MCP (Refer to Section 5). As assessments are completed they will continue to be provided in the annual MCP updates.</p> <p>SSB 2020 RMCP Assessment:</p> <p>ERA's commitment to include the above information in the RMCP is acknowledged.</p>
Soils	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Develop a site-specific EIL for uranium and any other contaminants that are not covered by National Environmental Protection Measure guidelines.</p> <p>ERA Response 2019 RMCP:</p> <p>This is planned to be developed as part of soil monitoring for contamination.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The 2020 RMCP indicates that soil contamination sampling has been undertaken, therefore it is expected that this comment should be addressed in the 2021 RMCP.</p>
Ecosystem restoration	Knowledge base	Overall strategy	<p>SSB 2018 RMCP Assessment:</p> <p>Expand the Revegetation Strategy to an ecosystem restoration strategy.</p> <p>ERA Response 2018 RMCP:</p> <p>The rehabilitation of the RPA will consider ecosystem establishment, and not simply the revegetation of the site. An ecosystem rehabilitation strategy will be developed, incorporating relevant KKN information, when complete, and be included within future MCP updates.</p> <p>SSB 2019 Assessment</p> <p>Not addressed</p> <p>ERA Response 2020 RMCP:</p> <p>Draft fauna closure criteria have been developed for the 2020 MCP. Following review and incorporation of comments from stakeholders this will form the basis of a faunal recolonisation strategy. Once complete the Revegetation Strategy can be updated to an 'Ecosystem Rehabilitation Strategy'.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The inclusion of draft fauna closure criteria in the 2020 RMCP is acknowledged. Some initial comments are provided in Table 3 and Attachment A, noting that further consultation will occur via the Ecosystem Restoration Working Group.</p>
Ecosystem restoration	Knowledge base	Reference vegetation communities	<p>SSB 2018 RMCP Assessment:</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			<p>Provide the survey methods used for the regional vegetation survey program.</p> <p>ERA Response 2020 RMCP:</p> <p>ERA is committed to long-term monitoring of reference sites, and review and refinement of methodology and site selection is ongoing with regulators.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The requested information has not been provided in the 2020 RMCP. Table 10-10 (Section 10, Monitoring and Maintenance) includes several references to '<i>standard NT vegetation survey methods</i>' but this needs to be clearly defined, including the spatial extent of monitoring.</p>
Ecosystem Restoration	Knowledge base	Revegetation similarity	<p>SSB 2018 RMCP Assessment:</p> <p>A proposed revegetation species list (including both over- and understorey species) should be provided.</p> <p>ERA Response 2019 RMCP:</p> <p>Overstorey and midstorey performance (Section 7.3.4.3) and understorey establishment (Section 7.3.4.4) have been added to the 2019 MCP. Outcomes of ongoing studies will inform this list and this will be updated accordingly. A preliminary species list (including understorey species) was presented at the Ranger Consultative Closure Group (August 2019). The list is likely to be finalised and presented in the 2020 MCP.</p> <p>SSB 2020 RMCP Assessment:</p> <p>It is noted that agreement to a final revegetation species list is subject to ongoing work by ERA and consultation with stakeholders. Additional specific comments on information presented in the 2020 MCP are provided in Table 3.</p>
Ecosystem restoration	Knowledge base	Understorey establishment	<p>SSB 2018 RMCP Assessment:</p> <p>Provide details on which species would be included in the understorey (in consideration of requirements for faunal colonisation), and evidence to support the assumption that direct seeding is the best option for the establishment of such species.</p> <p>ERA Response 2019 RMCP:</p> <p>Planned trials on rehabilitation understorey species are described in Section 7.6.3. It is not assumed that these species will be direct seeded, but predominantly introduced via tubestock. Habitat requirements for fauna return will be considered under KKN ESR2B, and will be reported on in the 2020 MCP</p> <p>SSB 2020 RMCP Assessment:</p> <p>It is noted that the original comment was in relation to understorey establishment, not fauna. As it is generated, the required information should be presented in updates to the RMCP and the Final Landform and Revegetation Application.</p>
Ecosystem restoration	Knowledge base	Faunal colonisation	<p>SSB 2018 RMCP Assessment:</p> <p>Provide evidence to demonstrate that appropriate measures will be taken to ensure fauna colonisation of the rehabilitated site.</p> <p>ERA Response 2019 RMCP:</p> <p>Work on fauna return strategies is ongoing and updates may be expected in 2020 MCP. Studies related to KKN ESR2 are underway.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The 2020 RMCP includes brief descriptions of planned fauna habitat trials for the TLF, although there is no indication of when results will be available. As it is generated, the required information should be presented in updates to the RMCP and the Final Landform and Revegetation Application.</p>
Ecosystem restoration	Knowledge base	Nutrient cycling	<p>SSB 2018 RMCP Assessment:</p> <p>Provide information on nitrogen dynamics in the rehabilitated landform, including an assessment of the potential for nitrogen to be a limiting factor for nutrient cycling, and nutrient availability and presence of soil biota to assist in plant growth.</p> <p>ERA Response 2019 RMCP:</p> <p>KKN ESR7 A, C & D studies with provide information on this query, and a summary of study findings will be summarised in the 2020 MCP update.</p> <p>SSB 2020 RMCP Assessment:</p> <p>There do not appear to be any significant updates in the 2020 RMCP to address this recommendation.</p>
Ecosystem restoration	Knowledge base	Vegetation sustainability	<p>SSB 2018 RMCP Assessment:</p> <p>Provide information demonstrating that waste rock can maintain long-term species diversity through recruitment and regeneration and whether there are factors that could be manipulated to facilitate this.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			<p>ERA Response 2019 RMCP:</p> <p>Revegetation monitoring does include recruitment and regeneration post-fire. Future trials are planned to investigate potential factors to be modified for benefit in longterm ecosystem self-sustainability.</p> <p>SSB 2019 RMCP Assessment:</p> <p>Further comments on the application of information obtained from revegetation trials are provided in the 2019 RMCP Assessment Report.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Limited information is presented in the 2020 RMCP which is based only on observations on the Trial Landform. This indicates that some species have the ability to recruit/regenerate in waste rock. It is recommended that a summary of all available information be presented in the 2021 RMCP, with a focus on quantitative data where possible (i.e. over the entire Trial Landform).</p>
Ecosystem restoration	Knowledge base	Vegetation sustainability	<p>SSB 2018 RMCP Assessment:</p> <p>Include more relevant information on fire and plant survivability in the region, including reference to fire severity and intensity, and survivability of specific species.</p> <p>ERA Response 2019 RMCP:</p> <p>Reporting on the completed Project 1240-30 (Trial landform fire report) will be presented in the 2020 MCP update. Monitoring of fire response will continue.</p> <p>SSB 2020 RMCP Assessment:</p> <p>While information from the Trial Landform fire study has been incorporated into the 2020 RMCP, this still needs to be put into the context of other relevant information available on plant survivability from fire in the region.</p>
Ecosystem restoration	Knowledge base	Vegetation sustainability	<p>SSB 2018 RMCP Assessment:</p> <p>Determine the most appropriate fire management regime to ensure a fire resilient ecosystem on the rehabilitated site, including reference to faunal colonisation.</p> <p>ERA Response 2019 RMCP:</p> <p>Information on fire management in the Maintenance and Monitoring Section has been updated. The fire management strategy will be continually developed as knowledge increases with ongoing monitoring. Reporting on the completed Project 1240-30 (Trial landform fire report) will be presented in the 2020 MCP update.</p> <p>SSB 2020 RMCP Assessment:</p> <p>While information from the Trial Landform fire study has been incorporated into the 2020 RMCP, it is noted that ERA has an additional study allocated to KKN ESR8A which will further inform the development of a fire regime.</p>
Ecosystem restoration	Knowledge base	Baseline introduced species	<p>SSB 2018 RMCP Assessment:</p> <p>Acknowledge that comprehensive surveys to inform the status of weeds and feral animals will be required before and during the rehabilitation process, including the entire Ranger Project Area and surrounding areas.</p> <p>ERA Response 2019 RMCP:</p> <p>Studies are underway and will be reported on in the 2020 MCP update. The KKN for fauna outside the RPA has been assigned to SSB.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Updates on weed status have been provided in the 2020 RMCP, although these only appear to include the Trial Landform. While relevant studies may be underway and it is acknowledged that the Supervising Scientist is undertaking work to address KKN ESR4A (introduced species in areas surrounding the RPA), the RMCP should include a commitment by ERA to undertake comprehensive surveys on the RPA to inform the status of weeds and feral animals before and during the rehabilitation process.</p>
Ecosystem restoration	Knowledge base	Risks - introduced fauna	<p>SSB 2018 RMCP Assessment:</p> <p>Quantify the magnitude of potential sources of feral animals (i.e. no. of animals per unit area), to allow comparison of densities between areas inside the Ranger Project Area and adjacent areas of Kakadu National Park.</p> <p>ERA Response 2019 RMCP:</p> <p>Studies are underway and will be reported on in the 2020 MCP The KKN for fauna outside the RPA has been assigned to SSB.</p> <p>SSB 2020 RMCP Assessment:</p> <p>A list of the species present on the RPA has been presented in the 2020 RMCP, which is based on previous work and doesn't include densities or areas adjacent to the RPA. The Supervising Scientist will undertake studies to address KKN ESR4A (introduced species in areas surrounding the RPA) and provide the information to ERA as it becomes available for inclusion in the RMCP.</p>
Ecosystem restoration	Knowledge base	Risks - introduced fauna	<p>SSB 2018 RMCP Assessment:</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			<p>Assess the risk of feral animals impacting on faunal colonisation of the rehabilitated site.</p> <p>ERA Response 2019 RMCP:</p> <p>Studies are underway and will be reported on in the 2020 MCP. The KKN for fauna outside the RPA has been assigned to SSB.</p> <p>SSB 2020 RMCP Assessment:</p> <p>There does not appear to be any updated information from studies (or their status) presented in the 2020 RMCP. It is noted that the 'KKN for fauna outside the RPA' (ESR4A) is not the most relevant KKN to this question. Both ERA and the Supervising Scientist have allocated studies to address the relevant KKN ESR2C ('What is the risk of introduced animals (e.g. cats and dogs) to faunal colonisation and long-term sustainability?') and as the results of these studies become available, they should be incorporated into the RMCP.</p>
Ecosystem restoration	Knowledge base	Risks - contaminants	<p>SSB 2018 RMCP Assessment:</p> <p>Assess the risk of potential impacts of contaminants leached from waste rock on revegetation and fauna, including details on how this would be avoided or mitigated.</p> <p>ERA Response 2019 RMCP:</p> <p>SSB are undertaking KKN ESR6A. What concentrations of contaminants from the rehabilitated site may be available for uptake by terrestrial plants? ESR6B will be completed and reported on in updated MCP.</p> <p>SSB 2019 RMCP Assessment:</p> <p>Noted that the need for KKN ESR6A (i.e. impact of contaminants on vegetation) is currently subject to discussion between SSB, ERA and ARRTC.</p> <p>Noted that the need to assess risk of contaminants to fauna is identified in KKN RAD8</p> <p>SSB 2020 RMCP Assessment:</p> <p>The Supervising Scientist has agreed that the KKN ESR6A could possibly be removed, if the relevant groundwater modelling (e.g. shallow aquifers) when completed by ERA indicates there is a low risk of exposure of revegetation on the final landform to contaminants. As noted previously, KKN RADA (assigned to ERA) is intended to assess the risk to fauna.</p>
Ecosystem restoration	Knowledge base	Risks - landscape	<p>SSB 2018 RMCP Assessment:</p> <p>Mitigations to address integrated landscape risks, such as weather, should be addressed in the Ecosystem Restoration Strategy.</p> <p>ERA Response 2019 RMCP:</p> <p>When further studies are completed, these mitigations will be included within the ecosystem rehabilitation strategy.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The commitment to include further detail on landscape risk mitigation measures in the RMCP is acknowledged.</p>
Ecosystem restoration	Knowledge base	Risks - landscape	<p>SSB 2018 RMCP Assessment:</p> <p>Provide information to assess how vegetation community development may be affected by landform stability, including re-contouring the landform surface.</p> <p>ERA Response 2019 RMCP:</p> <p>Landform stability is considered in the final landform design, and follow up monitoring. Refer to updated MCP relevant sections (7.5). The predicted date for completion of KKN LAN3 - will be the end of 2020, and thus results will be discussed in the 2021 updated MCP.</p> <p>SSB 2019 RMCP Assessment:</p> <p>Noted that it is not clear if the results discussed in section 7.5 of the RMCP from the analysis of the FLV5.2 landform are the same as those from the FLV6.2 landform.</p> <p>ERA Response 2020 RMCP:</p> <p>During the monitoring and maintenance phase, the landform may settle over time and there is also the potential for subsidence and/or erosion to occur. Revegetation must also progress towards a self-sustaining ecosystem. Potential remedial management practices to ensure continued progress towards a stable landscape and self-sustaining ecosystem in this phase are described in Section 10</p> <p>SSB 2020 RMCP Assessment:</p> <p>The additional information presented in the 2020 RMCP is acknowledged, noting that the risk will need to be assessed following the completion of all studies allocated to the KKN LAN3B.</p>
Ecosystem restoration	Knowledge base	Soil formation	<p>SSB 2018 RMCP Assessment:</p> <p>Provide information on soil formation properties for each type of waste rock to be used in landform construction, including:</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			<ul style="list-style-type: none"> • weathering rates • soil texture information for the entire waste rock substrate (i.e. not just < 2mm fraction). <p>ERA Response 2019 RMCP:</p> <p>The associated KKN study will be progressed, and the PSD investigation will be reported on within the 2020 MCP update.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Soil formation and PSD information have been presented in Appendix 5.1 but this is not consistent with what is presented in the main body of the RMCP. It is also noted that soil formation needs to be determined for other parameters in addition to PSD, such as organic content and nutrients.</p>
Ecosystem restoration	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Include a defined trajectory (or trajectories) in relation to vegetation community establishment, using site-specific indicators relating to ecosystem composition, structure and function.</p> <p>ERA Response 2019 RMCP:</p> <p>This information has been identified as a KKN and thus studies will be conducted to enable the formulation of such defined rehabilitation trajectories, to be utilised in monitoring, assessment of rehabilitation success against completion criteria, and the potential for requirement for further works if the ecosystem re- establishment is not on track of this defined trajectory. The KKN ESR5 studies are progressing, and an update will be provided in the 2020 updated MCP.</p> <p>SSB 2020 RMCP Assessment:</p> <p>There are several current and planned studies by both SSB and ERA allocated to KKN ESR5 and the information generated by these studies should be summarised in the RMCP as they are completed. There has not yet been significant progress in studies to address this comment in the 2020 RMCP.</p>
Ecosystem restoration	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Update terrestrial fauna closure criteria using data gathered with contemporary fauna sampling methodologies.</p> <p>ERA Response 2019 RMCP:</p> <p>It is intended that the fauna completion criteria will be finalised (with stakeholder input) after studies to address relevant KKNs have been completed. The MCP will be updated with this information, as appropriate</p> <p>SSB 2019 RMCP Assessment:</p> <p>SSB and ERA will need to consult on the development of appropriate fauna closure criteria.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Draft fauna closure criteria have been included in the 2020 RMCP. These are subject to ongoing consultation with stakeholders and specific comments are provided in Table 3 and Attachment A (Assessment of Closure Criteria) where appropriate.</p>
Ecosystem restoration	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Include standard quantitative biodiversity indices (e.g. species richness and abundance) for fauna that allow assessment of whether terrestrial fauna communities on the rehabilitated site are comparable (or on a trajectory to be comparable) with those in adjacent areas of Kakadu National Park.</p> <p>ERA Response 2019 RMCP:</p> <p>The development of quantitative biodiversity indices is pending further studies. This will be updated once information becomes available (there are a number of KKNs that are being addressed by both ERA and SSB on this topic). Future MCPs will incorporate this information when available.</p> <p>SSB 2019 RMCP Assessment:</p> <p>SSB and ERA will need to consult on the development of appropriate fauna closure criteria.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Draft fauna closure criteria have been included in the 2020 RMCP. These are subject to ongoing consultation with stakeholders and specific comments are provided in Table 3 and Attachment A (Assessment of Closure Criteria) where appropriate.</p>
Ecosystem restoration	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Provide evidence to support the assumption that fauna will colonise the rehabilitated site, once suitable habitat has established.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			<p>ERA Response 2019 RMCP:</p> <p>Work on fauna return strategies is ongoing (including relevant KKNs) and updates may be expected in the 2020 MCP.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Draft fauna criteria have been included in the 2020 RMCP but there is not yet evidence to support the assumption that fauna will colonise the rehabilitated site, once suitable habitat has established. There are several current and planned studies by both SSB and ERA allocated to KKN ESR2B and the information generated by these studies should be summarised in the RMCP as they are completed.</p>
Ecosystem restoration	Closure implementation	Seed availability/propagation	<p>SSB 2018 RMCP Assessment:</p> <p>Provide information on which species are currently able to be grown from seed, and which are not able to be successfully propagated.</p> <p>ERA Response 2020 RMCP:</p> <p>As nursery trials continue, this information will be compiled indicating any seed requiring pre-treatment for assisted germination rates. Soil ameliorants (that are applicable for tube stock) will also be investigated. Recalcitrant species will also be identified. 100% species diversity return in the short term is not a realistic goal for rehabilitation on a waste rock landform.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The ongoing plant propagation studies being undertaken by ERA to address the KKN ESR3A are acknowledged and the resulting information should be incorporated into the RMCP as it is generated.</p>
Ecosystem restoration	Closure implementation	Seed availability/propagation	<p>SSB 2018 RMCP Assessment:</p> <p>Provide further information to demonstrate that sufficient seed can be sourced to complete revegetation in the time frame required and reach the desired end state (including the amount of seed and resulting tube stock for each species), and consider classifying seed availability as a Class 3 risk.</p> <p>ERA Response 2020 RMCP:</p> <p>Seed availability in the 2019 MCP risk assessment is rated as a Class III risk, but is managed as a class IV risk due to the risk rating for the project schedule. The collection of seed has commenced with back-up air conditioning provided within the new seed storage facility at the nursery. The determination of quantity and type of seed required for rehabilitation plans of the RPA and a schedule for seed requirements are complete and a seed matrix is updated monthly for internal reporting.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The contingency plan presented in Section 9.4.6.2 of the 2020 RMCP only considers the nurseries capacity to produce tubestock, not the availability of seed to produce tubestock, or contingencies that may be required during the establishment phase. If the short-lived seeds are not producing well prior to the 24/25 planting season, then a significant lack of tubestock could occur with no potential for collection prior to the large-scale planting following final landform completion.</p> <p>The contingency plan should address the possibility on having low availability/low productivity in short-lived seeds prior to the final rounds of planting.</p> <p>To give confidence that the seed collection practices and contingencies will be able to produce the required number of plants in their ecologically-relevant proportions, more information on the seed collection database needs to be provided. For example, there may be logistical constraints and risks associated with the timely planting of a particular reference ecosystem (compared to another) if species are considered individually in terms of their seed collection requirements and progress against the plan. Information should include:</p> <ul style="list-style-type: none"> • the number of seeds currently collected per species, including specification of framework/culturally-important species • when the peak seed requirement is for each species • seed proportions collected relating to reference ecosystem/s proposed • rankings of species/community types on seed collection and storage difficulty.
Ecosystem restoration	Closure implementation	Revegetation works	<p>SSB 2018 RMCP Assessment:</p> <p>Additional information on the works proposed in the revegetation application should include:</p> <ul style="list-style-type: none"> • detailed action plans and timelines, including methods (i.e. planting, irrigation) • seed availability and collection plan • nursery details and propagation studies • target and planned planting densities and methods (e.g. final target density for each species) • habitat to be installed (e.g. nesting boxes, rock piles) • ongoing management activities, including weed control and infill planting • any other project specific assumptions or information which would be required to conduct a detailed assessment of the activity.

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – not yet addressed
			<p>ERA Response 2019 RMCP:</p> <p>The MCP cannot include this level of detail until further revegetation trials have progressed, and relevant KKNs completed. Thus, the revegetation strategy will remain at the current high level of detail in the 2019 MCP. Further detail will be added into each MCP update, with the ERA Ranger Revegetation Implementation Plan to be developed with the full detail in preparation for execution, and with adequate timing for review</p> <p>SSB 2019 RMCP Assessment:</p> <p>Note that this comment was made in relation to detail that should be included in the Final Landform and Revegetation application, not the RMCP.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The information should be summarised in the RMCP as it becomes available and detailed in the Final Landform and Revegetation application, as noted above.</p>
Ecosystem restoration	Closure implementation	Revegetation contingencies	<p>SSB 2018 RMCP Assessment:</p> <p>Refine the vegetation mortality contingencies to consider mortality beyond the first 6 months and the potential for mortality to vary between species and locations.</p> <p>ERA Response 2019 RMCP:</p> <p>Ongoing revegetation trials (described in Section 7.3.4) will address these queries.</p> <p>SSB 2020 RMCP Assessment:</p> <p>While ongoing studies may inform specific contingencies, high-level contingencies should be developed for inclusion in the RMCP that can be updated as the relevant information becomes available.</p>
Ecosystem restoration	Monitoring and maintenance	Monitoring	<p>SSB 2018 RMCP Assessment:</p> <p>The vegetation and fauna monitoring program should include detailed information about:</p> <ul style="list-style-type: none"> • justification for site selection • survey methods and quantitative metrics being to assess <i>condition</i> and <i>natural variability</i> • how the data from these surveys are being used to derive or update closure criteria. <p>ERA Response 2019 RMCP:</p> <p>Information derived from KKN studies will be used to further develop the monitoring programmes which will be updated in the 2020 MCP with information available. Site selection of 'reference' or analogue sites is still under discussion with SSB. Monitoring programmes cannot be finalised until the reference sites and completion criteria are further developed.</p> <p>SSB 2020 RMCP Assessment:</p> <p>There does not appear to be any updated information on vegetation/fauna monitoring programs presented in the 2020 RMCP. It is noted that consultation on ecosystem restoration monitoring programs is ongoing.</p>
Ecosystem restoration	Monitoring and maintenance	Monitoring	<p>SSB 2018 RMCP Assessment:</p> <p>Revise the proposed monitoring methods and frequency based upon the risks and mitigations identified through a trajectory model.</p> <p>ERA Response 2019 RMCP:</p> <p>A State-and-Transition Model for Ranger Mine revegetation is under development (in collaboration with ERA, SSB and CSIRO) and will enable the revegetation objectives (including the conceptual model), pathways, risks, contingencies and monitoring to be more clearly articulated in the 2020 MCP.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The State-and-Transition Model is mentioned in the 2020 RMCP with respect to refining the '<i>trajectories for key parameters for revegetation, to identify milestones and thresholds to inform the ERA Adaptive Management Plan</i>'. It is understood this information will be gathered in 2020/21 and it is also noted that both the Supervising Scientist and ERA are undertaking additional studies to address the relevant KKN ESR5B.</p>

Table 2. Recommendations from previous SSB RMCP assessments that have been addressed or subsumed

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – closed out
All	Risk assessment and management	Risk assessment	<p>SSB 2018 RMCP Assessment: Terms and definitions should be simplified and standardised.</p> <p>ERA Response 2020 RMCP: Terms and definition have been added at the beginning of the Section 7.</p> <p>SSB 2020 RMCP Assessment: Accepted - close out</p>
All	Risk assessment and management	Risk assessment	<p>SSB 2018 RMCP Assessment: The likelihood classifications may need to be reconsidered given the long timeframe for the life of the project (10,000 years).</p> <p>SSB 2019 RMCP Assessment: Timeframes have been added to the likelihood classifications, although it is not clear how these were considered in the risk assessment scoring.</p> <p>ERA Response 2020 RMCP: It is noted that some risks have the 10,000 year timeframe. The likelihood rankings used by ERA do not span this timeframe; however, it is the consequence of the risk occurring any time within the 10,000 years that is assessed. Based on this the likelihood descriptors are considered appropriate.</p> <p>SSB 2020 RMCP Assessment: Accepted - close out</p>
All	Risk assessment and management	Risk assessment	<p>SSB 2018 RMCP Assessment: Table 9-6 (risk assessment) should include:</p> <ul style="list-style-type: none"> • reference to the existing controls • the phase of closure for which the risk is being assessed • risk <i>TC4-03: Delays to rehabilitation and/or closure activities extending beyond 2026</i> in the Aquatic Ecosystem risk category (TA), as well as the People risk category (TC). <p>SSB 2019 RMCP Assessment: Table 10-5 includes reference to controls noting that there is no distinction between existing/potential controls, or the relevant closure phase.</p> <p>ERA Response 2020 RMCP: The risk assessment section in the MCP has been updated to distinguish between controls and actions. Actions, when implemented and realised becomes controls.</p> <p>SSB 2020 RMCP Assessment: Accepted - close out</p>
All	Risk assessment and management	Risk assessment	<p>SSB 2019 RMCP Assessment: To obtain the risk ranking, the controls are considered but those listed are a combination of existing controls, planned controls and contingencies (potential controls). If all of these elements are considered together, this may result in an artificial reduction in risk level by considering controls that aren't necessarily in place, or have a low level of effectiveness.</p> <p>Recommendation: Clearly distinguish between the existing and proposed controls for the planned closure scenario, along with evidence to support control adequacy and effectiveness, including consideration of control applicability or availability during the three closure phases (i.e. decommissioning, stabilisation and monitoring and post-closure)</p> <p>ERA Response 2020 RMCP: Controls that are not realised (still in progress or not implemented) are not considered in the risk evaluation and captured under "actions".</p> <p>SSB 2020 RMCP Assessment: Accepted - close out</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – closed out
All	Risk assessment and management/Closure implementation	Contingencies	<p>SSB 2018 RMCP Assessment:</p> <p>In the next version of the RMCP include detailed contingency plans for all key activities.</p> <p>ERA Response 2019 RMCP:</p> <p>Contingency plans have been included within the MCP for the key activities that have been approved to date. Contingency planning will form part of the BPT and risk analysis assessments for future applications of key activities (i.e. deconstruction of Tailings Storage Facility, deconstruction of processing plant, final landform).</p> <p>SSB 2019 RMCP Assessment:</p> <p>Refer to further comments on contingencies within body of report, below and in Appendix 4.</p> <p>SSB 2020 RMCP Assessment:</p> <p>This comment is being closed out, as it is duplicated in other comments provided by the Supervising Scientist.</p>
All	Best Practicable Technology (BPT)	Best Practicable Technology (BPT)	<p>SSB 2018 RMCP Assessment:</p> <p>As acknowledged within the RCMP, all rehabilitation activities will need to be supported by best practicable technology (BPT) analyses.</p> <p>ERA Response 2019 RMCP:</p> <p>BPT is a review to select the best practical technology and, as such, will not be appropriate for activities. Operations, such as the run according to best practice and under the Nursery Association national guidelines. The list of planned BPTs within the Section 9 are those dictated by the Authority and any additional requirements for planned applications.</p> <p>SSB 2019 RMCP Assessment:</p> <p>The BPT assessments to date are adequately detailed and a list of future BPT assessments described. All BPT assessments should include a wide range of options, taking into account relevant national and international experience and precedents where they exist.</p> <p>SSB 2020 RMCP Assessment:</p> <p>This comment is being closed out, as it is duplicated in another comment provided by the Supervising Scientist on the 2018 RMCP.</p>
Landform	Knowledge base	Landform stability	<p>SSB 2018 RMCP Assessment:</p> <p>Use synthetic rainfall datasets in flood modelling.</p> <p>ERA Response 2019 RMCP:</p> <p>The LEM (landform evolution model) does utilise a synthetic rainfall data set for 10,000 years, and also considers climate change scenarios.</p> <p>SSB 2019 RMCP Assessment:</p> <p>The comment was in relation to use of synthetic rainfall data in flood modelling, not LEM modelling.</p> <p>ERA Response 2020 RMCP:</p> <p>The flood modelling completed for ERA assesses the early year sediment and erosion controls and does not require the long term data set. The LEM modelling requires the synthetic long term data set. ERA is currently evaluating the final landform and completing sensitivity testing of key LEM model parameters including climate sequences, rainfall losses, particle size distribution and vegetation cover. In these evaluations, the synthetic rainfall data set of the SSB has been used. See also comment 35.</p> <p>SSB 2020 RMCP Assessment:</p> <p>This comment is being closed out, as it is duplicated in another comment provided by the Supervising Scientist on the 2019 RMCP.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – closed out
Landform	Closure implementation	Erosion and sediment control	<p>SSB 2018 RMCP Assessment:</p> <p>Provide the following information on the proposed flow and sediment control structures, including:</p> <ul style="list-style-type: none"> • the design • a program of maintenance • the volume of bedload requiring disposal • potential impacts and planned mitigation measures that the structures are ineffective. <p>ERA Response 2019 RMCP:</p> <p>Design features are provided in Section 11. The maintenance is included within Section 12 - Monitoring and maintenance.</p> <p>SSB 2019 Assessment:</p> <p>Most information has been provided, except volumes of sediment requiring disposal.</p> <p>ERA Response 2020 RMCP:</p> <p>It is not possible to determine the volumes of sediment that will require removal from the sediment traps each year as this will be highly dependent upon the final rock placed on the surface and the rainfall for that year. As such ERA's maintenance program will be adapted each year as required.</p> <p>SSB 2020 Assessment:</p> <p>Accepted, noting that:</p> <ul style="list-style-type: none"> • The requirement for more detail on the general approach to management of sediment control structures is covered in other comments that are yet to be addressed. • Pit 1 monitoring may help inform whether volumes of sediment requiring disposal may be a major issue requiring more detailed study.
Landform	Closure implementation	Infrastructure disposal	<p>SSB 2018 RMCP Assessment:</p> <p>Section 7.5.1 states that <i>all material with the potential for environmental impact</i> will be placed at the bottom of the mined-out pits. It is suggested this statement is removed from the plan as it is not readily achievable given grade 1 waste rock has the potential for environmental impact.</p> <p>SSB 2019 RMCP Assessment:</p> <p>It is noted that this comment was in the text but not specifically included in the relevant summary table of comments/recommendations in SSB's 2018 Assessment Report.</p> <p>ERA Response 2020 RMCP:</p> <p>The statement was removed from this Section. Waste and hazardous material management are now discussed in Section 9.4.2</p> <p>SSB 2020 RMCP Assessment:</p> <p>Accepted - close out</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – closed out
Landform	Closure implementation	Landform construction	<p>SSB 2018 RMCP Assessment:</p> <p>Provide additional information, including:</p> <ul style="list-style-type: none"> • detailed construction plans and timelines • engineering designs, construction tolerances and a digital elevation model • material movement and balances (including reference to consolidation models) • assumed availability rates/capacities of key equipment • mapped locations of material grades • quality control procedures to be employed during construction • a schedule showing material movements as the landform is constructed. <p>ERA Response 2019 RMCP:</p> <p>This additional information will be provided within the MTC application (final landform and revegetation) due for submission in 2022.</p> <p>SSB 2019 RMCP Assessment:</p> <p>In addition to the previously-listed information, the following should also be provided:</p> <ul style="list-style-type: none"> • plans/designs for the distribution/extent of the different surface materials (waste rock, rock armour, ripping, natural surfaces) on the final landform • engineering designs and long-term management plans for proposed sediment and erosion control structures on the final landform • up to date flood modelling <p>ERA Response 2020 RMCP:</p> <p>Section 11 of the 2019 MCP and the associated appendices provided all of the feasibility study engineering drawings for the final landform, ripping, erosion controls and the latest flood modelling ready for execution. It is not clear what additional information is required.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Much of the information on landform construction presented in the 2020 RMCP is adequate at this stage, noting that updates to the RMCP may be required when the Final Landform and Revegetation Application is approved. Note that there is a comment on material movements from the 2019 RMCP that still needs to be addressed (Table 1).</p>
Landform	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>The <i>probable worst-case scenario</i> should be retained in the closure criteria and clearly defined, in consultation with the Supervising Scientist.</p> <p>ERA Response 2019 RMCP:</p> <p>Finalisation of the completion criteria is aimed for the inclusion into the 2020 MCP, and this will done in consultation with the SSB.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The wording highlighted in the 2018 RMCP has been removed and is no longer considered relevant.</p>
Landform	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2019 RMCP Assessment:</p> <p>Closure criteria related to the physical isolation of tailings for 10,000 years that were proposed in the 2018 RMCP (i.e. previously L3 and L4) have been removed in the 2019 RMCP, without justification.</p> <p>Recommendation: Re-instate the closure criteria to demonstrate that tailings will be isolated for at least 10,000 years, or provide justification for their removal.</p> <p>ERA Response 2020 RMCP:</p> <p>The 2019 Landform closure criteria were reviewed and updated by ERA to match the Supervising Scientist Standard for Landform. Updated Closure Criteria are described in Section 8.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Updated Landform closure criterion L2 has been updated to '<i>Modelling of erosion on the constructed landform matches results of erosion modelling conducted on the approved landform design and confirms tailings will not be exposed for 10,000 years.</i>'</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – closed out
Water & Sediment	Knowledge base	Tailings consolidation modelling	<p>SSB 2018 RMCP Assessment:</p> <p>Clarify why tailings pore water expression during deposition has increased by more than 30% in consolidation modelling results between 2014 and 2016.</p> <p>ERA Response 2019 RMCP:</p> <p>Further explanation has been included within Section 7.1.3.</p> <p>SSB 2019 RMCP Assessment:</p> <p>In 7.1.3 it is stated that:</p> <p>‘The increase in expressed water (for the 2016 case) during deposition is due to thickening after Year 1 in the 2014 case.’</p> <p>However, the latest 2018 modelling shows that expression is now more consistent with the 2014 case (rather than 2016), which assumed thickened tailings.</p> <p>ERA Response 2020 RMCP:</p> <p>The 2014 modelling considered tailings thickening which allows more water to be freed from the tailings at the process plant and recycled into the process circuit. As a result, the ex-mill tailings have less water available for expression during deposition into the Pit. The 2016 modelling on the other hand did not consider tailings thickening. Consequently, the ex-mill tailings have more water available for expression during deposition, into the Pit, than the case of the thickened tailings. At the end of deposition, the thickened tailings achieved a dry density of 1.42t/m³ while a dry density of 1.39t/m³ was attained by the non-thickened tailings.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The additional clarification provided in the 2020 RMCP adequately addresses this comment.</p>
Water & Sediment	Knowledge base	Contaminant transport modelling	<p>SSB 2018 RMCP Assessment:</p> <p>The RMCP should detail future hydrogeological work that will be undertaken to refine the Ranger Conceptual Model, and explain how this will further inform rehabilitation planning, particularly with regard to:</p> <ul style="list-style-type: none"> • further refinement and characterisation of key hydrogeological units, aquifers and groundwater flows in high-risk areas for contaminant transport (around Pit1, Pit 3 and the Tailings Storage Facility) • further information on surface water/groundwater interactions • improved characterisation of existing contaminated groundwater (e.g. under the Tailings Storage Facility) and contaminated sites (e.g. Land Application Areas). <p>ERA Response 2019 RMCP:</p> <p>Work has been undertaken by ERA and INTERA in the last 12 months to update the Ranger Conceptual Model. Groundwater monitoring, specifically to support closure criteria, is detailed within Section 12.5.2. This monitoring has been designed to support further refinement of key hydrogeological units, and groundwater / surface water interaction via collection of groundwater quality and high resolution water level data via dataloggers. All monitoring data collected for both operational requirements and specific studies is used to support ongoing updates to the Ranger Conceptual Model. The updated Ranger Conceptual Model (INTERA 2019) details all refinements made to the characterisation of all hydrogeological units within the model domain, which includes all high risk areas. Project planning and scoping is underway to support future studies specifically to quantify the contamination below the Tailings Storage Facility and Processing Area. These studies will support the development of the remediation plan. The Tailings Storage Facility contaminated materials application will specifically address contamination as a result of operation of the Tailings Storage Facility. KKN WS2 and WS3 are to address surface water and groundwater interactions.</p> <p>SSB 2019 RMCP Assessment:</p> <p>The conceptual model will need to be updated as this information becomes available and the RMCP should detail future hydrogeological work that will be undertaken to refine the model and explain how this will feed into the contaminant transport modelling and rehabilitation planning. Additional comments are provided in the 2019 RMCP Assessment Report.</p> <p>ERA Response 2020 RMCP:</p> <p>Details on studies to support and inform updates to the Ranger Conceptual Model have been included in the 2020 MCP, Section 5.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The conceptual model has been updated. The comments in relation to surface water/groundwater interactions and improved characterisation of contaminated groundwater/sites are duplicated in other comments, therefore this is being closed out.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – closed out
Water & Sediment	Knowledge base	Suspended sediment transport	<p>SSB 2018 RMCP Assessment:</p> <p>Provide information on concentrations of suspended sediments and contaminants (including nutrients) bound to sediments, including:</p> <ul style="list-style-type: none"> • effects of sediment mobilisation on surface water quality • physical effects of suspended sediment on aquatic biodiversity • where, when and to what extent contaminants may accumulate in downstream sediments • monitoring methods. <p>ERA Response 2019 RMCP:</p> <p>Suspended sediment transport and accumulation will be predicted by the surface water model. Several projects to assess the biological impacts of contaminated sediments are listed against KKN WS5A. SSB has developed a rehabilitation standard to protect aquatic biodiversity from the effects of sedimentation. Information on these projects and agreement on monitoring approaches will be included in the next MCP update.</p> <p>SSB 2019 RMCP Assessment:</p> <p>The Supervising Scientist's Turbidity and Sedimentation Rehabilitation Standard is currently being developed.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Most of the matters raised in the original comment is considered by the Supervising Scientist as either no longer relevant or have been covered in other comments, therefore this is being closed out.</p>
Water & Sediment	Knowledge base	Pit 1 solute balance	<p>SSB 2019 RMCP Assessment:</p> <p>The solute balance indicates that the measured mass of solute recovered through the decant towers matches the mass of solute estimated to have been expressed from tailings (Figure 7-6).</p> <p>The volume balance indicates that the decant structures are recovering additional volume from the waste rock cap.</p> <p>Figure 7-6 actually shows the solute expression profiles are similar but in fact the predicted mass of solute is consistently underestimated by the model by up to 20% and is fairly consistent.</p> <p>Recommendation: Provide evidence or discussion to support the assumption this consistent difference is simply attributed to waste rock as a source term and not an inherent underestimation from the source term assessment or consolidation model outputs.</p> <p>ERA Response 2020 RMCP:</p> <p>Note that in the 2019 MCP, Figure 7-6 shows cumulative solute (magnesium) flow.</p> <p>The variation between the two curves occurs mostly in the first five months, when only a single sample of decant water was available (see chevron markers on x axis). This five month period corresponds to the wet season, when rainfall inflows can significantly influence concentration and a single sample is unlikely to be representative of the average concentration over the time.</p> <p>After the initial four months the curves are mostly parallel – the instantaneous rate of solute flow (given by the slope of the curves) is similar. If there was a consistent difference, the curves would continue to diverge.</p> <p>See the reference (Harvey, 2019) in the text for more information.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The clarification provided above adequately addresses this comment.</p>
Water & Sediment	Knowledge base	Site water model (OPSIM)	<p>SSB 2019 RMCP Assessment:</p> <p>The summary of the site water model is based on August 2018 results. Given that it is such an integral aspect of the site closure planning, the most up to date results and assumptions should be presented in the RMCP (e.g. as an Appendix).</p> <p>The approval status of assumptions for future water treatment processes is unclear, as some strategies are yet to receive regulatory approval.</p> <p>Recommendation: Present results of the most up to date site water model and assumptions and ensure the approval status of potential or proposed future water treatment processes is clearly stated.</p> <p>ERA Response 2020 RMCP:</p> <p>The model presented in the 2019 RCMP was the model current at the time of preparation of that RCMP.</p> <p>The model described in the 2020 RCMP is the current approved model dated February 2020. Section 9</p> <p>The approval status of future water treatment options have been included in the RCMP text. Section 9.4.3</p> <p>SSB 2020 RMCP Assessment:</p> <p>Accepted, noting that a comment is provided in Table 3 in relation to approval status of the Brine Squeezer for process water treatment.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – closed out
Water & Sediment	Knowledge base	Site water model (OPSIM)	<p>SSB 2019 RMCP Assessment:</p> <p>This modelling includes a number of significant assumptions, such as seasonal rainfall, water treatment capacity and efficiency over time and volume of contaminated water generated by the process of tailings consolidation in Pit 1 and Pit 3. However, there is no indication of model uncertainty based on the likely variability in these assumptions over time</p> <p>Recommendation: Provide information on surface (site) water model uncertainty relating to variability in model assumptions over time, to enable a detailed assessment of likely success of the proposed water treatment strategies.</p> <p>ERA Response 2020 RMCP:</p> <p>ERA assumes the word "surface" was mistakenly written instead of "site".</p> <p>The site water model provides forecasts of possible outcomes given variation in rainfall, with that variation being based on historical rainfall observations. Closure planning is completed on a median or 50th percentile basis, with contingencies identified to deal with higher rainfall scenarios. Any contingencies or strategy changes are all cost based and have no impact on the environmental outcome.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Accepted, noting that there are contingencies for additional treatment capacity during rehabilitation and a commitment to treat beyond 2026 as required.</p>
Water & Sediment	Knowledge base	Aquatic ecosystem protection	<p>SSB 2019 RMCP Assessment:</p> <p><i>Based on the predicted downstream solute concentrations, and the magnesium-calcium ratios, the post-closure final landform does not pose a risk to the downstream environment.</i></p> <p>There is currently insufficient information to support this statement and ERA is currently updating the surface water modelling to assess the risk of downstream impacts associated with contaminants from the post-closure landform.</p> <p>Recommendation: Until it can be demonstrated otherwise, remove any statements within the RMCP suggesting that the post-closure final landform does not pose a risk to the downstream environment.</p> <p>ERA Response 2020 RMCP:</p> <p>Updated. ERA is in the process of undertaking further updates to the surface water model. This updated information will be included in the next iteration of the MCP. More information is provided in Section 5.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Accepted - close out</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – closed out
Water & Sediment	Knowledge base	Aquatic ecosystem protection	<p>SSB 2018 RMCP Assessment:</p> <p>Assess the potential for offsite impacts associated with mobilisation and accumulation of contaminants via transport of suspended sediments.</p> <p>ERA Response 2019 RMCP:</p> <p>Sediment transport and accumulation will be predicted by the surface water model. ERA has several projects assessing the risk associated with sediment contamination. Refer to projects listed against KKN WS5A. <i>Will contaminants in sediments result in biological impacts, including the effects of acid sulfate sediments?</i></p> <p>SSB 2019 RMCP Assessment:</p> <p>Noted that the current surface water modelling being undertaken by ERA may not predict concentrations of suspended sediments.</p> <p>ERA Response 2020 RMCP:</p> <p>The surface water model (OPSIM) will provide suspended sediment concentrations at defined nodes (receptors).</p> <p>Sediment accumulation will not be modelled, on the basis that the majority of sediment generated from runoff is in the early phase of closure, where erosion and sediment controls will ensure sediment is largely managed and retained on the premises. The results of Landform Evolution Modelling completed by SSB suggest denudation rates off the final landform will be on a trajectory towards background and, as such, accumulation of sediments will be consistent with natural/background conditions.</p> <p>The surface water model predicts suspended sediment concentrations but not accumulation. CAESAR modelling undertaken by the SSB predicts sediment movement from the mine but not accumulation.</p> <p>ARRTC and stakeholder working groups discussed issues with modelling sediment accumulation and the associated risks and agreed</p> <p>(i) modelling of sediment accumulation is not required,</p> <p>(ii) turbidity criteria address the risk associated with suspended sediment, and</p> <p>(iii) the risk from bedload sediment will be managed by erosion control and monitoring plans.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Accepted - close out. Should future monitoring indicate significant sedimentation has occurred offsite, additional of monitoring of contaminants in those sediments would be required.</p>
Water & Sediment	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Acknowledge that there may be a requirement in future to consider the reintroduction of a closure criterion for pH, depending on the outcome of acid sulfate soil investigations.</p> <p>ERA Response 2019 RMCP:</p> <p>This is acknowledged within this section. It is stated that SSB is also investigating the need for a pH standard.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Accepted - close out</p>
Water & Sediment	Monitoring and maintenance	Surface water monitoring	<p>SSB 2019 RMCP Assessment:</p> <p>The proposed surface water quality monitoring program includes sulfate as a parameter at key monitoring sites on Magela and Gulungul Creeks. Given the risk of acid sulfate soil development on the Ranger Project Area and the Supervising Scientist's rehabilitation standard for this parameter, it should also be monitored at RP1 (and other onsite waterbodies, while they are present) and Georgetown and Gulungul Billabongs.</p> <p>Recommendation: Include sulfate as a water quality monitoring parameter at RP1 (and other onsite waterbodies, while they are present) and Georgetown and Gulungul Billabongs.</p> <p>ERA Response 2020 RMCP:</p> <p>The post-closure monitoring program is updated and includes sulfate as a water quality monitoring parameter at MG009, GCLB, MCUS, GCC, and Coonjimba and Gulungul Billabongs.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Accepted - close out, noting that Georgetown Billabong is included in Table 10-4 in the 2020 RMCP.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – closed out
Water & Sediment	Closure implementation	Water management	<p>SSB 2018 RMCP Assessment:</p> <p>A schedule should also be included for water treatment, indicating the planned options for process water treatment and demonstrating that these options will be sufficient to treat the predicted process water volumes.</p> <p>ERA Response 2019 RMCP:</p> <p>A schedule for water treatment has been included. Three active process water treatment routes are planned:</p> <ul style="list-style-type: none"> • Treatment using the existing Brine Concentrator. The Brine Concentrator will be the principal path for active process water treatment, with its feed water stream drawn from the bulk process water inventory – which is typically the highest. A feasibility study is underway to incrementally expand the distillate production capacity of the Brine Concentrator through an upgrade of the vapour recompression fan in unit three. Under the median forecast, the Brine Concentrator will be decommissioned in June 2025 – after all sources of process water have ceased. • Treatment using the HDS plant. This plant will treat an intermediate range of process water in terms of salt concentration, to minimise treatment cost and maximise plant throughput. HDS plant operation is planned from 2019 through to the end of 2021. • Treatment using reverse osmosis technology, of similar nature to (and perhaps using) the Brine Squeezer. This treatment process will target sources of process water with lower salt concentration, and is expected to run through to the middle of 2025. The contributions of the three active process water treatment routes are shown in Figure 11-29. <p>SSB 2019 RMCP Assessment:</p> <p>Given the uncertainty associated with the predicted process water volumes up to 2025, it is critical that ERA is able to fulfil its identified contingency to continue water treatment and disposal of all process water (including expressed tailings pore water) for as long as necessary. As the process water treatment predictions are further refined, this may also have implications for the disposal of brine in Pit 3. Additional information should be provided in the RMCP, including:</p> <ul style="list-style-type: none"> • results of investigations undertaken in order to reinstate the Pit 3 underdrain extraction bore • evidence to demonstrate the longevity of the brine injection wells and factors that may affect this. <p>ERA Response 2020 RMCP:</p> <p>ERA has acknowledged for some time that there are scenarios in which water treatment may need to be extended, such as if significantly above average rainfall occurs in one of the later wet seasons within the rehabilitation period before catchment areas are sufficiently progressed through planned transitions to pond and ultimately release water designations. ERA will maintain such water treatment infrastructure as is necessary to complete water treatment and the disposal of waste streams. It should be noted that whilst the cumulative volume of water to be treated will depend on many factors, predominantly rainfall, the inventory of contained salt is much less variable and thus there is a high degree of confidence in the capacity of the Pit 3 underfill void space for brine disposal.</p> <p>In regard to the underdrain bore, the bore casing and annulus was surveyed 3 times by full-wave sonic cement bond logging to identify potential failures in the cement bond in the annular cavity. The casing was perforated at a specific point and pressure-injected ~2,200litres of grout to seal the annulus. This was again wireline surveyed to confirm the cement bond. A low-mobility grout was placed below the intersecting lateral to seal that zone. This work is completed to minimise the potential for groundwater infiltrating the borehole and will be validated during commissioning and performance testing.</p> <p>As a further contingency plan, a new design has been sourced for a vertical decant well.</p> <p>In regard to the brine injection wells, early operation was significantly impacted by the on/off nature of the brine concentrator operation due to a range of factors. This intermittent operation contributed to blockages within the brine injection wells through scaling / and crystallisation of salts out of the highly concentrated brine. This was known at the time of the Closure Feasibility Study and as such provision was made for the construction of additional brine injection wells. Engineering and design activities for these additional wells is occurring through 2020. Since 2017 the performance of the brine concentrator has improved significantly such that unplanned outages have been effectively eliminated. The risk to the integrity of brine injection wells is consequently also significantly reduced. Ultimately the longevity of individual wells, whilst impacting costs, is not a risk to closure schedule or environmental outcomes, as additional wells can be constructed as required.</p> <p>In addition to the option for additional wells as required, ERA is investigating the use of higher injection pressures and different maintenance options and contingency options for two brine injection failure scenarios. This is summarised in Section 9.3.2.4. However, as these investigations are continuing, detail cannot be provided in the 2020 MCP.</p> <p>SSB 2020 RMCP Assessment:</p> <p>This comment is mostly addressed in the 2020 RMCP and remaining concerns in relation to brine injection are covered in other comments.</p>
Water & Sediment	Closure implementation	Water management	<p>SSB 2018 RMCP Assessment:</p> <p>It is critical that ERA fulfils its commitment to continue water treatment for as long as necessary to treat and dispose of all process water (including expressed tailings pore water) onsite. This commitment is fully supported by the Supervising Scientist, along with the intention to increase the capacity of process water treatment over time, which will be necessary to achieve treatment of all process water by 2025. This commitment should be included as a contingency in section 10.9.1.</p> <p>ERA Response 2019 RMCP:</p> <p>ERA is committed to continuing to treat water until such time as inventories are eliminated. The current plan facilitates this outcome within the legislated timeframe for average rainfall scenarios.</p> <p>However, ERA continues to investigate opportunities to increase process water treatment capacity, whilst monitoring progress of existing facilities and inventories as influenced by external factors (e.g. rainfall). Decisions to implement such initiatives will be dependent on ongoing assessment of business case, risk and contingency and BPT analysis as may be appropriate for identified technologies.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The commitment by ERA to treat water as long as necessary has been made and is specified in the 2020 RMCP as a contingency in Section 9.4.3.6.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – closed out
Water & Sediment	Closure implementation	Water management	<p>SSB 2019 RMCP Assessment:</p> <p>During progressive rehabilitation and construction of the final landform, there may be an increase in suspended sediment concentration in surface runoff from the site, which may increase the risk of sediment-related impacts to the offsite environment.</p> <p>Recommendation: Surface water modelling being conducted to predict the concentrations of suspended sediment in the creeks surrounding the Ranger Project Area should consider the deposition of sediment throughout surrounding catchments, particularly to assess the risk of infilling of nearby billabongs.</p> <p>ERA Response 2020 RMCP:</p> <p>During rehabilitation works and the construction of the final landform sediment will be actively managed according to the Ranger Water Management Plan.</p> <p>Post closure sediment and erosion control structures will be installed to actively manage sediment runoff. This negates the requirement of sedimentation modelling. Details of the design of these structures have been provided in Section 7.4.5.</p> <p>The surface water model predicts suspended sediment concentrations but not accumulation. CAESAR modelling done by SSB predicts sediment movement from the mine but not accumulation.</p> <p>ARRTC and stakeholder working groups discussed issues with modelling sediment accumulation and the associated risks and agreed (i) modelling of sediment accumulation is not required, (ii) turbidity criteria address the risk associated with suspended sediment, and (iii) the risk from bedload sediment will be managed by erosion control and monitoring plans.</p> <p>The surface water model (OPSIM) will provide suspended sediment concentrations at defined nodes (receptors).</p> <p>Sediment accumulation will not be modelled, on the basis that the majority of sediment generated from runoff is in the early phase of closure, where erosion and sediment controls will ensure sediment is largely managed and retained on the premises. The results of Landform Evolution Modelling completed by SSB suggest denudation rates off the final landform will be equivalent to or below background and as such accumulation of sediments will be consistent with natural/background conditions.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Accepted - close out</p>
Water & Sediment	Closure implementation	Disposal of contaminated materials	<p>SSB 2019 RMCP Assessment:</p> <p>The current works schedule states that the Tailings Storage Facility will be required for process water storage until late 2024, and that backfill of Pit 3 will be completed by 2025. This does not allow for the possible disposal of contaminated material from the Tailings Storage Facility in the lower levels of Pit 3, given that the pit backfill would be close to completion.</p> <p>Recommendation: Backfill of Pit 3 should not commence until it has been demonstrated that the placement of material from the TSF into Pit 3 is not required.</p> <p>ERA Response 2020 RMCP:</p> <p>A TSF contaminated material trade-off study has been completed, demonstrating better outcomes to leaving material in situ rather than placement in Pit 3. Refer to the TSF subfloor contaminated material management application (approved by stakeholder on 6 August 2020). A summary of this application has been provided in Section 9.3.3.3.3.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Accepted - close out</p>
Water & Sediment	Closure implementation	Disposal of contaminated materials	<p>SSB 2019 RMCP Assessment:</p> <p>Insufficient information is provided on the disposal of contaminated soils, site infrastructure and other materials to enable assessment of the planned waste disposal.</p> <p>Recommendation: Provide further information on the disposal of contaminated soils, site infrastructure and other materials, including the effect that in-pit disposal may have on tailings consolidation, and an assessment of the potential environmental risks and information on how they will be mitigated.</p> <p>ERA Response 2020 RMCP:</p> <p>Detailed contaminated sites field investigations were completed in late 2019 and results are being analysed. A summary of work completed to June 2020 has been provided in the 2020 MCP, Section 5. As this work continues it will be provided in subsequent MCPs. Also see Section 9.4.2.</p> <p>SSB 2020 RMCP Assessment:</p> <p>This comment is being closed out because the soil contamination aspect is covered in other comments and the implications of disposal of contaminated infrastructure/materials in Pit 3 has been re-articulated as a new comment on the 2020 RMCP (Table 3)</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – closed out
Radiation	Knowledge base	Radon exhalation	<p>SSB 2018 RMCP Assessment:</p> <p>The lack of a seasonal trend in radon exhalation rates on the waste rock-only section of the trial landform should be investigated in the context of the ability of the waste rock substrate to retain water</p> <p>ERA Response 2019 RMCP:</p> <p>Bollhöfer, A., Doering, C., 2016. Long-term temporal variability of the radon-222 exhalation flux from a landform covered by low uranium grade waste rock. J. Environ. Radioact. 151, 593–600.</p> <p>has discussed the effect of the soil moisture on the radon emission.</p> <p>SSB 2019 RMCP Assessment:</p> <p>The cited reference reports on seasonal trends in radon exhalation flux from waste rock. However, ERA has not integrated this information (in particular that seasonal variations in radon exhalation from waste rock begin to occur 2+ years after landform construction) into Section 7.3.3 of the MCP.</p> <p>ERA Response 2020 RMCP:</p> <p>Volumetric soil moisture content in the Trial Landform substrate is described in Appendix 5.1 (which includes the seasonal variation) is the same data in the published paper by Bollhöfer, A., Doering, C., 2016</p> <p>ERA has not used direct measurement data for soil moisture and not the relationship of seasonal trends in Rn-222 exhalation flux and soil moisture to date.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Accepted – close out, noting that ERA confirmed during the assessment of the 2020 RMCP that their response above should have read: “ERA has used direct measurement data for soil moisture...”</p>
Radiation	Monitoring and maintenance	Radionuclide monitoring of aquatic bushfoods	<p>SSB 2019 RMCP Assessment</p> <p>Po-210, in addition to Ra-226, is an important dose-forming radionuclide in aquatic bushfoods.</p> <p>Recommendation: Consider including Po-210 in the post-closure monitoring of radionuclides in water for the purpose of estimating ingestion doses from aquatic bushfoods.</p> <p>ERA Response 2020 RMCP:</p> <p>Noted. Po-210 is now included in the radiation closure and post-closure monitoring program provided in Section 10.</p> <p>SSB 2020 Assessment</p> <p>Suite of radionuclides updated as suggested (Table 10-9).</p>
Radiation	Monitoring and maintenance	Radionuclide monitoring of aquatic bushfoods	<p>SSB 2019 RMCP Assessment</p> <p>The gamma spectrometry method specified is unlikely to have the requisite sensitivity for measuring radionuclides in water.</p> <p>Recommendation: Consider alpha spectrometry as the analysis method for Ra-226 and Po-210 in water and ICP-MS as the analysis method for U in water.</p> <p>ERA Response 2020 RMCP:</p> <p>Noted. The monitoring program has been updated to remove the specific method for analysis of radionuclides in water. This can be determined closer to the 2026 and the best available method at the time used.</p> <p>SSB 2020 Assessment</p> <p>The analysis method can be specified later. What’s important now is to specify the suite of radionuclides, which has been done.</p>
Ecosystem Restoration	Knowledge base	Revegetation sustainability	<p>SSB 2018 RMCP Assessment:</p> <p>Additional information is required to give confidence in the ability of the final landform to support vegetation in the long term, particularly concerning plant available water, soil formation and the establishment of understory species.</p> <p>ERA Response 2020 RMCP:</p> <p>See specific comments</p> <p>SSB 2020 RMCP Assessment:</p> <p>This is being closed out, as specific comments are provided elsewhere for remaining concerns on this topic.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – closed out
Ecosystem Restoration	Knowledge base	Revegetation sustainability	<p>SSB 2018 RMCP Assessment:</p> <p>Provide uncertainty analysis for all modelling undertaken in relation to demonstrating that there will be sufficient plant available water in the final landform.</p> <p>ERA Response 2019 RMCP:</p> <p>Information on PSD and PAW modelling, plant rooting depth, subsurface consolidated layer, and more has been added to the 2019 MCP.</p> <p>Consistent with information previously provided as part of 2019 App. 3 to Pit 1 Application. Supporting information available within the reference</p> <p>Lu P, Meek I, Skinner R. 2019. Supporting Information on Revegetation Growth Substrates at Ranger for Pit 1 Application. Energy Resources of Australia Ltd report, Feb. 2019</p> <p>SSB 2019 RMCP Assessment:</p> <p>No additional uncertainty analysis has been provided in the 2019 RMCP.</p> <p>ERA Response 2020 RMCP:</p> <p>The key uncertainty in the PAW risk assessment associates with the following factors:</p> <ul style="list-style-type: none"> • Fines % of the growth medium (ie. Potential water holding capacity); • Growth media thickness (assuming it is also accessible by root system); • Type of vegetation supported by the growth media; and • Weather conditions. <p>To make it more explicit, the 2020 MCP PAW studies has been updated and revised, including a sub-section to describe the uncertainty analysis (Appendix 5.1).</p> <p>SSB 2020 RMCP Assessment:</p> <p>This comment is being closed out, noting that while a quantitative uncertainty analysis has not been undertaken, information presented in the RMCP is adequate to demonstrate that PAW is likely to be sufficient in the waste rock landform.</p>
Ecosystem Restoration	Knowledge base	Revegetation sustainability	<p>SSB 2018 RMCP Assessment:</p> <p>Provide further evidence to support the assumption that understorey is a minor component of evapotranspiration.</p> <p>ERA Response 2019 RMCP:</p> <p>During the dry season, understorey evapotranspiration is a minor component of the total system evapotranspiration. This is supported by the additional information within the 2019 MCP Supporting Studies Section. In particular, the figure relating to soil water dynamics at the analogue area which shows that during the dry season soil water is almost completely depleted in the top 1 m. This is where the understorey plants extract water from. Hutley et al 2000, showed that dry season understorey evapotranspiration is a minor component of the total evapotranspiration. Despite this, the CDU/ERA modelling included the simulated understorey evapotranspiration. REF: L. B. HUTLEY, A. P. O'GRADY and D. EAMUS 2000. Evapotranspiration from Eucalypt open-forest savanna of Northern Australia, Functional Ecology , 14, 183–194</p> <p>SSB 2019 RMCP Assessment:</p> <p>Further comments are provided in the 2019 RMCP in relation to the contribution of midstorey to evapotranspiration [see below].</p> <p>SSB 2020 RMCP Assessment:</p> <p>This comment is being closed out, noting that while the contribution of understorey to evapotranspiration has not been specifically assessed, information presented in the RMCP is adequate to demonstrate that PAW is likely to be sufficient in the waste rock landform.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – closed out
Ecosystem Restoration	Knowledge base	Revegetation sustainability	<p>SSB 2019 RMCP Assessment:</p> <p>The transpiration rate input to the WAVES modelling is based on a subset of key overstorey tree species but does not capture the midstorey species that may account for a moderate to high proportion of the total cover.</p> <p>Recommendation: Provide an estimation of the contribution of midstorey species (including evergreen species) to transpiration rates in the WAVES modelling.</p> <p>ERA Response 2020 RMCP:</p> <p>The transpiration in midstorey species was not omitted in the modelling, rather it was overestimated.</p> <p>Stand transpiration of the reference sites in the Georgetown area was estimated based on the measurement of the average sap flux density (SFD) multiplied by the stand's total sapwood area. The SFDs were measured in mostly overstorey (OS) species though some midstorey (MS) were also measured. Within scientific literature, it has been shown that overstorey SFD is usually higher than MS. Therefore, the average SFD calculated from OS trees will overestimate the true average SFD of the stand. As the stand sapwood area is the sum of each tree's sapwood area in the stand including every OS and MS trees, the estimated stand transpiration used for modelling is indeed conservative.</p> <p>SSB 2020 RMCP Assessment:</p> <p>This comment is being closed out, noting that while the contribution of midstorey to evapotranspiration has not been specifically assessed, information presented in the RMCP is adequate to demonstrate that PAW is likely to be sufficient in the waste rock landform.</p>
Ecosystem Restoration	Knowledge base	Revegetation sustainability	<p>SSB 2018 RMCP Assessment:</p> <p>Provide evidence to demonstrate that compaction layers:</p> <ul style="list-style-type: none"> • will improve the water-holding capacity of the waste rock • will not lead to other issues affecting plant growth (e.g. physical restriction of roots, formation of perched water tables) <p>ERA Response 2019 RMCP:</p> <p>The results of the completed KKN are summarised within Section 7.3.5 of the updated MCP. Demonstrated that 4-6 m of waste rock landform with various levels of rock contents can maintain a positive PAW water balance while supporting a vegetation similar to one of the reference sites.</p> <p>SSB 2019 RMCP Assessment:</p> <p>Any reference to compaction layers appears to have been removed from the 2019 RMCP, with no explanation provided for this.</p> <p>ERA Response 2020 RMCP:</p> <p>ERA has clarified that there is no purposely compacted layer proposed and, following subsequent stakeholder discussions, it was agreed that the term 'compaction' would be avoided in order misinterpretation. The term 'consolidated layer' replaces 'compaction'.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Accepted – close out.</p>
Ecosystem Restoration	Knowledge base	Revegetation sustainability	<p>SSB 2018 RMCP Assessment:</p> <p>Provide further information on the internal properties of the final landform (e.g. nature, depth and extent of compacted layers), in conjunction with a conceptual model and water balance (under a range of rainfall scenarios) to demonstrate that there will be sufficient water available for revegetation.</p> <p>ERA Response 2019 RMCP:</p> <p>The results of the completed KKN are summarised within Section 7.3.5 of the updated MCP. Demonstrated that 4-6 m of waste rock landform with various levels of rock contents can maintain a positive PAW water balance while supporting a vegetation similar to one of the reference sites.</p> <p>SSB 2019 RMCP Assessment:</p> <p>While the reference to compaction layers appears to have been removed from the 2019 RMCP and a water balance has been conducted, further information on the internal properties of the final landform is still required.</p> <p>SSB 2020 RMCP Assessment:</p> <p>The Supervising Scientist no longer considers this to be an issue, so this comment is being closed out.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – closed out
Ecosystem Restoration	Knowledge base	Revegetation strategy	<p>SSB 2018 RMCP Assessment:</p> <p>The Revegetation Strategy presented should be expanded to an ecosystem restoration strategy, based upon a suitable ecosystem trajectory model which addresses the interdependencies between flora and fauna.</p> <p>ERA Response 2020 RMCP:</p> <p>Additional studies in regard to fauna recolonisation on rehabilitation sites at Ranger Mine are continuing, as is the KKN studies in regard to development of a rehabilitation trajectory. The ecosystem rehabilitation strategy will be finalised when this additional information is available.</p> <p>SSB 2020 RMCP Assessment:</p> <p>This comment is being closed out, as it is duplicated in another comment provided by the Supervising Scientist on the 2018 RMCP.</p>
Ecosystem Restoration	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Clearly justify why some closure criteria would be more important than others, in relation to the Environmental Requirements.</p> <p>ERA Response 2019 RMCP:</p> <p>Some criteria, such as canopy architecture and ground cover index, are not independent of each other and should be considered collectively, or within the context of meeting the overall closure objective as a whole. This approach was recommended by DPIR as part of their initial assessment of the Ranger Mine closure criteria and ERA agrees with this recommendation.</p> <p>SSB 2019 RMCP Assessment:</p> <p>SSB will seek clarification from ERA on this response.</p> <p>ERA Response 2020 RMCP:</p> <p>It is acknowledged that the wording provided in the 2018 MCP was not clear. During 2020 the descriptive closure criteria for flora and fauna have been finalised. The closure criteria sections have been updated and this wording was removed. See Section 8.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Accepted – close out.</p>
Ecosystem Restoration	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Ensure that the closure criteria for ecosystem restoration use consistent and clearly defined terminology.</p> <p>ERA Response 2019 RMCP:</p> <p>Updating the content within the Closure Criteria and Supporting Studies sections has addressed these inconsistencies.</p> <p>SSB 2019 RMCP Assessment:</p> <p>SSB will seek clarification from ERA on this response.</p> <p>ERA Response 2020 RMCP:</p> <p>It is acknowledged that the wording provided in the 2018 MCP was not clear. During 2020 the descriptive closure criteria for flora and fauna have been finalised. The closure criteria sections have been updated and this wording was removed. See Section 8.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Accepted – close out.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – closed out
Ecosystem Restoration	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Provide information to justify the $\geq 15\text{--}30\%$ similarity as the closure criterion for species composition and relative abundance.</p> <p>ERA Response 2019 RMCP:</p> <p>ERA and SSB continue to work on reference site selection, data analysis and assessment metrics. Meanwhile, some criteria (including ground cover) are awaiting further consideration. Information to justify the similarity percentage range for species composition and relative abundance will be provided in updated MCPs following outcomes of ongoing studies.</p> <p>SSB 2020 RMCP Assessment:</p> <p>This comment is being closed out, as reference to the assessment metric has been removed and qualitative revegetation closure criteria have been agreed between stakeholders. Once ERA proposes quantitative metrics for the relevant closure criteria these will be reviewed and assessed by the Supervising Scientist.</p>
Ecosystem Restoration	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Provide information to justify the proposed total species number closure criterion of ≥ 35.</p> <p>ERA Response 2019 RMCP:</p> <p>This information is pending finalisation of reference sites. This criterion will be updated when this information becomes available.</p> <p>SSB 2020 RMCP Assessment:</p> <p>This comment is being closed out, as reference to the species number metric has been removed and qualitative revegetation closure criteria have been agreed between stakeholders. Once ERA proposes quantitative metrics for the relevant closure criteria these will be reviewed and assessed by the Supervising Scientist.</p>
Ecosystem Restoration	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>The canopy architecture criterion (F3) should not be expressed as presence/absence, rather should be presented as ranges and broken down into an appropriate classification of strata.</p> <p>ERA Response 2019 RMCP:</p> <p>The points made in the comment are noted. The finalisation of completion criteria will occur after further studies relating to KKNs are completed. ERA and SSB continue to liaise and discuss reference site selection, data analysis and assessment metrics.</p> <p>SSB 2020 RMCP Assessment:</p> <p>This comment is being closed out, as qualitative revegetation closure criteria have been agreed between stakeholders. Once ERA proposes quantitative metrics for the relevant closure criteria these will be reviewed and assessed by the Supervising Scientist.</p>
Ecosystem Restoration	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Clarify what is meant by <i>canopy/groundcover index</i> in relation to criterion F4 and do not include rocks in the assessment of understorey cover.</p> <p>ERA Response 2019 RMCP:</p> <p>ERA and SSB continue to work on reference site selection, data analysis and assessment metrics. Meanwhile, some criteria (including ground cover) are awaiting further consideration.</p> <p>SSB 2020 RMCP Assessment:</p> <p>This comment is being closed out, as qualitative revegetation closure criteria have been agreed between stakeholders. Once ERA proposes quantitative metrics for the relevant closure criteria these will be reviewed and assessed by the Supervising Scientist.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – closed out
Ecosystem Restoration	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Provide information to justify the proposed plant reproduction closure criterion of evidence of flowering and fruiting in 80% of species, including consideration of the amount and periodicity of flower, fruit and seed resources provided in the revegetated site.</p> <p>ERA Response 2019 RMCP:</p> <p>Information to justify this criteria is pending further studies and finalisation of the reference sites. This will be updated when suitable information is available. At present, woody species are being assessed and of these, evidence has demonstrated that only a single species has not reproduced on site trials.</p> <p>SSB 2019 RMCP Assessment:</p> <p>Criteria will need to take into account that there is a key difference between flowering/fruitleting and successful reproduction (i.e. new individuals established and surviving).</p> <p>SSB 2020 RMCP Assessment:</p> <p>This comment is being closed out, as qualitative revegetation closure criteria have been agreed between stakeholders. Once ERA proposes quantitative metrics for the relevant closure criteria these will be reviewed and assessed by the Supervising Scientist.</p>
Ecosystem Restoration	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Criterion F7 should capture seedling germination/sucker emergence, survivorship and growth, and the term <i>framework species</i> should be clearly defined.</p> <p>ERA Response 2019 RMCP:</p> <p>A review of this criterion is pending further research and finalisation of reference sites. Monitoring against closure criteria is an ongoing process, and effective recruitment over time will be assessed, through repeated surveys for flowering/fruitleting, and presence and development of recruits.</p> <p>SSB 2020 RMCP Assessment:</p> <p>This comment is being closed out, as qualitative revegetation closure criteria have been agreed between stakeholders. Once ERA proposes quantitative metrics for the relevant closure criteria these will be reviewed and assessed by the Supervising Scientist. Note that the need to define the term <i>framework species</i> is still required and has been incorporated into a new comment on the 2020 RMCP (Table 3), as it used throughout the closure criteria.</p>
Ecosystem Restoration	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Criterion F13 should be reworded to: feral animal densities 'not greater than' those in surrounding areas, as opposed to <i>similar</i> to those in surrounding areas.</p> <p>ERA Response 2019 RMCP:</p> <p>This criterion has been reworded in terms of weeds and feral animals to "not greater than" the surrounding areas. Note - Previous wording was used to align with the KKN. Work on fauna return strategies (including criteria / monitoring approaches) is ongoing and updates may be expected in 2020 MCP.</p> <p>SSB 2019 RMCP Assessment:</p> <p>Criterion F13 in Table 8-5 of the RMCP has not been reworded as per the ERA response.</p> <p>SSB 2020 RMCP Assessment:</p> <p>Accepted – close out. The relevant closure criterion has been updated to address the above comment.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	SSB Recommendations and ERA responses from previous RMCP assessments – closed out
Ecosystem Restoration	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>Criteria for nutrient cycling (F8) should be expanded to include a more detailed assessment of nutrient cycling, including:</p> <ul style="list-style-type: none"> • quantification of nutrients present • relative abundance for soil biota • appropriate spatial scales. <p>ERA Response 2019 RMCP:</p> <p>This criterion will be further developed when the relevant studies (for the associated KKNs) are complete. This information will be included in the updates of the 2020 MCP.</p> <p>SSB 2020 RMCP Assessment:</p> <p>This comment is being closed out, as qualitative revegetation closure criteria have been agreed between stakeholders and relevant studies addressing the closure criteria are incomplete. Once ERA proposes quantitative metrics for the relevant closure criteria these will be reviewed and assessed by the Supervising Scientist.</p>
Ecosystem Restoration	Post mining land use, closure objectives and closure criteria	Closure criteria	<p>SSB 2018 RMCP Assessment:</p> <p>The criterion proposed for fire resilience should clearly detail how resilience would be assessed and what an acceptable value for resilience is. Consideration should also be given to how the restored vegetation community responds to fire regimes that are characteristic of the surrounding area, rather than how it may respond to a single fire.</p> <p>ERA Response 2019 RMCP:</p> <p>The criteria proposed for fire resilience has been improved to detail how resilience would be assessed and to establish an acceptable measure of this. Trials are being carried out to assess behaviour and responses of vegetation to fire regimes. There are specific KKNs to address this.</p> <p>SSB 2020 RMCP Assessment:</p> <p>This comment is being closed out, as qualitative revegetation closure criteria have been agreed between stakeholders. Once ERA proposes quantitative metrics for the relevant closure criteria these will be reviewed and assessed by the Supervising Scientist.</p>

Table 3. 2020 RMCP SSB recommendations

Relevant Closure Theme	RMCP Chapter Heading	Topic	2020 RMCP reference	SSB Recommendations on 2020 RMCP
All	Introduction, purpose and scope	Approvals	1.4 Table 1-2	<p><i>Final Landform: Some information will have already been included within the MCP. Thus this application is to include any updates or additional information since July 2021 (MCP 2021).</i></p> <p>This could result in a disconnect on approval of final landform with some elements approved through the RMCP and some approved through the final landform 'update' in May 2022.</p> <p>Recommendation: All information included in the RMCP that is relevant to a given stand-alone application should be included in that application.</p>
All	Knowledge base	Feasibility Study	Executive Summary	<p><i>This Feasibility Study, which developed the technical, costing and scheduling aspects of Ranger Mine closure to a very high level of detail, was subject to scrutiny during multiple internal and external reviews.</i></p> <p>This could be interpreted as inferring that Ranger Minesite Technical Committee (MTC) stakeholders (including the Supervising Scientist) have reviewed the feasibility study, which is not the case.</p> <p>Recommendation: Clarify that the Feasibility Study was not reviewed or endorsed by the MTC, except through the elements provided in the RMCP.</p>
All	Risk assessment	Risks assessed	7.4	<p>Several Class 3 risks identified in the 2019 RMCP appear to have been removed entirely from the 2020 RMCP, including:</p> <ul style="list-style-type: none"> • <i>Actual consolidation of tailings (Pit 1 and Pit 3) does not match consolidation modelling and associated closure schedule leading to longer than planned process water treatment</i> • <i>No disposal option for high density sludge post tailings deposition (end of 2020)</i> • <i>Exposed land surface contributes to increased weed recruitment, decreasing revegetation success and spread into Kakadu NP</i> <p>Further, the following Class 3 risk identified in the 2019 RMCP has been downgraded to a Class 2 risk in the 2020 RMCP, without any justification provided:</p> <ul style="list-style-type: none"> • <i>Cannot achieve the desired tailings surface for post-deposition activities in Pit 3</i> <p>Recommendation: Provide clear justification for changes in levels of risk and/or risks that have been removed as a result of risk reviews.</p>
All	Risk assessment	Risk evaluation	7.3.6	<p>The probability range for different likelihood classifications has changed from the 2019 RMCP.</p> <p>Recommendation: Provide an explanation on the changes to the probabilities for likelihood classifications.</p>
All	Risk assessment	Risk controls/mitigation	7.4	<p>The effectiveness of a large proportion of the identified controls are 'Unrated', which means that it is not possible to assess the potential effectiveness of these controls.</p> <p>Recommendation: Provide details of, and as previously raised in reviews of both the 2018 and 2019 RMCP, justification for effectiveness for all controls identified to address risks.</p>
All	Closure implementation	Contingences	9.2	<p><i>The Ranger Mine closure plan factors in a number of contingency options for implementation in the event that the preferred option cannot be implemented or fails to achieve the desired outcome. The majority of these options are discussed in Section 6 as part of the best practical technology assessment with some specific contingencies further outlined in this section.</i></p> <p>The above statement implies that the BPT assessments in Section 6 describe contingencies. It is assumed this is referring to the options not taken up in the BPT assessments for approved activities. However, some of these 'contingencies' scored so poorly against the preferred options that they could potentially pose an increased/unacceptable environmental risk. Section 6 also describes BPTs for activities that have commenced or are completed but does not describe the BPTs to be undertaken for future applications, so it is unclear how Section 6 is useful for contingency consideration for any of the future activities specified in Section 9.</p> <p>Recommendation: Where contingencies for existing or ongoing approved activities are derived from a BPT described in Section 6, the options that are considered as contingencies should be clearly identified and the risks associated with using any contingencies based on BPT assessment should be discussed.</p>
All	Closure implementation	Contingences	9.3.3.4	<p><i>TSF deconstruction methods are currently being finalised by ERA in preparation for the TSF deconstruction application. This involves a best practical technology assessment of the options. The options not selected for progression, that have not been show stopped for environmental or cultural reasons, will then form the basis of ERA's contingency plan.</i></p> <p>This statement suggests that options which are show stopped for other reasons will be used in the contingency plan. It is not clear how ERA will give confidence that ALARA will be achieved via identified contingencies.</p> <p>Alternatively, it may be that ERA foresees that there are only show stopped options remaining in the BPT which can then be used as a contingency. If options selected in the BPT are all show stopped except the one selected, then the options should be reselected/new options should be realised.</p> <p>Recommendation: Clarify how ALARA will be achieved if options for the contingency planning are those that have been ruled out for implementation during closure (which do not meet BPT assessment criteria as they are show stopped).</p>
All	Closure implementation	Contingences	9.3.1.4	<p><i>There is an ongoing monitoring program (Section 10) that will consider the consolidation, erosion rates and revegetation success. Remedial action will be determined and implemented, where required, with appropriate consultation with the Minesite Technical Committee (MTC) stakeholders.</i></p> <p>Recommendation: Include contingencies for greater settlement than expected for Pit 1 e.g. add additional material to ensure the landform achieves modelled landform expectations, excessive erosion may be remediated with waste rock etc.</p>
All	Closure implementation	Contingences	9.3.5.4	<p><i>If the demolition of specific infrastructure planned to be deposited into Pit 3 is delayed, then RP2 has the capacity to take extra material than currently planned.</i></p> <p>It is unclear what level of capacity RP2 has and therefore how much of the demolished material it may contain to ensure all plant is buried at least 6m below the final landform surface. It is therefore difficult to assess the effectiveness of this proposed contingency.</p> <p>Recommendation: Provide further information on the RP2 burial contingency, including the capacity available vs current planned vs how much contingency this allows.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	2020 RMCP reference	SSB Recommendations on 2020 RMCP
All	Closure implementation	Contingencies	9.3.6.4	<p>The bulk material movement (BMM) plan provides for excavation of areas above the final landform (in the stockpiles and TSF) when there is nearly 100 percent acceptable material for the final landform.</p> <p>It is not clear what is meant by 'nearly 100 percent acceptable', or what contingencies are available should the material mass balance be incorrect and there is a material deficit for the final landform (e.g. through errors in density assumption of placed material).</p> <p>Recommendation: Provide further information on contingencies to be implemented if the material mass balance is incorrect and results in a material deficit for the final landform.</p>
All	Closure implementation	Contingencies	9.4.3.6	<p>Information is provided on process water contingencies but no contingencies are provided for pond water treatment, in the potential event that not all catchments have not been converted to release water and remain pond water.</p> <p>Recommendation: Determine whether contingencies are required for pond water treatment.</p>
All	Closure implementation	Contingencies	9.4.6.8	<p>These, and other methods, are being investigated by ERA and KNPS as part of the continued refinement of the revegetation program.</p> <p>Recommendation: Provide details of other contingency methods that are being considered for seed collection.</p>
All	Management of information and data	Data retention	12	<p>To support closure activities and provide confidence in the strategy, ERA has identified three key components for closure knowledge to be retained:</p> <ul style="list-style-type: none"> • validation of site conceptual/numerical models • landform design and construction, and • progressive rehabilitation. <p>Recommendation: Post-closure data retention and handover requirements need to be determined in close consultation with government.</p>
Landform	Knowledge base	Relevant studies	5.5.1	<p>The table at the start of this section suggests that it includes summaries of the completed studies in relation to the KKNs LAN2 and LAN3 (i.e. Pit 1 studies) but it does not appear to include this information.</p> <p>Recommendation: Provide summaries of relevant studies completed to date to address KKNs LAN2 and LAN3.</p>
Landform	Closure implementation	Drainage pathways	9.4.5.3	<p>Channels previously reporting to Djalkmarra Creek (flowing over Pit 3) in pre-mining conditions have been diverted to Corridor Creek (flows south of Pit 1) for the final landform. This reduces erosion possibilities over Pit 3.</p> <p>This appears to be inconsistent with Figure 9-88 (footprint of final landform requiring ripping), which still shows Djalkmara Creek re-establishing across Pit 3.</p> <p>Recommendation: Ensure there is consistency in planned/predicted drainage pathways from Pit 3.</p>
Landform	Monitoring and maintenance	Monitoring	10.3	<p>Recommendation: Note that the Supervising Scientist is currently revising the Rehabilitation Standard for Landform Stability, which will provide updated advice on the optimal method of monitoring and assessing against the closure criterion for suspended sediment (L6). This should be incorporated into the 2021 RMCP.</p>
Water & Sediment	Knowledge base	Baseline surface water quality	5.2.8	<p>The concentrations of Cu are high in Table 5-8 and the Supervising Scientist has derived a median background concentration of 0.2 µg/L, which was used as our previous Rehabilitation Standard. The median of 1 µg/L from Klessa (2000) is the same as the national DGV concentration and is double SSB's new effects-based, site-specific GV. The discrepancy between SSB's and the Klessa (2000) background concentration is most likely due to the dataset being acquired from an early upstream site affected by Georgetown Billabong outflows (as noted by ERA); inappropriate use of mine-affected "reference" data may affect other concentrations quoted in Table 5-8.</p> <p>Recommendation: Considering the data may be affected by Georgetown Billabong outflows, include a more accurate analysis of background surface water concentrations.</p>
Water & Sediment	Knowledge base	Water modelling	Figure 5-55	<p>The conceptualisation of the linkages between various models and reports is out of date.</p> <p>Recommendation: Update the RMCP each year to reflect most recent information/data.</p>
Water & Sediment	Knowledge base	Contaminant sources	5.5.2.15	<p>The sources of nutrients at Ranger to the water management system are from; waste rock, ammonia and phosphate (in lime) added to the mill process circuit, residual nitrates from blast residue in waste rock, and fertiliser application.</p> <p>The sources listed in the eutrophication risk study are not consistent with those used in the groundwater modelling.</p> <p>Recommendation: Ensure consistency between studies and models for contaminant sources.</p>
Water & Sediment	Knowledge base	Aquatic ecosystem protection	5.5.2.16	<p>Less conservative water quality objectives are required to support the RPA goal of impacts that are ALARA.</p> <p>This statement negates the possibility of the highest level of protection potentially being achievable.</p> <p>Recommendation: Revise language to reflect that ALARA should aim to meet the highest level of protection as a first principle.</p>
Water & Sediment	Post mining land use, closure objectives and closure criteria	Closure criteria	8.3.2.3	<p>Less likely, though still possible, is the potential that predicted concentrations exceed the draft W/SQO in small areas close to the RPA lease under certain (low) flow conditions</p> <p>(Justification for outcome, parameter and criteria, Step 7)</p> <p>It is not clear what is meant by "small offsite areas".</p> <p>Recommendation: Until all relevant modelling is completed SSB considers all surface water quality predictions as "interim". The final predictions should be provided in the Pit 3 application and the 2021 RMCP.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	2020 RMCP reference	SSB Recommendations on 2020 RMCP
Water & Sediment	Post mining land use, closure objectives and closure criteria	Closure criteria	8.3.2.3	<p>Assessing the need to revise the guideline values or add additional indicators and lines of evidence will be done by the stakeholder working group. The approach would depend on the nature (extent, duration, intensity, location etc.) of any predicted exceedance.</p> <p>SSBs rehabilitation standards will not be revised for the off-site environment based on predicted exceedances. It is up to ERA to mitigate in the event of predicted exceedances.</p> <p>Recommendation: Statements suggesting that guideline values off the RPA will be revised based on predicted exceedances should be removed. Predicted exceedances offsite should be managed through mitigation strategies.</p>
Water & Sediment	Post mining land use, closure objectives and closure criteria	Closure criteria	8.3.2.3	<p><i>Justification for outcome, parameter and criteria, Step 7: Consider additional indicators or refine the water/sediment quality objectives</i></p> <p>It is the Supervising Scientist's position the W/SQO for the offsite receiving waters should be considered 'final' and not in 'draft'</p> <p>Recommendation: Remove references to draft guideline values.</p>
Water & Sediment	Post mining land use, closure objectives and closure criteria	Closure criteria	8.3.2.3	<p><i>The draft W/SQO is for high-level ecosystem protection. On the RPA the goal is for impacts that are ALARA so the need to revise the GV for application to the RPA is not unexpected. Step six will indicate which COPC GVs need to be revised</i></p> <p>Application of ALARA should take into account the position and wishes of Traditional Owners.</p> <p>Step 8 describes the ALARA and BPT assessment process for onsite water bodies. This assessment does not take the wishes of Traditional Owners into account.</p> <p>Recommendation: Ensure that the wishes of Traditional Owners are considered when undertaking BPT assessment for onsite waterbodies.</p>
Water & Sediment	Post mining land use, closure objectives and closure criteria	Closure criteria	8.3.2.3	<p><i>Water quality off the RPA meets the national drinking water health guidelines (at times when they would be met in non-mine effected local creeks)</i></p> <p>It is not clear whether the statement "(at times when they would be met in non-mine effected local creeks)" means that water quality will be directly assessed against water quality in non-mine affected creeks, or if are there specific times when water quality in non-mine affected creeks is expected not to meet drinking water standards.</p> <p>Recommendation: Clarify what is meant in the statement "(at times when they would be met in non-mine effected local creeks)".</p>
Water & Sediment	Closure implementation	Disposal of contaminated materials	9.4.1	<p>Insufficient information is provided on the potential risks associated with disposal of contaminated site infrastructure and other materials in Pit 3.</p> <p>Recommendation: Assess the potential risks associated with disposal of contaminated site infrastructure and other materials in Pit 3, including the effect(s) this may have:</p> <ul style="list-style-type: none"> • as potential future contaminant sources • on tailings consolidation
Water & Sediment	Closure implementation	Process water treatment	2.2.9.4	<p><i>The Brine Squeezer has been approved to treat both pond and process water.</i></p> <p>Regulatory approval has been given to conduct process water treatment trials but release of the resulting permeate will require a further approval, demonstrating that the permeate is of suitable quality for release.</p> <p>Recommendation: Ensure that the process water treatment status (as a trial) is accurately described and more generally, that all activities described in the RMCP accurately reflect their regulatory approval status.</p>
Water & Sediment	Closure implementation	Process water inventory	2.2.9.9	<p><i>The understanding of the site's water systems, as captured in the model, is routinely tested by an annual validation and calibration process</i></p> <p><i>The most recent validation and calibration was completed in June 2019 by an external contractor, and no major changes that pertain to water management were found.</i></p> <p><i>Figure 2-12 shows the site water model process water inventory.</i></p> <p>There have been several significant changes in the site water model since the last validation in June 2019. For example, there has been an increase in the estimated tailings-entrained process water, resulting in less free process water than expected. It is concerning that an "annual validation" has not been undertaken since June 2019.</p> <p>Recommendation: Clarify/summarise any significant changes in site water systems and knowledge that have occurred since the previous RMCP.</p>
Water & Sediment	Monitoring and maintenance	Water Monitoring	10	<p>The surface water and groundwater closure monitoring programs outlined in the RMCP remain very high level, with little change from previous years. However, there is acknowledgement that these monitoring programs will need to be refined with stakeholder agreement in the coming years. The described frequency of the monitoring (especially for groundwater) does not yet align with the modelling outputs to target the key periods of risk.</p> <p>Recommendation: Update the water monitoring program in the RMCP to reflect modelling outputs and as agreement is reached through stakeholder consultation.</p>
Water & Sediment	Monitoring and maintenance	Groundwater Monitoring	10.4.2.1 Table 10-7	<p>The text and table for the general background groundwater COPCs is out of date and inconsistent with the background COPC study that has been recently completed.</p> <p>Recommendation: Update the RMCP for whole site groundwater monitoring once the current groundwater modelling is complete, and then periodically as required.</p>
Radiation	Knowledge base	Radiological impact assessment	5.5.3.1	<p>The summary information included in the MCP is not sufficiently detailed to assess whether the approach (including methods, data and assumptions) used in the radiological impact assessment is fit-for-purpose.</p> <p>Recommendation: Provide complete details of the methods, data and assumptions used in the radiological impact assessment.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	2020 RMCP reference	SSB Recommendations on 2020 RMCP
Radiation	Closure implementation	Uranium content in waste rock	9	<p>The following statement which appeared in the "Closure implementation" chapter of both the 2018 MCP (Chapter 10) and 2019 MCP (Chapter 11) and provided information on the average uranium content of the surface waste rock layer on the final landform has been removed from the 2020 MCP without any apparent justification:</p> <p><i>"The maximum uranium content of grade 1 material currently planned to form this surface layer is 200 parts per million U3O8 (170 parts per million uranium or 2 Becquerels per gram) with an average of 80 parts per million U3O8 (68 parts per million uranium or 0.8 Becquerels per gram)."</i></p> <p>Information on the uranium content of the surface waste rock layer on the final landform is needed for dose modelling of various radiation exposure pathways to the public (gamma, dust, radon and bush food) and wildlife (internal and external exposures).</p> <p>Recommendation: Provide an updated estimate of the average uranium content of the surface waste rock layer on the final landform and the data and analyses to support the estimate.</p>
Radiation	Monitoring and maintenance	Trigger Action Response Plan (TARP)	Table 10-13	<p>The trigger on all radiation exposure pathways is: <i>"Exceedance of the baseline radiation dose as defined in the closure criteria"</i> It appears that this should be an exceedance of the <u>dose constraint</u> as defined in the closure criteria.</p> <p>Recommendation: Provide clarification of the trigger for radiation pathways.</p>
Radiation	Monitoring and maintenance	Pit 1 targeted research tasks	Appendix 10.1, Table 7	<p><i>To verify that radon-222 exhalation flux densities</i></p> <p>The objective for the aspect radon-222 exhalation flux densities is unclear.</p> <p>It appears that this should be to verify the numerical values of radon-222 exhalation flux densities used in modelling of the radon exposure pathway for the final landform.</p> <p>Recommendation: Provide clarification of what is being verified.</p>
Radiation	Monitoring and maintenance	Pit 1 targeted research tasks	Appendix 10.1, Table 7	<p>The method for the aspect "Gamma dose rate, waste rock radium-226 activity concentration" does not include any sampling or analysis of waste rock for radium-226.</p> <p>Recommendation: Update the method to include waste rock sampling and analysis for radium-226.</p>
Ecosystem restoration	Knowledge base	Contingencies for limitations in PAW	Appendix 5.1	<p>A key driver of ERA's Ranger revegetation strategy is ensuring that plant assemblages can be sustained in waste rock in the face of drought, including a greater frequency of drier spells predicted in future climate projections. There is an emphasis on drought-proofing the revegetated site by introducing what are regarded as dry-tolerant species (so-termed "climate change contingency species"). Issues associated with this contingency include:</p> <ol style="list-style-type: none"> Plant available water is demonstrated to be adequate across the site, based on the information provided in the RMCP. For example: <ol style="list-style-type: none"> A worst-case scenario has been modelled (section 4.5.4.4 Model uncertainty analysis) of waste rock sitting on a crest (i.e. not receiving run-on) where roots are not able to either penetrate or access water below 4 m. By acknowledging that there is no such scenario for the final landform, PAW is demonstrated not to be limiting. Further, ERA have stated that a minimum of 15% fines is sufficient to sustain a native woodland ecosystem and there is high confidence that this minimum can be achieved across the landform. Wet season rainfall infiltration is high over waste rock (section 4.4.1) increasing the volume of water entering the substrate. There is no observable limitation to rooting depth in the waste rock landform (section 4.5.2) (This contrasts with limiting barriers (such as ferricretes) present in natural substrates to root penetration). Insufficient evidence has been presented to justify species suitability/unsuitability for the selection of overstorey species best suited to establishment on waste rock. Some examples of unsupported statements include: <ol style="list-style-type: none"> <i>"As indicated in previous findings on the LAA areas on site Eucalyptus miniata differs in its tolerance of soil moisture levels"</i> <i>"... site conditions on the RPA which may not support selected species (e.g. Eucalyptus miniata, due to lack of soil water holding capacity) and may support other species (e.g. Eucalyptus tectifica that are more drier site tolerant)."</i> <i>"Section 1a of the Trial Landform (TLF) was constructed of material with an average of 33% fines and has been able to successfully establish a native woodland ecosystem; although some specific species have struggled (e.g. Eucalyptus miniata and Acacia mimula) and adjustments in species mix may be required to ensure the functionality of the target ecosystem is achieved (e.g. using E. phoenicea, E. tintinnans and Acacia latescens)."</i> <p>The summary outcomes of TLF trials provided in section 3.5 make no mention of problems with <i>Eucalyptus miniata</i> and <i>Acacia mimula</i>. Neither SSB nor the Traditional Owners support the establishment of blended ecosystems.</p> Translocations of overstorey species from southern areas of Kakadu National Park may not be successful, or could result in unanticipated environmental impacts. For example: <ol style="list-style-type: none"> Potential to outcompete local species and become weedy – e.g. <i>Acacia holosericea</i> from the southern part of Kakadu was introduced to the Ranger site in the 1980s and, as acknowledged in the RMCP (Section 3.5.3.1), is now a local weed There is no evidence to demonstrate that species introduced from outside of the local provenance can be sustained (e.g. they may have a phenology adapted to 'original' climate such as cooler dry season nights than in areas to the north) <p>Recommendation: The Supervising Scientist will consult with ERA on these issues via the stakeholder Ecosystem Restoration Working Group, with a view to reaching a resolution prior to the next RMCP.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	2020 RMCP reference	SSB Recommendations on 2020 RMCP
Ecosystem restoration	Knowledge base	Evidence-based knowledge informing overstorey species suitability	Appendix 5.1	<p>There is scant information in the RMCP demonstrating evidence-based knowledge of overstorey species suitability for ecosystem establishment.</p> <p>1. Minesite vegetation trials</p> <p>ERA present survival and establishment data for species established on the TLF (section 3.5.1.1, Figure 3-9). Causes of mortality after 10 years are important in identifying species that can be sustained on waste rock but this information is not provided. Possible causes that are not explicitly listed include:</p> <ul style="list-style-type: none"> Initial establishment failure (evident in Figure 3-10) (e.g. lack of irrigation, planting in the wrong season, lack of mycorrhizal fungi to aid establishment). Natural mortality associated with short-lived species (e.g. Acacia) (referred to). Steady attrition over the 10 year period of the TLF (not possible to discern from the data provided) <p>Only the last dot point would suggest potential for non-sustainability of a species in waste rock but the data are not reported in a form that can identify such species. Further and noting the purported poor performance of <i>Eucalyptus miniata</i> (see earlier SSB comment above), the report notes (p.136) that in early trials at Ranger, <i>Eucalyptus miniata</i> tubestock had significantly improved establishment on waste rock when inoculated with mycorrhizal fungi to aid in the establishment of the framework species (Gordon <i>et al.</i> 1997; Reddell <i>et al.</i> 1999). Given the iconic status of <i>Eucalyptus miniata</i> in the landscape, this is key information ERA should be investigating to improve establishment success.</p> <p>2. Field evidence</p> <p>The report does not adequately review previous work that has examined possible environmental correlates of vegetation communities that could inform plant suitability:</p> <ol style="list-style-type: none"> Using data from 54 sites on the Georgetown (GT) analogue area, Humphrey <i>et al.</i> (2012) and Erskine <i>et al.</i> (2018) found just one relationship between species and edaphic conditions, i.e. <i>E. tetradonta</i> increased in abundance upslope Humphrey, Fox & Lu (2008) examined relationships between analogue vegetation communities and 39 soil properties associated with sites. They concluded from their analyses that vegetation community composition and structure were independent of the underlying soil properties that were measured and used in the analysis (i.e. lack of any relationship). On the basis of i. and ii. above, ERA should review the relevance of conclusions they draw from Brennan (1995) (p 14) who proposed that plant species should be selected on the basis of similar rock type to what is expected on the final landform. The RMCP (section 2.1.2.1) cites Cook (2020 in draft) who found that “evergreen trees” (presumably <i>miniata-tetradonta</i> community type) increased in basal area as soil depth increased ... most likely through the mechanism of water availability during the dry season. This simply supports comments against rooting depth provided by SSB above, noting that Cook’s maximum depth was 1.4 m in natural substrates and depth of waste rock over the landform will be much greater than this. <p>Recommendation: The Supervising Scientist will consult with ERA on these issues via the stakeholder Ecosystem Restoration Working Group, with a view to reaching a resolution prior to the next RMCP.</p>
Ecosystem restoration	Knowledge base	Conceptual reference ecosystems	Appendix 5.1	<p>Sections 2.1.3 and 6.1.1 describe a process of collaboration between ERA and key stakeholders to develop a series of ‘conceptual reference ecosystems (CREs)’. Proposed <i>Agreed</i> CREs (ACREs) require a different terminology because stakeholders have had no input nor agreement yet to versions of the “draft ACREs” presented in the RMCP (and these have not undergone any BPT process of the type shown in Figure 1-1).</p> <p>The subsampling of the full suite of sites used in the original multivariate dendrogram depicted in Figure 2-11 to arrive at a new classification (Fig 2-12) is not described, including the method for combining early 20x20 m plot data with new SSB 1-ha data for multivariate analysis. Translation of the species density data for the sites depicted in the dendrogram to the stems per ha tabulation in Table 2-5 requires some follow up with ERA as well (i.e. verification). That aside, SSB notes:</p> <ol style="list-style-type: none"> ACRE v3: Further consideration of this community type would require evidence that (i) a particular constraint on the rehabilitated landform required this low open forest community, and (ii) this community type is suitably adapted for the potential (drought-related) constraint proposed. No evidence is provided in the RMCP to support these needs. ACRE v1 and ACRE v2 reflect variants of SSB’s <i>Eucalyptus miniata-tetradonta</i> CRE. SSB supports in principle further development of the v2 CRE with ERA. <p>As described on p.50 of Appendix 5.1, in March 2016, the flora and fauna closure criteria technical working group (TWG) reached a consensus on a Ranger Mine revegetation tree and shrub species list (MCP Section 9.4.6.1). SSB notes that since 2016, a more rigorous approach to defining the ICRE has been applied. Species appearing in the original 2016 list and not appearing in the ICRE require justification through a BPT process.</p> <p>Recommendation: The Supervising Scientist will provide more detailed feedback to ERA on the information presented in the RMCP on conceptual reference ecosystems, via detailed technical review of the referenced reports and consultation via the stakeholder Ecosystem Restoration Working Group.</p>
Ecosystem restoration	Knowledge base	Revegetation planning	Appendix 5.1	<p><i>Once construction and land-forming is completed, and inspection of the planting area will enable the final revegetation plan to identify the most suitable target native ecosystem and propagation and planting execution can proceed</i></p> <p>It is assumed that this statement is suggesting that final minor ‘tweaks’ to the planting plan could occur once the final landform is completed, rather than basing the entire revegetation plan on the as-built landform.</p> <p>Recommendation: Clarify what is meant by the above statement regarding revegetation planning in relation to the completion of the final landform.</p>
Ecosystem restoration	Knowledge base	Land capability assessment	Appendix 5.1	<p>Table 2-1 presents the results of a land capability assessment (LCA) of the final landform, in context of the region.</p> <p>The rationale for undertaking a LCA is not clear, as these types of assessments are generally used to assess the potential of land for broad land use (such as agriculture) and determine if there are any development constraints and risks associated with development. However, a LCA could be applicable at Ranger if there was an alternative being considered to the standard for restoration outlined in the ERs.</p> <p>Recommendation: Clarify the rationale for undertaking a land capability assessment and how this will be used to inform the rehabilitation of Ranger.</p>
Ecosystem restoration	Post mining land use, closure objectives and closure criteria	Closure objectives	Table 8-3	<p>Recommendation: Include ER 2.1 as a relevant closure objective for flora and fauna.</p>
Ecosystem restoration	Post mining land use, closure objectives and closure criteria	Closure criteria	8.3.5.1	<p><i>“Fauna habitat including the provision of hollow bearing tree species and edible fruit species is addressed in the flora closure criteria”</i></p> <p>Recommendation: State explicitly which of the flora closure criteria address fauna habitat requirements or include a specific closure criterion for fauna habitat.</p>

Relevant Closure Theme	RMCP Chapter Heading	Topic	2020 RMCP reference	SSB Recommendations on 2020 RMCP
Ecosystem restoration	Post mining land use, closure objectives and closure criteria	Closure criteria	8.3.5.1	The term 'framework species' is used throughout the closure criteria and is not clearly defined. Recommendation: Clearly define what a framework species is, including quantitative measures (i.e. abundance, response to fire, life-history strategy, life-form etc.).
Ecosystem restoration	Post mining land use, closure objectives and closure criteria	Closure criteria	8.3.5.1	<i>Assessment of achievement of [naturalness] criteria will be based on surveys conducted according to the Northern Territory vegetation survey guidelines (Brocklehurst et al. 2007).</i> This assessment approach is not recommended as it would likely not assess 'naturalness' on an ecologically appropriate spatial scale. Recommendation: Engage with stakeholders in selecting the most appropriate survey method in assessing 'naturalness', which should include measures of understorey.
Ecosystem restoration	Monitoring and maintenance	Revegetation monitoring	10.7.1	<i>Ongoing annual monitoring of establishment success will continue until all initial establishment and subsequent infill plantings have developed sufficiently and attrition rates have dropped to a recoverable level.</i> Recommendation: Clarify what is meant by 'recoverable level' in relation to attrition rates in revegetation.
Ecosystem restoration	Monitoring and maintenance	Revegetation monitoring	10.7.1	It appears that monitoring will only take place after infill planting occurs. However, there needs to be a strategy in place to confirm that the site has been prepared to the conditions expected/specified (i.e. ripped, scarified etc.), before revegetation starts. If this assurance check is already specified, then it should be referred to in this section. Recommendation: Include monitoring of the final landform prior to large-scale revegetation, to confirm that it has been prepared according to design and will therefore be suitable for revegetation.
Ecosystem restoration	Monitoring and maintenance	Revegetation monitoring	10.7	<i>Initial annual monitoring may involve recording every planted stem, though this will depend on the size of the area revegetated. Alternatively, belt transects, point centred quarter or other techniques may be used to sample a subset of the stems. Some permanent plots will be established and repeatedly measured to gather information on rates of change of various attributes over time.</i> The monitoring framework needs to be well documented, statistically-rigorous and meet the requirements for adaptive management. Multiple types of monitoring are not recommended as a single method removes ambiguity in interpreting results. Recommendation: Develop a statistically-rigorous monitoring framework for ecosystem restoration that meets the requirements for adaptive management.
Ecosystem restoration	Monitoring and maintenance	Trigger Action Response Plan (TARP)	Table 10-13	<i>Trigger = Exceedance of final criteria defined in closure criteria</i> A developing ecosystem isn't going to statistically look like a mature "final" ecosystem, so it should be made explicit if the comparison between the reference and the restored ecosystems is done at a successional stage along the restoration trajectory, or when at "maturity". Criteria should consider both values that are too high (i.e. require thinning of certain species) and too low (i.e. require infill planting), not just "exceedance". Recommendation: Clarify what 'exceedance' of final criteria means and when this is expected to apply. The TARP should be clearly linked to the risks identified in the Ecosystem Restoration Trajectory Model.